Comprehensive Management Plan for Puget Sound Chinook

Harvest Management Component

Annual Postseason Report 2003-04 Fishing Season

Washington Department of Fish and Wildlife
And
Puget Sound Indian Tribes

August 16, 2004

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Executive Summary

Overall outcomes from 2003-04 fisheries were disappointing. Spawning escapement for some Puget Sound chinook populations did not meet preseason expectations, and total (preliminary) chinook catches in Puget Sound recreational and commercial fisheries were down about 60% from preseason expectations. Much of this shortfall can be attributed to higher-than-expected impacts in Canadian fisheries. Actual landed catches in Canadian fisheries exceeded preseason expectation by about 36%, or over 100,000 fish.

1. Introduction

The Co-managers' Puget Sound Chinook Harvest Management Plan (HMP) mandates an annual report documenting the performance of chinook harvest management relative to the standards and guidelines of the plan (PSIT and WDFW 2001). The present report fulfills that requirement by assessing the performance and effectiveness of fishery management actions adopted for the most recent management year. Included in this report are:

- Population guidelines, preseason projected exploitation rates and preliminary postseason spawning escapements
- Fishery descriptions, including preseason projected catch and preliminary postseason catch estimates, and providing information about inseason regulation changes
- Recent historic exploitation rates, catches and spawners
- Descriptions of monitoring programs, including sample rates.

The annual management plan implementation period extends from May 1, 2003, through April 30, 2004 - the time period referred to as the "2003-04 management year". Although preliminary spawning escapement estimates and harvest numbers for net fisheries for 2003-04 are available, review of these estimates is still underway and further adjustments are expected. Therefore, ALL 2003-04 SEASON DATA PROVIDED IN THIS REPORT ARE TO BE CONSIDERED PRELIMINARY and subject to revision.

Puget Sound recreational fishery harvest estimates that come from catch record cards are not available because the process of collecting catch records, data input, editing and analysis takes almost two years to complete. Exploitation rates, the primary measure of plan performance, are delayed many years as well. These estimates use coded-wire tags, and must collect those tags for an entire brood (three to five years for chinook), so actual exploitation rates, for comparison with plan guidelines and preseason projections, are not available for at least three years after a fishery has occurred. For these reasons, this report will not contain all of the information necessary to review plan performance for the most recent management year.

Final recent-historic catch, spawner and exploitation rate information will be reported in subsequent reports with a retrospective review of plan performance. This year's report will provide a historic perspective of catches and escapements through 2002, and exploitation rates for the 1998-2000 management years.

2. 2003 HMP Management Objectives

Planning objectives for 2003-04 fisheries, as presented in the 2003-04 HMP, are presented in Table 2-1. Discussion of derivation for these objectives can be found in the HMP document itself, with population details provided in HMP appendices (Appendix A).

Table 2-1 2003-04 HMP Guidelines

Management Unit	RER	Escapement Goal	Critical Abundance Threshold
Nooksack	Under development		
North Fork			1,000 [1]
South Fork			1,000 [1]
Skagit summer / fall	52%		4,800
Upper Skagit summer			2,200
Sauk summer			400
Lower Skagit fall			900
Skagit spring	42%		576
Upper Sauk			n/a
Cascade			n/a
Suiattle			n/a
Stillaguamish	25%		650 [1]
North Fork summer			500 [1]
South Fork & MS fall			n/a
Snohomish	24%		2,800
Skykomish			1,745 [1]
Snoqualmie			521 [1]
Lake Washington	15% PT SUS		
Cedar River		1,200	200 [1]
Green	15% PT SUS	5,800	1,800
White River spring	20%	1,000	200
Puyallup fall	50%		500
South Prairie Creek		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

3. Predicted and actual spawning escapement estimates

This section summarizes natural chinook spawning escapement in 2003 to each of the Puget Sound management units. Escapement is compared with levels projected by FRAM at the conclusion of pre-season planning (Table 3-1) to provide a preliminary assessment whether escapement objectives were achieved. Escapement estimates for 2003 are preliminary for all units, and subject to further revision. HMP objectives are also presented for comparison purposes.

There can be many reasons that actual escapements do not match preseason expectations; the two most common are a) errors in fishery management (i.e., higher fishing mortality than intended) and b) preseason forecast is not correct. There can be many variations on these two themes, for example, the forecasted abundance may be correct, but the age structure is very different (causing fishery mortality to deviate from model predictions).

In 2003, the overall natural escapement for all Puget Sound stocks fell below preseason expectations. One potential cause can be readily identified: harvest in Canadian fisheries was higher than preseason (model) expectations, nearly to the ceilings provided for by the Pacific Salmon Treaty. Since Canadian fisheries impose heavy impacts to Puget Sound chinook stocks, these increased catches reduced the abundance entering the U.S. fishing areas, and, consequently, escaping fisheries.

Puget Sound native, naturally reproducing chinook stocks generally met (± 5%) or exceeded (up to 104%) preseason expectations for natural escapement. Exceptions are Skagit summer-fall at 18% below forecast and Stillaguamish at 57% below forecast. Natural production of composite stocks generally fell below expectations: Puyallup fall (-51%), Nisqually fall (-43%), Skokomish (-16%) and Mid-Hood Canal (-63%). Preseason spawner estimates are not available for the North Lake Washington tributaries.

Table 3-1 2003 HMP objectives, projected escapements and preliminary escapement estimates

Management Unit	HMP Escapement Goal	HMP Critical Abundance Threshold	Preseason Predicted Escapement /a	Preliminary Actual Escapement Estimates /e	Percent Change from Preseason Prediction
Nooksack			399 /b	414	+ 4%
North Fork		1,000 [1]		210	
South Fork		1,000 [1]		204	
Skagit summer / fall		4,800	11,634	9,489	- 18%
Upper Skagit summer		2,200		7,107	
Sauk summer		400		1,493	
Lower Skagit fall		900		889	
Skagit spring		576	1,136	2,323	+104%
Upper Sauk		n/a		178	
Cascade		n/a		255	
Siuattle		n/a		1,890	
Stillaguamish		650 [1]	2,322	988	- 57%
North Fork summer		500 [1]		883	
South Fork & MS fall		n/a		105	
Snohomish		2,800	5,073	5,447	+ 7%
Skykomish		1,745 [1]		3,472	
Snoqualmie		521 [1]		1,975	
Lake Washington				774	
Cedar River	1,200	200 [1]	307 /c	562 /c	+ 83%
Green	5,800	1,800	7,534	10,405	+ 38%
White River spring	1,000	200	1,507	1,434	- 5%
Puyallup fall		500	2,392	1,173	- 51%
South Prairie Creek	500			740	
Nisqually	1,100		1,106	627	- 43%
Skokomish	3,650 aggregate, 1,650 natural	1,300 aggregate 800 natural	1,347	1,125	- 16%
Mid-Hood Canal	750	400	531	194	- 63%
Dungeness		500	352 /b	640	+ 82%
Elwha		1,000	2,125 /d	2,305	+ 8%
Western JDF		500		1,100	

/a Source: FRAM Chin1603 4/11/2003 except Hood Canal and JDF: Chin1603AEQfix

/b These stocks are managed under Appendix C of the HMP

/c Includes only the Cedar River portion of the Lake Washington Management Unit

/d Includes escapement to both natural spawning grounds and to the hatchery

/e Source: Pers. Comm. Bruce Sanford, 3/19/04, per WDFW and Puget Sound Indian Tribes

4. Exploitation Rate Performance

Table 4-1 shows the results of preseason planning for the 2003-04 season relative to the HMP exploitation rate objectives. 2003-04 predicted exploitation rates averaged 23% lower than the associated HMP RER. Actual exploitation rates for the 2003-04 fishing season will be available in 2007, when returns of five-year-olds from the 2001 brood can be assessed.

Table 4-1 2003-04 Preseason ERs and HMP ERs

Management Unit	HMP RER	Preseason Projected ERs /a	Percent difference
Nooksack	Under development	20%	n/a
Skagit summer / fall	52%	50%	-4%
Skagit spring	42%	24%	-43%
Stillaguamish	25%	18%	-28%
Snohomish	24%	21%	-13%
Lake Washington	15% PT SUS	11% PT SUS	-27%
Green	15% PT SUS	11% PT SUS	-27%
White River spring	20%	19%	-5%
Puyallup fall	50%	50%	0%
Nisqually	Na	Na	
Skokomish	15% PT SUS	13% PT SUS	%
Mid-Hood Canal	15% PT SUS	13% PT SUS	%
Dungeness	10% SUS	5% SUS	-50%
Elwha	10% SUS	5% SUS	-50%
Western JDF	10% SUS	5% SUS	%

/a Source: FRAM Chin1603 4/11/2003 except Hood Canal and JDF: Chin1603AEQfix

Table 4-2 ERs by population and year

Management Unit	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	83-89 avg.
TOTAL Adult Equivalent Exploitation Rates												
Skagit S/F Nat	24%	33%	24%	38%	32%	60%	57%	65%	63%	54%	50%	78%
Skagit Spr Nat	30%	21%	28%	41%	44%	46%	50%	46%	56%	63%	48%	74%
Stillag. Sum/Fall	25%	19%	14%	29%	34%	40%	27%	27%	41%	36%	44%	69%
Snohom. S/F Nat	25%	30%	23%	29%	42%	62%	47%	60%	60%	51%	49%	73%
White R. Spr	17%	25%	19%	20%	31%	31%	43%	22%	30%	44%	31%	55%
Puyallup R.	72%	74%	36%	60%	67%	76%	69%	69%	67%	65%	66%	81%
Preterminal Southern U.S. Adult Equivalent Exploitation Rates												
HdCnl S/F	13%	9%	9%	30%	26%	22%	45%	36%	40%	21%	25%	45%
JDF S/F	37%	26%	10%	15%	29%	20%	26%	23%	30%	50%	45%	43%
Lk. Wa.	10%	8%	7%	19%	17%	15%	17%	24%	32%	27%	26%	29%
Green R.	10%	8%	7%	20%	17%	15%	17%	24%	32%	27%	26%	29%

Source: Chinook FRAM: 2002 calibration; 05/20/03 version (*gyy8; time4AEQfix*)

4.1 Updated recent-year (1983-2000) exploitation rate estimates

Table 4-2 presents exploitation rate estimates for Puget Sound management units, taken from FRAM calibration.

5. 2003-04 Commercial Fisheries & Catch Summary

5.1.1 Fisheries Introduction

During April, 2003, comanagers completed development of the 2003-04 Management Year fishing seasons for treaty and nontreaty salmon fisheries in the ocean north of Cape Falcon and in Puget Sound (*2003-04 State/Tribal Agreed-to Fisheries Document*; PSIT and WDFW, 4/10/03; Appendix B-1). These regulations were expected to achieve management objectives for all Puget Sound chinook management units. Catch quotas were imposed on coastal troll and recreational fisheries, whereas time-area restrictions were defined for Puget Sound recreational and commercial fisheries. For two management units, Green and Nisqually, monitoring programs provided inseason estimates of abundance that enabled adjustment of fisheries, when necessary, to ensure achievement of HMP objectives.

Included in this section are fisheries descriptions, highlighting significant inseason deviations from preseason expectations.

5.1.2 Catch Introduction

This section compares expected and actual landed commercial chinook catch for the 2003-04 management year, and recreational chinook catch for Puget Sound Areas 6 – 13 for .the 2002-03 management year.

Expected catch is gleaned from the Fishery Regulation Assessment Model (FRAM). Expected catch reflects either pre-season quotas or catch estimated by the final pre-season chinook FRAM run (Run #1603). Most expected catch figures from FRAM are expressed as total fishery-related mortality, which is typically higher than what will be landed, particularly in cases where release is required. For the purposes of preseason versus postseason comparison, catch figures provided in this document are landed catch only. Expected landed catch is taken from a FRAM landed catch table (as transferred to the to the TAMX table in the report-generating spreadsheet TAMM); unmarked and marked estimates are summed. Because of this, expected catch figures appearing in this document will not match the figures provided in most of the preseason FRAM reports, since the latter provide total mortality estimates.

Landed catch is tabulated from commercial sales documents (‘fish tickets’) on a database maintained by WDFW and the NWIFC. Recreational catch is estimated through creel surveys (in the Washington ocean and Strait of Juan de Fuca), or estimated postseason using recreational catch record card (CRC) reports (area 5 during the winter period, and areas 6-13).

Because direct harvest of chinook is prohibited in many cases, non-landed fishing mortality comprises a significant proportion of total fisheries mortality for chinook. Non-landed mortality occurs when sub-legal chinook are encountered and released, and when regulations forbid the retention of chinook. Non-landed mortality is incorporated into preseason estimates of mortality (and, therefore, into projected exploitation and spawner rates), but is not commonly available for postseason use. Thus, postseason catch analyses compare projections of landed catch against the actual landed catch tabulated during the fishing season.

Separate evaluations of components of non-landed mortality estimates are conducted annually, and special studies add to the knowledge base feeding these estimates. For example, estimates are made for all ocean troll and recreational harvests and the Strait of Juan de Fuca summer recreational fishery. Additional discussion of monitoring and evaluation of non-landed mortality can be found in the monitoring section of this report.

Preseason projections are made in consideration of differential impacts to natural and hatchery-origin chinook, however catch reporting does not provide hatchery/natural breakouts. Estimates of impacts to natural and hatchery fish, separately, are completed when runs are reconstructed postseason using information from commercial and sport catch data, information on catch in Canadian and Alaskan fisheries, and analyses of coded-wire tag recoveries.

Although the majority of fishing effort directed at Puget Sound chinook occurs in the summer and fall, significant treaty Indian and non-Indian fisheries authorized under the annual plan are in progress during the winter and spring period. Commercial chinook catches from December through April range up to 1,500, and marine and freshwater recreational harvest during this period averages 13,000 (based on a 1992-2002 average).

5.1.3 Summary of 2003-04 Fisheries Conduct And Chronology, and Comparisons of Preseason Expected (Landed) Catch and Preliminary Postseason (estimated “actual”) (Landed) Catch

Conduct of each of the 2003-04 pre-terminal and terminal fisheries is described below, highlighting any significant departures from pre-season expectations. Coastal troll and recreational fisheries, which were under the jurisdiction of the Pacific Fisheries Management Council, and net and recreational fisheries in the Strait of Juan de Fuca and San Juan Islands-Georgia Strait are described with respect to their actual fishing schedule and current estimates of landed chinook catch. Terminal fisheries for each chinook management unit are also described, noting where in-season assessments of abundance informed management actions that may have resulted in changes from preseason intent.

Tables for each fishery grouping summarize fishing seasons, expected catch, and estimated actual landed chinook catch where such estimates are available, for all fisheries that harvested significant numbers of Puget Sound chinook during the 2002-03 management year.

5.2 Overview of Major Fisheries Affecting Puget Sound Chinook

Overall, catches in fisheries impacting Puget Sound chinook were lower than expected preseason with the exception that Canadian fishing impacts were higher. Fisheries in Canada began to approach the full capacity allowed under the 1999 Chinook Annex of the Pacific Salmon Treaty. Because annual salmon management processes in U.S. and Canada occur during the same time frame, it is difficult to conclude anything but a general overview of fishery expectations for preseason modeling. This uncertainty was reflected during 2003 fishery modeling when the assumption for Canadian fisheries was described mostly as "similar to last year" where 2002 catch levels were used in many cases. FRAM modeling of Puget Sound 2003 chinook impacts were based on general information on expected levels of catch from the Canadian Department of Fisheries and Oceans.

Expected and estimated catches in Canadian (troll and sport) fisheries that harvest significant numbers of Puget Sound chinook are also tabulated. During 2003, landed chinook catch in these Canadian fisheries was 36% greater than expected (Table 5-1). Increases in Canadian catch continue to be a serious problem facing the comanagers. For many Puget Sound management units, the majority of the total fisheries impact (including non-landed impacts) occurs in Canadian fisheries.

Expected and actual chinook catch for major fishery aggregates affecting Puget Sound chinook are shown on Table 5-1. Pre-terminal net fishery catch was 25% lower than expected, while terminal fisheries directed at species other than chinook were down 59% from preseason expectation.

Table 5-1 Summary of 2003-04 Landed Catch in Major Fishery Aggregates

Fishery	Expected (landed)	Actual (preliminary)	% Difference
Canadian North/Central BC, West Coast Vancouver Island, Georgia Strait Sport & Troll Fisheries	304,826	414,700	+36%
Washington* Ocean Nontreaty Troll	69,400	69,173	0%
Washington* Ocean Recreational	54,600	36,634	-33%
Washington Ocean** Treaty Troll	60,000	34,674	-42%
Puget Sound Pre-terminal Net	6,421	4,800	-25%
Puget Sound Terminal Net	67,985	28,000	-59%

* Catches are from Ocean areas 1-4 and include catches south to Cape Falcon, Oregon.

** Catches in areas 2-4 and in Area 4B from May-September.

Beginning with Section 5.2, summaries of expected and preliminary actual landed chinook catch for Puget Sound 2003-04 fisheries are provided, organized by management region. In general, preliminary estimates are available for all commercial harvest. Comparison of these estimates with pre-season expectations provides an initial assessment of the performance of this management regime. These estimates will be revised as agencies correct errors in the database. Not included are catches from the Strait of Juan de Fuca winter troll fishery currently in progress.

Table 5-2 shows the percentage above or below preseason expectation for each of the FRAM-modeled fisheries. Most catches fell below preseason projections. Exceptions are 7/7A treaty net, 8D and 10E treaty net, 13, 13C & 13D-K treaty net, Nisqually treaty net, and 12C treaty seine fisheries. Fisheries in areas 8D, 10E and 12C are directed at and catch primarily hatchery components. Fisheries in Areas 13+ and the Nisqually River are directed at hatchery fish that are intermixed with composite natural fish. In areas 7/7A, overall impacts from the aggregate of treaty and nontreaty fisheries were 5% below the total projection for those fisheries.

Table 5-2 Summary of 2003 Projected & Actual Catches for Major Puget Sound Fishery Aggregates

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Chinook Catch	Catch % Above/Below Projection
Areas 4B, 5, 6C Treaty Net	1,350	900	-33%
Area 4B, 5, 6C Troll [1]	1,010	1,567	55%
Areas 7/7A Net	5,071	4,827	-5%
Areas 7B,C,D/Nooksack R. Net	41,327	18,877	-54%
Area 8/Skagit R. Net (landed)[2]	689	302	-56%
8A/8D/Stillag. R. Net	7,352	9,237	26%
Area 10/11/13/13+ Net	4,373	4,718	8%
Area 10E Treaty	5,693	7,579	33%
Lake Washington Net	543	698	29%
10A/Green R. Net	11,363	5,343	-53%
White/Puyallup R. Net	2,720	2,652	-3%
Nisqually/McAllister Treaty	9,703	10,648	10%
Hood Canal Net	16,332	2,038	-88%
6D/JDF Tribs	3	0	-100%

[1] May through September Area 4B troll managed with Area 4 ocean through PFMC; Values in this table refer to the October through April time period.

[2] Non-landed (release) mortality estimates are provided on the Skagit detail table, below, but are not included in these values.

Table 5-3 provides a legend of common abbreviations used throughout this document, primarily in the tables.

Table 5-3 Common Abbreviations

Abbreviation	Translation	Abbreviation	Translation
GN	Gillnet	MSF	Mark- Selective Fishery
PS	Purse Seine	NR	Non-Retention
RN	Reefnet	Wk	Mgmt Week Number (Sun-Sat)
RH	Round Haul	NLM	Non-Landed Mortality
SN	Setnet	TM	Total Mortality
T	Treaty	NT	Nontreaty
C&S	Ceremonial & Subsistence Fishery	SAF	Special Area Recreational Fishery
Ck	Chinook	Pk	Pink
Cm	Chum	Sh or Sthd	Steelhead
Co	Coho	Sox	Sockeye

Following are tables showing generalized 2003-04 fishing schedules and restrictions for Washington ocean and Puget Sound commercial fisheries. Table 5-4 shows seasons for ocean and Puget Sound pre-terminal treaty commercial seasons; terminal treaty fisheries are detailed in the following sections. Table 5-5 depicts seasons for ocean and Puget Sound nontreaty commercial fisheries. Note that area-specific details, such as sub-area closures, are not included in these summary tables, and may be found in the State-Tribal Agreed-to Fisheries Document (Appendix B-1). Standard nontreaty commercial closures and restrictions are available in the WDFW Puget Sound Commercial Salmon Fisheries Regulation and Catch Areas Pamphlets (http://wdfw.wa.gov/fish/regs/commregs/salregs.htm).

Table 5-4 2003-04 Treaty Anticipated Commercial Seasons – Ocean & Preterminal

Fishing Area	Gear	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1	Na												
2	Troll												
3	Troll												
4	Troll												
4B	Troll												
5	Troll												
6	Troll												
6C	Troll												
4B	Net												
5	Net												
6C	Net												
6	Net												
7	Net												
7A	Net												

	Chinook only ; Subquota		Gillnets; Coho 4d/w; target
	All Species; Jul-Sep = Chin subquota; Coho quota		Gillnets ; chum 5d/w
	All Species, chum release; quotas as above		Fraser Sox & Pink control
	Setnets only		Subsistence only
	Closed		

Table 5-5 2003-04 Nontreaty Anticipated Commercial Salmon Fishing Seasons

Fishing Area	Gear	May	Jun	Jul	Aug					Sep				Oct				Nov				Dec				Jan	Feb	Mar	Apr
Week beg.					03	10	17	24	31	07	14	21	28	05	12	19	26	02	09	16	23	30	07	14	21				
1	Troll																												
2	Troll																												
3	Troll																												
4	Troll																												
6	PS /GN															1	1	1	1										
7	PS /GN															1	1	1	1										
7	Reef net										7	7	7	7	7	7	7	7	7										
7A	PS /GN															1	1	1	1										
7B/C	PS /GN						1	3	3	3	3	7	7	7	7	7	7	7	7	7	7	7							
8	PS /GN							1	1																				
8A	PS /GN						2	2						1/1	1/3	1/3	2/4	1/3	2/4	1/3	2/4								
8D	PS /GN											1/3	1/3	1/3	1/3	1/3	2/4	1/3	2/4	1/3	2/4								
10/11	PS /GN														1/3	1/3	1/3	1/3	1/3										
12/12B	PS /GN															1/3	2/3	1/3	1/3	0/3									
9A	GN							2	7	7	7	7	7	7	7	7													
12A	BS							5	5	5	5	5	5																
12C	PS /GN																		1	1	1								

Numbers within cells tell how many days per week the fishery was expected to be open.

Table 5-5 Footnotes: 2003-04 Nontreaty Commercial Salmon Fishing Seasons

	Chinook only; Quota		Pink-directed
	All Species; Coho quota; Chin guideline; Release chum through 9/30, unmarked coho		Coho-directed
	Fraser Sox & Pink control		Chum-directed
	Closed		
Purse Seines	Area 7,7A, 8,10,11,12+ Chin NR; Area 7, 7A, 10, 11 Coho NR; Area 7,7A Chum NR through 9/30	Gillnets	Area 7,7A chum fishery: chin & coho NR live box, limited soak time; Area 9A chinook & chum NR
Reefnet	Area 7 coho fishery: chin NR; unmarked coho NR through 9/30; chum NR through 9/30	Beach Seine	7B Open w/b 10/12 – w/b 11/9 at 5d/w; 12A chin & chum NR

Following are narratives of pre-terminal and terminal-area fisheries in Puget Sound, highlighting differences between the pre-season plan and inseason management in 2003-04. Natural chinook are not significantly impacted by harvests in some terminal areas, for example, Sinclair Inlet (Area 10E), and Deep South Sound (Areas 13-13K), yet all terminal areas are included in this report, regardless of the level of impact to Puget Sound natural chinook management units.

5.3 Strait of Juan de Fuca and San Juan Islands Fisheries and Catch

Table 5-6 provides a preterminal, mixed-stock fisheries summary for Strait of Juan de Fuca and San Juan Islands fishing areas. Release requirements were applied to nontreaty commercial fisheries for chinook, coho and chum salmon; the latter to protect ESA-listed summer chum.

Table 5-6 Strait of Juan de Fuca – San Juan Islands Fisheries Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated actual landed chinook catch	Schedule & Notes
Areas 4B, 5, 6C Treaty Net	1,350	908	Sox: wks 30-33, 5-6-6-5; wks 36-37, 4-4; Coho: wks 38-41, 4-4-4-4; Chum: wks 42-45, 5-5-5-5
Area 4B, 5, 6C Troll *	1,010	1,567	See Appendix B-1
Areas 7/7A Treaty Net	3,722	4,761	Sox: 3 wks Aug Sox, 2 wks Sep Pink Chum: wks 42-43, 1-2
Areas 7/7A Nontreaty Net	1,349 (includes purse seine release mortality)	800 (includes 196 landed plus estimated 604 purse seine mortality)	Sox: 3 wks Aug Sox, 2 wks Sep Pink Reefnet: at end Fraser Panel control: Coho selective through wk 40, ck NR, cm NR through 9/15 Chum: wk 42-44, PS ck & co NR

* May through September Area 4B troll managed with Area 4 ocean through PFMC; Figures in this table refer to the October through April time period.

Seasons and catches proceeded similar to preseason expectations.

5.3.1 Strait of Juan de Fuca Treaty Troll (Area 4B, 5, and 6C)

The preliminary estimates of the 2003 Strait of Juan de Fuca treaty troll fishery are 523 chinook, including catches of 27 chinook from Areas 4B and 5 during the May-September PFMC management period.

5.3.2 Strait of Juan de Fuca Net

Preliminary estimates of the 2003 catch in Strait of Juan de Fuca tribal net fisheries are 908 chinook salmon. Strait impacts to chinook were less than the preseason expectations of 1,350 chinook.

5.3.3 San Juan Islands Net (Area 7 and 7A)

Preliminary estimates of the 2003 catch in San Juan Island net fishery directed at sockeye, pink or chum salmon totaled 4,957 (landed; 5,561 including nontreaty purse seine non-landed mortality) chinook salmon. San Juan impacts slightly exceeded the preseason expectation of 5,071 chinook.

5.4 Nooksack - Samish Terminal Area

In 2003, Nooksack River early chinook escapement was projected to fall below the low abundance threshold of 2,000 (i.e. 1,000 in each of the North and South Forks). With approximately 70 percent of the harvest impacts on these stocks occurring in Canadian fisheries, the comanagers have a limited ability to affect a reduction in the total exploitation rate on this management unit. Table 5-7 compares actual net catches to the preseason expectation. Net catches were 40% below the amount expected preseason.

Table 5-7 Nooksack-Samish Terminal Area Fisheries Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Areas 7B, 7C, 7D & Nooksack R. Treaty	18,829	10,505	See Appendix B-1
Area 7B, 7C Nontreaty Net	22,498	8,372	Wks 34-39 PS: 700 max 34-37 then 3,3,7 Wks 34-39 GN: 1,3,3,3,3,7 NT wks 40-49 PS&GN 7-7-7-7 then 5d/wk BS 42-46 5,5,5,5,5

Terminal fisheries in Bellingham Bay, Samish Bay, and Lummi Bay (Areas 7B, 7C, and 7D), and in the Nooksack River, directed at hatchery-origin fall chinook, were delayed to minimize impacts on the early chinook stocks. Net fisheries for fall chinook occurred from late July through September in Areas 7B, 7C, and 7D. Their impact on Nooksack early chinook was projected to be less than 100 fish; the actual impact will be assessed when coded-wire tag recoveries are available. Very limited tribal ceremonial and subsistence fisheries occurred in the Nooksack River, with harvest limited to no more than 50 chinook. The river is divided into five zones that open to fishing progressively upriver to minimize impacts on early chinook.

In 2003, Samish River hatchery chinook returned later than normal and about one-third lower that forecast. Because of concerns that the run was returning far below expectations, the 7B/ 7C nontreaty chinook catch was reduced by the imposition of a sub-area closure south of a line from Governors Point to Vendovi Island Light, effectively shutting off chinook catch at productive areas such as Wildcat Cove and Point Williams. The non-Treaty chum and coho directed fisheries in Areas 7B-7D do not impact Nooksack early chinook.

5.5 Skagit Bay and Skagit River Terminal Area

Almost all Skagit terminal area impacts on chinook were expected to occur during commercial fisheries targeted at pink and coho salmon, and during Skagit River test fisheries (Table 5-8). Chinook release was required in Swinomish beach seine fisheries, Sauk-Suiattle pink fisheries, Upper Skagit Tribal sockeye, pink, and coho fisheries (through week 41), and nontreaty purse seine fisheries. Chinook retention was permitted in Non-treaty and Swinomish gillnet fisheries, Sauk-Suiattle coho fisheries, Upper Skagit fisheries after week 41, and the test fisheries.

The Baker sockeye run was the largest ever recorded (escapement records go back to 1926); nonetheless, the Upper Skagit Tribal gillnet fishery was conducted for only 1 day (July 7-8), at the mouth of the Baker River. No chinook were encountered.

The Skagit pink run was larger than expected preseason, but no days were added to the tribal fishing schedules. The Swinomish and Sauk-Suiattle fisheries were conducted according to their preseason schedules; the Upper Skagit pink fishery was reduced by a total of 8 days from its preseason schedule, in order to avoid conflicts with sportsmen, and to ensure availability of fish buyers. Chinook encounters were substantially less than predicted preseason.

The coho run appeared to be somewhat larger than predicted preseason. Coho fisheries were conducted according to the preseason schedule during the first week, and chinook encounters were very low. Thereafter, days were added to the Swinomish and Sauk-Suiattle schedules, and chinook encounters remained low. The Upper Skagit fishery was conducted according to the preseason plan through week 41. Days were added during weeks 42 and 43, which was after nearly all chinook spawning was completed, but floods during this time period all but eliminated the remainder of the coho fishery.

The test fisheries were conducted essentially as scheduled, except that, due to floods, the Spudhouse and Area 2 sites were unfishable during week 42, no sites could be fished in week 43, and Blake's Drift was unfishable in week 44. Chinook catches in the test fisheries were also less than projected preseason.

Skagit chum fisheries were conducted for more days than expected preseason, but no chinook were caught in these fisheries.

Table 5-8 Projected and actual landed catch and total mortality in terminal-area fisheries in Skagit Bay / Saratoga Passage (Area 8) and the Skagit River (lower/Area 78C and upper/78D) in 2003

	Preseason Projected			Post-season Observed/Estimated			Difference (Post-season minus Preseason)	
Fishery	**Schedule**	**Landed Catch**	**Total Mort-ality**	**Schedule**	**Landed Catch**	**Total Mort-ality**	**Landed Catch**	**Total Mort-ality**
Test:								
Chinook	1 site, wks 19-35	157	157	Same	91	91	-66	-66
Coho	3 sites, wks 34-45	127	127	No wk 43; 3 sites cancelled in wks 42 & 44 (flood)	106	106	-21	-21
Baker Sockeye:								
Week 28	1 day	0	6	Same	0	0	0	-6
Week 29	1 day	0	2	None	0	0	0	-2
Area 8/78C Pink:								
Week 35	4 days	104	148	Same	18	35	-86	-113
Week 36	4 days	62	102	Same	12	56	-50	-46
Week 37	7 days	159	194	Same	47	62	-112	-132
Week 38	1 day	11	65	Same	7	8	-4	-57
Area 78D Pink:								
Week 35	4 days	0	232	3 days	0	33	0	-199
Week 36	4 days	0	197	3 days	0	27	0	-170
Week 37	7 days	0	232	4 days	0	7	0	-225
Week 38	7 days	0	282	4 days	0	30	0	-252
Area 8/78C Coho:								
Week 39	2 days	18	20	Same	1	3	-17	-17
Week 40	2 days	18	18	4 days	11	13	-7	-5
Week 41	None	0	0	4 days	7	7	7	7
Week 42	None	0	0	3 days	2	2	2	2
Week 43	None	0	0	Same	0	0	0	0
Area 78D Coho:								
Week 39	3 days	0	216	Same	0	22	0	-194
Week 40	3 days	0	25	Same	3	6	3	-19
Week 41	3 days	0	12	Same	0	10	0	-2
Week 42	None	0	0	4 days	0	0	0	0
Week 43	None	0	0	4 days	0	0	0	0
Chum Fisheries:								
Area 8/78C	Wk 45: 2 days	6	6	Wk 46-48: 2-2-4*	0	0	-6	-6
Area 78D	Wk 45-46: 2-2	1	1	Wk 44-49: 2-2-1-3-4-5	0	0	-1	-1
Total Skagit Terminal Area		**663**	**2042**		**305**	**517**	**-358**	**-1525**

* Daylight hrs open only in weeks 46-47; Sauk 3 daylight days wk 46

It is estimated that there were 517 total chinook mortalities (including non-retention mortalities) in Skagit terminal area net fisheries during the adult accounting period: 197 in test fisheries, 257 in pink fisheries, 63 in coho fisheries, and none in chum or river sockeye fisheries. In comparison, it was projected preseason that there would be 2,042 total chinook mortalities in Skagit terminal area net fisheries: 284 in test fisheries, 1,452 in pink fisheries, 291 during coho fisheries, and 15 in chum and river sockeye fisheries. Thus, post-season estimated chinook mortalities were 1,525 less than what was projected preseason.

Of the post-season estimated mortalities, 305 were landed catch. In comparison, it was projected preseason that the landed catch would be 663 in Skagit terminal area net fisheries – a 54% reduction. The remainder of the mortalities comprised releases during non-retention fisheries. These mortalities were estimated as follows: chinook encounters during Swinomish beach seine fisheries were counted by observers who monitored the beach seine sets at Lone Tree Point and Snee-oosh. These encounters were expanded by the portion of the beach seine pink catch that had not been observed. Chinook mortality in beach seine fisheries was estimated by assuming a 50% mortality rate on the chinook encountered. This mortality rate is higher than the observed mortality rate (26%), but it was assumed that there were additional post-release mortalities. Chinook encounters in the Upper Skagit and Sauk-Suiattle pink fisheries (which were chinook non-retention) were estimated by multiplying the respective tribe's observed pink catch by the chinook/pink ratio in simultaneous test fisheries. Chinook encounters in these tribes' coho fisheries were estimated by multiplying the tribe's coho catch by the chinook/coho ratio in simultaneous test fisheries. The preseason mortality rate (52.4% for gillnets) was applied to these encounters to estimate their respective non-retention mortalities.

Area 8 nontreaty chum-directed fishing days increased from one to four for both gillnet and purse seine gears and still did not catch the nontreaty chum allocation. Effort was lower than expected. In general, catches throughout the season in the Skagit terminal area were less than anticipated preseason.

5.6 Stillaguamish and Snohomish Terminal Area

In 2003, terminal fishery catches were less than preseason expectations for all species (Table 5-9). The Tulalip Bay (Area 8D) terminal net harvest of primarily hatchery returns was approximately 42% higher than expected preseason.

5.6.1 Stillaguamish River

No directed chinook fisheries were planned for the Stillaguamish River. The Stillaguamish Tribal fishery was open 5 days per week, 24 hours per day throughout the pink, coho, chum and steelhead management periods. Effort and catch were nil for all species.

Table 5-9 Stillaguamish-Snohomish Terminal Fishery Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Area 8A Treaty	853	334	Mid-Aug C&S max 100 chinook Pink fishery Wk 33-36: Coho fishery Wk 37-42: Chum Fishery Wk 43-48 SH Fishery begins Wk 49 GN Test Fishery Wk 37-48
Area 8A Nontreaty Net	212	0	Wk 34-35: 2-2, PS CkNR Wk 41-42: PS 1-1 CkNR, GN 1-3 Wk 43-48 PS: 1-2-1-2-1-2 CkNR Wk 43-48 GN: 3-5-3-5-3-5
Area 8D Treaty	6,244	8,903	May/June C&S Chin fishery Wk 27-38 Coho fishery Wk 39-45 Chum fishery Wk 46-50
Area 8D Nontreaty Net	12	0	Coho fishery Wks 29-45 Chum fishery Wks 46-48
Stillaguamish R. Treaty	31	0	5 d/wk thru pink, coho, chum and sthd
Snohomish R. Treaty	0	0	Closed

5.6.2 Snohomish Area Net Fisheries

In Possession Sound (Area 8A), coho fisheries occurred in September and early October, and chum fisheries began October 19. Most of the incidental chinook impacts occurred during the early weeks of the coho fishery. Treaty and nontreaty chinook incidental catch in area 8A was less than expected due to limited effort in pink and coho fisheries. The Area 8A nontreaty gillnet fishery was changed from nighttime hours to daytime hours at fisher request and total gillnet fishing days were reduced to fit with the treaty fishing schedule.

The Tulalip Tribes opened a ceremonial and subsistence fishery in Tulalip Bay (Area 8D) in May and June, targeting spring chinook produced by the Tulalip Hatchery. From July through September 20, commercial Treaty fisheries directed at Tulalip Hatchery fall chinook salmon were operated in Area 8D, with gillnet, setnet and roundhaul gears. Treaty and nontreaty coho fisheries, which intercept some chinook salmon, occurred in Area 8D between September 21 and November 8, and chum fisheries operated in Area

8D between November 9 and December 13. Chum fisheries in Area 8D are managed to achieve escapement adequate to meet Tulalip hatchery broodstock requirements.

Treaty chinook catches in Area 8D, which is a hatchery-directed fishery, were similar to pre-season expectations. Very limited fishing effort during pink and coho mgmt periods due to weak prices. Tulalip Hatchery chum returns were poor.

No commercial or subsistence fisheries were conducted in the Snohomish River.

5.7 South Puget Sound terminal area

5.7.1 Seattle and Tacoma marine areas (10 and 11)

Very limited numbers of chinook salmon were expected to be taken incidental to fisheries targeting harvestable sockeye, coho, and chum salmon in 2003 (Table 5-10). Fisheries in these areas were consistent with the preseason plan. Generally, modeled impacts overestimated the actual chinook interceptions.

Table 5-10 Areas 10/11 and 10E Fisheries Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Area 10/11 Treaty	440	215	See Appendix B-1
Area 10/11 Nontreaty Net	439 (includes purse seine release mortality)	93 *	Wks 42-46 PS 1d/wk ck&coNR; GN 3d/wk * Note: estimates of release mortality are not yet available
Area 9/10 Test Fisheries (ACP & coho)	183	244	See Appendix B-1
Area 10E Treaty	5,693	7,579	See Appendix B-1

The tribal Sinclair Inlet (Area 10E) terminal net harvest of isolated hatchery returns was approximately 25% higher than expected preseason.

Modeled incidental chinook impacts for Area 10 and 11 overestimated actual interceptions. This is partially because an anticipated sockeye fishery, for which mortality estimates were made preseason, did not occur, and coho were underutilized due to poor market values.

Inseason assessment based on the Area 9/10 test fishery indicated that coho abundance was adequate to support limited fishing in Areas 10 and 11. Chum catch and effort data collected by the Apple Cove Point test fishery indicated a fall chum return to south Puget Sound significantly above preseason forecast. Two hundred forty-four chinook were encountered in combined test fishing for coho and chum salmon.

Because of better-than-expected chum returns, the nontreaty purse seine fishery was increased from five to eleven days and the gillnet fishery from fifteen to twenty-one. Chum catches exceeded preseason expectation, though chinook catch was about as expected preseason.

5.7.2 Lake Washington extreme terminal area

Fisheries in these areas were consistent with the preseason plan. Generally, modeled impacts were similar to the actual chinook interceptions.

Table 5-11 Lake Washington Extreme Terminal Area Fishery Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Lake Washington Ship Canal & N. Lake Washington	543	494	See Appendix B-1
Lake Sammamish (Issaquah Hatchery)	N/a	204	See Appendix B-1

The 2003 chinook return to Lake Washington was forecast at 7,700 chinook. The lock count yielded an inseason estimate of 16,000. Prior years' tagging results indicate that about 10% of entering chinook subsequently leave the lake, so locks counts are adjusted to account for this phenomenon. The preliminary adjusted estimate of total chinook abundance is about 14,400. Of the chinook viewed through the counting window, 61% were adipose clipped.

The Treaty net fishery in Lake Washington and the Ship Canal proceeded per preseason plan. Catches were less than anticipated preseason (Table 5-11). The actual chinook catch for Areas 10F-10G includes a chinook directed catch (204) in Lake Sammamish targeting Issaquah hatchery adults.

5.7.3 Green River extreme terminal area (Including Elliott Bay)

Terminal-area fisheries for Green River chinook are managed to achieve the escapement goal of 5,800 natural spawners to the basin. Run strength is assessed in-season by test fisheries and analysis of commercial net fishery catch and effort.

Table 5-12 Green River and Elliott Bay Extreme Terminal Fishery Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Area 10A Test	673	387	See Appendix B-1
Area 10A Treaty	4,431	1,815	See Appendix B-1
Green R. Treaty	5,246	3,141	See Appendix B-1

Green River terminal fisheries proceeded per the terminal area management plan. Test and initial openings provided fishing opportunities as planned preseason.

Recreational and Treaty net fisheries were scheduled on the basis of preseason expectations, but catch data from test and initial commercial fisheries were used to confirm abundance. Threshold values are established for these initial fisheries, below which subsequent fisheries would be cancelled. Actual catch in the Elliott Bay (Area 10A) net fishery was 1,815, down 59% from the expected level during the directed chinook fishery. Net catch in the river (Area 80B) was 3,141 which was 53% below the expected level. The natural escapement estimate was 13,950 chinook; total escapement to the system was approximately 24,400.

5.8 Puyallup, Nisqually and Deep South Sound extreme terminal areas

A portion of the allowable White River Chinook harvest was allocated to a tribal ceremonial and subsistence fishery in the White River, on the Muckleshoot Indian Reservation. This fishery occurred in July, with catches as expected preseason (Table 5-13).

Net fisheries directed at chinook salmon were conducted by the Puyallup Tribe in the Puyallup River, as proposed in the pre-season plan. Commercial catch matched preseason expectation.

Table 5-13 Puyallup, White, Nisqually and Deep South Sound Fisheries Summaries

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Areas 13, 13D-K Treaty	1,237	3,377	See Appendix B-2
Area 13A Treaty	1,325	0	See Appendix B-2
Area 13C and Chambers Ck. Treaty	749	789	See Appendix B-2
Puyallup R. Test	250	248	Wb 7/30-wb 8/21 (wks 30-34); 1 d/w
Puyallup River Treaty	2,320	2,290	See Appendix B-1
White River Treaty	150	114	See Appendix B-1
Nisqually/McAllister Treaty	9,703	14,352 estimated total catch + 73 test catch	See Appendix B-1

A test fishery is conducted on the Puyallup River to collect standardized catch and CPUE data for assessing abundance. Two driftnet boats fish six sites, one day per week, for five weeks. The Puyallup River test fishery has been conducted consistently since 2001, and after the 2005-06 season, Puyallup Tribe hopes the data can be used to provide an inseason abundance update. Test catch in 2001 was 239 and in 2002 was 233.

A Nisqually chinook inseason abundance update confirmed the forecasted abundance, however the actual proportion of natural spawners was lower than anticipated in the update model.

5.9 Hood Canal terminal area

Fisheries for chinook were conducted only in Marine Areas 12C and adjacent to the Hoodsport Hatchery, as well as in the Skokomish River (Table 5-14). Schedules proceeded according to preseason plan. Fisheries for coho throughout Hood Canal also proceeded according to preseason plan, however effort was lower than expected.

Fisheries for fall chum started according to preseason plan, however some relatively minor adjustments were made in November treaty chum fisheries in response to inseason abundance assessment. Nontreaty chum fishery purse seine days were increased from seven to ten. The nontreaty chum fishery was poorly attended by gillnet fleet due to higher incidence of dark fish with lower market value. Overall, catches were better than expected preseason, with incidental chinook impacts about as expected preseason.

Table 5-14 Hood Canal Terminal Area Fisheries Summary

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated Actual Landed Chinook Catch	Preseason fishing schedule
Areas 9A/12A Treaty	16	0	See Appendix B-1
Areas 9A/12A Nontreaty	18	0	See Appendix B-1
Areas 12, 12B, 12C Treaty	756	0	N/a
Areas 12, 12B Nontreaty Net	140	0	NT: 12/12B PS 43-46 ckNR 1,2,1,1;GN 43-47 3d/wk;12C 46-48 1,1,1 PS;3,3,2GN
12C Treaty	12,248	16,089	Hoodsport Hatchery Treaty Seine fishery. See Appendix B-1
Skokomish, Big Quil R. Treaty	3,154	2,167	N/a

Chinook catches were close to those predicted preseason (Table 5-14). Coho catches were lower than preseason (because of lower effort). Chum catches were significantly higher than predicted preseason (because of higher abundance).

In 2003, actual incidental chinook impacts in my terminal area were about as expected preseason. However, the distribution of actual catches was higher in the Hoodsport Hatchery area versus the Skokomish River.

5.10 Strait of Juan de Fuca Tributaries (including Dungeness Bay)

Seasons and catches in the Dungeness and Elwha areas proceeded as expected preseason (Table 5-15).

Table 5-15 Strait of Juan de Fuca Tributaries Fisheries Summaries

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated actual landed chinook catch	Preseason fishing schedule
Dungeness Bay & R. Treaty & Nontreaty Net	1	0	NT: 5 d/w, Wks 40-44
Elwha R. Treaty Net	2	0	See Appendix B-1
Hoko R. Treaty	0	0	See Appendix B-1

Dungeness River management proceeded according to the preseason framework. Spawning escapement was projected to fall below the low abundance threshold of 400, so measures were implemented to eliminate terminal area impacts. Because the abundance of the Dungeness population has been critically low, similar conservation measures have been in place for several years. The abundance of the Dungeness chinook return is not assessed in-season.

No chinook were landed in Dungeness Bay during coho directed net fisheries. No net fisheries occurred in the Dungeness River.

5.11 Recent Historic Commercial Catches

Below is a table showing recent historic commercial catches, including ceremonial and subsistence and take home catches reported on fish tickets, as well as any estimates recorded on fish tickets of the number of carcasses associated with egg sales.

Table 5-16 1992-2002 Treaty Indian Puget Sound Commercial Net Chinook Catches

Area	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002*
4B/5/6/6C	939	1418	5864	4769	604	492	265	589	782	931	1074
7/7A	6884	6546	4862	3002	2965	18476	3308	3	768	953	2170
6D	1	1	0	0	0	0	1	0	0	0	0
Elwha R.	143	100	34	2	2	1	2	17	0	0	0
7B,C,D	8486	10832	9935	8180	10232	9054	9593	22796	17510	30896	20701
Nook. R.	2230	194	925	2134	1659	1749	405	2248	997	806	408
8	129	63	0	121	4	229	0	35	0	21	1
Skagit R.	1970	1297	493	2885	231	850	297	328	451	211	286
8A/8D	3961	4094	4677	8643	11382	8626	7227	15438	7726	5458	5520
Stillag. R.	6	0	0	66	0	0	5	0	0	0	0
9	1	2	0	0	0	0	0	0	0	0	0
10	6750	1556	928	876	440	53	569	69	280	246	91
10A	5023	3443	5065	3229	4165	473	1866	646	3558	4364	1657
Green R.	3465	3085	3246	884	4068	167	1670	2152	4105	4696	9877
10C,D,F,G	2175	1521	29	61	53	58	4	0	591	3297	182
10E	3599	1818	4734	6515	2895	1932	2950	5261	3764	6561	4787
11	120	1	0	10	7	0	0	0	0	0	0
11A	4	41	43	107	93	109	107	25	0	148	0
Puyallup R.	718	1705	3566	5001	4886	2700	1581	1884	1982	6712	4749
White R.	0	0	0	3	0	0	9	0	3	83	0
13	483	263	293	124	0	5	413	153	4458	120	152
Nisq./ McAll.	2116	5304	9347	12201	7636	7675	8405	16395	4531	10528	17027
13A	1326	309	886	642	75	75	259	3836	2430	2380	973
13C	3290	2088	1766	3206	2459	1148	4860	559	1408	336	689

Table 5-17 1992-2002 Treaty Indian Puget Sound Commercial Net Chinook Catches (continued)

Area	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002*
Chambers.	0	0	0	0	0	67	0	0	0	0	0
13A-13H	5432	4332	6136	5032	3354	414	632	5194	4817	3030	1005
12, 12B	35	108	7	5	0	1	0	0	0	34	90
9A, 12A	7	5	27	35	7	11	66	83	30	338	4
12C, 12D	81	456	40	0	0	6	1059	7956	11094	21481	21080
Skok. R.	676	456	249	0	0	0	1	1080	943	5830	2649
Purdy Ck.	0	22	16	0	0	0	0	0	0	0	0

Source: WDFW, PSIT Fish Ticket Database (7/04)

Table 5-18 1992-2002 Nontreaty Puget Sound Commercial Net Chinook Catches

Area	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002*
6/7/7A	7035	7279	8988	2283	969	10739	496	0	61	17	59
7B/7C	6675	9105	9593	3532	7629	10690	11910	9243	11369	18002	17564
8	104	0	3	54	0	14	0	0	0	8	0
8A/8D	63	12	1	17	2	0	0	4	0	0	0
10/11	5592	2489	2243	642	444	67	12	247	30	2	0
9A/12	9	19	0	2	2	3	10	18	8	0	3

Source: WDFW/PSIT Commercial Fish Ticket Database (7/04)

6. Recreational Catch Evaluation

Included in this section are fisheries descriptions, highlighting significant inseason deviations from preseason expectations. The following sections present expected (modeled) recreational catch for the current (2003-04) management year, inseason creel survey results, where available, expected and actual recreational chinook catch for Puget Sound Areas 6 –13 for .the 2002-03 management year, and recent historic recreational catches.

6.1.1 Fisheries Introduction

Regulations implementing the *2003-04 State/Tribal Agreed-to Fisheries Document* were expected to achieve management objectives for all Puget Sound chinook management units. Catch quotas were imposed on coastal troll and recreational fisheries, whereas time-area restrictions were defined for Puget Sound recreational and commercial fisheries. For two management units, Green and Nisqually, test fishery and catch monitoring programs provided inseason estimates of abundance that enable adjustment of fisheries, when necessary, to ensure achievement of HMP escapement objectives.

Table 6-1 depicts generalized 2003-04 fishing schedules and restrictions for recreational fishing seasons in the ocean and Puget Sound. Note that area-specific details, such as sub-area closures, are not included in these summary tables, and may be found in the State-Tribal Agreed-to Fisheries Document (Appendix B-1). Standard recreational closures and restrictions are detailed in the Washington State Sport Fishing Rules – Pamphlet Edition (available at http://wdfw.wa.gov/fish/regs/2003/2003sportregs.pdf).

Table 6-1 2003-04 Recreational Fishing Seasons

Fishing Area	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1												
2												
3												
4												
5												
6												
7												
8-1												
8-2												
9												
10		C&R										
11												
12 N Ayock												
12 S Ayock												
13												

	2-bag; coho & chinook MSF; chum NR		2/1-bag, any salmon, only 1 of which can be chinook
	2-bag coho MSF +2 pink; chinook & chum NR		1 bag; chinook 22" min.
	2-bag coho MSF +2 pink; chum NR		4-bag; no more than 2 coho or chum in total; chinook NR
	2-bag coho MSF; chinook & chum NR		4-bag; 2 coho; chinook & chum NR
	2-bag; chinook & chum NR		4-bag; 2 chinook; chum NR
	2-bag; chinook NR		4-bag coho; chinook, chum, pink NR
	2-bag (any salmon)		4-bag; 1 chinook
	2-bag; coho MSF		2/1 bag + 1 pink; coho MSF; co & ck quota mgt
	2/1 bag; coho MSF; Sun-Thurs weekly; quota mgt		2/1 bag + 1 pink; co & ck quota mgt
	Closed	Note:	See Appendix B-1 for subarea openings and other details.

6.1.2 Catch Introduction

Expected catch reflects either pre-season quotas or landed catch estimated by the final pre-season chinook FRAM run (Run #1603). For the purposes of preseason versus postseason comparison, catch figures provided in this document are landed catch only. Because of this, expected catch figures appearing in this document will not match the figures provided in most of the preseason FRAM reports, since the latter provide total mortality estimates (i.e. landed catch plus mortality caused by release or encounter with fishing gear).

Because direct harvest of chinook is prohibited in many cases, non-landed fishing mortality comprises a significant proportion of total recreational fisheries mortality for chinook. Non-landed mortality occurs when sub-legal chinook are encountered and released, and when regulations forbid the retention of chinook. Non-landed mortality is incorporated into preseason estimates of mortality (and, therefore, into projected exploitation and spawner rates), but is not commonly estimated postseason. Thus, postseason catch analyses presented in this report compare projections of landed catch against the actual landed catch tabulated during and after the fishing season.

Although the majority of fishing effort directed at Puget Sound chinook occurs in the summer and fall, significant recreational fisheries authorized under the annual plan are in progress during the winter and spring period. Marine and freshwater recreational harvest during this period averages 13,000 (based on a 1992-2002 average) total chinook.

6.1.3 2003-04 Recreational Fishery Monitoring Introduction

Chinook harvest in 'quota fisheries', which include Area 1-4 / 4B recreational fisheries under the jurisdiction of the Pacific Fisheries Management Council, is monitored inseason through a creel survey methodology, which provides inseason catch estimates with which the fishery is managed. Though not a quota fishery per se, the Area 5 recreational fishery is monitored in similar fashion to ensure the harvest "ceiling" is not exceeded. For this fishery, WDFW conducts creel surveys (angler interviews) according to a sampling design that achieves the desired level of statistical precision and accuracy (2003 Fishery Monitoring Operational Plan, WDFW Puget Sound and Ocean Sampling Program, April 2003, Appendix C).

Ocean recreational catch is reported annually by the Pacific Fisheries Management Council in the Annual Review of Ocean Salmon Fisheries, available at http://www.pcouncil.org/salmon/salsafe.html .

In 2003, over 93,000 recreational anglers were interviewed in Puget Sound, 6,900 chinook sampled, and 550 CWTs collected (Table 6-2). Recent sampling rates are presented in Section 8.2.

Table 6-2 2003 Recreational Fishery Sampling Summary

Area	Anglers	Chinook Sampled	Coho Sampled	Chum Sampled	Pink Sampled	Sockeye Sampled	CWT Chinook	CWT Coho
4	235	9	24	0	24	0	1	2
5	14,863	767	8,407	0	959	2	98	913
6	7,992	497	771	2	537	4	46	41
7	7,434	542	354	10	399	2	40	11
8-1	4,016	51	293	1	378	0	9	29
8-2	15,186	806	1,934	12	781	0	78	159
9	7,163	219	2,543	38	382	0	19	254
10	15,655	1,785	4,165	19	74	0	118	449
11	13,546	1,870	1,259	34	75	1	119	83
12	3,615	166	312	155	312	0	6	55
13	3,574	227	202	18	15	0	16	18
Total	**93,279**	**6,939**	**20,264**	**289**	**3,936**	**9**	**550**	**2,014**

Source: Puget Sound Sampling Program; 4/04

Recreational chinook harvest in Puget Sound is generally estimated from sampling of catch record cards that anglers are required to maintain and return. In past years the ‘punch card’ estimates have been validated by creel surveys for specific areas. Creel surveys may also be conducted to monitor ‘special area’ and/or ‘special rule’ recreational fisheries.

In 2003, creel surveys relevant to chinook harvest were conducted in Areas 5/6 selective fishery, Elliott Bay, the Skykomish River selective chinook sport fishery, the Skokomish river sport fishery (nonselective), the Carbon river selective chinook sport fishery, and the Nisqually River sport fishery (nonselective).

6.2 2003-04 Recreational Catch Discussion

Table 6-3 summarizes projected landed catches in Puget Sound recreational fisheries, and, where available, provides inseason estimates with which to evaluate management performance. As noted above, mark-selective chinook recreational catch in area 5 and portions of area 6 were estimated inseason from July 1 through August 3, 2003, after which the fishery switched to chinook non-retention. Recreational catch in Puget Sound Areas 6 – 13, and in Area 5 outside of the summer period, is estimated from catch record cards (CRC). Preliminary CRC estimates of catch in 2003-04 will be available late in 2004 and reported in the 2004 post-season report.

Table 6-3 2003-04 Expected Recreational Catches and Seasons; preliminary inseason catch estimates provided where available.

Fleet/Fishing Area	Projected Landed Chinook Catch	Estimated actual landed chinook catch	Schedule & Notes
Area 5,6 Recreational	6,464	N/a	See Appendix B-1 for seasons; See next row for mark-selective fishery estimate
Area 5 Recreational MSF ONLY	3,500 ceiling	3,586	Scheduled for 7/5-8/14; closed on 8/3
Area 7 Recreational	4,313	N/a	See Appendix B-1
Nooksack-Samish Freshwater Recreational	3,702	N/a	See Appendix B-1
Area 8-1 Recreational	1,478	N/a	See Appendix B-1
Skagit R. Recreational	20 NLM	N/a	See Appendix B-1
Area 8-2 Recreational	1,886	N/a	See Appendix B-1
Area 8D Recreational SAF	1,981	N/a	Tulalip Special Area Recreational Fishery 7/4 – 9/29; open 12:01am Friday to 11:59pm Monday weekly; 2-bag
Stillaguamish R. Recreational	6	N/a	Open 9/1-12/31 chin release
Snohomish R. Recreational (excl. SkyMSF)	11	N/a	Open 8/16-12/31 chin release
Skykomish MSF component	489	212	Skykomish chinook MSF 6/1-7/31
Area 10/11 Recreational	6,628	N/a	See Appendix B-1
"Area 10E" Recreational SAF	1,500	N/a	See Appendix B-1
Lake Washington, Sammamish, Cedar Recreational	18 NLM	N/a	See Appendix B-1
Area 10A Nontreaty Recreational SAF	4,700	2,841	-40%
Green R. Recreational	27	N/a	See Appendix B-1
Puyallup/White R. Recreational	1,426	N/a	See Appendix B-1
Area 13 Recreational	3,766	N/a	See Appendix B-1
Nisqually/McAllister Recreational	1,290	N/a	See Appendix B-2
Chambers, Deschutes, Kennedy, Johns recreational	585	N/a	See Appendix B-2
Area 12 Recreational	1,045	N/a	See Appendix B-1
Skokomish R. Recreational	2,649	[6,070 from 7/1 through 9/30]	Jul-Sep estimate is 129% above expected annual (modeled) catch
Strait Tributaries Freshwater Recreational	1	N/a	See Appendix B-1

Source: Chinook FRAM 1603

6.3 Strait of Juan de Fuca Recreational

During the summer of 2003, a selective chinook recreational fishery was implemented in waters of the Strait of Juan de Fuca with the objective of increasing meaningful recreational opportunity while meeting conservation goals for Puget Sound chinook salmon defined by the Puget Sound Chinook Harvest Management Plan. The Northwest Treaty Tribes and the Washington Department of Fish and Wildlife reached agreement to consider selective chinook sport fishing in this area for the 2003 and 2004 seasons as part of a pilot program for the purpose of collecting information necessary to enable evaluation and planning of future potential chinook mark-selective fisheries. It was thought that a pilot fishery limited in time and area, as described below, would allow managers to determine the success of monitoring and sampling programs for collection of essential information.

The Chinook Selective Fishery started on July 5, 2003 and ran continuously through August 3, 2003 in Marine Area 5 and the western portion of Marine Area 6 (from Low Point easterly to Ediz Hook). Area 6 fishery was restricted to this location because the eastern portion of Area 6 has many more boat ramps and other access points, and would have required substantially more sampling effort to obtain precise estimates of harvest and effort. Additional closures to help achieve fishery objectives were established: 1) in the eastern half of Marine Area 4; 2) near the mouths of the Sekiu and Hoko rivers; 3) near the mouth of the Elwha River; and 4) in Port Angeles Harbor.

Anglers were allowed to retain two, marked (adipose fin clipped) chinook salmon $\geq$ 22" as part of their daily limit, and were required to immediately release, unharmed, any unmarked chinook caught. Integral to the selective fishery was a new regulation that, "Any salmon to be released may not be brought on board a vessel". Education efforts were undertaken to provide anglers with alternative methods for proper release of fish, other than netting the fish and bringing them into the boat. During the Chinook Selective Fishery anglers were also allowed to retain pink (*O. gorbuscha)*, sockeye (*O. nerka)*, and marked hatchery coho salmon.

The season was scheduled to run from July 5, 2003 through August 14, 2003 (41 days), or until a quota of 3,500 hatchery chinook salmon were caught and retained by anglers. The fishery was closed by emergency regulation effective at 11:59 p.m., August 3, 2003 because the quota was expected to be reached.

In summary, selective recreational fisheries for marked hatchery chinook and coho were opened in the Strait of Juan de Fuca during 2003 as follows:

- Catch Area 5 — Marked chinook only, from July 5 through August 3
- Catch Area 6 west of a true north/south line through buoy two just east of Ediz Hook — Marked chinook only, from July 5 through August 3
- All of Areas 5 and 6 — Marked coho only, from July 1 through September 30

Areas 5 and 6 were subsequently open to chinook retention November 1-30, 2003 and February 14 to April 10, 2004, with a 1 fish daily limit. Chinook retention was not allowed other than as noted above.

An inseason creel survey was conducted during the July-August fishery in areas 5/6. Methodologies and results for that survey are included in Appendix E-1 and results are summarized on Table 6-4, below. Catches from July 5 through August 3 were estimated at 3,586 chinook, at which time chinook non-retention was imposed. Catch record card estimates for salmon taken at times other than noted above are not yet available.

Table 6-4 Areas 5/6 Recreational Chinook Catch Estimate

Fishery	Trips		Harvested Chinook	Released Chinook
	Boats	Anglers		
Area 5	8,026	19,444	2,535	13,019
Area 6	2,646	5,174	972	1,732
Total	**10,672**	**24,618**	**3,507**	**14,751**

Two "test" fishing boats were used to determine the species composition, percent of fish encountered that were adipose clipped (mark rate), the percentage of fish that were legal-size, and to collect scales, tissue samples, coded wire tags and fork lengths. Additional information on mark rates and the percentage of fish that were legal-size was obtained from Voluntary Trip Reports (VTR's).

Freshwater recreational fishing in the Dungeness River was delayed to permit clearance of chinook.

6.4 San Juan Islands Recreational

The southern and southeastern (Rosario Strait) portions of this catch area were again closed in 2003 to protect migrating, mature Puget Sound chinook salmon. The remaining area was opened for retention of chinook and coho salmon from July 1 to September 30. Release of unmarked coho salmon was required for the months of August and September. Chinook retention was allowed in the entire area from February 1 – March 31 and for the month of November; chinook retention was not allowed in October when retention of other salmon was allowed.. Recreational fishery harvest estimates are unavailable at this time. Additional subarea closures are described in the Sport Fishing Rules Pamphlet available at http://wdfw.wa.gov/fish/regs/2003/2003sportregs.pdf

6.5 Skagit Area Recreational

Chinook release was required in river sport fisheries.

6.5.1 Skagit River recreational fishery monitoring

The recreational fishery in the Skagit River, from the mouth upstream to Sedro Wooley, was surveyed from mid-August to mid-October. The goal was to estimate the number of chinook encountered during the pink and coho fishery. Effort and catch were sampled, and estimates will be made of total chinook encounters, total number of angler trips (broken out by bank and boat), number of pinks kept and release, number of coho kept and released, and other species (bull trout etc.) encountered (either kept or released). Between August 15 and September 31, over 40,000 pink were kept, and 15,000 released, in about 13,706 angler trips. During that same period, about 1,000 coho were kept or released, and only 9 chinook were encountered (all released). Complete estimates for this sampling period and area will be available later in 2004.

6.6 Snohomish Area Recreational

Recreational fishing regulations for Area 8-2 allowed chinook retention only in November 2003 and from February 14 through April 10, 2004. Chinook retention was allowed in the Tulalip Terminal Area, under a bag limit of two per day, three days per week, from July 4 through September 29.

The pre-season plan did not allow chinook retention by recreational fishing throughout the Snohomish River (including the Skykomish and Snoqualmie systems). When chinook escapement to the Wallace River Hatchery appeared to greatly exceed broodstock and other escapement requirements, a selective recreational fishery was opened from June 1 through July 31 on the main stem of the Skykomish River, directed at marked hatchery chinook salmon. Fishing was constrained to the area from the Lewis Street Bridge in Monroe to the confluence with the Snoqualmie River (RM 20.8). In accordance with the Chinook Harvest Plan, an analysis of potential impacts on listed chinook was prepared prior to the opening showing that overall harvest objectives for the natural Skykomish chinook population would not be exceeded. WDFW staff monitored the fishery by creel survey, and inseason catch estimates were made. An estimated 635 chinook were encountered; an estimated 212 (33%) chinook were retained while 423 (67%) were released. Table 6-5 provides detailed results for the Skykomish creel survey.

Table 6-5 Skykomish Mark Selective Recreational Fishery Inseason Catch Estimates

EFFORT SUMMARY:	June & July		
	BOAT	SHORE	TOTAL
NUM. ANGLERS INTERVIEWED	941	295	**1,236**
TOTAL HOURS OF FISHING	5,982	748	**6,730**
EST. TOTAL EFFORT (HRS.)	17,512.2	27,725.3	**45,237.5**
EST. AVG. TRIP LENGTH (HRS.)	6.1	2.6	**---**
EST. NUM. ANGLER TRIPS	2,744	10,749	**13,493**
EST. VALUE OF FISHERY**	$356,720	$1,397,370	**$1,754,090**

****Source: WDFW Economic Factors Analysis (2003-Ave Econ. Impact/Day Fishing $130.00)**

Table 6-6 Skykomish Mark Selective Recreational Fishery Inseason Catch Estimates (continued)

HARVEST SUMMARY:	June & July		
	BOAT	SHORE	TOTAL
NUMBER OF FISH OBSERVED (SAMPLER)			
Chinook	26	3	**29**
Chinook-Jack	5	1	**6**
Steelhead	82	4	**86**
Bull Trout	4	0	**4**
Other trout	1	2	**3**
NUMBER OF FISH RELEASED (INTERVIEW)			
Chinook	20	5	**25**
Chinook-Jack	51	5	**56**
Steelhead	56	1	**57**
Bull Trout	24	5	**29**
Other trout	38	16	**54**
Other Species	10	4	**14**
ESTIMATED TOTAL HARVEST			
Chinook	80	97	**177**
Chinook-Jack	15	20	**35**
Steelhead	232	99	**331**
Bull Trout	12	0	**12**
Other trout	3	41	**44**
ESTIMATED TOTAL RELEASED			
Chinook	66	104	**170**
Chinook-Jack	149	104	**253**
Steelhead	186	52	**238**
Bull Trout	80	199	**279**
Other trout	154	333	**487**
Other Species	34	114	**148**

Source: Pers. Comm.. Chad Jackson July 23, 2004

6.7 South Sound Recreational

Recreational fisheries, scheduled on the basis of preseason expectations, proceeded according to the pre-season plan in 2003.

6.7.1 Elliott Bay Recreational Fishery Inseason Catch Estimate

This fishery is managed annually to achieve inseason management objectives. The fishery was scheduled at 3 days per week from July 11 through August 17, and proceeded as planned. Preseason expected catch for the Elliott Bay recreational SAF was 4,700 landed chinook. Inseason estimates are 2,841 chinook landed and 3,158 released in 18 fishing days.

Table 6-7 Elliott Bay Recreational Fishery Inseason Catch Estimates

Jul 11 - Aug 17	Boats	Anglers	Catch				Released			
			Chinook	Coho	Pink	Sockeye	Total	Chinook	Coho	Pink
Grand Total	**6448**	**13358**	**2841**	**1032**	**173**	**10**	**4305**	**3158**	**639**	**57**

Preseason expected catch for this fishery was 4,700 landed chinook. Inseason estimates are 2,841 chinook landed and 3,158 released in 18 fishing days (Table 6-7).

6.7.2 Carbon River selective chinook recreational fishery

WDFW implemented a pilot chinook selective recreational fishery on the Carbon River in 2003, which was one of very few selective salmon fisheries occurring in freshwater in Washington. Regulations, detailed in the Sport Fishing Rules 2003/2004 pamphlet can be summarized as follows:

> Salmon fishing was open from the mouth of the Carbon River to Voights Creek (approximately 4 miles), from September 1 through November 30, 2003. Daily limit 6 salmon. No more than 4 adults may be retained, of which no more than 2 may be adult hatchery chinook. Release wild adult chinook and chum.

WDFW conducted a creel survey of this chinook selective fishery, designed to estimate angler effort, numbers of salmon kept and released by species, and percent of chinook that were marked (adipose fin clipped). This survey provided initial data sets for angler participation and catch numbers during the salmon fishery in the Carbon River.

Table 6-8 shows results from the Carbon River creel survey, including actual number of chinook observed, and expanded numbers for the fishery. Data used to estimate angler effort and fish encounters came from 1,842 anglers interviewed during the survey. Anglers spent an estimated 55,981 hours fishing the Carbon River from September 1 through October 31, 2003. These anglers kept an estimated 1,287 chinook, 3,966 coho, and 2,936 pink salmon. They also reported releasing 1,718 chinook, 3,253 coho, and 11,225 pink salmon. No other species were observed.

Table 6-8 Carbon River Creel Survey

Origin	Kept Chinook		Released Chinook	
	Observed	Expanded	Reported	Expanded
Marked	171	1,202	135	832
Unmarked	9	79	105	635
Mark status unknown	1	6	33	251
Total	**181**	**1,287**	**273**	**1,718**

6.7.3 Nisqually River recreational fishery

The objective of the Nisqually recreational fishery monitoring project was to estimate angler effort and chinook catch during the Nisqually recreational fishery in August and September. Information about the method, equations and results can be found in Appendix E-4.

Table 6-9 provides estimates of chinook salmon caught and released in Nisqually sport fishery 2003 by stratum, statistical week and for the total period. The fishery was sampled from August 1 to September 30. A total of 2,829 interviews were made with 215 total chinook observed (90 adipose fin-clipped) and 154 reported as released.

An estimated 1,384 chinook salmon were harvested in the sport fishery, of which 568 were adipose fin clipped. In addition an estimated 885 chinook salmon were released. The fishery peaked during the week of September 8-14.

Table 6-9 Nisqually R. Chinook Catch, Aug-Sept 2003

	Total Chinook Catch	Ad-clipped Chinook Catch	Chinook Released
Total	**1,384**	**569**	**886**

6.8 Hood Canal Recreational

Retention of chinook by recreational fishers in Hood Canal marine areas was allowed from July 1 through October 15 south of Ayock Point (4-bag, 2 chinook, release chum), from September 1 through October 15 North of Ayock Point (4-coho only), and in the entire area from October 16 through December 31 (4-bag, 1 chinook) and February 14 through April 10 (1-bag). Additional marine area recreational harvest was authorized in the Hoodsport Hatchery zone from July 1 through December 31 (4-bag, 2 chinook, night closure, release chum July 1- October 15). In the Skokomish River, recreational harvest of chinook was authorized from August 1 through September 30 (1-bag, release chum) and October 1 through December 15 (4-bag, 1 chinook, release chum through October 15).

A creel census in the Skokomish River, initiated in 2002, was expanded in 2003 in order to improve the estimates of recreational harvest in the Skokomish River. The Puget Sound Sampling Program conducted surveys to estimate harvest and effort for Skokomish River recreational fisheries during August and September 2003 at five major access sites – up from two in 2002.

Table 6-10 provides preliminary estimates of Skokomish River recreational salmon catch in August and September 2003. Catch totaled 6,070 marked chinook kept and 8,200 unmarked chinook released in this selective fishery.

Table 6-10 Skokomish River Recreational Salmon Catch, July-September 2003

Site	Number Chinook Sampled	Number Anglers	Chinook Catch	Chinook Release	Coho Catch	Pink Catch	Percent Sampled
Site 1	567	6,845	1,678	764	183	5	33.8%
Site 2	315	18,428	4,392	7,436	836	6	7.2%
Total	**882**	**25,273**	**6,070**	**8,200**	**1,019**	**11**	**14.5%**

6.9 Previous Year (2002-03) Recreational Catch Evaluation

Preliminary Catch Record Card (CRC) estimates of recreational salmon catch in Puget sound are provided for the 2002-03 “license year” (April 1, 2002 through March 31, 2003) on Table 6-11.

Table 6-11 Preliminary 2002-03 Puget Sound Recreational Catch Estimates

	CHIN	COHO	PINK	SOCK	CHUM	TOTAL SALMON	TRIPS
Area 5	3,043	38,777	14	16	0	41,850	73,926
Area 6	331	1,046	8	9	15	1,409	8,848
Area 7	4,823	3,316	19	71	96	8,325	49,007
Area 8-1	574	859	92	0	19	1,544	18,838
Area 8-2	2,212	6,201	43	0	107	8,563	43,497
Area 9	2,139	10,056	61	15	457	12,728	59,962
Area 10	4,462	7,098	22	9	272	11,863	44,252
Area 11	9,746	2,170	4	3	131	12,054	58,969
Area 12	1,562	2,742	0	0	3,436	7,740	32,222
Area 13	1,466	731	0	0	1,034	3,231	28,287

Source: Manning 10/7/03

Table 6-12 Expected and Preliminary Actual 2002-03 Puget Sound Recreational Catches

Area	Expected Chinook Catch (FRAM 0802)	Preliminary Estimated Chinook Catch	Percent Difference (Actual/Expected)
Area 5	4,546	3,043	-26%
Area 6		331	
Area 7	5,132	4,823	-6%
Area 8-1	1,602	574	-64%
Area 8-2	1,480	2,212	+49%
Area 9	2,436	2,139	-12%
Area 10	12,817	4,462	+11%
Area 11		9,746	
Area 12	748	1,562	+109%
Area 13	3,634	1,466	-60%

In the 2002-03 management year, average recreational catches were generally below the preseason expectation (Table 6-12). Catches for areas 7, 9 and 10/11 fell within 12% of the estimate, while area 13 catches were about 60% lower than expected. Catches in area 8-2 and 12 exceeded the preseason expectation be about 49% and 109%, respectively. Area 8-1 catches fell 64% below expected.

6.10 Recent-Historic (1992-2002) Recreational Chinook Catch

Following are tables showing recent historic chinook catches by recreational fishers by area or area-grouping.

Table 6-13 1992-2002 Puget Sound Marine Recreational Chinook Catches

CRC Area	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002*
5 & 6	38,090	32,216	1,661	6,349	4,825	12,238	2,159	1,429	1,424	4,819	554
7	6,636	6,916	5,795	7,863	12,674	9,155	3,069	2,747	3,447	6,495	1,701
8-1	2,123	2,275	1,771	2,449	1,810	1,225	508	590	665	931	275
8-2	6,205	5,493	2,393	5,519	4,398	5,894	1,029	1,151	1,724	4,254	835
9	20,076	15,745	5,920	13,351	18,023	10,641	3,118	4,076	3,183	5,645	1,247
10	12,229	8,551	12,994	13,526	12,244	8,920	3,486	1,568	2,957	5,211	360
11	8,633	6,778	13,847	16,378	15,316	9,602	9,154	12,822	7,619	14,422	383
12	508	355	544	159	380	592	347	1,346	1,281	467	255
13	3,233	1,837	3,361	4,205	2,399	2,158	3,244	3,060	1,639	2,557	31
Total Marine	97,733	80,166	48,286	69,799	72,069	60,425	26,114	28,789	23,939	44,801	5,641

* Preliminary

Source: WDFW Recreational Catch Record Card Estimates (12/03)

Table 6-14 1992-2002 Puget Sound Freshwater Recreational Chinook Catches

Freshwater Areas	1992	1993	1994	1995	1996	1997	1998	1999	2000*	2001*	2002*
7 & 7A Independents	0	0	7	14	0	0	19	3	7	0	10
Straits	6	19	8	0	4	18	0	6	0	115	81
Nook-Sam-Whatcom	806	3,198	1,494	2,101	1,568	2,929	6,532	2,896	1,871	5,096	6,182
Skagit	76	326	0	68	13	96	40	48	19	292	76
Stilly-Sno	108	157	48	39	17	21	41	35	7	394	373
South Sound	582	1,732	1,768	3,694	2,364	1,854	2,490	4,180	2,493	3,690	3,798
Hood Canal	71	78	26	6	2	8	10	993	600	3,216	137

* Preliminary

Source: WDFW Freshwater Sport Catches (12/03)

7. Meeting federal objectives and requirements

7.1 PFMC Salmon Plan Criteria

Conservation objectives for Puget Sound chinook are not included in the PFMC Coastwide Salmon Management Plan, so analysis of consistency with that plan is not provided.

7.2 ESA compliance requirements

Although preliminary escapement data are provided for the 2003-04 management year, complete assessment of the execution of fisheries affecting Puget Sound chinook, relative to achievement of ESA provisions, cannot be completed until exploitation rates are available for all management units. These are expected to be reported in the 2006-07 postseason report.

Initial assessment of spawning escapement for the 2003-04 year indicates that some populations did not achieve the escapements predicted preseason, but returned well above the “critical abundance threshold” for most natural populations, with the exceptions of Nooksack and Mid-Hood Canal.

7.3 Expectations for achievement of PST objectives

It is anticipated that post-season assessment of broodyear exploitation rates will indicate that the 2003 fishing season met the PST objectives for the southern U.S. Individual Stock Based Management (ISBM) Fishery.

The 1999 chinook agreement requires that ISBM fisheries be managed over time to contribute to the achievement of MSY or other agreed biologically-based escapement objectives. The Puget Sound escapement indicator stocks for monitoring achievement of this objective are Nooksack early, Skagit spring, Skagit fall, Stillaguamish, Snohomish, Lake Washington, and Green River. The Hoko stock is used within the PST forum as part of the indicators for the Washington Coastal stock group.

ISBM fisheries for the US includes: south Puget Sound marine net and sport and freshwater sport and net; north Puget Sound marine net and sport and freshwater sport and net; Juan de Fuca marine net, troll and sport and freshwater sport and net; Washington Coastal marine net, troll and sport and freshwater sport and net; Washington Ocean marine troll and sport; Columbia River net and sort; Oregon marine net, sport and troll; Idaho (Snake River Basin) freshwater sport and net.

The PST objectives state that when a stock’s spawning objective is not attained, reductions in exploitation from the 1979-82 base period are required. The general obligation for southern U.S. fisheries is a 40% reduction from the base period if an escapement objective is projected not to be achieved. If this general obligation is insufficient to meet the escapement objectives for particular stocks, then further reductions are to occur. These additional reductions should result in either the achievement of the escapement objective or, when taken together with the general obligation, be at least equivalent to the average of reductions that occurred for the stock group during the years 1991-1996.

The management objectives incorporated within the Puget Sound Comprehensive Chinook Plan were structured to be more restrictive than the obligations contained within the PST chinook annex. The achievement of the Comprehensive Chinook management objectives identified for these stocks during preseason fishery planning are considered to translate to achievement of PST obligations.

The PSC Chinook Technical Committee reviews the performance of the AABM (aggregate abundance based management) and ISBM fisheries, and results in terms of population performance, as data become available. Results of those analyses are reported by the CTC; reports are available through the Pacific Salmon Commission.

8. Monitoring

The co-managers jointly and individually conduct a variety of fisheries monitoring activities that are essential to evaluating and improving management. These include catch monitoring (including bycatch and incidental mortality studies), encounter surveys, in-season creel surveys, coded-wire tag recovery sampling, biological sampling of catch and escapement to describe populations structure by age, sex and (hatchery or natural) origin, and escapement surveys and estimation.

Monitoring is divided into several components: Fisheries (boats and fishers) are monitored to estimate catch, encounters, and non-landed mortality rates, and methods differ from area to area depending upon specific needs. Catch is sampled for coded-wire tags and biological samples. Escapement is estimated through surveys, sampling and estimation. Special studies are conducted to meet specific management or research needs. Finally, regulatory compliance is monitored through enforcement presence and contacts.

Information regarding special recreational creel surveys conducted in the 2003-04 management year is incorporated within the recreational fishery evaluation section. This section summarizes ongoing monitoring activities, including commercial fishery monitoring, biological sampling, and escapement monitoring. Since data summarization and analysis generally requires at least one year for completion, most products from the most recent management year are incomplete at this time.

8.1 Commercial catch monitoring

WDFW, the Northwest Indian Fisheries Commission, and individual tribes cooperate in tracking cumulative commercial catch by the non-Indian and Treaty Indian fleets, respectively, using Fish Receiving Tickets, which are documents recording sale from fisher to buyer. Information from fish tickets is summarized by WDFW and tribal staff and made available to fishery managers. This system enables tracking of catch for target species as well as species caught and retained incidentally. Incidental chinook harvest is carefully monitored in preterminal net fisheries in the San Juan Islands-Georgia Strait, and in central Puget Sound, as well as in terminal area fisheries directed at pink and coho salmon.

Ocean and Juan de Fuca troll catch and summaries of Puget Sound net catch are reported annually by the Pacific Fisheries Management Council in the Annual Review of Ocean Salmon Fisheries, available at http://www.pcouncil.org/salmon/salsafe.html .

In additional to routine aerial nontreaty vessel counts, WDFW conducted focused on-water monitoring in several fishing areas in 2003. On-water surveys were conducted for nontreaty fisheries in areas 7/7A directed at sockeye and pink salmon, and for chum-directed fisheries conducted in areas 10/11 and Hood Canal. This 2003 monitoring schedule represented an increase over previous years, and twelve observers were hired to gather data in the various fisheries throughout Puget Sound.

Note that estimates of total bycatch reported below are preliminary and subject to change.

8.1.1 Sockeye and Pink Salmon Directed Fisheries (Areas 7 and 7A)

WDFW monitored nontreaty commercial purse seine catch and bycatch in both the Fraser-Panel-controlled sockeye and pink salmon fisheries. Bycatch for these areas consisted of chinook and coho salmon, as well as other non-target fish species, benthic invertebrates, and marine birds and mammals. This report focuses primarily on bycatch of chinook and coho.

Encounters of “bycatch” species were tallied, and encounter rates (bycatch per 1000 target species) estimated using observer data collected during each fishery. Estimates of total “bycatch” will be based on those tallies, expanded using actual catch numbers reported on fish tickets for each Management Week. The expanded numbers will reflect estimates of total encounters, but do not represent the total bycatch mortality.

Table 8-1 Areas 7/7A Nontreaty Commercial Net Fishery Monitoring Summary

Mgmt Wk	Gear	Obser-vations	SOX	PINK	CHIN	COHO	CHUM	Directed Species	Chin per 1000 Directed Species
31	PS	42	4,658	1,839	33	3	0	SOX	7.1
32	PS	79	3,309	599	133	17	0	SOX	40.2
33	PS	150	7,684	10,195	526	8	1	SOX	68.5
34	PS	22	937	5,052	86	5	0	SOX	91.8
36	PS	21	185	6,771	16	19	3	PK	2.4
37	PS	21	228	47,894	34	121	2	PK	0.7
38	PS	27	17	13,416	142	318	20	PK	10.6
43	PS	4	0	0	0	72	895	CHUM	0

The sockeye fishery in Areas 7/7A occurred during Management Weeks 31 through 34. The encounter rate observed for chinook was low in both areas during week 31 (averaging 7 per 1000 sockeye) and steadily increased each week thereafter (Table 8-1). Due to low numbers of sockeye in the fishery, presumably due to a lower than predicted diversion of sockeye south through the Strait of Juan de Fuca, encounter rates of chinook seemed relatively high (double the 2002 rate) overall compared to 2002. In contrast, a preliminary estimate of total chinook bycatch for 2003 will be about half that for 2002. Encounter rates and total computed bycatch for coho during the sockeye fishery were low throughout the sockeye fishery.

The Area 7/7A pink fishery began in Management Week 36 and continued through Week 38. Observed chinook encounters were low throughout the pink fishery, ranging from less than one to about eleven per thousand pink (Table 8-1). As total chinook bycatch decreased over time in Area 7, it increased north in Area 7A.

8.1.2 Pink, Coho and Chum Directed Fisheries in Areas 8 and 8A

Very few chinook were encountered during Area 8 pink fisheries, and in pink, coho and chum fisheries in area 8A (Table 8-2).

Table 8-2 Areas 8/8A Nontreaty Commercial Net Fishery Monitoring Summary

Mgmt Wk	Gear	Area	Obser-vations	SOX	PINK	CHIN	COHO	CHUM	Directed Species	Chin per 1000 Directed Species
36	PS	8	11	4	6,736	7	16	1	PK	1.0
34	PS	8A	3	0	590	0	1	0	PK	0
35	PS	8A	11	3	21,209	25	20	0	PK	1.2
42	PS	8A	18	0	1	0	415	46	COHO	0
47	GN	8A	5	0	0	0	0	30	CHUM	0

8.1.3 South Sound and Hood Canal Chum Directed Fisheries

Chum fishing began in Areas 10 and 11 in the week beginning October x (Week 41), with purse seines starting the following week. During the Area 10 and 11 chum directed fishery, purse seines were not allowed to keep chinook or coho.

South Sound purse seine encounter rates for chinook were low in Area 10 throughout the fishery. Total bycatch was greatest in weeks 43 and 44, when two to four chinook were encountered per thousand chum caught (Table 8-3). Chinook encounters declined the last two weeks of the fishery. Area 11 encounter rates were highest during the first week of the purse seine fishery, week 42, at 26 chinook per 1000 chum, then dropped to only a few in following weeks. No chinook were observed in weeks 46 and 47.

The South Sound gill net fishery began in week 41 in both areas and ran through week 47. No data were collected during week 45 due to lack of actual fishing boats available to monitor. The gill net fleet fishing these areas numbered so few vessels that several were sampled more than once during the season. Chinook are allowed to be kept by gillnets in this fishery, and are not considered bycatch. No chinook were observed encountered by gillnets in the areas 10/11 chum fishery (Table 8-3).

Table 8-3 Areas 10/11 Nontreaty Commercial Chum Net Fishery Monitoring Summary

Mgmt Wk	Gear	Area	Obser-vations	SOX	PINK	CHIN	COHO	CHUM	Chin per 1000 Chum
42	PS	10	8	0	0	0	108	630	0
43	PS	10	7	0	0	1	18	441	2.3
44	PS	10	17	0	0	7	26	1845	3.8
46	PS	10	10	0	0	2	10	1159	1.7
41	GN	10	14	0	0	0	9	563	0
43	GN	10	11	0	0	0	5	524	0
45	GN	10	4	0	0	0	0	275	0
42	PS	11	22	0	0	30	382	1136	26.4
43	PS	11	10	0	0	1	51	1068	0.9
44	PS	11	32	0	0	10	98	6598	1.5
45	PS	11	11	0	0	2	17	7277	0.3
46	PS	11	6	0	0	0	0	1035	0
47	PS	11	12	0	0	0	0	1644	0
41	GN	11	8	0	0	0	14	291	0
43	GN	11	12	0	0	0	11	439	0
45	GN	11	1	0	0	0	0	123	0
46	GN	11	7	0	0	0	0	302	0
47	GN	11	2	0	0	0	0	76	0

Hood Canal area 12 and 12B fisheries began in week 43 and continued through week 47. Purse seines were allowed to keep coho in these areas. Only one chinook was observed in the purse seine fishery during Week 45 (Table 8-4). Due to low numbers of nontreaty gillnets fishing these areas, gillnet bycatch was observed only in Weeks 43 and 44. No chinook were observed or reported on fish tickets for the Area 12, 12B gill net fishery.

Table 8-4 Hood Canal Nontreaty Commercial Chum Net Fishery Monitoring Summary

Mgmt Wk	Gear	Area	Obser-vations	PINK	CHIN	COHO	CHUM	Chin per 1000 Chum
43	GN	12	2	0	0	4	358	0
44	GN	12	4	0	0	0	313	0
43	PS	12/12B	17	0	0	134	1909	0
44	PS	12/12B	31	0	0	109	13080	0
45	PS	12/12B	27	0	1	64	9243	0.1
46	PS	12/12B	26	0	0	40	19690	0
47	PS	12/12B	25	0	0	47	4530	0

8.2 Biological Sampling Summary

Commercial catch is sampled cooperatively by WDFW and tribal fisheries agencies; WDFW samples the recreational fisheries. An increasing proportion of all hatchery chinook and coho production in Washington is now mass-marked with an adipose clip, so recovery of coded-wire tags requires electronic sampling of all adipose clipped chinook to determine whether a coded-wire tag is present. The effectiveness of electronic sampling equipment has been demonstrated, but the large increase in the number of adipose-clipped coho and chinook has correspondingly increased the effort required to check the desired proportion of the total catch.

When catch and sampling data are acceptably complete, CWT sampling rates are calculated to determine whether the overall sampling objectives have been achieved. Most of these sampling data are summarized by calendar year rather then the management year being reported for catch and escapement.

8.2.1 Sampling rates in catch

Commercial and recreational catch is sampled to recover coded-wire tagged chinook and coho. The objective for commercial fisheries is to sample 20% of the catch each week in each catch area. The objective for recreational catch is to sample 10% of the catch each month in each area. These sampling rates have been shown to generate sufficient recoveries of “indicator tag groups” to estimate catch distribution and fishery-specific exploitation or harvest rates.

“Indicator” stocks are hatchery releases from each production region in Puget Sound and the Washington coast, as well as the Columbia River and British Columbia. They are coded-wire tagged and marked with an adipose clip. Selection of indicator stocks, marking, sampling, and analysis of tag recovery data is funded by the Pacific Salmon Commission. The Pacific States Marine Fisheries Commission maintains an electronic database containing all CWT release and recovery data.

Table 8-5 presents the number of chinook sampled in 2001 chinook recreational fisheries. Table 8-6 provides information on sampling rates as a demonstration of "typical" sampling efficiency.

Table 8-5 Chinook sampled in 2001 Recreational Fisheries

Month	Catch Area									
	5	6	7	8-1	8-2	9	10	11	12	13
Jan	0	0	0	0	0	0	0	0	0	0
Feb	38	91	189	6	123	85	92	47	28	5
Mar	0	119	140	3	129	126	71	47	2	8
Apr	21	24	79	0	25	54	21	21	1	1
May	0	0	0	0	0	10	0	135	0	47
Jun	0	0	5	0	25	3	2	234	2	14
Jul	418 *	0	102	0	152	9	747	587	1	32
Aug	66 *	7	218	1	63	40	404	1,360	17	112
Sep	81 *	5	50	0	10	3	14	97	1	19
Oct	0	18	21	4	10	66	17	44	0	0
Nov	0	26	31	20	51	178	42	18	0	0
Dec	0	0	0	0	0	0	33	35	0	2
Total	**624**	**290**	**835**	**34**	**588**	**574**	**1,443**	**2,625**	**52**	**240**

* Taken from creel survey

A total of 7,305 chinook were sampled by the Puget Sound sampling crew during the 2001 calendar year. Overall, sampling objectives for recreational fisheries were met or exceeded in most 2001 Puget Sound fisheries (Table 8-6).

Table 8-6 Sampling Rates for Chinook in 2001 Recreational Fisheries

Month	Catch Areas									
	5	6	7	8-1	8-2	9	10	11	12	13
Jan	na /1	na	na	0%	na	0%	0%	0%	na	0%
Feb	24%	29%	23%	4%	16%	12%	11%	16%	18%	16%
Mar	0%	35%	17%	1%	13%	13%	17%	13%	2%	29%
Apr	12%	20%	17%	0%	9%	7%	16%	10%	5%	2%
May	0%	na	0%	na	0%	28%	0%	38%	na	29%
Jun	0%	na	3%	0%	22%	3%	5%	22%	na	10%
Jul	26% *	0%	6%	0%	16%	2%	49%	16%	4%	8%
Aug	23% *	39%	15%	33%	12%	6%	41%	19%	11%	8%
Sep	22% *	29%	14%	na	10%	9%	26%	16%	5%	8%
Oct	0%	14%	14%	3%	11%	13%	10%	16%	na	0%
Nov	0%	15%	6%	6%	11%	14%	7%	6%	na	na
Dec	na	na	0%	0%	0%	0%	8%	19%	na	2%

/1 "na" denotes strata with zero catch; 0% means there was catch, but none was sampled.

* Taken from creel survey

Historic sampling rates for Puget Sound recreational fisheries are presented in Table 8-7. Overall, sampling objectives for recreational fisheries are being met or exceeded in most Puget Sound fisheries, though rates in some smaller fisheries are low.

Table 8-7 Sampling Rates for Chinook in 1998-2002 Recreational Fisheries

Area	Month											
Area 5	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	34%	11%	25%	0%	0%	22%	12%	42%	0%	1%	0%
2001		24%	0%	12%	0%	26%	26%	23%	22%	0%	0%	
2000		32%		43%	0%			17%	25%			0%
1999		46%	45%	1%				17%	24%			
1998		38%	13%	15%				26%	19%			
Area 6	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002		19%	34%	37%		0%	0%		33%	0%	35%	
2001	0%	29%	35%	20%			0%	39%	29%	14%	15%	
2000		8%	60%	12%						0%	25%	33%
1999		33%	41%	19%				25%	33%	0%	13%	40%
1998		22%	12%	2%				35%	27%	2%	7%	12%
Area 7	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	10%	31%	9%	0%	0%	4%	15%	14%	0%	18%	0%
2001		23%	17%	17%	0%	3%	6%	15%	14%	14%	6%	0%

Table 8-7 Sampling Rates for Chinook in 1998-2002 Recreational Fisheries

Area	Month											
2000		45%	47%	23%	0%	0%	8%	11%	14%	21%	11%	43%
1999		13%	35%	23%			16%	16%	23%	25%	12%	
1998	18%	20%	21%	9%			16%	12%	9%	7%	9%	
Area 8-1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002		2%	8%	7%				0%		0%	27%	
2001	0%	4%	1%	0%		0%	0%	33%		3%	6%	0%
2000			13%	10%			0%	0%	25%		20%	15%
1999		4%	18%	2%						0%	30%	40%
1998	8%	10%	5%	17%				20%	17%		6%	
Area 8-2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002		25%	27%	22%	0%	24%	16%	27%	20%	1%	38%	0%
2001		16%	13%	9%	0%	22%	16%	12%	10%	11%	11%	0%
2000		29%	23%	22%	0%	0%	34%	20%	10%	25%	1%	0%
1999		8%	18%	27%			5%	23%	22%	50%		
1998	16%	13%	14%	6%			31%	13%	23%	23%		
Area 9	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	7%	8%	11%	0%	14%	2%	13%	15%	0%	40%	
2001	0%	12%	13%	7%	28%	3%	2%	6%	9%	13%	14%	0%
2000		11%	4%	9%	0%	2%	2%	7%	22%	11%	10%	5%
1999	0%	8%	13%	24%		9%	8%	3%	9%	18%	17%	2%
1998	25%	13%	17%	15%			4%	12%	14%	9%	13%	
Area 10	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	1%	14%	13%		0%	22%	46%	45%	6%	16%	17%
2001	0%	11%	17%	16%	0%	5%	49%	41%	26%	10%	7%	8%
2000		37%	66%	38%	0%	0%	8%	32%	33%		7%	3%
1999		24%	55%	48%			4%	22%	40%	9%	15%	6%
1998	29%	32%	16%	21%			9%	19%	31%	22%	10%	14%
Area 11	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	12%	21%	19%	0%	0%	20%	28%	22%	18%	22%	44%
2001	0%	16%	13%	10%	38%	22%	16%	19%	16%	16%	6%	19%
2000		13%	29%	25%	0%	22%	16%	17%	17%	16%	6%	24%
1999		11%	15%	20%		30%	19%	17%	14%	21%		6%
1998	9%	2%	14%	27%	20%	14%	19%	20%	24%	27%	15%	11%
Area 12	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	0%	36%		22%	0%	0%	22%	5%	4%	12%	14%
2001		18%	2%	5%			4%	11%	5%			
2000			44%	0%	0%		4%	13%	10%	1%	0%	86%
1999		1%	15%	5%			0%	13%	14%	0%	0%	28%

Table 8-7 Sampling Rates for Chinook in 1998-2002 Recreational Fisheries

Area	Month										
1998	15%	36%	21%				0%	9%	6%	13%	13%	7%
Area 13	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	0%	40%	10%	0%	12%	33%	3%	17%	18%			2%
2001	0%	16%	29%	2%	29%	10%	8%	8%	8%	0%		2%
2000		8%	2%	35%	14%	1%	29%	16%	20%	20%	5%	500%
1999		25%	2%	16%	19%	10%	4%	16%	12%	14%		
1998	5%	4%	10%	21%	1%	6%	7%	8%	9%	20%	21%	9%

Note: Blank cells denote strata for which catch was zero; 0% means there was catch (e.g., from an open pier in a closed area), but none was sampled

31,350 chinook were sampled, and 1,829 CWTs collected, in commercial net fisheries in Puget Sound (Table 8-8). Sampling rates in Puget Sound commercial fisheries generally exceed 20%, and are often much higher.

Table 8-8 2001-02 Puget Sound Commercial Net Fishery Chinook Sampling Rates (includes C&S and Take Home)

Area	2002			2001		
	Catch	Number Sampled	% Sampled	Catch	Number Sampled	% Sampled
4B Neah Bay	57	0	0%	432	30	7%
Waatch River	43	0	0%	16	0	0%
Sooes River	2,017	0	0%	80	0	0%
Area 5 Clallam Bay	1,017	537	53%	499	202	40%
Area 7 San Juan Islands	562	171	30%	305	170	56%
Area 7 Point Roberts	1,669	820	49%	665	291	44%
Area 7B Bellinhan Bay	30,550	7,588	25%	40,641	13,744	34%
Area 7C Samish Bay	7,712	707	9%	7,447	1,242	17%
Area 7D Lummi Bay	3	3	100%	17	1	6%
Nooksack River	447	297	66%	1,098	644	59%
Area 8 Skagit Bay	1	0	0%	29	11	38%
Skagit River	294	255	87%	235	230	98%
Area 8A Saratoga Passage	5,520	1,758	32%	429	14	3%
Area 8D Tulalip Bay	With Area 8A			5,024	1,733	34%
Area 9 Admirality Inlet	na	na	na	29	0	0%
Area 10 Seattle	117	115	98%	327	166	51%
Area 10A Elliott Bay	1,499	1,045	70%	4,778	1,544	32%
Area 10E East Kitsap	4,794	693	14%	6,625	1,662	25%
Duwamish River	7,976	5,108	64%	4,170	2,479	59%
Area 10C South Lake Washington	na	na	na	285	0	0%
Area 10D Lake Sammamish	na	na	na	1,809	0	0%
Area 10F Ship Canal	135	63	47%	na	na	na
Area 10G North Lake Washington	na	na	na	20	3	15%
Area 11 East And West Passage	na	na	na	0	5	
Area 11A Commencement Bay	na	na	na	148	0	0%
Puyallup River	4,749	3,038	64%	7,330	1,757	24%
Area 13 Nisqually River	152	0	0%	117	0	0%
Area 13A Carr Inlet	973	111	11%	1,248	32	3%
Area 13C Chambers Bay	689	412	60%	336	52	15%
Area 13D Dana Passage	4	0	0%	106	24	23%
Area 13F Budd Inlet	28	28	100%	241	0	0%
Area 13I Skookum Inlet	na	na	na	62	0	0%
Area 13K Case Inlet	na	na	na	241	17	7%
Nisqually River	11,834	7,198	61%	10,467	6,282	60%
McAllister Creek	317	0	0%	232	0	0%

Table 8-8 2001-02 Puget Sound Commercial Net Fishery Chinook Sampling Rates (includes C&S and Take Home)

Area	2002			2001		
	Catch	Number Sampled	% Sampled	Catch	Number Sampled	% Sampled
Minter Creek	40	0	0%	na	na	na
Area 9A Port Gamble Bay	3	0	0%	2	2	100%
Area 12B Quilcene/Dabob Bays	4	0	0%	338	0	0%
Area 12B Central Hood Canal	90	0	0%	na	na	na
Area12C South Hood Canal	21,110	3,493	17%	3,161	1,081	34%
Skokomish River	2,656	242	9%	586	237	40%
Total	**83,199**	**29,947**		**95,488**	**32,335**	

Note: Blank cells denote strata for which catch was zero; 0% means there was catch, but none was sampled

"na" denotes strata that were not sampled

In conclusion, sampling rates tend to be good for Puget Sound commercial and recreational fisheries.

8.2.2 CWT Samples

Table 8-9 shows the number of CWTs recovered by the sampling crew in 2003. Sampling rates cannot be calculated until recreational catch estimates are completed. The numbers of tags collected in 2003 probably represents an average year's sampling rates.

Table 8-9 Chinook CWTs collected in 2003-04 Recreational Fisheries

Month	Recreational Catch Area									
	5	**6**	**7**	**8-1**	**8-2**	**9**	**10**	**11**	**12**	**13**
Jan							12	5		
Feb	1	2	13	7	13	9	4		1	
Mar		7	14		13	3		3	2	
Apr	5	3			8			1		
May										2
Jun								24		
Jul	57	27	6		10		29	22		1
Aug	23	6	5	1	23	2	70	53	2	12
Sep	12					1	1	5	1	1
Oct								2		
Nov		1	2	1	11	4	2			
Dec								4		
Total	**98**	**46**	**40**	**9**	**78**	**19**	**118**	**119**	**6**	**16**

Note: Blank cells denote strata for which no CWTs were collected.

More CWTs are collected in commercial fisheries (Table 8-10), because sampling rates are higher, and because commercial fisheries present a higher overall magnitude of instantaneous catch.

Table 8-10 Chinook CWTs collected & AdClips counted in 2003-04 Commercial Fisheries

Commercial Catch Area	Chinook Sampled	CWT Recoveries	No. AdClips
4B	0	0	0
Sooes R	264	30	31
Waatch R	0	0	0
5	616	54	215
Sekiu R	0	0	0
6D	0	0	0
7	784	6	40
7A	1,387	12	19
7B	2,945	113	1,517
7C	3,064	96	1,903
7D	2	1	1
Nooksack R	247	14	112
8	32	5	7
Skagit R	327	14	73
8A+8D	5,248	474	542
10	220	21	42
10A	1,681	133	954
Duwamish R	1,332	142	782
10D	203	3	141
10E	1,984	25	191
10F	178	108	130
10G	63	8	52
11	1	0	0
Puyallup R	1,534	67	1,078
13	165	6	126
Nisqually R	4,833	437	3,747
13A	497	9	415
13C	187	3	171
13D	203	1	185
13F	32	0	29
13K	22	0	20
9A	0	0	0
12C	2,779	25	22
Big Quilcene R	0	0	0
Skokomish R	520	22	15
Grand Total	**31,350**	**1,829**	**12,560**

8.2.3 Scales

An unfortunate ambiguity has surrounded the collection of chinook scales in both commercial and recreational fisheries. For many years it was believed that scales were not needed, and scale collection was dropped in order to improve sampling efficiency (i.e. reduce costs). Clearly, these chinook scales provide key pieces of biological information, and sampling objectives have been reestablished for them. The general objective is to collect 150 scale samples per gear / area / time stratum. Table 8-11 and Table 8-12 show a wide variation in the numbers of scale samples taken for each recreational and commercial fishing area. Though the quantity and geographic distribution of samples taken vary widely from year to year, these samples continue to provide data with which to assess of origin and age of chinook. Information from 2002 and 2003 fisheries has not yet been compiled, and will be provided in future reports.

Table 8-11 Recent Historic Number of Recreational Chinook Scale Samples Collected, 1998-2001

Catch Area	Year		Total
	1998	2000	
5	190	295	485
6	444	505	949
7	547	1,047	1,594
8-1	199	0	199
8-2	637	0	637
9	719	797	1,516
10	1,414	0	1,414
11	6,938	0	6,938
12	264	0	264
13	1,042	0	1,042
Grand Total	12,394	2,644	15,038

Note: no scales were taken in Puget Sound recreational sampling in 1999 and 2001

Table 8-12 Recent Historic Number of Commercial Chinook Scale Samples Collected, 1998-2001

Area	Gear	Year				Total
		1998	1999	2000	2001	
7B	Carcass Disposal			167		167
8	Gillnet				1	1
Skagit	Gillnet	737		9		746
	Setnet	68				68
8A	Gillnet				20	20
8D	Carcass Disposal			198		198
	Gillnet			208		208

Table 8-12 Recent Historic Number of Commercial Chinook Scale Samples Collected, 1998-2001

Area	Gear	Year 1998	1999	2000	2001	Total
	Hook & Line		2			2
	Marine Sport	3				3
	Mixed Gillnet		50			50
	Round Haul			1,633		1,633
	Setnet			420		420
	Unknown			17		17
10	Gillnet			81		81
	Purse Seine			2		2
10A	Gillnet	1,697				1,697
	Setnet	35				35
Green	Setnet	308				308
10E	Gillnet	1,416				1,416
	Round Haul	38				38
	Setnet	3,352				3,352
	Unknown	54				54
10F	Setnet			9		9
11	Marine Sport		368			368
	Purse Seine				1	1
	Setnet		3			3
11A	Gillnet		1			1
	Setnet		16			16
	Unknown	60				60
Puyallup	Gillnet	903				903
	Mixed Gillnet	507				507
	Setnet	39				39
	Unknown		20			20
13	Drag Seine	70				70
Nisqually	Mixed Gillnet	2,525				2,525
	Unknown	6				6
13C	Drag Seine	60				60
	Gillnet	20				20
	Setnet	110				110
13D	Drag Seine	10				10
	Gillnet			98		98
	Setnet	1				1

Table 8-12 Recent Historic Number of Commercial Chinook Scale Samples Collected, 1998-2001

Area	Gear	Year				Total
		1998	1999	2000	2001	
13F	Drag Seine	16				16
	Gillnet	208				208
	Mixed Gillnet	14				14
	Setnet	63				63
12C	Drag Seine		2			2
Unidentified	Marine Sport		18			18
	Round Haul		20			20
Grand Total		**12,320**	**504**	**2,838**	**22**	**15,684**

8.3 Escapement Monitoring

The estimation and sampling of natural spawning escapement is an essential element in assessing the annual abundance of chinook, which ultimately enables the estimation of fisheries exploitation rates and assessment of the performance of fisheries management regimes. Concurrent biological sampling of spawners in a number of areas provides essential data on the age composition of the return and the hatchery or wild origin of adults. Cohort strength estimates are also based on the escapement and harvest of age-2 through age-6 adults from any brood year.

Fishery managers have emphasized the need to understand the contribution of hatchery-origin salmon to natural spawning, whether of local hatchery origin or strays from other facilities or river systems. With the increase in mass marking of hatchery fish, spawning ground sampling is now able to collect this essential information. Depending on the accuracy required of such estimates, more sampling effort may be required than has previously been expended on collecting biological data on the spawning grounds to determine age and sex composition and origin of spawners.

8.3.1 Spawning ground surveys and escapement estimation

A variety of techniques are used to estimate spawning escapement. (Detailed descriptions are provided in Appendix A of the 2003 Comprehensive Chinook Management Plan). The choice of method depends on the degree of accuracy required of the escapement estimate, accessibility of spawning areas, water clarity, flow levels, and cost (Smith and Castle 1994). In a few large rivers, aerial surveys are flown repeatedly to count redds. In a few streams the entire length of available habitat is censused by boat or on foot.

In all major salmon-producing streams and rivers, index reaches are also surveyed on foot to count either live or dead adult salmon or redds. These index surveys serve to ground-truth aerial survey data. In some cases, the numbers of fish or redds observed in index reaches can be compared with index counts in prior or base years, when comprehensive surveys were made, to estimate total spawning escapement. This expansion requires the assumption that the relationship between counts in the index reaches and total escapement is stable. In other cases, index counts are expanded only to represent the total number of spawners in that index area. In these situations, the spawner estimate generated is adequate to track trends in spawning escapement, but are only minimum estimates of total escapement for a stream. These index escapement estimates are only useful if spawning distribution does not vary greatly from year to year.

When flow and visibility conditions permit, redd counts are believed to provide more accurate estimates than counts of live and dead fish. In some streams, frequent counts of new redds are not possible. In some cases counts of total visible redds may be plotted over time, and the number of spawners estimated by assuming redd-life of 21 days. If poor visibility precludes redd counts, peak counts of live and dead spawners may be substituted. If such counts are made weekly, or similar interval, total fish-days may be integrated under the spawner curve, and converted to escapement assuming some value for the residence time of adults on the spawning grounds.

WDFW and tribal staff conduct chinook escapement surveys throughout the Puget Sound ESU according to the standardized regime. Surveys are conducted at weekly intervals, if possible, and newly constructed redds identified and marked. The count of redds is expanded to numbers of chinook according to an assumed ratio, for example, 1.5 males per female or 2.5 fish per redd (Orrell 1976). Where a count of new redds is made in index reaches, the resulting number of spawners is expanded to total utilized spawning habitat, based on prior comprehensive surveys. Spawners per mile of surveyed habitat are expanded to total miles of available habitat.

Supplemental escapement surveys occur in some river systems to better understand the current spawning distribution and improve the accuracy of estimates based solely on index reaches. They supplement the standard escapement survey regime, by surveying reaches outside of normal index areas or areas not previously surveyed. In other systems, this work focuses on describing the extent to which hatchery-origin salmon contribute to natural spawning, particularly outside of their specific natal drainage.

8.3.2 Escapement Methodology Studies

The Pacific Salmon Commission funded escapement methodology studies in the Skagit, Stillaguamish, Snohomish, and Green rivers in 1999, 2000, 2001 and 2002. Final reports for those studies are not yet available, and will be provided in a future postseason report.

8.3.3 Sampling for Hatchery-Natural Origin

Estimating the contribution of first-generation, hatchery-origin adults to natural spawning is essential to understanding the natural productivity of any chinook population. Natural productivity (i.e. survival) can only be estimated by distinguishing hatchery- and natural-origin components of harvest and escapement. In several Puget Sound systems, hatchery production is used to enhance fishing opportunity or supplement natural production. Hatchery returns may intermingle and interbreed with natural-origin chinook. Conversely, natural-origin fish may stray into hatchery racks. Hatchery-origin adults are distinguished by some identifying mark - either a visible mark such as a fin clip (which may signify that the fish also carries a coded-wire tag), or an internal otolith mark.

Accurate estimation of the contribution of hatchery-origin adults to natural escapement (and the contribution of natural-origin adults to hatchery escapement) may be accomplished by mass marking of hatchery-produced smolts. Spent adults or carcasses can be examined for external marks. Where DIT programs operate, all unmarked fish will have to be passed through an electronic tag detector to recover coded-wire tagged fish. Studies in the Green River suggest that carcass sampling can provide superior estimates of the contribution of hatchery fish to natural spawning, than sampling extreme terminal (freshwater) catch. Otoliths will be dissected from a sample of unmarked carcasses to establish the presence of this mark group. Otolith marking has been used successfully to estimate the number of Tulalip Hatchery fall chinook on spawning grounds in the Snohomish Basin (Rawson et al 2001).

8.4 Results of Special Fishery Monitoring Studies (e.g., non-landed mortality)

Non-landed mortality may comprise a significant proportion of total fisheries-related mortality, because release mortality rates are assumed to be 10%-20% for barbless hook-and-line sport gear, and 26% for barbless commercial troll gear. FRAM is used to estimate total chinook encountered in a fishery based on the age-specific abundance and growth rate of stocks contributing to that fishery for each model run year. As the number of nonretention and mark selective fisheries increases, there is increasing need to verify the model encounter estimates and to refine the release mortality rates used in the model..

8.4.1 Troll Fisheries Study

In recent years, funds have become available through the PSC Chinook Technical Committee's research program, to sample commercial troll and sport fisheries in coastal Areas 1-4 in order to estimate chinook encounter rates to estimate non-landed mortality. This study, conducted by Makah Fisheries Management (Leon and Crewson 2001; 2002; Leon and Peterschmidt, 2003; Appendix D), is intended to address data needs of the Chinook Technical Committee and other fishery management agencies by estimating sublegal chinook encounter rates in treaty and, later, nontreaty troll fisheries. The study involved direct observation and fisherman logbooks.

In previous years, the study involved only treaty vessels in Areas 4 and 4B, but in 2001 the study was expanded to nontreaty vessels in Areas 1-3. Observers are places aboard commercial troll vessels.

This study recorded observed encounters of 940 chinook and 554 coho by treaty troll vessels and 4,014 chinook and 1,130 coho by nontreaty vessels fishing in Areas 3, 4 and 4B, during the months of May through September. Coho were not targeted during the May and June chinook-only fishery. Only 80 coho encounters were recorded during this period, all from Area 3. The fishermen keeping logbooks recorded observations of 13,833 chinook and 2,943 coho, mostly on nontreaty boats.

8.5 Regulatory compliance

WDFW enforcement officers monitor recreational fisheries in all marine catch areas, from ocean Catch Record Card (CRC) Area 1 (and including the Columbia River Buoy 10 fishery) through Puget Sound CRC Area 13. This effort is designed to measure and monitor adherence to wild salmon release rules, as well as general fishing rule compliance. Presence is accomplished using vessels, dock patrols, and joint operations with other enforcement agencies.

The average 2003 for compliance with overall salmon rules in marine areas 1-13 was 84.6%. The presence of pink salmon complicated fish identification for some people such that undersized chinook and unmarked coho salmon were mistaken for pink salmon. This resulted in more illegal possession of unmarked chinook or coho.

Compliance in the Strait of Juan de Fuca recreational fisheries (CRC areas 5 and 6) was about 91% overall. Compliance with wild coho release was about 99% and with chinook release after the retention period closed also about 99%. A total of 223 citations and 72 warnings were issued during the 774 enforcement hours in the Strait summer fishery.

Compliance with overall salmon rules varied widely throughout Puget Sound, however compliance with mark-selective rules was generally high (around 99%) everywhere this was monitored (Table 8-13).

Table 8-13 Enforcement Effort and Regulatory Compliance in 2003 Puget Sound Recreational Fisheries

CRC Area	Overall Compliance	Coho Mark-Release	Contacts	Citations	Warnings	Enforcement Hours
5	90.2	98.7	1662	130	38	334
6	91.6	99.6	1013	93	34	440
7	84.2	99.8	1331	188	23	669
8-1	95.5	na	132	5	1	74
8-2	67.7	na	430	71	67	183
9	75.1	na	590	90	78	203
10	69.3	na	678	176	61	633
12	86.1	na	331	56	35	251

13	64.9	99.9	522	151	59	324

Appendices

A Comprehensive Chinook Management Plan – Harvest Component 2002-2003 (PSIT and WDFW, 2/19/03)

B Fishing Schedules

- B-1 State/Tribal Agreed-to Fisheries Document (PSIT and WDFW, 4/18/02)
- B-2 Medicine Creek Treaty Area In-Common Fishery 2003 Pre-season Regulations (July 10, 2003)

C 2003-04 Puget Sound Sampling Program Operating Plan

D Estimates of Encounter Rates and Releases of Sublegal Chinook in the 2003 Washington Troll Salmon Fishery (Leon and Peterschmidt, 2003)

E Management & monitoring reports

- E-1 2003 Chinook Selective Fishery, Marine Areas 5 and 6 (Thiesfeld & Hagen-Breaux)
- E-2 2003 Carbon River Selective Chinook Fishery Angler Creel Survey Report
- E-3 Summary of 2003 South Sound chum in-season management
- E-4 Nisqually chinook preliminary sport estimates for 2003

F WDFW 2003 Selective Salmon Fishery Enforcement Report

PUGET SOUND

COMPREHENSIVE CHINOOK MANAGEMENT PLAN:

HARVEST MANAGEMENT COMPONENT

Puget Sound Indian Tribes

And

The Washington Department of Fish and Wildlife

February 19, 2003

PILB

Table of Contents

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	Under development		
North Fork			1,000 [1]
South Fork			1,000 [1]
Skagit summer / fall	52%		4,800
Upper Skagit summer			2,200
Sauk summer			400
Lower Skagit fall			900
Skagit spring	42%		576
Upper Sauk			N/A
Cascade			N/A
Siuattle			N/A
Stillaguamish	25%		650 [1]
North Fork summer			500 [1]
South Fork & MS fall			N/A
Snohomish	24%		2,800
Skykomish			1,745 [1]
Snoqualmie			521 [1]
Lake Washington	15% PT SUS		
Cedar River		1,200	200 [1]
Green	15% PT SUS	5,800	1,800
White River spring	20%		200
Puyallup fall	50%		500
South Prairie Creek		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 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.

- **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

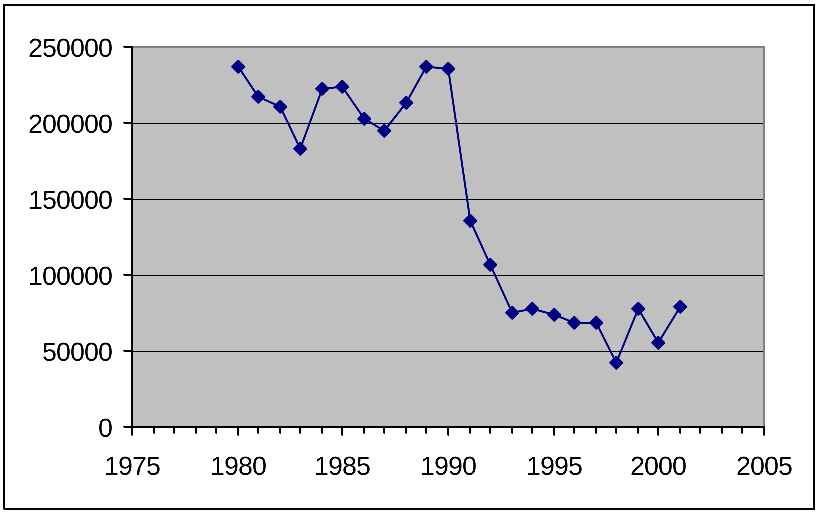
Commercial salmon fisheries in Puget Sound, including the U.S. waters of the Strait of Juan de Fuca, Rosario Strait, and Georgia Strait, embayments of the Puget Sound proper, and Hood Canal, are co-managed by the tribes and WDFW under the Puget Sound Salmon Management Plan. Several tribes conduct small-scale 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).

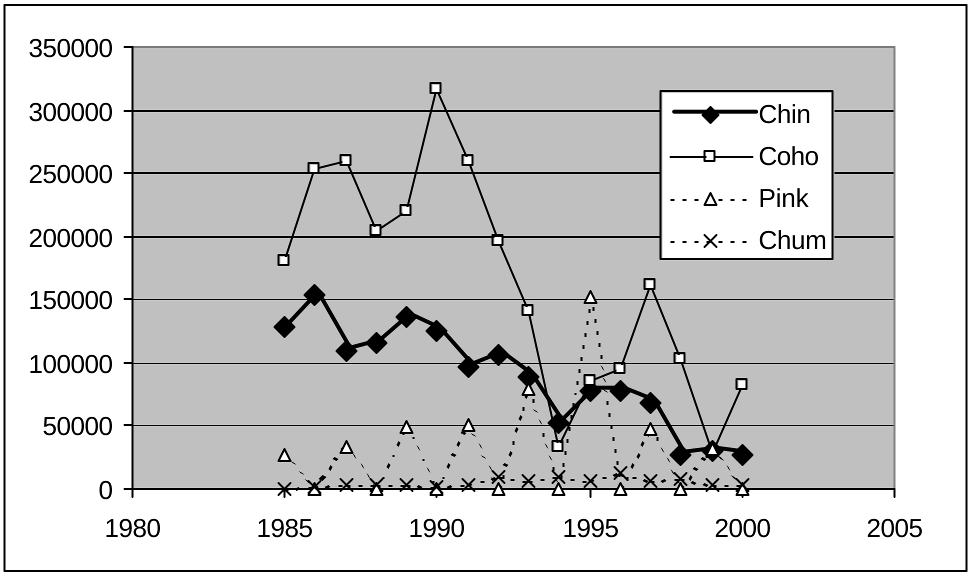
	Strait of Juan de Fuca	Georgia & Rosario Strait	Nooksack Samish	Skagit	Stillaguamish Snohomish	So Puget Sound	Hood Canal	Total
1997	1,200	10,525	15,034	1,348	25,193	78,634	9,925	141,859
1998	8,083	1,980	22,892	10,359	24,743	65,617	21,974	155,648
1999	5,586	1	50,175	7,411	18,439	21,189	4,845	107,646
2000	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.

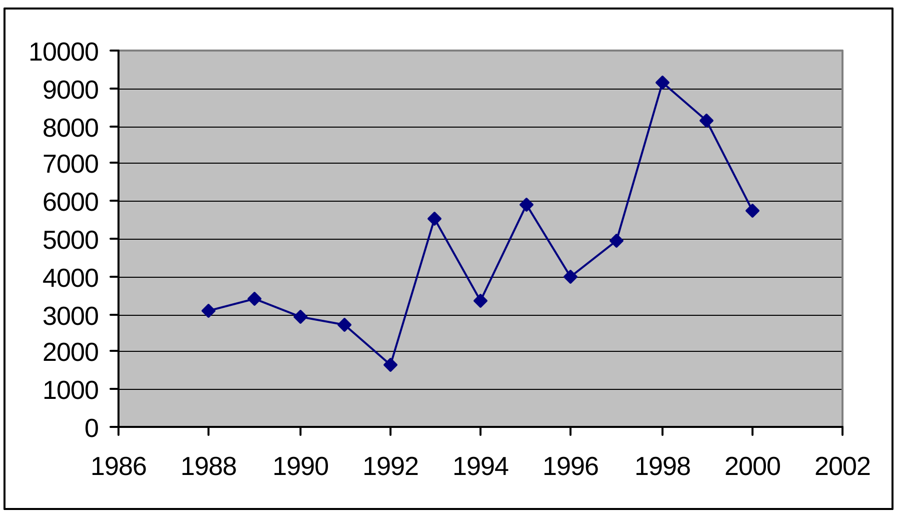
Recreational fisheries target mature chinook occur during the summer months (July – September), and continue through the fall and winter months, primarily in central Puget Sound, targeting immature chinook ('blackmouth'). Recreational chinook catch has been increasingly constrained to avoid overharvest 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	26%	5%
- barbed hooks	30%	5%
Puget Sound recreational	> 22" - 10%	5%
	< 22" - 20%	5%
Gillnet		terminal areas - 2% pre-terminal areas - 3%
Skagit Bay	52.4%	
Purse Seine	immature fish- 45%	0%
	mature fish - 33%	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).

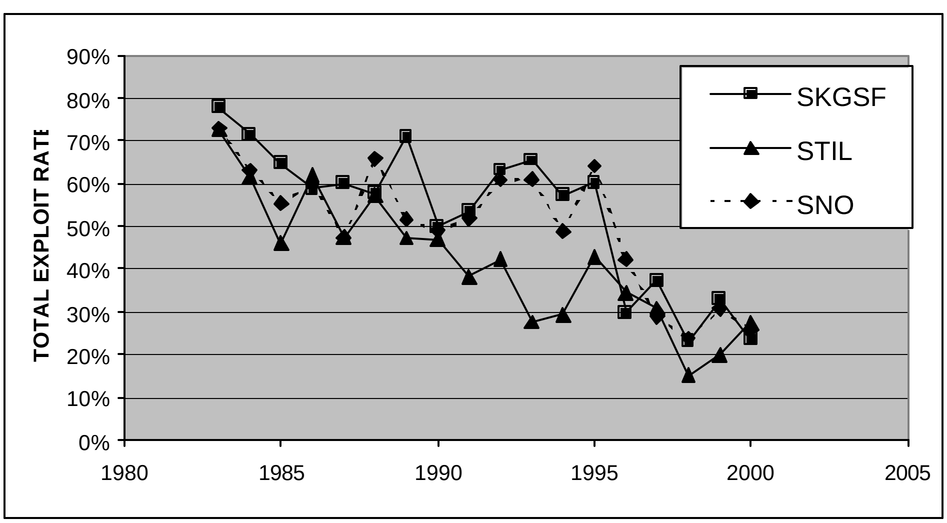
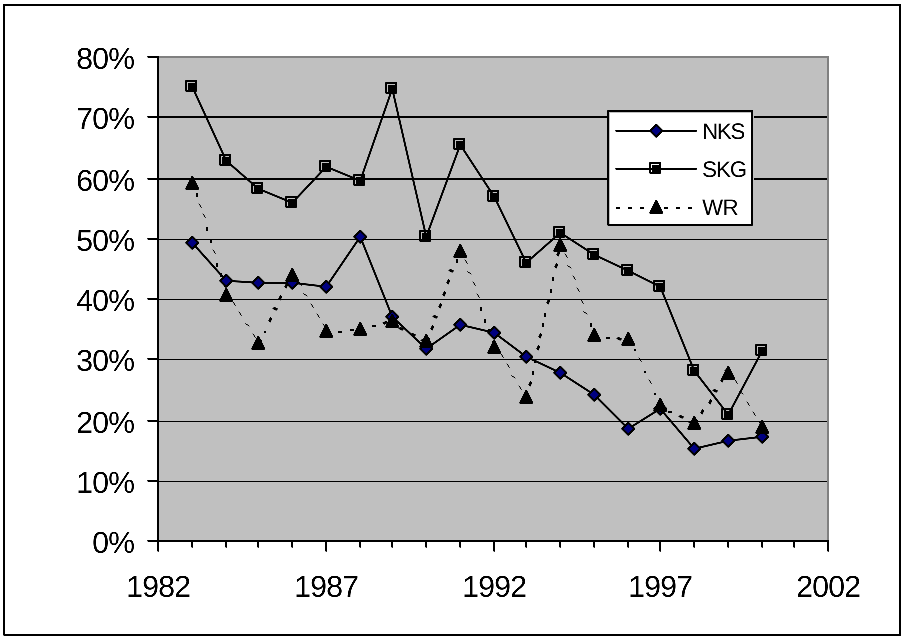
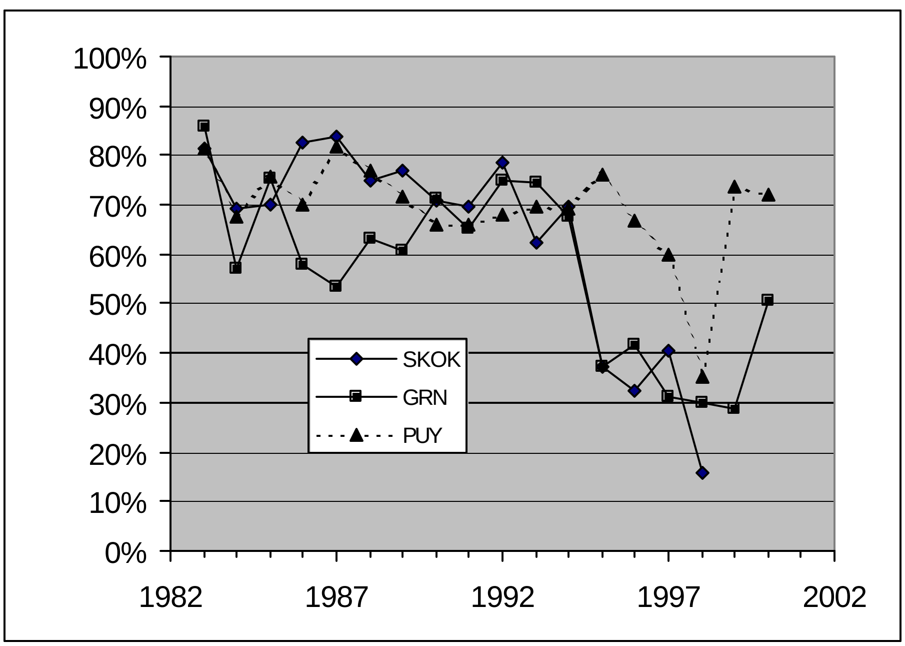


Figure 5. Trend in total exploitation rate for Nooksack, Skagit, and White spring chinook management units (post-season FRAM estimates)



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

PILB

Appendix A: Management Unit Status Profiles

PILB

Nooksack River Management Unit Status Profile

Component Stocks

North Fork Nooksack early chinook
South Fork Nooksack early chinook

Geographic description

The Nooksack River natural chinook management unit is comprised of two early-returning, native chinook stocks that are genetically distinct, geographically separated, and that exhibit slightly different migration and spawning timing. They have been combined into a management unit because their passage through the fishing areas in the Nooksack River, below the confluence with the South Fork, and Bellingham and Samish Bays are similar and distinct from the migration timing of the Nooksack hatchery chinook stocks of Green River origin in the same areas.

The North Fork drains from high altitude, glacier-fed streams. Early-timed chinook spawn in the North Fork from the confluence of the Middle Fork (RM 40) up to the Excelsior Powerhouse at RM 65, and in several tributaries including Glacier, Cornell, Canyon, Maple, Kendall, and Racehorse creeks. A hatchery based egg bank and restoration program has operated at the Kendall Creek facility since 1981. Up to 2.3 million fingerlings, 142,458 unfed fry and 348,000 yearlings have been released annually into the North Fork, or various acclimation sites. The yearling release program was discontinued after it was shown to produce returns at rates no better than those produced by fed fry releases.

The South Fork drains a lower-elevation watershed in the foothills, with a markedly different hydrograph and temperature regime than the North Fork. Early chinook spawn in the upper South Fork up to RM 30.4, and in Hutchinson and Skookum creeks. An hatchery-based egg bank and restoration program operated at the Skookum Creek facility in brood years 1980 – 1993, but was discontinued when the natural returns to the hatchery ladder did not materialize in significant numbers, and the capture of wild broodstock was not deemed appropriate at such low abundance.

Allozyme analysis of samples collected from both stocks indicates significantly different frequencies of common allozymes, but there are fewer differences in allele frequencies between the two native stocks than between the native stocks and fall hatchery stock, suggesting that they have distinct evolutionary history.

Life History Traits

Nooksack early chinook are characterized by early entry into freshwater, a slow upstream migration, and lengthy residence in the river prior to spawning. The North Fork stock enters the lower Nooksack River from March through July, slowly moves up the river and spawns in the upper reaches from August through late September. The peak of spawning for the South Fork stock occurs two to three weeks later than that of the North Fork stock. Spawning is concentrated in the North Fork, from RM 44 to RM 64, but also occurs in tributary streams and the Middle Fork. In the South Fork spawning is concentrated between RM 23 and RM 30. Efforts are currently underway to better describe the spawning distribution throughout the Nooksack Basin. There have been few recoveries of coded-wire tagged North Fork-origin chinook on spawning grounds in the South Fork during periods of low North Fork stock escapement, suggesting that stray rate of returning adults is low

Naturally produced smolts from the North Fork are predominantly (91 percent) age-0 (WDFW 1995 cited in Myers et al 1998). In the South Fork, yearling smolts making up a larger and highly variable (as much as 69 percent) proportion of the annual production (WDFW 1995 cited in Myers et al 1998).

The recent average (1986 – 1994) age composition of adults returning to the North Fork indicates that age-3, age-4, and age-5 fish comprise 4 percent, 75 percent, and 20%, respectively of annual returns. The age composition of returns to the South Fork, for the same period, averaged 10 percent, 61 percent, and 28 percent, respectively (WDF et al 1993 and WDFW 1995 cited in Myers et al 1998). Age-5 proportions of these magnitudes are also observed among other Puget Sound spring chinook stocks, e.g. the Suiattle River and White River.

Status

The current status of the Nooksack early chinook stocks is critical, due to chronically low returns and poor freshwater survival. The SASSI review (WDF et al 1993) reached the same conclusion. While spawning escapement to the North Fork has increased slightly in recent years, (i.e. the geometric mean for all returns in 1997 – 1999 was 592, compared with 261 for 1992 – 1996), it remains below 200 in the South Fork. Survey effort has increased to better estimate the abundance and distribution of spawners throughout the Nooksack Basin, but the glacial nature of the North Fork hampers efforts to enumerate live fish or redds. Progeny of the hatchery program is essential to the recovery of the stock, and is therefore included with the listed stocks. Kendall Creek hatchery production contributes significantly to the abundance and return of the North Fork stock.

Table 1. Spawning escapement of Nooksack early chinook, 1990-2000.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
North Fork	110	490	440	40	228	538	621	366	911	1242	259
South Fork	365	103	235	118	290	203	180	157	213	283	245

504 245 The status of the North Fork stock appears less critical than that of the South Fork stock, given recent spawning escapement levels. North Fork escapement in the last three years has been more than three times the average for the preceding five-year period (1992-96), while South Fork escapement has been stable at about 200 for the last five

years.. Degraded fresh water habitat has contributed to low spawner success and egg-to-fry survival.

Increasing escapement to the North Fork (Table 2) suggests that terminal harvest rates have declined, but the recruits per natural-origin spawner have consistently remained below one recruit per pair of spawners. Preliminary estimates of the proportion of natural origin spawners in the North Fork, as determined from otolith studies, indicate that the return rate of natural origin spawners for brood years 1992 through 1995 ranged from 0.14 to 0.62 per spawner (Table 3), well below the replacement rate. This would suggest that something other than the limited incidental terminal area harvest is responsible for the decline of the natural origin spawners.

Table 2: Origin of Spawners in the North Fork Nooksack River (Lummi DNR unpublished data).

Return Year	Natural Origin	Cultured Origin	Total
1995	175	53	228
1996	210	328	538
1997	121	500	621
1998	39	327	366
1999	91	820	911
2000	160	1082	1242

Table 3. Natural origin return per spawner rates for early chinook in the North Fork of the Nooksack River (Lummi DNR unpublished data).

Brood year	Natural spawners	Total age 3 - 6 Returns	Return per Spawner
1992	493	181	0.37
1993	445	95	0.21
1994	45	28	0.62
1995	230	32	0.14
1996	535	171	0.32

Comparison of brood year escapement in the South Fork to escapement four years later indicates that the average replacement rate has been 1.17 (Table 4).

Table 4. Replacement rate of early chinook in the South Fork Nooksack River.

Brood Year	Spawners	Spawners (BY+4)	Replacement Rate
1991	365	290	0.79
1992	103	203	1.97
1993	235	180	0.77
1994	118	157	1.33
1995	290	213	0.73
1996	203	283	1.39
		average	1.17

Harvest distribution

Recoveries of coded-wire tagged North Fork early chinook indicate that a majority of the historic harvest mortality occurs outside of Washington waters, primarily in Georgia Strait and other net and recreational fisheries in British Columbia (Table 5). The principles of abundance-based management of chinook, which were agreed to in the re-negotiated Pacific Salmon Treaty Chinook Annex in 1999, may constrain harvest of Nooksack early chinook in Georgia Strait, where they comprise less than one percent of the total catch. Conservation measures aimed at reducing spring chinook harvest in the Strait of Juan de Fuca and northern Puget Sound have been in place since the late 1980's. There have been no directed fisheries in Bellingham Bay and the Nooksack River since the late 70's. Incidental harvest in fisheries directed at fall chinook in Bellingham Bay and the lower Nooksack River was reduced in the late 80's by severely reducing July fisheries. Since 1997, there has been a very limited subsistence fishery in the lower river in early July, no tribal commercial fisheries until August and no Non-tribal commercial fisheries until mid-August. Since 1997 the release of summer fall chinook from the Kendall hatchery was moved down to the tidal portion of the river and then to the Maritime heritage center on the eastern shore of Bellingham bay, and then eliminated entirely. This has shifted the emphasis of the terminal area fishery away from the Nooksack River to the Samish Bay and Lummi Bay areas and reduced the proportion of the tribal harvest taken in the Nooksack River

Table 5. Average harvest distribution of Nookack early chinook, for management years 1996 – 2000, as percent of total adult equivalent fishery mortality (TCChinook 02-3).

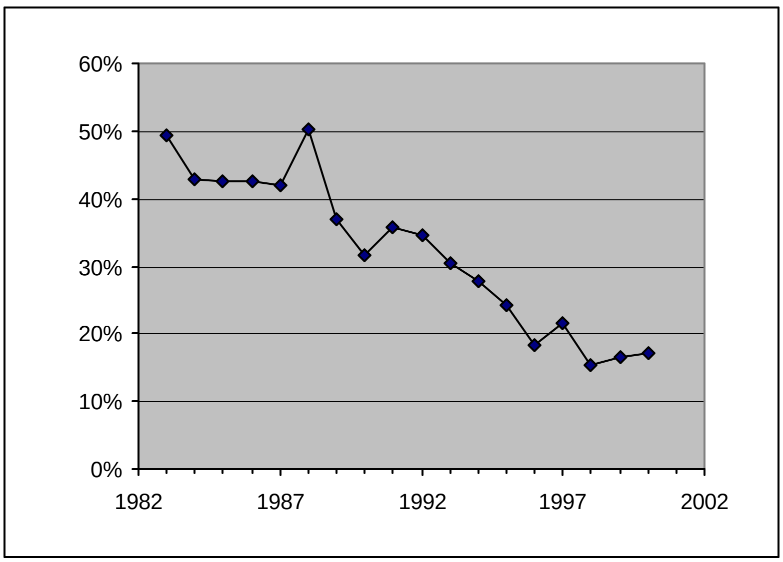
Mgmt Years	Alaska	B.C.	Wash. troll	Puget Sound net	Washington sport
1996-2000	1.6%	75.7%	1.5%	3.0%	18.3%

Coded-wire tag recoveries indicate that, in Washington waters, Nooksack early chinook have been caught in the Strait of Juan de Fuca troll fishery, recreational fisheries in southern and northern Puget Sound, and net fisheries (primarily in Areas 7 and 7A, Bellingham Bay, and the Nooksack River) in northern Puget Sound. This tag information may not represent the constrained, current fishing regimes in all areas, particularly in Puget Sound since 1997, or the potentially different migration pathways of yearling and fingerling hatchery releases. The Kendall Creek facility currently releases only fingerling early chinook.

Exploitation rate trends:

The total annual fisheries exploitation rate for Nooksack early chinook, as estimated by post-season FRAM runs, has declined 59 percent, since the 1980's (Figure 1), from levels in excess of 40 percent in 1983 – 1988, to less than 20 percent in the last five years. Some uncertainty is associated with the absolute value of FRAM-based exploitation rates, but they are believed to accurately index the trend in rates. There are no current CWT data enable a specific computation for the South Fork stock.

Figure 1. Total adult equivalent fisheries exploitation rate of Nooksack early chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

The management objectives for Nooksack early chinook constrain harvest under co-manager jurisdiction so that it will not impede recovery, while allowing for the exercise of treaty-reserved fishing rights and providing non-treaty fishing opportunity.

Degraded spawning and rearing habitat present the most significant constraint on productivity, so an ambitious and long-term effort to restore habitat, working in concert with appropriate hatchery production and harvest management regimes, is essential to recovery. The potential for hatchery production, net and recreational fisheries to alter the age and size composition of adult returns is recognized, so harvest managers will collect information to determine if current regimes are having such an effect, and will develop measures to reduce selectivity if it is identified.

For the next two years it is not expected that the abundance of natural origin spawners returning to either of the Nooksack early chinook stocks will exceed the critical abundance thresholds. The co-managers and the NMFS will work together toward the development of an acceptable recovery exploitation rate to be implemented when the returning abundance of natural origin spawners exceeds the critical abundance threshold for both stocks.

When the projected escapement to the spawning grounds, in preseason modeling, is below the critical abundance threshold of 1,000 natural-origin spawners for either of the Nooksack early chinook stocks, fisheries that impact the escapement of these stocks will be shaped so the exploitation rate in southern US fisheries, that is defined by modeling the fisheries regime listed in Appendix C with the current season's forecast abundance, is not exceeded.

With approximately 70 percent of the historic total harvest mortality occurring in Canadian fisheries, the scope for reducing fisheries impacts in Washington waters is limited. Net, troll, and recreational fisheries in Puget Sound have been shaped to minimize incidental chinook mortality to extent possible while maintaining fishing opportunity on other species such as sockeye and summer/fall chinook. The net fishery directed at Fraser River sockeye, in catch areas 7 and 7A in late July and August, has caught very few Nooksack early chinook. Chinook fisheries in Bellingham Bay and the Nooksack River are delayed until early chinook have cleared the fishing areas, entered freshwater, or in the case of river fisheries, until migration to upstream spawning and holding areas has occurred. There will be a limited harvest of an Nooksack early chinook in the river for the purpose of a tribal first salmon ceremony, amounting to a single fish and such additional chinook that are entangled before the net is removed from the water (total not to exceed five chinook). Limited tribal fisheries for ceremonial and subsistence purposes will occur in early July to meet minimal tribal requirements. Fisheries in Bellingham Bay directed at fall chinook will not open prior to August 1. Subsequent fishing in the river occurs in progressively more upstream zones as early chinook stocks clear these areas. Thus the area extending two miles downstream of the confluence of the North and South Forks will not open prior to September 16.

Total exploitation rates projected by the FRAM model in the last two (management) years were 13 percent in 2000 and 20 percent in 1999. FRAM based Recovery exploitation rates were estimated by NMFS to be 17 percent and 21 percent for the North and South Fork stocks, respectively, based on a preliminary stock-recruit analysis (NMFS 2000). The FRAM chinook model has some difficulty in accurately representing the total exploitation rate on Nooksack early chinook stocks. It is recognized that tag data do not exist to support a direct analysis of the productivity of the South Fork stock, and given its status, there is ample reason to exert conservative caution in planning fishing regimes.

The co-managers are evaluating the productivity, abundance and diversity of the early chinook runs that could be expected from the Nooksack watershed under properly functioning habitat conditions that might have been expected to exist at Treaty time. The calculation of a normal exploitation rate has not be made but at the current escapement goal of 2000 natural origin spawners in each population, and an exploitation rate of 60%, a AEQ recruit abundance of 5,000 in each stock would be anticipated. It is not expected that these goals will change until that study is completed and validated.

Data gaps

Following are the highest priority needs for technical information necessary to understand stock productivity and refine harvest management objectives:

1) Improved estimates of total escapement to the North and South Forks by stock and region of origin.

2) Estimates of natural early chinook smolt production from the North and South Forks.

3) Development of stock/recruit functions, or component freshwater survival data to monitor the productivity of the two stocks.

Skagit River Management Unit Status Profiles

Component Stocks

Summer/fall chinook management unit
- Lower Sauk River (summer)
- Upper Skagit River mainstem and tributaries (summer)
- Lower Skagit River mainstem and tributaries (fall)

Spring chinook management unit
- Upper Sauk River
- Suiattle River
- Upper Cascade River

Geographic description

There are two wild chinook management units originating in the Skagit River system - spring and summer/fall chinook. The number of separate chinook populations within each of these units is unclear at this time. The co-managers (WDFW and WWIT 1994) identified three spring and three summer/fall populations. Analysis continues (Ruckelshaus et al. in prep) to resolve the population structure of each management unit.

Summer/fall management unit

The three populations tentatively identified within the summer/fall management unit are: Upper Skagit summers, Lower Sauk summers, and Lower Skagit falls. Upper Skagit summer chinook spawn in the mainstem and certain tributaries (excluding the upper Cascade River), from above the confluence of the Sauk River to Newhalem. Spawning also occurs in Diobsud, Bacon, Falls, Goodell, Illabot, and Clark creeks. Gorge Dam, a hydroelectric facility operated by Seattle City Light, prevents access above RM 96, but historical spawning in the high-gradient channel above this point is believed to have been very limited. The lower Sauk summer stock spawns primarily from the mouth of the Sauk to RM 21 - separate from the upper Sauk spring spawning areas above RM 32. The lower mainstem fall stock spawns downsteam of the mouth of the Sauk River, and in the larger tributaries, including Hansen, Alder, Grandy, Jackman, Jones, Nookachamps, Sorenson, Day, and Finney creeks.

Skagit summer/fall stocks are not currently supplemented to a significant extent by hatchery production. A PSC indicator stock program collects summer broodstock (about 40 spawning pairs per year) from the upper river. Eggs and juveniles are reared at the Marblemount Hatchery. The objective of the program is to release 200,000 coded-wire tagged fingerlings for monitoring catch distribution and harvest exploitation rate. Summer chinook fingerlings are acclimated in the Countyline Ponds before they are released. Development of a lower river fall indicator stock was initiated in 1999, with similar production objectives. Production programs for fisheries enhancement of Skagit summer/fall chinook, and plants of fall chinook fingerlings into the Skagit system from the Samish Hatchery have been discontinued.

Spring management unit

The Skagit spring management unit includes stocks originating in the upper Sauk, the Suiattle, and upper Cascade rivers. The upper Sauk stock spawns in the mainstem, primarily above the town of Darrington up to RM 40, the Whitechuck River, and tributary streams. The Suiattle stock spawns in several tributaries including Buck, Downey, Sulphur, Tenas, Lime, Circle, Straight, and Big creeks. Cascade springs spawn in the mainstem above RM 19, and are thus spatially separated from the lower Cascade summer chinook. Spring chinook reared from Suiattle River broodstock are released from the Skagit Hatchery. Annual releases averaged 112,000 yearlings for the period 1982 – 1991 (WDF et al 1993). Since then, about 250,000 subyearlings have also been released each year. All spring chinook releases are coded-wire tagged.

Life History Traits

The upper mainstem and lower Sauk River and summer stocks spawn from September through early October. Operational constraints imposed by the Federal Energy Regulatory Commission on the Skagit Hydroelectric Project's operation have, to some extent, mitigated the effects of flow fluctuations on spawning and rearing in the upper mainstem, and reduced the impacts of high flood flows by storing runoff from the upper basin. The lower river fall stock enters the river and spawns later than the summer stocks; spawning peaks in October. Age of spawning is primarily 4 years, with significant Age 3 and Age 5 fish. Most summer/fall chinook smolts emigrate from the river as subyearlings, though considerable variability has been observed in the timing of downstream migration and residence in the estuary, prior to entry into marine waters (Hayman et al 1996).

Spring chinook begin entering freshwater in April, and spawn from late July through early September. Adult spring chinook returning to the Suiattle River are predominantly age-4 and age-5 (WDF et al 1993 and WDFW 1995 cited in Myers et al 1998). Glacial turbidity from the Siuattle River and Whitechuck River limit egg survival in the lower Sauk River. Up to 82 percent of the smolts from the Siuattle River, and 45 percent of the smolts from the Sauk River, emigrate as yearlings (WDF et al 1993; WDFW 1995 cited in Myers et al 1998).

Status

Stocks that comprise the summer/fall management unit are depressed. Annual spawning escapement has fallen well below the nominal goal of 14,900 for most of the last ten years (Table 1), and has approached the critical threshold of 4,800 in 1997 and 1999. The geometric mean of the last four years' escapement was 8,833, an increase from the geometric mean of 1992-1996, 7,537 (Myers et al 1998). Recent assessment of freshwater productivity for summer/fall chinook suggests that the current MSY escapement is about 9,000 (NMFS 2000)..

Table 1. Spawning escapement of Skagit River chinook, 1990-1999.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Sauk sum	658	469	205	100	263	1103	295	460	295	576	1103
U Skagt su	3656	5548	4654	4565	5948	7989	4168	11761	3586	13092	10084
L Skag fall	1510	1331	942	884	666	1521	409	2388	1043	3262	2606
S/F MU	5824	7348	5801	5549	6877	10613	4872	14609	4924	16930	13793
Cascade sp		205	168	173	226	208	308	323	83	273	625
Siuattle sp	354	201	292	167	440	435	428	473	208	360	688
Sauk Sp	747	580	323	130	190	408	305	290	180	273	543
Spg MU		986	783	470	856	1051	1041	1086	471	906	1856

Spawning escapements for the spring unit have also been consistently below the nominal goal of 3,000, but have, with the exception of 1994 and 1999, been above the critical threshold of 476 (Hayman 2000). The geometric mean of escapement in 1997 – 2000 was 859.

Harvest distribution

Coded-wire tag recovery data for PSC indicator stocks provide a description of the harvest distribution of Skagit chinook (Table 2), and contrast the differences between summer / fall and spring stocks. Releases from Marblemount Hatchery describe the distribution of spring chinook. The Samish Hatchery fall fingerling releases are believed to provide an accurate surrogate for describing the distribution of Skagit summer / fall chinook. Local summer and fall indicator stocks are being developed. Approximately 45 percent of the mortality of summer / fall chinook has occurred in fisheries in British Columbia and Alaska (i.e. outside the jurisdiction of the Washington co-managers). Few (2 percent) summer / fall chinook are caught in Washington ocean fisheries. Puget Sound net fisheries and Washington sport fisheries accounted for 40 percent and 13 percent, respectively, of total summer / fall fishing mortality. The harvest distribution of spring chinook is markedly different, with about 52 percent of mortality occurring in northern fisheries, while Puget Sound fisheries account for the 7 percent. Washington recreational fisheries account for 30 percent of total mortality.

Table 2. Average harvest distribution of Skagit River chinook, for management years 1996 – 2000, as percent of total adult equivalent fishery mortality (TCChinook 02-3)

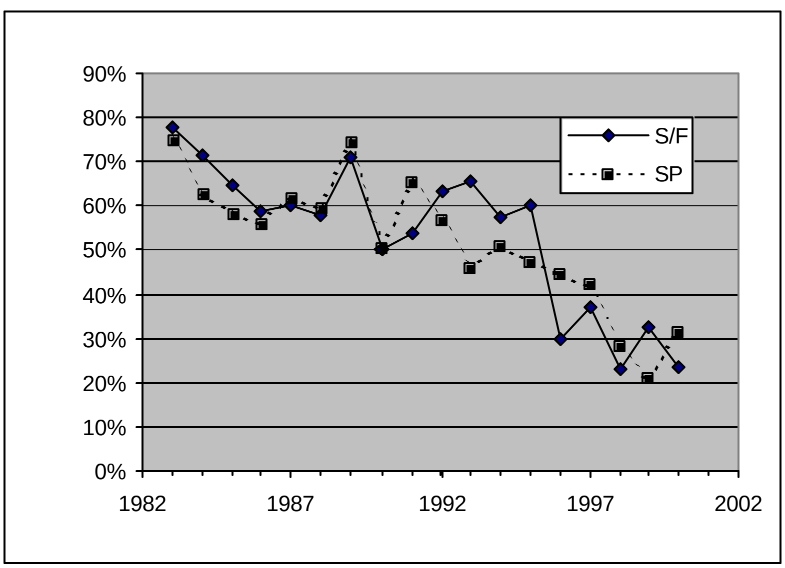
	Alaska	B.C.	Wash. Ocean	Puget Sound Net	Washington sport
Summer Fall	2.3%	43.0%	1.8%	40.2%	12.7%
Spring	1.0%	51.4%	1.2%	7.1%	39.2%

Coded-wire tagged Skagit summer/fall chinook were released in the 1970's, but, since that time, sufficient coded-wire tag recoveries to directly assess the harvest distribution of Skagit summer/fall chinook in recent years are not yet available. However, for PSC analyses, recoveries of marked fall chinook released from the Samish hatchery are believed to represent the pre-terminal harvest distribution of Skagit summer/falls. For the period 1991 – 1996, less than one percent of the total harvest-related mortality of Samish fingerlings occurred in Alaska, and 42 percent in British Columbia fisheries, primarily on the west coast of Vancouver Island and in Georgia Strait. Net fisheries in Puget Sound, and sport and troll fisheries in Washington incurred 30 percent, 20 percent, and 6 percent of total mortality, respectively (CTC 1999). The proportion of mortality in British Columbia fisheries has declined in recent years with the restriction of fisheries on the west coast of Vancouver Island, and other net fisheries.

The harvest distribution of Skagit spring chinook is described by recoveries of tagged yearling smolts released from the Skagit Hatchery. For the period of 1991 – 1996, 52 percent of fishery-related mortality occurred in British Columbia, primarily in Georgia Strait. Washington sport and net fisheries incurred 24 percent and 21 percent of total mortality, respectively.

Exploitation rate trend:
Annual (management year) exploitation rates for Skagit summer/falls, as estimated by the FRAM model with known catch and stock abundance, have fallen 56 percent, from levels in excess of 60 percent in 1983 – 1988, to an average of 29 percent in the last five years (1996-2000). Over the same period, exploitation rates for spring chinook have fallen 47 percent, from similar historical levels to a recent average of 33 percent.

Figure 1. Total adult equivalent fisheries exploitation rate of Skagit summer / fall and spring chinook, estimated from post-season FRAM runs for management years 1983 – 2000.



Management Objectives

The management objectives for Skagit summer/fall and spring chinook include recovery exploitation rates that insure, while maintaining fishing opportunity, that harvest will not impede recovery, and low abundance thresholds that guard against abundance falling below the point of instability (Hayman 1999a; 2000a; 2000b). Recovery exploitation rate objectives were developed to meet the following criteria:

1) The percentage of escapements less than the critical escapement increases by less than 5 percentage points relative to the baseline (i.e., in the absence of fishing mortality).

And either:

2) Escapements at the end of 25 years exceed the recovery level at least 80% of the time;

or

3) The percentage of escapements less than the recovery level at the end of 25 years differs from the baseline by less than 10 percentage points.

The critical escapement is defined as that which would result in a 5 percent probability that the management unit would become extinct (i.e. fall below 100) at the end of ten years. Since a satisfactory method to calculate critical escapement has not been developed, escapement equal to 5 percent of the stock replacement level was chosen (Hayman 1999a). Replacement escapement is based on the current productivity of the management unit, and therefore incorporates parameters that define the Ricker stock / recruit functions for Skagit units, and recent freshwater and marine survival. For the summer / fall and spring units, the critical escapement levels are 1,165 and 220 (Hayman 2000a and 2000b).

The recovery escapement is that current level for which there is a 99 percent probability that the run will persist at viable levels. Put another way, if current exploitation rates and freshwater and marine survival conditions were maintained, the probability that the run would go extinct (i.e., fall below 100) at the end of 100 years would fall below one percent. Recovery escapements were computed by simulating the population dynamics for 100 years, given a recent average brood year exploitation rate and age composition of escapement, for a range of initial escapement levels. Simulations were replicated 2,000 times, until an initial escapement resulted in extinction in fewer than 1 percent of those replicate runs (Hayman 1999a; 2000b). Recovery escapement levels for summer/fall and spring units are 4,700 and 320, respectively.

With the critical and recovery escapement levels established, the population dynamics of the two Skagit units were simulated for 25-year periods into the future. The simulation model incorporated the average age composition and age-specific escapement of the units, and randomly or cyclically varying productivity and management error parameters. Each model run used an input exploitation rate, and was replicated 2000 times. The probabilities of exceeding the recovery escapement level, or falling below the critical escapement level, at the end of the simulation period were computed for each run from the 2000 outcomes. A range of exploitation rates, from 0 to 80 percent, were simulated to determine the maximum exploitation rate at which the conservation criteria were met (Hayman 1999a; 2000b). The Washington co-managers have set an exploitation rate guideline of 54 percent for the Skagit summer/fall management unit, and 54 percent for the spring management unit, as estimated from coded-wire tag recoveries. These management objectives were developed from productivity functions characteristic of brood years of Skagit chinook, and were translated into annual exploitation rates that are output from the FRAM model (Table 4). These exploitation rate objectives are set to be 82 percent of the mean rate from fishing years 1989-1993 for summer/falls, and 76 percent of the 1989 –1993 mean rate for springs (Hayman 2000c). In the event that the FRAM calibration for the 1989 – 1993 fishing years changes, the numerical exploitation rate objectives used in FRAM (or other management model that is used for fishery planning) for Skagit summer/falls and springs will be changed to be 82 percent and 76 percent, respectively, of their re-calibrated 1989 – 1993 rates.

Low abundance thresholds ("crisis escapement levels") were also established for the summer/fall and spring management units. These thresholds are defined as the pre-season forecast escapement for which there is a 95 percent probability that the actual escapement will be above the point of instability, given management error and uncertainty about what level the point of instability is (Hayman 1999a;2000b). The derivation of these thresholds takes into account the difference between forecast and observed escapement in previous years, and variance of the spawner-recruit parameters used to calculate the point of instability, thereby reducing the probability of actual escapement falling below the actual point of stock instability. The derivation involved varying the preseason forecast until the area of overlap between the management error distribution curve and the uncertainty curve about the point of instability is less than 5% of the error distribution curve (Hayman 2000b).

In low-abundance years, when projected spawning escapement (from the FRAM model) fall to the lower thresholds, fisheries managers will implement further conservation measures in fisheries to reduce mortality, as described in Section 3 and Appendix C. For the summer/fall management unit, the critical abundance threshold is 4,800; for the spring management unit, the critical abundance threshold is 576. For the summer/fall unit, critical abundance thresholds have been developed for each component population, so that forecast weakness in any one population may trigger the more conservative harvest regime. The crisis escapement thresholds for Upper Skagit summers, Lower Sauk summers, and Lower Skagit falls are 2,200, 400, and 900, respectively (Hayman 2000a). For spring chinook, data to calculate population-specific critical abundance thresholds are not yet available.

The escapement of individual summer/fall populations may be projected from the aggregate escapement, which is output from the simulation model, in proportion to brood year escapement for each population, or in proportion to estimated age-3 and age-4 adults recruited from their brood-year escapement. Survival rates to compute recruitment will be those implied by the Ricker spawner / recruit function for each population.

The ceiling exploitation rates defined in this plan, which are intended to maximize long-term harvestable numbers and prevent extinction for the Skagit spring and summer/fall management units separately, are consistent with a "no jeopardy" ruling. The jeopardy standards themselves were explicitly used to calculate those rates, and the calculated ceiling rates are comparable to the rates on Skagit summer/fall chinook that were evaluated and approved in the Northern Fisheries Biological Opinion (NMFS 2000), which, depending on abundance, ranged from about 50 to 70 percent. Additional conservatism, beyond that evaluated in the Northern BO, is also provided. Critical abundance threshold escapement levels, below which additional actions would be required, are established for both the spring and summer/fall chinook management units separately, and for each of the three summer/fall populations proposed in WDFW & WWTIT (1994). If it is decided that this management unit is composed of only one population, then the corresponding population-specific escapement thresholds can be deleted from this plan. Regardless, the intent of this plan is to take actions that prevent extinction of individual populations, while maximizing long-term harvestable numbers and achieving ESA jeopardy standards for the two Skagit wild chinook management units

During pre-season fishery planning, the impacts from a proposed fisheries management regime will be simulated, and escapement projected, based on the forecast abundance of all contributing chinook units (including those from British Columbia, the Washington coast, and the Columbia River, as well as those from Puget Sound). If the projected escapement of either management unit, or of any Skagit summer/fall stock falls below the low abundance threshold, further management actions will be triggered to reduce fishing mortality, as described in Section 3 and Appendix C. The FRAM fisheries simulation model, which is currently in use, estimates escapement for the Skagit summer/fall management unit, but that management unit total may be resolved into component stocks in proportion to their forecasted total abundance.

An analysis of how this regime would have functioned if it had been applied in previous years indicates that the exploitation rates would generally have been significantly lower than observed, and that the Appendix C provision would have been triggered in two of the recent years (R. Hayman, Skagit System Cooperative pers comm.)

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions or population dynamics simulations necessary to testing and refining harvest management objectives include:

- Consistent release of coded-wire tagged fingerling summer and fall chinook to enable direct assessment of harvest distribution, and estimation of harvest exploitation rates and marine survival rates;.

- Estimates of natural-origin smolt abundance from spring chinook production areas.

- Estimates of estuarine and early-marine survival for fingerling and yearling smolts.

- Limiting factors on yearling chinook abundance.

Stillaguamish River Management Unit Status Profile

Component Stocks

Stillaguamish summer chinook
Stillaguamish fall chinook

Geographic description

The Stillaguamish River management unit includes summer and fall stocks which are distinguished by differences in their spawning distribution, migration and spawning timing, and genetic characteristics. The summer stock, a composite of natural and hatchery-origin supplemental production, spawns in the North Fork, as far upstream as RM 34.4 but primarily between RM 14.3 and 30.0, and in the lower Boulder River and Squire Creek. Spawning also occurs in French, Deer, and Grant creeks, particularly when flows are high. The fall stock, which is not enhanced or supplemented by hatchery production, spawns throughout the South Fork and the mainstem of the Stillaguamish River (WDF et al 1993), and in Jim Creek, Pilchuck Creek, and lower Canyon Creek. Despite the small overlap in spawning distribution, it is likely that the two stocks are genetically distinct.

Allozmye analysis of the summer stock show it to be most closely related to spring and summer chinook stocks from North Puget Sound, and the the Skagit River summer stocks in particular. The fall stocks align most closely with South Sound MAL, which includes Green River falls and Snohomish River summer and falls.

Life History Traits

Summer run adult enter the river from May through August. Spawning begins in late August, peaks in mid-September, and continues past mid-October. Fall chinook enter the river much later – in August and September. The peak of spawning of the fall stock occurs in early to mid-October, about three weeks later than the peak for the summer stock. The age composition of mature Stillaguamish River summer chinook, based on scales collected from 1985 – 1991 was as follows: 4.9% age-2, 31.9% age-3, 54.7% age-4, and 8.5% age-6 (WDF 1993 cited in HGMP). Juvenile summer chinook produced in the Stillaguamish River primarily (95%) emigrate as sub-yearlings (WDF 1993 cited in HGMP).

Status

WDF et al. (1993) classified both the summer and fall stocks as depressed, due to chronically low escapement. Degraded spawning and rearing habitat currently limit the productivity of chinook in the Stillaguamish River system (PFMC 1997). After analyzing the trends in spawning escapement through 1996, the PSC Chinook Technical Committee concluded that the stock was not rebuilding toward its escapement objective (CTC 1999).

Aggregate spawning escapement for Stillaguamish summer/fall chinook has averaged 1,341 (geometric mean) over the period 1997 – 2001. From 1988 through 1995 escapement ranged from 700 to 950 (except 1991), and since 1995 has ranged from 1100 to 1500. The geometric mean of escapement in the last three years (1999 - 2001) was 1356, which was higher than the mean of 953 from the preceding five years (Myers et al 1998). From 1985 – 1991 the average escapements of summer and fall chinook were 879 and 145, respectively (WDF et al 1993). In the last five years (1997-2001) escapement to the South Fork ranged from 226 – 283), while escapement to the North Fork ranged from 930 to 1403 . Escapement to the North Fork has comprised an average of 82% of total escapement since 1997 (K. Rawson, Tulalip DNR, pers comm., February 10, 2003).

Table 1. Spawning escapement of Stillaguamish summer/fall chinook, 1990-1999.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
North F	486	583	667	599	993	930	1292	845	1403	1066
South F	294	345	287	223	251	226	248	253	243	283
Total	780	928	954	822	1244	1156	1540	1098	1646	1349

The total annual abundance of Stillaguamish summer/fall chinook for the period 1979 – 1995, estimated as potential escapement (i.e. the number of chinook that would have escaped to spawn absent fishing mortality), ranged from 1,300 to 2,500 without showing a clear positive or negative trend (PSSSRG 1997). However, the productivity, as indexed by the trend in MSY exploitation rate, declined substantially through this period.

The summer chinook supplementation program, which collects broodstock from the North Fork return, was initiated in 1986 as a Pacific salmon Treaty indicator stock program, and its current objective is to release 200,000 tagged fingerling smolts per year. Most releases are into the North Fork, via acclimation sites; relatively small numbers of smolts have been released into the South Fork. This supplementation program is considered essential to the recovery of the stock, so these fish are included in the listed ESU. The program contributes substantially to spawning escapement in the North Fork.

Harvest distribution

Recoveries of coded-wire tagged North Fork Stillaguamish summer chinook provide an accurate description of recent harvest distribution. Northern fisheries in Alaska and British Columbia account for about 68 percent of total harvest mortality (Table 2). Washington ocean fisheries account for less than one percent. Washington sport fisheries account for 29 percent of total fisheries mortality.

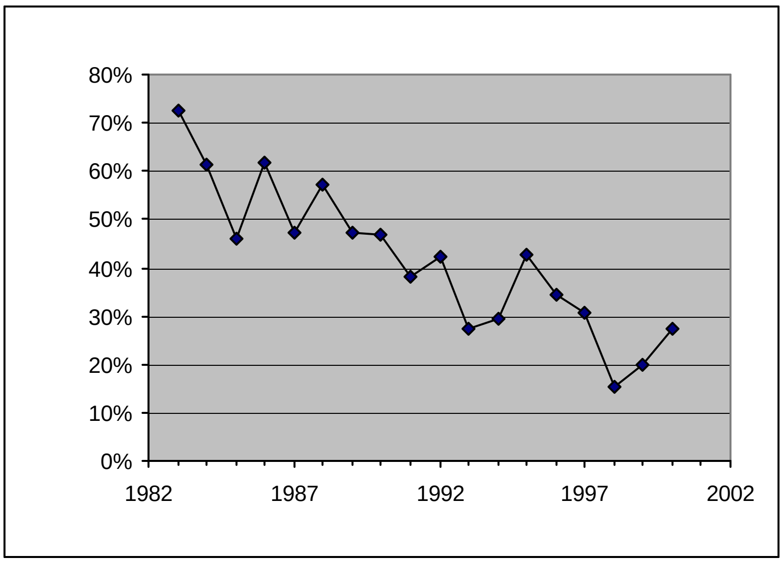
Table 2. The harvest distribution of Stillaguamish River summer chinook, expressed as an average proportion of annual adult equivalent harvest mortality for 1996 - 2000 (TCChinook 02-3).

	Alaska	B.C.	Washington Troll	Puget Sound Net	Washington sport
1996 – 2000	17.8%	50.3%	0.3%	2.6%	29.1%

Exploitation rate trends:

Post-season FRAM runs, incorporating actual catch in all fisheries and actual abundance, indicate that total fishery-related, adult equivalent, exploitation rates for Stillaguamish chinook have fallen 56 percent, from 1983 – 1988 to 1996 – 2000.

Figure 1. Total adult equivalent fishery exploitation rate of Stillaguamish chinook from 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

The management guidelines for Stillaguamish chinook include an exploitation rate objective and a critical escapement threshold. The exploitation rate objective is the maximum fraction of the production from any brood year that is allowed to be removed by all sources of fishery-related mortality, including direct take, incidental take, and non-landed mortality. The exploitation rate is expressed as an adult equivalent rate, in which the mortality of immature chinook is discounted relative to their potential survival to maturity.

Analysis specific to Stillaguamish summer chinook was completed to develop the exploitation rate objective to reflect, to the extent possible, the current productivity of the stock. Brood year recruitment (i.e., number of recruits per spawner) was estimated, for brood years 1986 through 1993, by reconstructing the total abundance of natural origin chinook that were harvested or otherwise killed by fisheries, or escaped to spawn. The resulting brood year recruitment rates were partitioned into freshwater and marine survival rates. The future abundance (i.e. catch and escapement) of the stock was simulated for 25 years, using a simple population dynamics model, under total fishery exploitation rates that ranged from 5 percent to 60 percent. In the model, production from each year's escapement was subjected to randomly selected levels of freshwater and marine survival, and randomly selected levels of management error. Each model run (i.e. for each level of exploitation rate) was replicated one thousand times, and the set of projected population abundances analyzed to determine the probability of achieving the management objectives. The simulation for Stillaguamish summer chinook, across a range of exploitation rates (Table 3), indicated that total exploitation rates below 0.35 met the recovery criteria.

Table 3. Summary of results of 1,000 runs of the simulation model at each exploitation rate.

Exploitation Rate	Probability of Falling below critical	Probability of recovery	Median Escapement ratio	Median Escapement
0.00	1%	96%	2.75	3,597
0.05	1%	96%	2.81	3,377
0.10	1%	96%	2.76	3,165
0.15	2%	95%	2.66	2,964
0.20	2%	95%	2.56	2,758
0.25	3%	93%	2.57	2,418
0.30	4%	92%	2.48	2,210
0.35	6%	92%	2.46	1,920
0.40	7%	91%	2.29	1,686
0.45	11%	87%	2.14	1,444
0.50	17%	80%	1.92	1,180
0.60	41%	52%	1.04	648
0.70	73%	12%	0.27	259
0.80	94%	0%	0.02	55

The fishery management objectives for the 2000 management year was to realize an exploitation rate that, if imposed consistently over a future time interval

- would not increase the probability that the stock abundance would fall below the critical escapement threshold, after 25 years, by more than five percentage points higher than were no fishing mortality to occur; and

- would result in at least an 80 percent of greater probability of the stock recovering (i.e. escapement exceeding the current level) after 25 years.

Stock recovery, for this analysis, was defined as the average spawning escapement for the final three years in the simulation period exceeding the average for the first three years in the simulation period (Rawson 2000).

At the present time, there is very little information concerning the productivity of the Stillaguamish fall stock other than the fact that the average abundance of this stock has been approximately 50% of the Stillaguamish summer stock based on relative escapement. Incorporating this lower estimate of abundance, and assuming the same productivity (i.e. recruitment rates), the simulation model predicted that exploitation rates below 35% met the first management objective. The probability of rebuilding at this exploitation rate was 96%. This analysis indicates that a target exploitation rate of 0.35 would also be appropriate for the Stillaguamish fall stock.

The Washington co-managers have set an exploitation rate guideline of 0.25, as estimated by the FRAM simulation model, for the Stillaguamish chinook management unit. According to the simulation model this level of exploitation results in a 4 percent risk of the stocks falling below the critical escapement threshold of 500, and affords a 92 percent probability of recovery (i.e., that spawning escapement will exceed the current average level).

The critical abundance threshold for North Fork Stillaguamish chinook is 500 natural-origin spawners. Reconstruction of the total brood abundance of adult Stillaguamish chinook suggests that escapements of 500 (+/- 50) can result in recruitment rates ranging from two to five adults per spawner (Rawson 2000). The genetic integrity of the stock may be at risk and depensatory mortality factors may affect the stock when annual escapement falls below this threshold to 200 (NMFS BO 2000). The critical threshold for South Fork Stillaguamish chinook is undetermined pending further analysis of data. The critical abundance threshold for the Stillaguamish management unit is based on the 1996-2002 average fraction of the natural escapement for the years 1996-2002 that was in the North Fork. This average was .813 (range: .770 - .852). Thus a management unit escapement of 500/.813 = 615 would, on average, include 500 North Fork fish. The range of management unit escapement thresholds computed this way is 586 to 649. Based on this, we have selected a management unit critical escapement threshold of 650 for the Stillaguamish for 2003. Whenever spawning escapement is projected to be below this level, fisheries will be managed to either achieve the total exploitation rate determined by the Minimum Fisheries Regime (Appendix C), or exceed the critical threshold escapement.

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions or population dynamics simulations necessary to testing and refining harvest management objectives include:

- Spawning escapement estimates that include variance for summer and fall stocks
- Estimates of natural-origin smolt production (freshwater survival to the estuary)

Snohomish River Management Unit Status Profile

Component Stocks

The stock structure of summer/fall chinook in the Snohomish basin is based on the report of the Puget Sound TRT (2001) suggesting that there are two populations of summer/fall chinook in the Snohomish basin. The comanagers have reviewed this report along with additional information, and have tentatively concluded that the former four-stock structure of Snohomish chinook should be revised to conform to the TRT's population structure.

Summer/fall chinook management unit

Skykomish
Snoqualmie

Geographic description

Skykomish chinook spawn in the mainstem of the Skykomish River, and its tributaries including the Wallace and Sultan Rivers, in Bridal Veil Creek, the South Fork of the Skykomish between RM 49.6 and RM 51.1 and above Sunset Falls (fish have been transported around the falls since 1958), and the North Fork up to Bear Creek Falls (RM 13.1). Relative to spawning distribution in the 1950's, a much larger proportion of summer chinook currently spawn higher in the drainage, between Sultan and the forks of the Skykomish (SBSRTC 1999). There is some indication that spawning in the North Fork has declined over the last twenty years (SBSRTC 1999). Fish spawning in Snohomish mainstem and the Pilchuck River are currently considered to be part of the Skykomish stock pending further collection of genetic stock identification data.

Snoqualmie chinook spawn in the Snoqualmie River and its tributaries, including the Tolt River, Raging River, and Tokul Creek). There is some uncertainty whether a spring chinook stock once existed in the Snohomish system. Suitable habitat may still exist in the upper North Fork, above Bear Creek Falls.

Life History Traits

Summer chinook enter freshwater from May through July, and spawn, primarily, in September, while fall chinook spawn from late September through October. However, fall chinook spawning in the Snoqualmie River continues through November. The peak of spawning in Bridal Veil creek is in the second week of October (i.e. slightly later than the peak for fish spawning in the mainstem of the Skykomish. Natural spawning in the Wallace River occurs throughout September and October (WDF et al 1993).

The age composition of returning Snoqualmie River fall chinook showed a relatively strong age-5 component (28 percent), relative to other Puget Sound fall stocks. Age-3 and age-4 fish comprised 20 and 46 percent, respectively, of returns in 1993 – 1994 (WDFW 1995 cited in Myers et al 1998).

Most Snohomish summer and fall chinook smolts emigrate as underyearlings, but, based on scale data, an annually variable, but relatively large, proportion of smolts are yearlings. Of the summer chinook smolts sampled in 1993 and 1994, 33 percent were yearlings (WDFW 1995 cited in Myers et al 1998). Based on scale data, 25 to 30 percent of returning fall chinook also showed a stream-type life history (SBSRTC 1999). No other summer or fall chinook stocks in Puget Sound produces this high a proportion of yearling smolts. Rearing habitat to support yearling smolt life history is vitally important to the recovery of these stocks.

Management Unit / Stock Status

Total natural spawning escapement of Snohomish summer/fall stocks has ranged between 2,700 and 8,200 over the last ten years, and has exceeded the 1968-1979 average of 5,237 only three times since 1980: in 1998, 2000, and 2001 (Table 1). However, due in part to reduced exploitation rate, escapement has, rebounded from the levels less than 4,000 observed in the early 1990's. Escapement of the Skykomish stock was below 1,000 through most of the 1990's, and fell to an historic low of 263 in 1997. In contrast, escapement of chinook in the Snohomish and Snoqualmie rivers has increased in recent years, with natural-origin fish comprising more than 90% of the fish on the spawning grounds. Escapement of the Bridal Veil stock, however, has declined, based on counts at Sunset Falls (SBSRTC 1999). Returns to Wallace River have also declined to an average of less than 500. Otolith analysis indicates that 60 percent of the natural spawners in 1997 were hatchery-origin fish (SBSRTC 1999).

Table 1. Natural spawning escapement of Snohomish summer/fall chinook, 1990-2001.

	Snoqualmie	Skykomish	Total
1990	1277	2932	4209
1991	628	2192	2820
1992	706	2002	2708
1993	2366	1653	4019
1994	728	2898	3626
1995	385	2791	3176
1996	1032	3819	4851
1997	1937	2355	4292
1998	1892	4412	6304
1999	1344	3455	4799
2000	1427	4665	6092
2001	3589	4575	8164
average	1443	3146	4588
average %	31.4%	68.6%	

Harvest distribution and exploitation rate trends:

The harvest distribution and exploitation rate for Snohomish summer/fall chinook have been assessed, however lack of representative tagged production from this Snohomish system has necessitated basing the analysis on the chinook harvest model used by the Chinook Technical Committee of the Pacific Salmon Commission. This analysis indicates that total exploitation rate has declined more than thirty percentage points from levels in 1983 – 1988 between 50 and 70 percent to an average of 30 percent for 1996 – 2000. (Table 2).

Table 2. Total, adult equivalent exploitation rates for Snohomish summer/fall chinook

Brood Year	AEQ ER
1979	0.78
1980	0.75
1981	0.71
1982	0.66
1983	0.62
1984	0.63
1985	0.67
1986	0.66
1987	0.64
1988	0.59
1989	0.54
1990	0.54
1991	0.55
1992	0.47
1993	0.27
1994	0.21

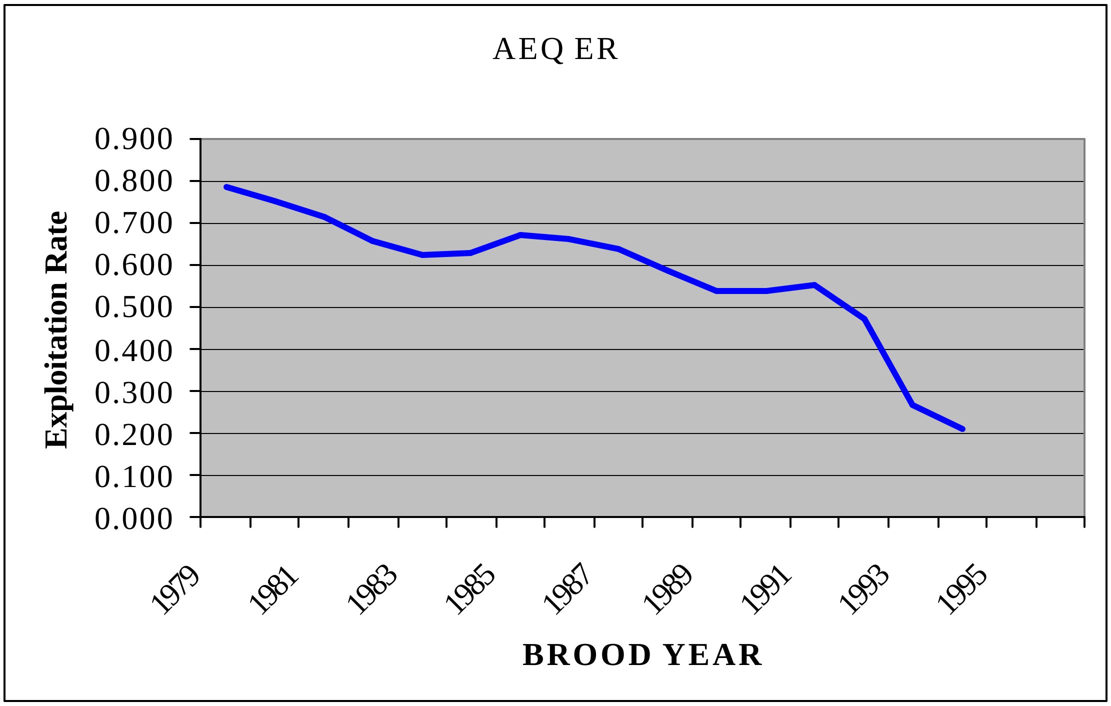
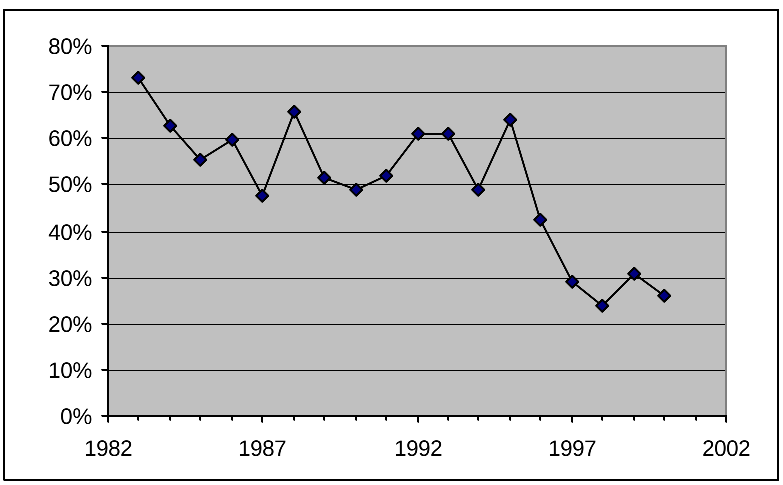


Figure. 1. Total annual ,adult-equivalent, fishery-related exploitation rate of Snohomish River chinook, from 1983 – 2000, estimated by post-season FRAM runs.



Harvest-related mortality in fisheries in British Columbia and Alaska , accounted for 25 percent of the total mortality. About six percent of mortality occurs in Washington ocean fisheries under the purview of the PFMC. Puget Sound pre-terminal fisheries account for the majority of impact (55 percent), while terminal-area fisheries in Area 8A and 8D account for 14 percent (Table 3).

Table 3. Harvest distribution of Snohomish summer/fall chinook – average of management years 1996 – 2000 (), estimated from post-season FRAM runs.

	Alaska	B.C.	Wash Ocean	Puget Sound Pre-Terminal	Puget Sound Terminal
1996 – 2000	1.7%	23.2%	6.2%	54.8%	14.1%

Table 4. Harvest distribution of Snohomish summer/fall chinook – average of brood years 1980 – 1986 (PSSSRG 1992).

Brood years	Alaska	B.C.	PFMC	Puget Sound troll	North Puget Snd net	Other Puget Sound net	Puget Sound sport
1980-86 avg	4.6%	59.3%	0%	2.2%	2.0%	8.3%	23.5%

Through this same period, the total production of Snohomish chinook was declining steadily. The potential escapement, which represents the annual abundance (catch plus escapement) fell from 25,000 in 1980 to about 6,000 in the early 1990's. Increasingly constrained fishing failed to reverse this trend, which has been attributed to declining freshwater and marine survival (PSSSRG 1997, WDF et al 1993). The SASSI review, WDF et al (1993) concluded that Snohomish summer and fall stocks were depressed. The comanagers are currently updating their assessment of the status of the Skykomish and Snoqualmie stocks using the new stock delineation and more recent data.

Management Objectives

Management objectives for Snohomish summer/fall chinook include an upper limit on total exploitation rate, to insure that harvest does not impede the recovery of the component stocks, and a critical threshold for spawning escapement to maintain the viability of the stocks.

Fisheries will be managed to achieve a total, adult equivalent exploitation rate, associated with all coastal fisheries, not to exceed 24 percent.

Lacking direct information on the extent to which the current fisheries regime may disproportionately harvest any single stock, the spawning escapement of each stock will be carefully monitored for indications of harvest impact. Average escapement during the period of 1965 – 1976 will be the benchmark for this monitoring (SMSRTC 1999).

The Puget Sound Salmon Management Plan (1985) mandated that fisheries will be managed to achieve maximum sustainable harvest (MSH) for all primary natural management units. The recovery exploitation rate is likely to be lower than the rate associated with MSH under current conditions of productivity. The conservatism implied by the recovery exploitation rate imbues caution against the potential size and age selectivity of fisheries, and the effects of that selectivity on reproductive potential, and potential uncertainty and error in management.

Low Escapement Threshold for Management

A low escapement threshold of 2,800 spawners (natural origin, naturally spawning fish) for the management unit is established as a reference for pre-season harvest planning. If escapement is projected to fall below this threshold under a proposed fishing regime, extraordinary measures will be adopted to minimize harvest mortality. Directed harvest of Snohomish natural origin chinook stocks, (e.g., net and sport fisheries in the Snohomish terminal area or in the river) has already been eliminated in Washington. Further constraint, thus, depends on measures that reduce incidental take.

The low escapement threshold for the management unit was derived from critical escapement thresholds for each of the Snoqualmie, Skykomish, and Bridal Veil populations in a two step process. First, for each population, the critical escapement threshold was expanded to a critical level for management according to the following formula

$$E_{man,p} = E_{crit,p} / [(R/S)_{low,p} * (1-RER_{mu})]$$

Where $E_{man,p}$ is the lower management threshold for population ***p;***
$E_{crit,p}$ is the critical threshold for population *p;*
$R/S_{low,p}$ is the average of recruits/spawner for population ***p*** under low survival conditions; and
RER_{mu} is the RER established for the management unit

The following describes the $\boldsymbol{E_{man,p}}$ for the Snoqualmie and Skykomish stocks within the Snohomish management unit. The following analysis is based on estimates of natural spawning escapement to the Snohomish system, by population, for the most recent twelve years (Table 5).

Based on three years of data from intensive sampling of chinook carcasses in the Snohomish system for thermally marked otoliths from local hatcheries, it is possible to estimate the natural origin component of each of the escapement estimates in Table 4 (K. Rawson, unpublished data and analysis). These estimates are reproduced below in Table 5. The estimates in Table 5 are likely to be modified once additional years of otolith samples are available.

Table 5. Estimated natural origin (NOR) component of natural escapement for Snohomish chinook salmon stocks and total management unit based on estimates of hatchery contribution to natural spawning populations from 1997-2001 (K. Rawson, unpublished data and analysis).

	Estimated NOR Escapement		
	Skykomish	Snoqualmie	Total
1990	2551	1111	3661
1991	1951	496	1447
1992	1642	600	2242
1993	942	2248	3190
1994	1478	561	2039
1995	1144	108	1252
1996	1719	660	2379
1997	1696	1821	3517
1998	1500	1419	2919
1999	1382	1048	2430
2000	1773	1127	2900
2001	3052	2817	5869

Snoqualmie
The critical threshold was set at 400 natural origin spawners. The smallest value for estimated NOR spawners in this system since 1990 (Table 5) is only 108 in 1995. However, it is likely that spawner survey conditions were very poor in 1995 due to high flows during the chinook spawning season and the flashy pattern of flows (C. Kraemer, WDFW, personal communication). Therefore, the 1995 spawning escapement estimate for the Snoqualmie is considered to be an extreme underestimate. We chose a value of 400 as a low level of NOR spawners that has produced positive returns in the past and is in excess of the VSP recommended level. The low escapement threshold for management purposes was derived by the same method used for the Stillaguamish summers (Rawson 2000):

$$\frac{E_{crit}}{(R/S)_{low}} = \frac{400}{(1.01)*(1-.24)} = 521$$

The average lowest R/S was 1.01 (1987, 1990-1992) and the exploitation rate objective is 24% (see below). The low R/S buffers against years of low productivity and the exploitation rate objective buffers against escapements falling below the critical escapement threshold under the maximum allowable exploitation rate regime.

Skykomish

The critical threshold was set at 942 natural origin spawners based on the smallest observed value since 1990 and a generally increasing escapement trends since then. Estimated natural origin escapements since 1990 have generally been higher than what would be considered critical (range = 942-3052). The 1990-2001 median total natural escapement has been 1,321 (789 NOR). The low escapement threshold for management purposes was set at 1745, using the method described above for the Snoqualmie. The average lowest R/S was 0.71, and the exploitation rate objective was again 24%.

Maximum Exploitation Rate Guideline

INTRODUCTION

The recovery exploitation rate (RER) is the highest allowable ("ceiling") exploitation rate for the population under normal conditions of stock abundance. This rate is designed to meet the objective that, compared to a hypothetical situation of zero harvest impact, the impact of harvest under this plan will not significantly impede the opportunity for the population to grow towards the recovery goal. Since recovery will require changes to harvest, hatchery, and habitat management and since this plan only addresses harvest management, we cannot directly evaluate the likelihood of this plan's achieving its objective. Therefore, we evaluate the RER based on Monte Carlo projections of the near-term future performance of the population under current productivity conditions, in other words, assuming that hatchery and habitat management remain as they are now.

We choose the RER such that the population is unlikely to fall below a lower abundance threshhold[1] (LAT) and likely to grow above an upper abundance threshold (UAT). The LAT is chosen as the smallest previously-observed escapement from which there was a greater than 1:1 return per spawner, while the UAT is chosen as the smallest escapement level such that the addition of one additional spawner would be expected to produce less than one additional future recruit under current conditions of productivity. This level is also known as the maximum sustainable harvest (MSH) escapement. It is extremely important to recognize, though, that under this plan the UAT is not an escapement goal but rather a level that is expected to be exceeded most of the time. It is also the case that, should the productivity conditions for the population improve, the UAT will increase and the probability of exceeding the UAT using the RER computed for current conditions will also increase over the probability computed under current conditions. Thus the UAT serves as a proxy for the true goal of the plan, which can only be evaluated once we have information on likely future conditions of habitat and hatchery as well as harvest management.

[1] Note that, there are other provisions of this plan that call for further reduction of the exploitation rate ceiling ahould the abundance be observed or expected to be near the lower threshold. This will provide additional protection against falling below the lower threshold that is not considered in this section, which address only the conditions under which the RER would apply.

It also follows from the above that the actual harvest from the population under this plan will be much less than the maximum sustainable harvest amount. All sources of fishing-related mortality are included in the assessment of harvest, and nearly 100% of the fishing-related mortality will be due to non-retention or incidental mortality and only a very small fraction due to directed fishing.

There are two phases to the process of determining an RER for a population. The first, or model fitting phase, involves using recent data from the target population itself, or a representative indicator population, to fit a spawner-recruit relationship representing the performance of the population under current conditions. Population performance is modeled as

$$R = f(S, \mathbf{e}),$$

where S is the number of fish spawning in a single return year, R is the number of adult equivalent recruits[2], and **e** is a vector of environmental, density-independent correlates of annual survival.

Several data sources are necessary for this: a time series of natural spawning escapement, a time series of total recruitment, age distributions for both of these, and time series for the environmental correlates of survival. In addition, one must assume a functional form for f, the spawner-recruit relationship. Given the data, one can numerically estimate the parameters of the assumed spawner-recruit relationship to complete the model fitting phase.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to project the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the environmental correlates. Also, since fishing-related mortality is modeled in the projection phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed "management error" and its distribution, as well as the others are estimated from available recent data.

We used the viability and risk assessment procedure (VRAP, N J Sands, in prep.) for the projection phase. For each trial RER the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the LAT and the fraction of runs for which the final year's escapement is greater than the UAT. Trial RERs for which the first fraction is less than

[2] Equivalently, this could be termed "potential spawners" because it represents the number of fish that would return to spawn absent harvest-related mortality.

5% and the second fraction is greater than 80% are considered acceptable for use as ceiling exploitation rates for management under this plan.

MODEL FITTING PHASE

Fishery Rates

Preterminal

Fishery rates were based on an aggregate of Puget Sound summer/fall chinook hatchery indicator stock populations (Stillaguamish, Green, Grovers, George Adams, Nisqually, Samish). There is currently no indicator stock for the Snohomish populations and no direct measure of fishery exploitation on the wild populations. We evaluated two options for estimating fishery rates on the Snohomish populations: 1) an aggregate of Puget Sound summer/fall chinook hatchery coded-wire-tag (CWT) indicator stocks using the Pacific Salmon Commission Chinook Technical Committee (CTC) exploitation rate indicator stock analysis (need a reference); 2) estimates from the CTC chinook model (need a reference). Option 1 uses CWT recoveries from individual years to reconstruct the fishery rates for that year, but is dependent on a consistently high rate of catch and escapement sampling to make precise estimates. Also, it is possible that the Snohomish populations may not have the same distribution as the populations within the aggregate. Under Option 2, the CTC model uses CWT recoveries from the Stillaguamish indicator stock during the 1979-1982 base period to estimate fishery exploitation on the Snohomish population in subsequent years so estimates are less subject to year-year variability in sampling rates. Several of the managers also felt the CTC model estimates better reflected the pattern of reduced overall exploitation they expected to see in the early 1990's in response to more restrictive fishing regimes. Again, it is possible that the distribution and exploitation of the Stillaguamish and Snohomish populations are different.

After further evaluation, we chose option 1 because we determined that, for the purposes of deriving an RER, year specific fishery rates would be better than estimates derived from a base period based on a limited number of Stillaguamish CWT recoveries. Option 1, by using an aggregate set of populations, maximizes the use of the available data and smoothes differences in any one year associated with a particular population. Also, we were able to address most of the concerns we had with option 1. Puget Sound summer/fall chinook populations, in fact, show similar patterns of exploitation in preterminal fisheries, so one could reasonably expect the Snohomish summer/fall populations to follow a similar pattern. In addition, catch and escapement sampling for most of the populations within the aggregate meet or exceed their target sampling rates in most years. Therefore, the aggregate was used as a surrogate to represent the Snohomish populations in preterminal fisheries. Fishery rates were derived from the CTC CWT exploitation rate analysis for each population in the aggregate and averaged across all populations for each year for which data were available.

The average CTC CWT exploitation rate analysis for fall indicator stocks by age was used for brood year 1979 to 1994, ages 2-4 for brood year 1995 and ages 2-3 for brood year 1996. The 1995 age 5+ fishery rate was based on an average of the 1993-94 rates. The 1996 ages 4-5+ were based on an average of the 1994-1995 rates because the current CTC CWT exploitation rate analysis is not complete for these ages for these brood years. However, available data for ages 2 and 3 indicate fishery rates were similar in 1994-1996. Fishery rates will continue to be updated as data become available.

Terminal

"Terminal" area fisheries include mature chinook harvested in net fisheries throughout Puget Sound and in recreational fisheries in the Snohomish River system and Area 8D. The in-river recreational fishery harvest is partitioned into natural and hatchery-produced components based on the relative magnitudes of the escapement to natural areas and to the Wallace River Hatchery.

The stock composition of the Area 8D recreational and net harvest is estimated using results of recoveries of thermally-marked otoliths from Tulalip hatchery. The otolith recoveries are used to estimate the Tulalip hatchery contribution to this fishery for the brood years from 1997 on (Rawson, Kraemer, and Volk 2001), which is subtracted from the total catch. The remaining catch is partitioned into components based upon the relative run strengths of the Stillaguamish and Snohomish chinook returns to their rivers. In particular, the Snohomish natural fraction is estimated as the Snohomish natural escapement plus the Snohmish natural portion of the in-river recreational harvest divided by the sum of the escapements to the Stillaguamish and Snohomish Rivers and the in-river harvests of chinook in those rivers. For years before 1997 the procedure is the same, except that the proportional contribution of Tulalip hatchery fish to Area 8D is assumed to be the average of the values measured for 1997-2001.

The stock composition of the Area 8A net harvest is estimated using the relative proportions of all the Stillaguamish/Snohomish stocks passing through Area 8A. Only chinook harvested during the so-called "adult accounting period" of July1 through September 30 are included in this analysis. Other chinook harvested in Area 8A are part of the preterminal fishing rate. In particular, the Snohomish natural fraction is the sum of the Snohomish natural escapement, the Snohomish natural fraction of the in-river harvest, and the Snohomish natural fraction of the 8D harvest, divided by the sum of the total escapement and harvest in both rivers plus the Area 8D harvest and escapement to Tulalip hatchery.

To the three harvest components computed above (in-river, 8D, and 8A) the harvest of mature Snohomish natural chinook in Puget Sound net fisheries outside of Area 8A must be added. This computation was completed using coded-wire tag recoveries by Jim Scott and Dell Simmons of the CTC. The terminal, or mature fishery, fishing rate is then the sum of the harvest in the four components divided by the numerator plus the Snohomish natural escapement.

Maturation Rates

We also considered two options for the maturation rates (the fraction of each cohort): 1) maturation rates derived from age data collected from scales and otoliths from the spawning grounds combined with the age-specific fishing rates described above; 2) estimates derived from the CTC model for the Snohomish model population. In general, fish matured at older ages under option 1 than option 2, and no fish matured as two year olds. We decided to use option 1 because it is a more direct measure of the age structure of the spawners.

However, we identified two potential concerns that should be taken into account when using the data: 1) age 2 fish are generally underrepresented in spawning ground samples for several reasons: e.g., carcasses decay faster, the smaller body size makes them more susceptible to being washed downstream, they are less visible to samplers; and 2) only one year, 1989, had a sufficient number of samples to use. The age structure for other years was extrapolated from 1989 by using the 1989 age composition to reconstruct brood year and calendar year escapements by age. The age structure is then adjusted to minimize the difference between the estimated calendar year escapements and the observed calendar year escapements for each year for which data are not available.

Hatchery Effectiveness

No adjustments were made for the relative fecundity of naturally-spawning hatchery-produced fish as compared with natural-origin fish, since there is no available data for the effectiveness of hatchery spawners in the wild when compared with their natural origin counterparts for Puget Sound chinook. For the RER analysis, we assumed all spawners were equally fecund regardless of their origin. This is a conservative assumption since it would tend to underestimate productivity and therefore the resulting RER, minimizing the possibility of adopting a harvest objective that was too high (Table 6.)

Table 6. Intrinsic Productivity (MSY Exploitation Rate) by Production Function for the Skykomish chinook population

Hatchery Effectiveness	Ricker	Beverton-Holt	Hockey Stick
Hatchery not Effective	7.58 (49%)	14.14 (65%)	8.07 (77%)
Hatchery Half as Effective	6.26 (52%)	8.34 (65%)	4.55 (63%)
Equal Effectiveness	5.49 (47%)	6.51 (53%)	3.66 (51%)

Spawner-recruit Models

The data were fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1975), Beverton-Holt (Ricker 1975), and hockey stick (Barrowman and Myers 2000). The simple forms of these models were augmented by the inclusion of environmental variables correlated with brood year survival. For marine survival we used an index based on the common signal from a several chinook coded-wire tag groups released from Puget Sound hatcheries (J Scott, Washington Department of Fish and Wildlife, personal communication). We tried two indices: one (PS6) used tag groups from throughout Puget Sound; the other (NPS2) used coded wire tags from North Puget Sound hatcheries only. The other environmental correlate, associated with survival during the period of freshwater residency, was the September-March peak daily mean stream flow during the fall and winter of spawning and incubation.

Equations for the three models are as follows:

$$(\mathbf{R} = \mathbf{aS}e^{-\mathbf{bS}})(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [Ricker]

$$(\mathbf{R} = \mathbf{S}/[\mathbf{bS} + \mathbf{a}])(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [Beverton-Holt]

$$(\mathbf{R} = min[\mathbf{aS}, \mathbf{b}])(\mathbf{M}^{\mathbf{c}}e^{\mathbf{dF}})$$ [hockey stick]

In the above, M is the index of marine survival and F is the freshwater correlate, peak Sep-Mar mean daily flow in this case.

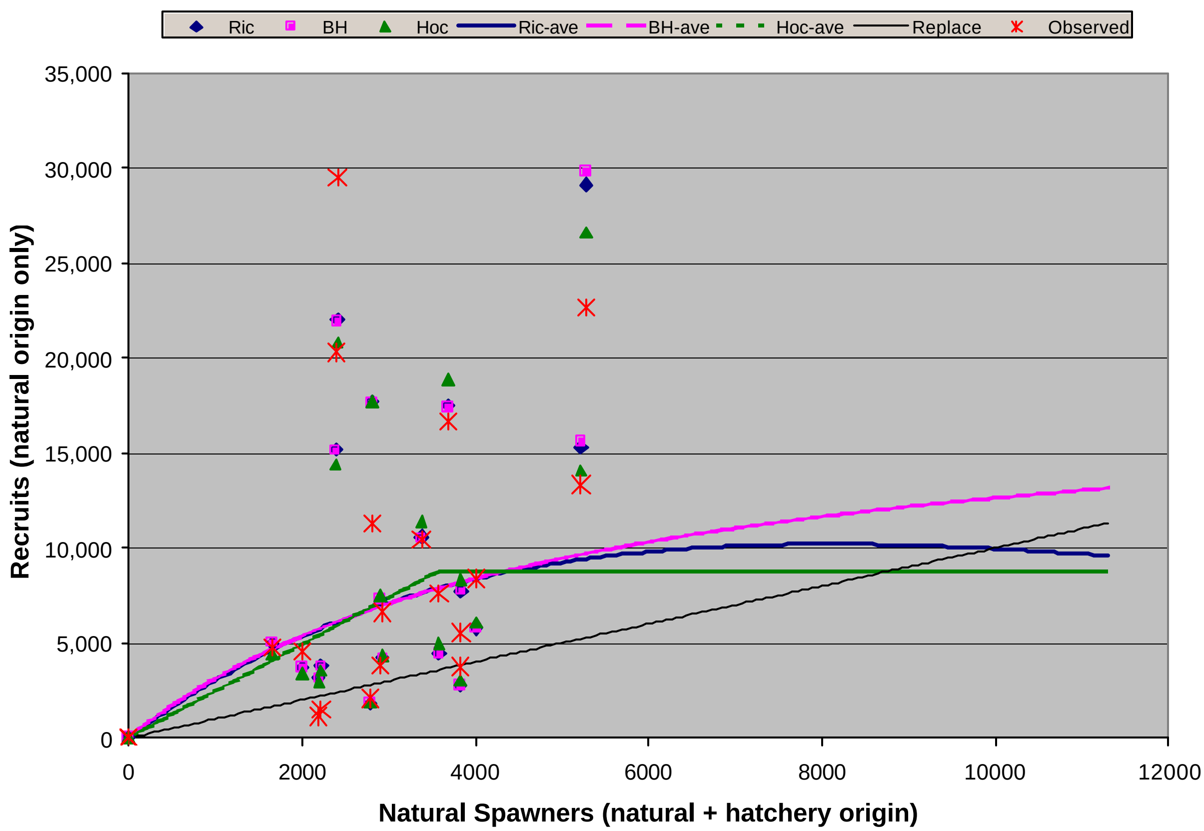
Data used for the Skykomish Population

The Skykomish RER was based on analyses of the 1979-1996 brood years. Uncertainty about accuracy of escapement data and completeness of catch data precluded use of data before 1979. The 1996 brood year was the last year for which data were available to conduct a complete cohort reconstruction. There was no evidence of depensation or of a time trend in the data after adjustment for environmental variables.

Results

The results of model fitting for various combinations of environmental correlates are summarized in Appendix Table 1. We used the parameter from the fits using the NPS2 marine survival index and using both the marine and freshwater environmental correlates (upper right corner of the appendix table).

Figure 1. Comparison of observed and predicted recruitment numbers for the Skykomish chinook populations, brood years 1979 – 1996, under three different models of spawner / recruit relationship. See text for further explanation.



PROJECTION PHASE

We projected the performance of the Skykomish stock at exploitation rates in the range of 0 to .30 at intervals of .01 using the fitted values of a, b, c, and d for the three spawner-recruit models. All projections were made assuming low marine survival using the average and variance of the marine survival indices observed for the most recent 10-year period. The freshwater environmental correlate (peak winter flow) was projected using the average and variance observed for the entire period used in the model fitting phase. Projections were run for target exploitation rates varying from 0 to .50, in increments of .01. The lower abundance threshold (LAT) was 1,745, derived as described above. The upper abundance threshold was the MSH escapement level (also described above). This biological reference point varies with the assumed marine survival and also with the particular form of the spawner-recruit relationship. We used the average marine survival index for the low marine survival period to obtain the UAT for each spawner-recruit function. These values were: 3,500 – Ricker, 3,600 – Beverton-Holt, and 3,600 – hockey stick.

For each combination of spawner-recruit relationship and exploitation rate we ran 1000 25-year projections. Estimated probabilities of exceeding the UAT were based on the number of simulations for which the final spawning escapement exceeded the UAT. Estimated probabilities of falling below the LAT were based on the number of years (out of the total of 25,000 individual years projected for each combination) that the spawning escapement fell below the LAT. For each spawner-recruit relationship the sequence of Monte Carlo projection running through the exploitation rate range from 0 to .30 started with the same random number seed so that the results for the different spawner-recruit models would be copmparable.

Detailed results of these projections are in Appendix 2, and summarized results are in Table 7. Indicated target exploitation rates are 0.25 – Ricker, 0.27 – Beverton-Holt, and 0.22 – hockey stick. Since there is no basis to choose one of these models over the other, we propose to use the average of these values as the target exploitation rate. This average is 0.24, rounding down to the nearest whole percentage exploitation rate.

Table 7. Results of the VRAP projections of the Skykomish chinook stock under current conditions showing the indicated target exploitation rate for each form of the spawner-recruit relationship.

	Target	#fish	%runs	%yrs	%runs	1st	LastYrs
Model	ER	Mort.	extnct	<LEL	end>UEL	Year	Ave.
Ricker	0.25	1671	0	4.0	80.0	2123	5711
Beverton-Holt	0.27	1889	0	4.5	80.3	2084	6149
Hockey-Stick	0.22	1427	0	3.0	81.3	2172	5747

Management unit exploitation rate and lower escapement threshhold

The management unit maximum exploitation rate was set at .24, which is the average of the maximum allowable rates computed for the Skykomish stock using the three different spawner-recruit relationships. This is assumed to provide the appropriate protection to both populations. It was not possible to obtain a fit of the Snoqualmie data to any of the spawner-recruit models, with or without the use of environmental correlates. It is believed that this is due to the fact that some of the escapement estimates for the Snoqualmie are unreliable, and biased low, due to poor visibility in some years.

The lower escapement threshold for management was set starting with critical escapement levels, expands these to per population management thresholds, and expands again to a management unit threshold based on the average contribution of each population to the management unit's escapement.

The second step in deriving the management unit lower threshold was to expand each stock's lower management threshold by dividing the percentage of the total escapement that the stock is expected to comprise.

We can then compute the total system escapement required such that we expect each stock to achieve its lower escapement management threshold by dividing the percentage of the total escapement the stock is expected to comprise. The expected percentages of each stock came from the recent 12-year escapement breakout by stock (Table 5). Averaging the ratios of the two stocks' estimated NOR escapements over the twelve years gives an average Snoqualmie fraction of 37.7% of the total.

Table 8. Derivation of the lower management threshold for each Snohomish chinook population and the management unit escapement necessary to achieve this level for each population.

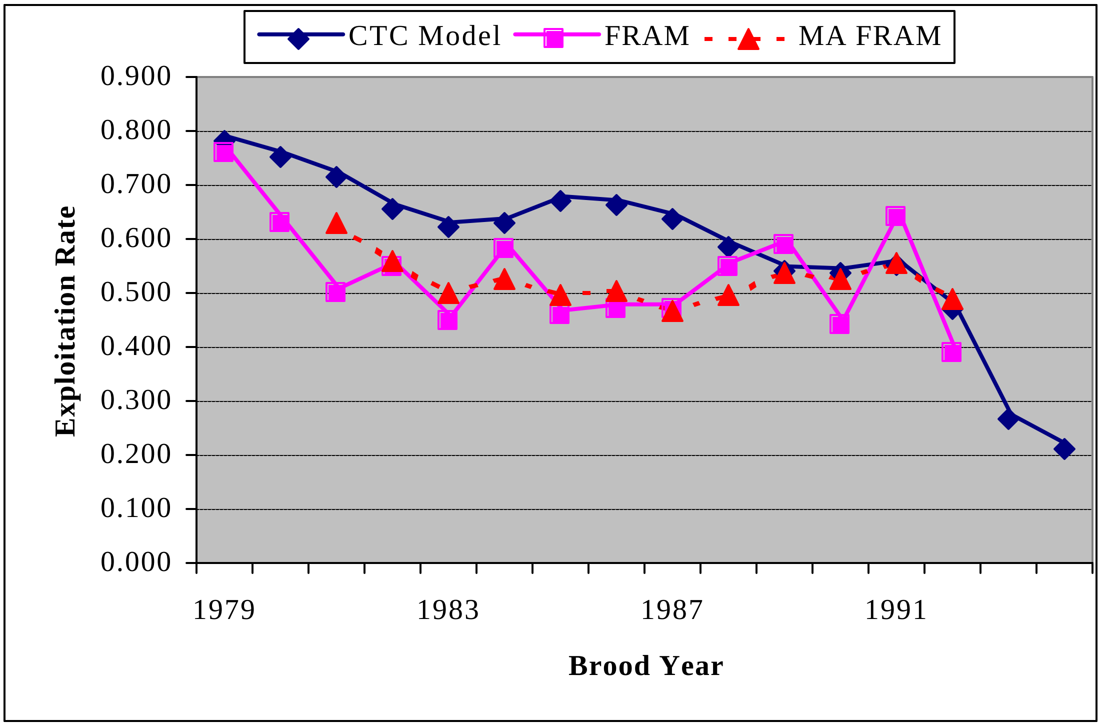
	Snoqualmie	Skykomish
Critical level	400	942
Low R/S	1.01	0.71
Exp. rate	.24	.24
Low threshold	521	1745
Implied MU LT	1,381	2,802

The maximum of the management unit lower thresholds required to achieve the lower thresholds for the two stocks is 2,800, which was chosen as the management unit lower threshold for management planning purposes. Because this is so much higher than the indicated management threshold for protection of Snoqualmie escapement, this plan is providing extra protection to the Snoqualmie stock pending acquisition of better escapement data.

Interpretation of FRAM model for preseason planning

Currently the comanagers use the Fishery regulation Assessment Model (FRAM) for preseason planning of total fishery impacts. This model assesses exploitation rates over all coastal fisheries impacting the Snohomish management unit from Alaska to California. Dell Simmons of NMFS has provided data from which the following graph was constructed comparing the estimate of exploitation rate on the Snohomish management unit using the CTC model (Table 2) to the rate estimated by FRAM (postseason run of the FRAM model).

Figure 2. Estimates of the fisheries exploitation rate for Snohomish chinook from the Chinook Technical Committee model, the Fisheries Regulation Assessment Model (FRAM), and the moving average (MA) of FRAM estimates.



On average, the FRAM estimates are smaller than the CTC estimates from which the management guidelines proposed here were developed. Ordinarily, this relationship would indicate an upward adjustment in the FRAM number to achieve a given guideline as developed using the CTC data (for example, we might use an upper guideline of 0.35 from FRAM as equivalent to our 0.32 guideline based on the CTC data). However, since the exploitation rates have declined greatly in recent years, the relationship between the FRAM and CTC rates might be changing. Also, the FRAM and CTC rates in the above graph are not directly comparable, since the CTC rates are based on brood years, while the FRAM rates are based on fishing years. To adjust for this difference, the three-year moving average of the FRAM rate is graphed as a dashed line in the figure. Although this line falls below the CTC line for most years in the series, it matches the CTC line nearly exactly for the four most recent years available. Therefore, we have chosen to make no adjustment for the exploitation rate as estimated by FRAM, and, for now, the 0.24 maximum exploitation rate guideline will apply to the preseason output from FRAM. In the future we will continue to compare the postseason FRAM estimates of exploitation rates to estimates from the CTC model and modify the FRAM adjustment as appropriate.

Data gaps

Priorities for filling data gaps to improve understanding of stock / recruit functions, harvest exploitation rate, and marine survival:

- Annual implementation of a double-index coded-wire tagging program using fingerling summer chinook from Wallace River Hatchery to enable direct assessment of harvest distribution, and estimation of harvest exploitation rates and marine survival rates. (Initiated beginning with the 2000 brood year).

- Estimates of natural-origin smolt abundance from chinook production areas. (Smolt trapping began in the Skykomish in 2000 in the Snoqualmie in 2001).

- Estimates of estuarine and early-marine survival for fingerling and yearling smolts.

- Quantification of the contribution of hatchery-origin adults to natural spawning for each stock. Research is underway, estimates of hatchery contribution to natural spawning are available for the 1997 through 2001 return years.

APPENDIX 1. Results of model fits for different combinations of environmental correlates.

	PS(6) for marine, FW			NPS(2) for marine, FW		
	Ric	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
a - productivity	4.1658	0.2400	4.1658	5.1234	0.1782	3.6572
b - Spawners	0.000000	0.000000	42,216	0.000124	0.000035	13,092
c – Marine	0.8330	0.8330	0.8330	0.6418	0.6394	0.6313
d - Freshwater	-0.000011	-0.000011	-0.000011	-0.000014	-0.000014	-0.000014
SSE	2.414	2.414	2.414	0.343	0.345	0.347
MSE (esc)	0.268	0.268	0.268	0.038	0.038	0.039
autocorrelation in error	0.199	0.199	0.199	-0.366	-0.358	-0.449
R	0.680	0.680	0.680	0.895	0.891	0.891
F	2.579	2.579	2.579	12.096	11.569	11.568
PROBABLITIY	0.1184	0.1184	0.1184	0.0016	0.0019	0.0019
MSE (reruits)	0.564	0.564	0.564	0.276	0.278	0.255
autocorrelation in error	-0.390	-0.390	-0.390	-0.133	-0.126	-0.147
Ave.Pred. Error	7237	7237	7237	3994	4092	3999

	No Freshwater, PS(6)			No Freshwater, NPS(2)		
	Ric	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
a - productivity	2.8789	0.3474	2.8789	4.6677	0.0761	3.9737
b - Spawners	0.000000	0.000000	42,216	0.000254	0.000132	6,238
c - Marine	0.8398	0.8398	0.8398	0.6986	0.7042	0.7341
d - Freshwater	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	2.897	2.897	2.897	1.056	1.057	1.065
MSE (esc)	0.290	0.290	0.290	0.106	0.106	0.106
autocorrelation in error	0.203	0.203	0.203	0.175	0.141	0.116
R	0.617	0.617	0.617	0.862	0.855	0.877
F	3.066	3.066	3.066	14.505	13.605	16.739
PROBABLITIY	0.0915	0.0915	0.0915	0.0011	0.0014	0.0006
MSE (reruits)	0.447	0.447	0.447	0.298	0.304	0.316
autocorrelation in error	-0.372	-0.372	-0.372	-0.071	-0.088	-0.069
Ave.Pred. Error	7773	7773	7773	4310	4437	4089

	No Marine			No Marine or Freshwater		
	Ric	**Bev**	**Hoc**	**Ric**	**Bev**	**Hoc**
a - productivity	3.7071	0.2697	3.7071	2.7118	0.3688	2.7118
b - Spawners	0.000000	0.000000	19,851	0.000000	0.000000	66,517
c - Marine	1.0062	1.0000	1.0000	0.5000	0.5000	0.5000
d - Freshwater	-0.000010	-0.000010	-0.000010	-0.000001	-0.000001	-0.000001
SSE	3.463	3.463	3.463	3.758	3.758	3.758
MSE (esc)	0.346	0.346	0.346	0.342	0.342	0.342
autocorrelation in error	0.086	0.086	0.086	-0.017	-0.017	-0.017
R	0.435	0.435	0.435	0.299	0.299	0.299
F	1.164	1.164	1.164	1.076	1.076	1.076
PROBABLITIY	0.3512	0.3512	0.3512	0.3219	0.3219	0.3219
MSE (reruits)	0.768	0.768	0.768	0.789	0.789	0.789
autocorrelation in error	-0.324	-0.324	-0.324	-0.369	-0.369	-0.369
Ave.Pred. Error	7838	7838	7838	7938	7938	7938

Appendix 2. Summary of projections of the Skykomish population at different target exploitation rates for three different forms of the spawner-recruit relationship.

	Pr(final esc > UAT) %			Pr(ann. Esc. < LAT) %		
Target ER	**B-H**	**Ricker**	**Hockey-St**	**B-H**	**Ricker**	**Hockey-St**
0.00	99.20	96.60	96.30	0.30	0.50	0.50
0.01	99.40	97.80	96.50	0.40	0.70	0.60
0.02	99.00	96.40	95.80	0.50	0.70	0.60
0.03	98.70	95.80	95.60	0.40	0.60	0.50
0.04	98.10	95.60	94.70	0.40	0.70	0.60
0.05	98.40	96.40	95.80	0.50	0.70	0.70
0.06	97.80	95.10	94.30	0.60	0.90	0.80
0.07	97.40	94.70	93.20	0.60	0.90	0.80
0.08	97.80	94.90	94.00	0.60	0.90	0.80
0.09	97.50	94.80	93.70	0.70	1.00	1.00
0.10	97.40	94.20	92.70	0.70	1.00	1.00
0.11	96.90	94.10	92.20	0.90	1.20	1.10
0.12	95.70	92.10	90.50	0.80	1.20	1.20
0.13	96.50	93.40	90.70	1.20	1.60	1.60
0.14	96.00	92.10	90.30	1.10	1.40	1.40
0.15	95.60	90.40	89.30	1.20	1.50	1.60
0.16	93.60	90.90	88.20	1.60	2.00	2.00
0.17	93.70	89.80	87.00	1.50	1.80	2.00
0.18	91.40	87.90	84.60	1.60	1.90	2.10
0.19	91.10	87.70	83.80	2.10	2.50	2.80
0.20	91.00	86.90	83.90	1.90	2.30	2.60
0.21	91.00	87.90	84.40	2.10	2.40	2.80
0.22	90.70	87.30	**82.50**	2.30	2.70	3.00
0.23	86.40	82.70	78.70	2.80	3.20	3.70
0.24	86.40	82.30	77.10	3.40	3.70	4.40
0.25	84.30	**80.00**	75.30	3.50	4.00	4.80
0.26	85.80	82.40	76.90	3.30	3.90	**4.70**
0.27	**80.30**	77.10	71.50	4.50	**4.90**	6.10
0.28	77.90	73.90	68.70	**4.50**	5.00	6.30
0.29	78.40	73.90	65.80	5.10	5.60	7.20
0.30	75.20	72.00	65.60	5.20	5.60	7.50

Lake Washington Management Unit Status Profile

Component Stocks

Cedar River fall chinook
Sammamish River tributaries fall chinook
North Lake Washington tributaries all chinook

Geographic description

Fall chinook are produced in three basins in the Lake Washington watershed, the Cedar River, Big Bear Creek and its tributary Cottage Creek (the "Northern Tributaries" which are tributaries of the Sammamish Slough), and Issaquah Creek. Historically, chinook also spawned in other smaller tributaries to Lake Washington (e.g. – May and Kelsey creeks) and the Sammamish Slough, (e.g. Little Bear, Swamp, and North creeks), and field studies are in progress to quantify their current use of these streams. Adults that return to Issaquah Creek are presumed to be predominately of hatchery origin. Genetic samples from chinook in Bear/Cottage Creek are similar to those from Issaquah Creek. It is not clear whether the introgression of hatchery genetics into Bear/Cottage is historical or ongoing.

Chinook enter Lake Washington drainages from late May through early November, and spawning is usually complete by the end of November. About ten miles of Bear Creek, and three miles of Cottage Creek, are accessible to chinook. Recent surveys have located concentrated spawning between RM 4.25 and 8.75 in Bear Creek and the entire three miles of Cottage Lake Creek. Spawning in Issaquah Creek occurs predominately in reaches between RM 1 and the Issaquah hatchery (Ames et al 1975). Chinook surplus to hatchery needs are sometimes passed upstream of the rack and spawn in Issaquah Creek. In the Cedar River, access above RM 21 is blocked by the Landsburg diversion dam. Chinook spawning in the Cedar River is concentrated between RM 4.0 and 19.0.

Allozyme analysis of samples collected from Cedar River chinook suggest that this stock is genetically distinct, but closely related to that in the Green River. Green River hatchery fish were outplanted into the Cedar River system from 1952 to 1964. Until 1916 the Cedar River drained into the Green River, so a close relationship is not surprising. Sampling and genetic analysis of returns to the Sammamish River and other independent tributaries is in progress, and preliminary analysis suggests that chinook in Bear/Cottage Creek have similar genetics to those chinook spawning naturally in Issaquah Creek. Outplants were made to most of the tributaries to the Lake Washington basin from the Issaquah and Green River hatcheries, from the period of record (1952 on). Most of these plants have continued through at least the early 1990s. The one exception is the Cedar River where the last plants were in 1964.

Life History Traits

Juvenile outmigration trapping in the Cedar River has shown that the outmigrant is bimodal with most of the fish entering the lake prior to April as fry. A smaller percentage of these fish rear in the river to smolt size and outmigrate between May and July. In 1999, approximately 75% of the outmigrants were fry. These fry rear along the lakeshore, growing quickly and leaving the lake as zero-age smolts. The smolts that migrate out of the river are thought to reach the Locks about the same time as the fry, although some fish are still migrating out of the river in late July. The migration through the Locks begins in mid-May and continues until at least September. Recent PIT tagging of Cedar River chinook suggests that the Cedar River fish migrate out later in the season than hatchery chinook. The Cedar River chinook fry that rear along the lakeshore are unique in that most, if not all, of the chinook stocks that use a lake for rearing are age one or two smolts. The Lake Washington stocks also have a protracted smolt outmigration, with a large percentage of the run outmigrating after July 1.

Table 5. Age composition data collected for fall chinook during 1998 in Big Bear Creek and Issaquah Hatchery (Carasco et al 1998).

	Issaquah Creek		Big Bear Creek		
Age	Male	Female	Male	Female	blank
2	0	0	2	0	
3	19	6	29	9	
4	69	66	17	14	2
5	2	17	0	1	
6	0	1			
Unk			2		
total	90	90	50	24	2

Status

The SASSI assessment concluded that the status of the Cedar River stock was unknown, though there was evidence of a short-term decline in escapement in the late 1980's (WDF et al 1993 Appendix I). Escapement into the northern Lake Washington tributaries and the Sammamish River was not adequately quantified, so the status of these stocks were also unknown (WDF et al 1993 Appendix I). Escapement to the Cedar River has been consistently below the goal of 1,200 since 1974. The geometric mean of escapement from 1992 – 1996 was 377. for the subsequent four years the mean escapement further declined to 255. . However, in 2001 escapement increased to 810. Surveys of the Bear Creek system, which provide an index of the North Lake Washington tributaries, indicate that escapement declined below 100 in 1996 and 1997, compared with an average of 300 that was seen in the 1980's (WDFW and MIT et al 1999). In subsequent years the Bear Creek system has experienced increased escapement to a high of 537 fish in 1999. Directed terminal fisheries have been closed since 1994, and pre-terminal fishing mortality reduced by 50 percent since 1997. .

Table 1. Spawning escapement of Lake Washington fall chinook, 1990-1999 (MIT et al 1999).

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cedar River	525	156	452	681	303	227	432	241	120	810
North Lake Tribs index	265	89	436	249	25	67	265	537	228	458

Watersheds that drain into Lake Washington are among the most heavily developed in the Puget Sound. Spawning and rearing habitat required by chinook has been degraded by development of riparian corridors. Migration is constrained by barriers in the mainstem and in many tributaries, and the migration route through Lake Washington and Lake Union, and connecting waterways severely influenced by industrial and urban development**.** Predation by introduced species is significant.

Harvest distribution

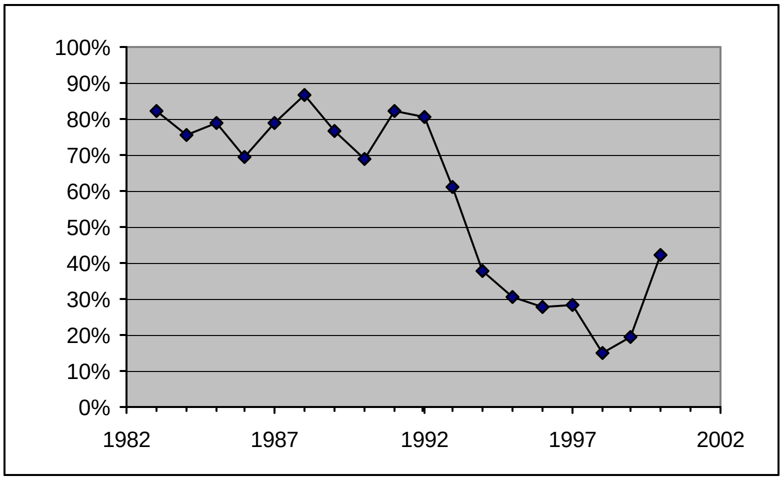
The harvest distribution of Lake Washington chinook has not been directly assessed because representative coded-wire tagged hatchery releases are only available for a few brood years from the Issaquah Hatchery in the late 1980s, and the University of Washington hatchery in the late 90s. However, because of their similar life history and genetic heritage, tagged fingerling releases from South Puget Sound (Soos Creek hatchery on the Green River, and Gorst Creek) facilities are thought to provide a reasonably accurate representation of pre-terminal harvest distribution (see Green River profile)

Terminal harvest of Lake Washington chinook has been minimized in recent years by regulatory measures that have eliminated directed harvest and reduced incidental harvest in Shilshole Bay, the Ship Canal, and in Lake Washington. Commercial and recreational fisheries directed at sockeye and coho salmon have been specifically shaped to reduced impacts on chinook. Recreational fishing regulations are promulgated to focus effort on the Issaquah Hatchery returns. Monitoring of the return through Ballard Locks has, since 1994, provided in-season assessment of the abundance of chinook.

Exploitation rate trends

Based on post-season FRAM runs, average total annual exploitation rates for Lake Washington chinook have fallen 66 percent from levels in the 1980's to 1996 – 2000.

Figure 1. Total annual, adult equivalent, fisheries exploitation rate of Lake Washington chinook, estimated by post-season FRAM runs for management years 1983 – 2000.



Management Objectives

The co-managers expect to manage impacts to Lake Washington natural chinook in all of the various fisheries throughout Puget Sound so as to constrain total exploitation rates in southern U. S. fisheries to a level within the range observed in recent years, e.g., 1998-2000. The co-managers will continue to employ management actions of recent years, which have limited impacts on Lake Washington natural chinook to very low incidental levels. The co-managers believe this harvest management plan will ensure harvest impacts are consistent with recovery of listed stocks. The co-managers also expect to further refine their harvest management plan for Lake Washington natural chinook within the next two years in light of on-going ESA recovery planning to ensure harvest impacts are consistent with recovery of listed stocks. During the next two years, if estimated impacts are predicted to exceed the range observed in recent years, the co-managers will meet and discuss what additional actions, if any, may be appropriate to bring the exploitation rate back within the range.

Fisheries will be managed to achieve an escapement 1,550 to Lake Washington streams, which will be determined by live counts in the Cedar River index reach of 1,200 chinook. As a general observation 22% of the natural run entering the lake, or 350 fish (if the Cedar has 1,200), will reach the Northern Tributaries.

Escapement goal management is retained for Lake Washington chinook in the terminal area because an inseason update (ISU) is possible to assess run strength inseason. The ISU is based on a count of adult passage at the Ballard Locks. Further, the alternative, management by exploitation rate, requires fundamental stock management data that is not currently available. Data is not available, for example, to expand index counts into a total estimate of escapement. Neither is the contribution of hatchery-origin fish to escapement in the northern tributaries quantified. The long-term objective for Lake Washington chinook is to increase production to the point that the escapement goal is regularly met or exceeded.

Lake Washington chinook have been one of the weaker key stocks in the mix of chinook populations impacted by ongoing pre-terminal fisheries. Directed terminal fisheries have been closed for seven years, pre-terminal exploitation rates have been declining (cut in half since 1997), and in 1999 additional restrictions were imposed. Escapements in 2001 and 2002 improved.

Underlying specific harvest management objectives is the need to maintain the diversity of naturally reproducing stocks that comprise the management unit. Diversity is manifest in several measurable qualities of the populations, including the age composition of mature fish, migration timing, spawning and rearing distribution, and genetic and phenotypic variation.

The impact of historic or current harvest management practices on population diversity of Lake Washington stocks has not been described. The potential effects of terminal harvest on diversity, due to age or size selectivity of fishing gear, are much reduced since directed fisheries have been closed since 1994.

The critical abundance threshold is defined as spawning escapement of 200 in the Cedar River index reach. If pre-season fishery simulation modeling indicates that escapement will fall below this level, conservation measures will be implemented to reduce fisheries mortality to the level defined by modeling the fisheries regime detailed in Appendix C.

Data gaps

The highest priority will be placed on collecting the data needed to quantify the productivity of Lake Washington stocks. Until the fundamental aspects of productivity are defined it will be difficult to assess the success of recovery actions, whether they entail improvement in habitat productivity, production supplementation, or restriction of harvest.

Table 3. Data gaps related to harvest management, and projects required to address those data needs.

Data gap	Research needed
Estimates of total spawning escapement for each stock.	Mark/recapture study, repeated for a minimum of three years; or an alternate approach to expanding index reach counts to total escapement. First done in FY2000
Estimates of smolt production in Issaquah Creek.	Fry/smolt trapping in Issaquah Creek to supplement ongoing trapping in the Northern Tributaries and the Cedar River.
Quantification of fry and smolt survival in Lake Washington and the Ship Canal.	Smolt trapping at the locks to quantify mortality as smolts transit the lake and the locks. Expected to begin in 2001.
Quantification of freshwater predation on smolts	Continuation of the Lake Washington Studies Project to further quantify fish, bird and lamprey predation.
Comprehensive estimates of incidental fishing mortality.	Creel surveys of recreational fisheries that target other species. The approach should be research oriented.
Estimates of bias in ladder counts at Ballard Locks, relative to spawning ground surveys.	Tagging and tracking of adult chinook from the locks and the ladder to estimate repeat passage. Started in 1998.

Related Data Questions

Is chinook survival from emergent fry to adult (smolt?) correlated with early life history strategy? (i.e. – what are the relative survival rates of fry outmigrants compared to smolt outmigrants in the Cedar River).

Is scour of chinook redds related to the magnitude of peak flow events in the Cedar River, and the position of redds in the stream channel?

What is the relationship between flow at Landsburg and the availability of water at the Locks for operating the smolt slides?

Green River Management Unit Status Profile

Component Stocks

Green River fall chinook

Geographic description of spawner distribution

Fall chinook are produced in the mainstem Green River and in two major tributaries - Soos Creek and Newaukum Creek. Adults that spawn in Soos Creek are presumed to be predominantly of hatchery origin. However, recent investigations into straying raise questions regarding this, and other assumptions related to run reconstruction. (See stock status, below). Newaukum Creek spawners appear to be closely related to the spawners in the mainstem.

Spawning in the mainstem Green River occurs from RM 26.7 up to RM 61. Spawning access higher in the drainage is blocked by the City of Tacoma's diversion dam, and at RM 64 by Howard Hanson Dam. Spawning occurs in the lower 10 miles of Newaukum Creek. Adults returning to the hatchery at RM 0.7 of Soos Creek may also spawn naturally and adults surplus to program needs at the Soos Cr. Hatchery are often passed upstream.

Life History Traits

Fall chinook begin entering the Green River in July, and spawn from mid-September through October. Ocean-type freshwater life history typifies summer/fall stocks from South Puget Sound, with 99 percent of the smolts outmigrating in their first year (WDFW 1995 cited in Myers et al 1998). A long-term average of the age composition of adults returning to the Green River indicates the predominance of age-4 fish (62 percent), with age-3 and age-5 fish comprising 26 percent and 11 percent, respectively (WDF et al 1993, WDFW 1995 cited in Myers et al 1998).

Status

The SASSI review (WDF et al 1993) classified Green River chinook as healthy, because spawning escapement had consistently met the objective since 1978. Spawning escapement has increased recently, with the mean of the 1997 – 1999 (8721) exceeding that for the preceding five-year period (4799). Total escapement fell below the nominal goal of 5,500 in 1992 – 1994, which triggered an assessment of factors contributing to the escapement shortfall by the PFMC (PSSSRB 1997). However, escapement has exceeded the goal in each subsequent year.

Table 1. Spawning escapement of Green River fall chinook, 1990-1999.

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
5,267	2,476	4,078	7,939	6,026	9,967	7,300	9,100	6170	7975

It is known, however, that returns from hatchery production contribute substantially to natural spawning in the Green River and tributaries, and viability of the naturally spawning stock, absent the hatchery contribution, is uncertain because hatchery returns may be masking poor natural productivity (Myers et al 1998). Analysis of coded wire tags recovered from the spawning grounds and the in-river fishery has yielded highly variable results.

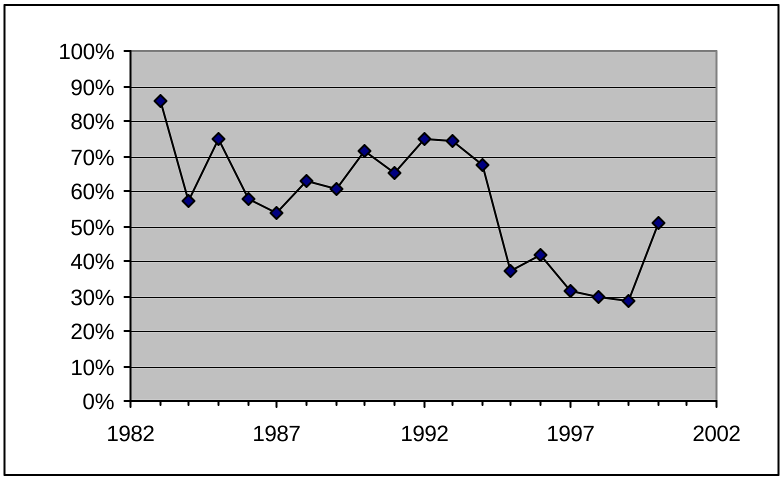
The nominal escapement goal is based on approximate estimates of escapement in the 1970's, and may not reflect the productivity constraints associated with current degraded habitat, but will be used to guide fisheries management until natural capacity is better quantified. Escapement estimation methods are under review. Surveys have been expanded in recent years to calibrate assumptions regarding the relationship between index area counts and total escapement and the first year of a mark/recapture method, also for the purpose of calibration of escapement estimates, was just completed.

Hatchery facilities currently operate on Soos Creek and Icy Creek. Broodstock has always been collected from local returns, so the hatchery stock presumably retains its native genetic character. Allozyme analysis has not shown a difference between hatchery-reared and naturally spawning adults (WDFW unpublished data).

Harvest distribution and exploitation rate trends:

Post-season FRAM runs, incorporating actual catch and stock abundance indicate that annual exploitation rates for Green River chinook have declined 45 percent from levels in the 1980's to 1996 – 2000 (Figure 1). As noted above, in recent spawning escapement has exceeded the goal.

Figure 1. Total annual, adult equivalent, fishery exploitation rates for Green River chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



Coded-wire tagged releases from the Green River (and Grovers Creek) describe harvest distribution in recent years. Fisheries in British Columbia and Alaska account for 32 percent of total fishing mortality. Washington recreational and Puget Sound net fisheries account for 41 percent and 22 percent of total mortality, respectively (Table 3).

Table 3. The harvest distribution of Green River chinook, expressed as a proportion of total annual, adult equivalent, exploitation rate (TCChinook 02-3).

	Alaska	B.C.	Washington Sport	Puget Snd net	Washington sport
1996 – 2000	2.0%	29.6%	6.0%	21.7%	40.7%

Management Objectives

The co-managers manage fisheries to meet or exceed the spawning escapement goal of 5,800 Green River chinook. In fact, the goal has been met or exceeded in 9 of the last 13 years. The co-managers expect that the goal will continue to be met or exceeded as a result of this management approach. The co-managers will also expect to further refine their management plan for Green River chinook over the next two years in light of on-going ESA recovery planning, to ensure harvest impacts are consistent with recovery of listed stocks. When the escapement is expected to be less than 5,800, the co-managers will discuss what additional actions, if any, may be appropriate to bring the escapement above the 5,800 level.

Management objectives for Green River chinook include an exploitation rate objective for pre-terminal fisheries and a procedure to manage terminal-area fisheries, based on an inseason abundance update (ISU), to assure that the escapement goal will be achieved. A critical abundance threshold is identified to guard against abundance falling below the point of instability. This management regime assures that harvest of Green River chinook will not impede recovery of the ESU.

Pre-terminal fisheries in Washington are managed to achieve a 15 percent ('SUS') exploitation rate, as estimated by the FRAM model. Pre-terminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and commercial net and recreational fisheries in Puget Sound outside of Elliott Bay.

Due to restriction of pre-terminal fisheries a greater proportion of allowable harvest will be available in the terminal fishery in Elliott Bay and the Duwamish River, where tribal net fisheries and recreational fisheries will be managed on the basis of the terminal area ISU.

The central objective of terminal-area fisheries management is to assure adequate natural spawning escapement and to supply broodstock to the fisheries enhancement program. There is no genetic distinction between hatchery and natural-origin adults, though concern has been expressed that hatchery-origin that spawn naturally are obscuring the low productivity of natural origin recruits, and reducing the fitness of natural spawners by interbreeding. However, the current productive capacity of the natural system is not well quantified, and the potential effects of interbreeding only theoretically described. The terminal area harvest regime has resulted in achievement of the nominal escapement goal since 1995.

Terminal fisheries are managed to achieve the escapement goal of 5,800. In-season assessment of the extreme terminal abundance, based on catch rates by a test fishery in Elliott Bay and/or commercial fisheries in the Duwamish River and Elliott Bay enables fishery managers to shape the terminal recreational and commercial fishery to achieve the escapement goal. The ISU has been successful in providing more accurate estimates of abundance, but it relies on the pre-season forecast of the proportion of natural-origin chinook in the terminal run. An evaluation of its performance in 1992 – 1994 indicates that the ISU estimates of abundance were closer to the true abundance in all three years, and guided management decisions correctly in either constraining or liberalizing terminal harvest direction (PSSSRG 1997). However, deviations between the forecasted natural component and their true abundance were substantial, and these, in combination with a relatively unrestricted sport fishery contributed to under escapement of natural spawners in 1993 and 1994. Accurate accounting of commercial and recreational harvest is essential to the ability of the managers to attain the escapement goal consistently. The co-managers have made steady progress toward improved accounting in recent years.

Pre-season forecasts have indicated that the natural return (i.e., terminal run) to the Green River would be greater than the hatchery return in two years (1995 and 1996) in the period since 1989. Post-season assessment of escapement has shown that the actual natural escapement exceeded the hatchery return twice (1991 and 1992) between 1989 and 1996. These estimates do not account for hatchery fish present in the naturally spawning population, nor natural origin fish entering the rack. As stray rates are better quantified with the return of mass-marked hatchery fish in coming years these estimates will also improve.

Review of the ISU model, prior to year 2000 fisheries, reached two significant conclusions. First, it was observed that catch from the first commercial openings in the bay and river were a better predictor than the three-week, five-boat test fishery in the bay (Bob Conrad, NWIFC, memo 2/10/00). Second, it was recommended that the managers avoid use of the ISU model output as a point estimate (B. Conrad, NWIFC pers comm).

Application of the ISU in 2000 was manifest in setting thresholds below which planned directed fisheries would not proceed. A value below 100 chinook for the test fishery would cause cancellation of the commercial and sport fisheries. A value below 1000 chinook for the first commercial opening would cause cancellation of any further chinook-directed fishing. These values corresponded with a total run of about 15,000 chinook.

The system escapement goal of 5,800 has been exceeded every year since 1995; the preliminary estimate for 2002 is in excess of 13,000. For the past three years, terminal area chinook-directed treaty net and sport fisheries were implemented according to the respective pre-season plans.

A critical abundance threshold of 1,800 natural spawners is established for the Green River management unit on the basis of the lowest observed escapement resulting in a higher escapement four years later. If natural escapement is projected to fall below this threshold during pre-season planning, then additional management measures will be implemented in accordance with procedures established in Appendix C, to minimize fishery-related mortality. The terminal fishery will also be shaped to increase escapement if the in-season update indicates that the critical threshold will not be attained.

Data gaps

Several aspects of the productivity of Green River chinook are potentially affected by hatchery-origin fish spawning naturally. The abundance, timing, spawning distribution, and age structure of natural-origin chinook may be masked by the presence of hatchery-origin fish. The viability of the natural origin population cannot be accurately assessed without determining the effects of hatchery straying, so the need for this information will prioritize research. Below are descriptions of the data needs and how they are being addressed.

Data need	Related project
Quantification of the proportion of natural escapement that is comprised of hatchery strays.	Completion of a CWT data set for refinement of current CWT-based estimates. (work in progress) Mass marking of hatchery production. (Brood year 1999 marked; 2000 proposed)
Re-evaluation of escapement estimation methodology	Expanded surveys to calibrate expansion of index area data to total. (begun in 1998 – work continues.) Mark/recapture study to independently calibrate total escapement estimate in association with expanded survey effort. (done in 2000 – proposed for two more years)
Estimation of the number of Chinook fry and smolts that emigrate annually from the mainstem Green, Newaukum and Soos Creeks.	Trap placement in the mainstem Green and Soos Creek (completed in 1999-proposed to continue)
Estimation of differential survival of natural and hatchery origin Chinook in-situ in the Green.	A literature review of methodologies that may have utility for an in-situ experiment should be done.
Estimation of estuarine hooking mortality if selective fisheries are proposed for Elliott Bay.	A literature review and preliminary study design should be done.

White River Spring Chinook Management Unit Profile

Component stocks

White River spring

Geographic description

White River spring chinook are trapped at the Puget Power diversion dam and transported into the upper watershed, above Mud Mountain Dam, where they spawn in the West Fork of the White River, Clearwater River, Greenwater River, and Huckleberry Creek. They also spawn in the lower mainstem, below the diversion dam at RM 2 3.4, though habitat suitability is constrained by the flow regime, and river conditions preclude good estimates of spawner abundance.

The White River population is the only spring stock still present in southern Puget Sound, is geographically isolated from summer/fall stocks, and genetically distinct from all other chinook stocks in Puget Sound. Production is supplemented by the White River hatchery program, and the stock has, in past years, been maintained as captive brood at the Hupp Springs and Peale Pass net pen facilities. The supplementation program is considered essential to recovery, so hatchery production is included in the listed ESU.

Life History Traits

Spring chinook enter the Puyallup River from May through mid-September, and spawn from mid-September through October. All chinook arriving at the trap are wanded and fish with detectable tags are tranferred to the White River hatchery where they are genetically tested before being incorporated into broodstock. Chinook without adipose clips are passed upstream.

Fry emerge from the gravel in late winter and early spring. In contrast to other spring stocks in Puget Sound, White River chinook smolt emigrate primarily (80 percent) as subyearlings (SSSCTC 1996), after a short rearing period of three to eight weeks. Adults mature primarily at age-3 or age-4.

Status

Escapement of White River chinook exceeded 5,000 in the early 1940's, but the construction of hydroelectric and flood control dams, and degradation of the spawning and rearing habitat reduced abundance to critical levels in the 1970's. Escapement was less than 100 through the 1980's and fell below 10 in 1984 and 1986. A supplementation program has been operating since 1971, and it has succeeded in raising escapement to levels between 300 and 600 in recent years (Table 1). The geometric mean of escapement in 1992 – 1996 was 477, and for the three more recent years, 413.

Table 1. Spawning escapement of White River spring chinook, 1990-1999. Upper river figure represents untagged fish captured at the Buckley trap and transported to upstream spawning grounds (ACOE data cited in HGMP). Broodstock includes collections at Minter Creek, South Sound Netpens, and White River hatchery, and excludes jacks through 1995 (WDFW et al 1996 cited in HGMP). Broodstock values from 1996 on represent collection at White River Hatchery only.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Upper river	406	409	392	605	630	400	316	553	1523	2002
Broodstock	1606	1444	2033	1982	924	822	454	429	740	814
Total	2012	1853	2425	2587	1554	1222	770	982	2263	2816

The status of White River spring chinook has been considered critical. Returns in recent years have improved, but evaluation of natural-origin versus hatchery-origin returns is not complete. Degraded spawning and rearing habitat, and the migration blockage imposed by dams, currently imposes severe constraints on natural productivity. The contribution of natural-origin adults to spawning escapement has not been quantified, but there is evidence to suggest that the stock is not currently viable in the absence of supplementation. The supplementation program succeeded in raising escapement above the critically low levels seen in the 1970's and 1980's, and it may continue to protect the viability of the stock, but natural production will not recover until the habitat constraints are addressed.

Harvest distribution and exploitation rate trends:

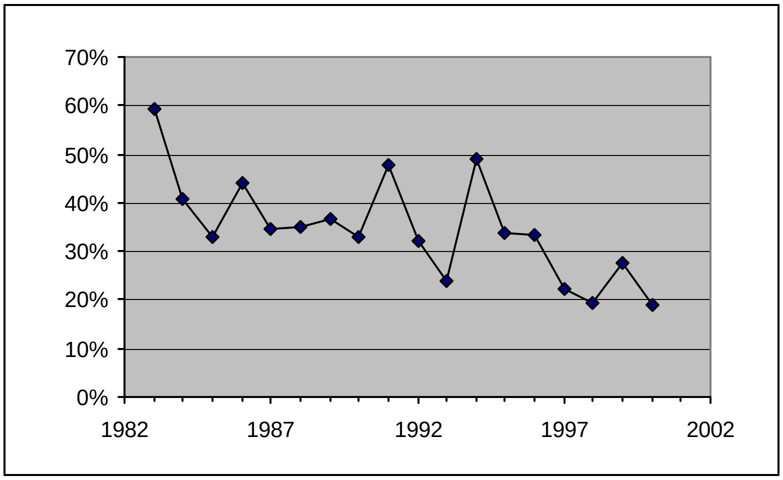
Based on recoveries of coded-wire tagged yearling releases from White River and Hupp Springs hatcheries, 91 percent of the total harvest mortality of White River springs has taken place in Puget Sound recreational fisheries. For the period of 1996 – 2000, an average of five percent of total mortality occurred in British Columbia fisheries.

Table 2. The distribution of annual harvest mortality for White River spring chinook, expressed as a proportion of total annual adult equivalent exploitation rates (TCChinook 02-3)

	Alaska	B.C.	Washington Troll	Puget Sound net	Washington sport
1996 – 2000	0.0%	4.5%	0.6%	3.5%	91.4%

Increasingly conservative management of Washington fisheries has resulted in a declining trend in total exploitation rate over the last six years, as estimated by post-season FRAM runs that incorporate actual catch and stock abundance (Figure 1). The average rate for management years 1996 – 2000 was 42 percent lower than the average for management years 1983 – 1987. . The fisheries simulation model (FRAM) has been modified to incorporate only White River fingerling tag codes, which show a slightly different harvest distribution than yearlings that comprise the PSC Indicator Stock.

Figure 1. Total annual, adult equivalent fisheries exploitation rate for White River chinook for management years 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

Fisheries in Washington will be managed to achieve a total exploitation rate (including impacts of fisheries in British Columbia) no greater than 20 percent. This exploitation rate ceiling was derived from highly constrained fishing regimes implemented since 1999, which have effected an increase in escapement to the White River. The ceiling is based on the recent re-calibration of the FRAM, that incorporated additional coded-wire tag data and revised historical catch data (L. LaVoy, WDFW, memorandum to co-manager technical staff, February 12, 2002). The new FRAM produces slightly higher estimates of exploitation rates for White River than the former version of the model, for the same constrained fishing regime. Achievement of this rate requires continued constraint of Puget Sound net and recreational fisheries, and allows minimal tribal ceremonial and subsistence fisheries in the river. Tag recovery and escapement data are insufficient, at present, to support direct assessment of the productivity of the stock.

The current management objective constrains fishing mortality and, in recent years, has provided spawning escapement well in excess of the critical threshold of 200. Escapement below this level is believed to present significant risk to genetic diversity and exposure to depensatory mortality factors, particularly when considering the low productivity of naturally spawning fish.

If preseason fishery simulation modeling suggests that escapement will not exceed the low abundance threshold, further conservation measures will be implemented in fisheries that catch White River chinook, so as to reduce their total exploitation rate to a level that is defined by modeling the fishing regime described in Appendix C. A very conservative approach is warranted in managing this stock, and projected escapement near the critical threshold, or failure to achieve broodstock collection objectives, will be considered grounds to re-institute the captive brood program.

Data gaps

- Description of spawning distribution in the upper White River system.
- Quantification of hatchery- and natural-origin adults on the spawning grounds.
- Estimation of natural smolt production.
- Estimation of pre-spawning mortality of adults that are trapped and transported above Mud Mountain dam.

Puyallup River Fall Chinook Management Unit Status Profile

Component Stocks

Puyallup River fall chinook
South Prairie Creek fall chinook

Geographic description

Fall chinook spawn primarily in South Prairie Creek (a tributary of the Carbon River) up to RM 15, the Puyallup mainstem up to Electron Dam at RM 41.7 , the lower Carbon River up to RM 8.5, Voights's Creek, Fennel Creek, Canyon Falls Creek, Clarks Creek, Clear Creek and Kapowsin Creek, and, possibly, the lower White River. Surplus Voights Creek Hatchery adult chinook are currently released to spawn naturally above the Electron diversion and juvenile chinook produced at the Puyallup Voights Creek Hatchery are outplanted to acclimation ponds in the upper Puyallup River, above the diversion dam. Construction of a fishway at Electron Dam is expected to re-establish adult access to the upper river, however, downstream juvenile passage is still deficient in the near future.

Life History Traits

Hatchery programs have introduced non-native stocks, primarily of Green River origin, into the Puyallup system, so it is not clear that naturally spawning chinook bear the native genetic legacy. A remnant native stock may persist in South Prairie Creek, though genetic testing to date has not been conclusive in that respect.

Freshwater entry into the Puyallup River begins in late July, and spawning occurs from mid-September through mid-November. Based on scale samples collected in 1992-93, returning adults were primarily (76 percent) age-4, and age-3 and age-5 fish made up 16 and 6 percent of the sample (WDF et al 1993 cited in Myers et al 1998). South Prairie Creek age samples taken between 1992 and 2002 provides a mean age composition, based on brood contribution of the 1991-1997 broods, of 1.0% age-2, 19.1% age-3, 67.3% age-4, 12.3% age-5 and 0.3% age-6 fish (WDFW, unpublished data). Juveniles exhibit ocean-type life history, primarily, with estimated 97 percent of smolts emigrating as subyearlings (WDF et al 1993 cited in Myers et al 1998).

Status

Between 1994 and 2001, escapement to the South Prairie Creek sub-basin has ranged from 667 to 1430 fish, averaging 1048. The turbid nature of the Puyallup and Carbon rivers, due to its their glacial origin, makes enumeration of spawners or redds difficult in the mainstem, so the accuracy of the system-wide estimates is uncertain.

The former nominal escapement goal, that was intended principally to assure adequate broodstock to hatchery programs, was 3,250, including natural spawning and escapement to the hatcheries.

Harvest distribution and exploitation rate trends:

The harvest distribution of Puyallup fall chinook has not been assessed, because there is no local, consistently-tagged indicator stock. Distribution in pre-terminal fisheries is likely similar to that of the South Sound fingerling indicator stock, which is composed of tagged releases from the Green River (Soos Creek) and Grovers Creek. This distribution is shown, above, in the Green River profile.

Post-season FRAM runs, which incorporate actual catch in all fisheries and actual abundance of all chinook stocks, indicate the total, annual, adult-equivalent exploitation rate for Puyallup fall chinook declined sharply from 1995 – 1998, and that rates have since increased as improved survival has enabled increased harvest, while still achieving the escapement objectives.

Management Objectives

Since the existence of an indigenous fall chinook stock in the Puyallup system is uncertain, and current natural production is substantially augmented by hatchery-origin fish, the harvest management objectives will reflect the need to adequately seed natural spawning areas until the productive capacity of habitat is quantified, and the existence of an indigenous stock is resolved. Until recently fisheries were managed to supply adequate broodstock to the hatchery programs.

The harvest management objective for Puyallup fall chinook is to not exceed a total exploitation rate of 50 percent, to assure that a viable, natural-spawning population is perpetuated. Pre-season fisheries planning, to not exceed this ceiling rate, has been shown to result in spawning escapement of more than 500 to the South Prairie Creek - Wilkeson Creek complex. . Though escapement estimation methods have evolved recently to better quantify total fall chinook escapement to the entire Puyallup system, as previous described, water clarity in South Prairie Creek still affords the most reliable index.. Achieving escapement to South Prairie / Wilkeson of at least 500, according to the most recent surveys, indicates that the entire system is seeded adequately to assure viable natural production. Based on more comprehensive spawning surveys, including monitoring of recolonization of the basin above Electron Dam, the co-managers expect, in the near future, to develop a system escapement goal for fall chinook.

Pre-terminal and terminal fisheries in Puget Sound were constrained in 1999 and 2000 to achieve this objective. The productive capacity of habitat in South Prairie Creek, or in the Puyallup mainstem and tributaries is not quantified, so a system-wide escapement goal has not been established. By reducing the total exploitation rate, relative to those levels in the early- to mid- 1990's, this harvest regime will is intended to provide stable or increasing levels of natural escapement. Achieving higher natural escapement, under the new management objective, will experimentally probe the productivity of natural spawners in the system.

A critical abundance threshold of 500 spawners, for the entire system, is established for the Puyallup fall management unit. If escapement is projected to fall below this threshold, fisheries-related mortality will be reduced to a level defined by the fisheries regime described in Appendix C. The threshold is set above the point of stock instability, to prevent escapement from falling to that level which incurs substantial risk to genetic integrity, or expose the stocks to depensatory mortality factors.

Data gaps

Improve spawning escapement estimates for the Puyallup River and/or validate the use of South Prairie Creek and Wilkeson Creek counts as an index for the system.

Estimate the contribution of hatchery- and natural-origin adults to natural spawning , by mass-marking hatchery production. Brood year 1999 hatchery production was 100% marked.

Develop a spawner – recruit function for natural-origin, naturally spawning chinook to validate the recovery exploitation rate objective. This task is dependent on completion of the two preceding tasks.

Conduct an evaluation fishery, during the early weeks of the fall chinook management period, in the Puyallup mainstem, to collect catch and catch-per-effort data that may, in future, become the basis for in-season assessment of stock abundance. Statistical models relating catch or CPUE to abundance will, in addition to several other sources of information regarding migration timing and progress of the river fishery, inform the fishery managers regarding possible changes in the fishery schedule, should these indicators suggest that abundance differs significantly from the pre-season forecast.

Nisqually River Chinook Management Unit Status Profile

Component Stocks

Nisqually fall

Geographic description

Adult chinook ascend the mainstem of the Nisqually River to river mile 40, where further access is blocked by the La Grande and Alder dams, facilities that were constructed for hydroelectric power generation by the City of Tacoma's public utility. It is unlikely that chinook utilized higher reaches in the system, prior to the dams' construction. Below La Grande dam the river flows to the northwest across a broad and flat valley floor, characterized by mixed coniferous and deciduous forest and cleared agricultural land. Between river miles 5.5 and 11 the river runs through the Nisqually Indian Reservation, and between river miles 11 and 19 through largely undeveloped Fort Lewis military reservation. At river mile 26, a portion of the flow is diverted into the Yelm Power Canal, which carries the water 14 miles downstream to a powerhouse, where the flow returns to the mainstem at river mile 12. A fish ladder provides passage over the diversion. Both Tacoma's and Centralia's FERC license requires minimum flows below the project.

Fall chinook spawn in the mainstem above river mile 3, in numerous side channels, as well as in the lower reaches of Yelm Creek, Ohop Creek, the Mashel River and several smaller tributaries. Production is augmented by production at the Kalama Creek and Clear Creek hatcheries, which are operated by the Nisqually Tribe. Supplementation of spawning in the upper mainstem, by outplanting of juvenile chinook into suitable rearing habitat, is an important objective of the hatchery program.

Life History Traits

Adult fall chinook enter the Nisqually River system from July through September, and spawning activity continues through November. After emerging from the gravel, juveniles typically spend two to six months in freshwater before beginning their seaward migration. Residence time in their natal streams may be quite short, as the fry usually move downstream into higher order tributaries or the mainstem to rear. Extended freshwater rearing for a year or more, that typifies some Puget Sound summer/fall chinook stocks, has not been observed in the Nisqually system.

Returning adults mature primarily at age-3 and age-4, comprising 45 and 31 percent, respectively (WDF et al 1993, WDFW 1995 cited in Myers et al 1998).

Stock Status

It is generally agreed that native spring and fall chinook stocks have been extirpated from the Nisqually River system, primarily as a result of blocked passage at the Centralia diversion, de-watering of mainstem spawning areas by hydroelectric operations, a toxic copper ore spill associated with a railroad trestle failure, and other habitat degradation (Barr, 1999). Studies are underway to determine whether any genetic evidence suggests persistence of the native stock. Initial results indicate that the existing naturally-spawning and hatchery stocks are identical, and were derived from hatchery production that utilized, principally, Puyallup River and Green River fall chinook. Like other stocks in South Puget Sound, in which current production is based on naturalized and supplemented returns from a hatchery program, the Nisqually has been managed to achieve escapement sufficient to provide broodstock to the enhancement program.

Natural escapement has not met the escapement goal of 900 since 1994. (The escapement goal was increased to 1,100 effective 2000.) Recent natural spawning escapement has ranged from 100 to 1,700 (Table 2), and hatchery returns have ranged from 200 to 4,100, in the period between 1991 and 1998. Escapement surveys are made difficult in the mainstem by the turbidity caused by glacial flour.

Table 1. The abundance of fall chinook returning to the Nisqually River system.

	Peak escapement counts		Natural escape [3]	Hatchery escape.	Terminal harvest	Terminal Run
	Mainstem redds[1]	Mashel R. live+dead [2]				
1991	54	5	953	215	419	1587
1992	1	13	102	325	329	756
1993	94	8	1655	1370	4024	7049
1994	98	9	1730	2104	6183	10017
1995	40	20	817	3623	7171	11611
1996	26	12	606	2701	5365	8672
1997	13	12	340	3251	4309	7900
1998	25	60	834	4067	7990	12891
1999			1399	13481	14614	29494
2000			1253	4923	6836	13012
2001			1079	7612	14098	22789

[1] Mainstem redd counts, from R.M. 21.8 to 26.2, are multiplied by 2.5 to estimate number of spawners.
[2] Mashel fish counts, from R.M. 0.0 to 3.2 expanded by visibility factor some years.
[3] Peak count of spawners in the mainstem and Mashel River index areas is expanded by 6.81.

Harvest distribution and exploitation rate trend:

The harvest distribution of Nisqually chinook has been described by analysis of coded-wire tagged fingerling chinook released from Clear Creek and Kalama Creek hatcheries. In recent years 15 percent of the total harvest mortality has occurred in British Columbia and Alaska, primarily in Georgia Strait. Washington ocean fisheries have accounted for less than three percent of total fishery mortality. Recreational (ocean and Puget Sound) and net fisheries in Puget Sound , have accounted for 38 and 45 percent of total mortality, respectively.

Table 2. The harvest distribution of Nisqually River fall chinook, expressed as the proportion of annual, adult equivalent fisheries exploitation rate (TCChinook 02-3)
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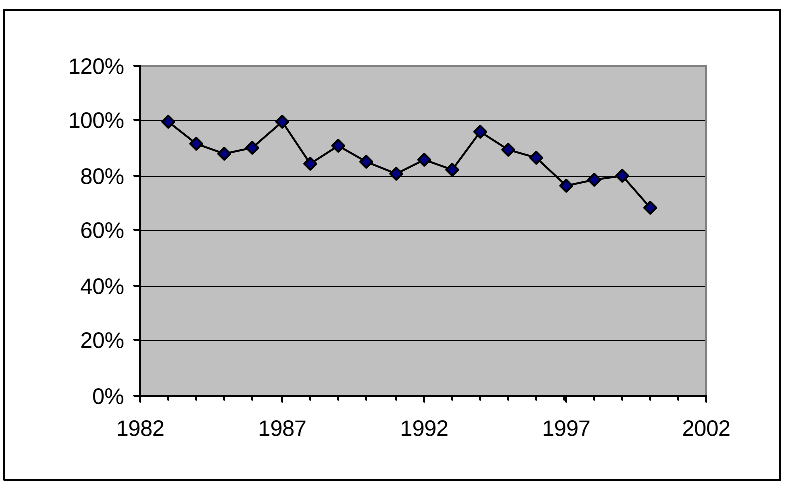
	Alaska	B.C.	Washington Troll	Puget Sound net	Washington sport
1996 – 2000	0.5%	14.5%	2.6%	44.9%	37.6%

The total annual exploitation rate for Nisqually chinook has declined slightly since 1993, as described by post-season FRAM runs (Figure 1). FRAM rates are assumed to accurately index the recent trend in exploitation rate, but may not accurately quantify annual exploitation rates, because of the lack of CWT data in the model base period,

Figure 1. Total annual, adult equivalent fisheries exploitation rate of Nisqually fall chinook, from 1983 – 2000, estimated by post-season FRAM runs.



Management Objectives

Because the Nisqually management unit is not a unique, native stock, the need to optimize natural production from natural-origin spawners will be balanced against the fishery enhancement objectives of the hatchery programs. In this sense, the Nisqually unit is similar to other South Puget Sound and Hood Canal natural units in which the production depends on non-native, introduced chinook stocks, and where natural productivity is severely constrained by habitat degradation. For these units, management intent is significantly distinct from other Puget Sound management units in which production is comprised primarily of native, naturally-spawning stocks.

A recovery exploitation rate has not been developed for the Nisqually chinook stock. It is possible that further productivity analysis, enabled by better quantification of natural escapement, and assessment of the contribution of natural-origin adults to that escapement, will allow development of a recovery exploitation rate objective that reflects the recent productivity of the stock.

The terminal fisheries are managed based on an inseason runsize estimated by the relationship of total runsize and catch success for the tribal commercial net fishery. This method for updating the runsize in-season will initially be applied with information through the third week of August. Subsequent updates will be conducted as catch data continues to accumulate. To enable the fishery to be managed for the 1,100 escapement goal, managers will translate the total runsize to an expected escapement by making an assumption of the proportion of the total run that will spawn naturally. When the in-season update indicates that the escapement goal (1,100) will not be achieved, terminal area fisheries will be constrained by agreement between the co- managers with the objective of increasing spawner abundance to a level at or above the escapement goal.

Data gaps

- Improve total natural escapement estimates, including age-specific estimates of both natural and hatchery-origin recruits and develop stock-recruit analysis.
- Test the accuracy of the in-season assessment of extreme terminal abundance, and improve the in-season update model as new data allows.
- Quantify the current natural productivity of the system.

Skokomish River Management Unit Status Profile

Component Stocks

Skokomish summer/fall

Geographic description

Spawning takes place in the mainstem Skokomish River up to the confluence with the South and North forks, in the South Fork of the Skokomish River, primarily below RM 5.0, and in the North Fork up to RM 17, where Cushman Dam blocks higher access. Most spawning in the North Fork occurs below RM 13, because flow fluctuation associated with operations of the hydroelectric facility limit access and spawning success higher in the system (WDF et al. 1993).

On the North Fork Skokomish, two hydroelectric dams block passage to the upper watershed. However, a small, self-sustaining population of landlocked chinook salmon is present in Lake Cushman, upstream of the dams. Adults spawn upstream of the lake in the North Fork Skokomish River from river mile 28.2 to 29.9 during November.

Life History Traits

Genetic characterization of the Skokomish chinook stocks has, to date, been limited to comparison of adults and juveniles collected from the Skokomish River with adults from other Hood Canal and Puget Sound populations. Genetic collections were made during 1998 and 1999 in the Skokomish River and there appeared to be no significant genetic differentiation between natural spawners and the local hatchery population. It appears that Hood Canal area populations may have formed a group differentiated from south Puget Sound populations, possibly indicating that some level of adaptation may be occurring following the cessation of transfers from south Sound hatcheries (Anne Marshall, WDFW memo dated May 31, 2000). Current adult returns are a composite of natural- and hatchery-origin fish. During 1998 and 1999, known hatchery-origin fish comprised from 13% to 41% of the samples collected on the natural spawning grounds. Genetic analysis of samples collected from Lake Cushman was inconclusive as to stock origin, and the adults sampled exhibited low genetic variability. (Marshall, 1995a).

Summer/fall chinook enter the Skokomish River starting in late July with the majority of the run entering from mid-August to mid-September. Chinook in the Skokomish River spawn from mid-September through October with peak spawning during mid-October. Adults mature primarily at age-3 (33%) and age-4 (43%); the incidence of age 2 fish (jacks) is highly variable. In 1999, based on a sample of 143 fish, the age composition of naturally-spawning chinook in the Skokomish River system was estimated to be 2.8% age 2, 58.0% age 3, 38.5% age 4, and 0.7% age 5 fish (Thom H. Johnson, WDFW memo dated November 8, 2000). In 2000 and 2001, the age composition of naturally spawning chinook was 16.1% and 1.2% age 2, 11.3% and 58.3% age 3, 71.0% and 36.9% age 4, and 1.6% and 3.6% age 5, respectively (Thom H. Johnson, pers. Comm.. 12/3/02). Consistent with most other summer/fall populations in Puget Sound, naturally produced smolts emigrate primarily during their first year; 2 percent of the smolts may migrate as yearlings (Williams et al 1975 cited in Myers et al 1998). In the Skokomish River, most naturally-produced chinook juveniles emigrate during the spring and early summer of their first year of life as fingerlings (Lestelle and Weller 1994).

Status

The SASSI classified Hood Canal summer/fall chinook as a single stock of mixed origin (both native and non-native) with composite production (sustained by wild and artificial production) (WDFW et al. 1992). The combination of recent low abundances (in all tributaries except the Skokomish River) and widespread use of hatchery stocks (often originating from sources outside Hood Canal) led to the conclusion in SASSI that there were no remaining genetically unique, indigenous populations of chinook in Hood Canal. However, a sampling effort is currently under way (led by WDFW in cooperation with NMFS and Treaty Tribes) to collect genetic information from chinook juveniles and adults in the tributaries of Hood Canal. This investigation is intended to provide further information on the genetic source and status of existing chinook populations.

The existence of historical, indigenous populations, that have not been significantly impacted by past management practices and that have remained distinct and sustainable is at least questionable. The genetic sampling effort referenced above is intended to help resolve remaining uncertainty about the existence of any historical, indigenous populations. In the interim, management measures have been formulated to provide reasonable protection for naturally spawning chinook and adequate flexibility for future change.

Historically, the Skokomish River supported the largest natural chinook production of any stream in Hood Canal. However, habitat degradation has severely reduced the productive capacity of the mainstem and South Fork portions of the system. As previously noted, the North Fork has been blocked by two hydroelectric dams. Hatchery chinook production has been developed at Washington State's George Adams and McKernan hatcheries to augment harvest opportunities and to provide partial mitigation for reduced natural production in the Skokomish system, primarily caused by the North Fork dams. The Skokomish Tribe, whose reservation is located near the mouth of the river, has a reserved treaty right to harvest chinook salmon.

Over the period from 1996 – 2001, natural spawning escapement ranged from 450 to 1,900, exceeding the nominal goal of 1,650 twice (Table 1)

Table 1. Total spawning escapement of Skokomish River fall chinook, 1990 - 2000.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Hatchery	3068	294	612	495	5196	3100	1885	5584	8227	4033	8616
Natural	1719	825	960	657	1398	995	452	1177	1692	926	1913
Total	4787	1119	1572	1152	6594	4095	2337	6761	9919	4959	10729

Harvest distribution and exploitation rate trends:

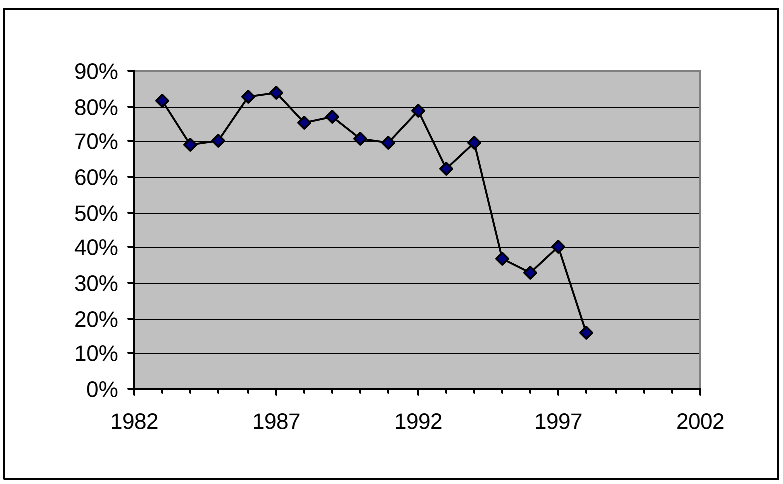
The harvest distribution of Skokomish chinook is best described by recovery of coded-wire tagged fingerlings released from George Adams Hatchery. The average of management years 1996 – 2000 indicates that 39 percent of harvest mortality was associated with Canadian and Alaskan fisheries, nine percent with Washington ocean troll fisheries, 45 percent in recreational fisheries, and 7 percent with net fisheries in Puget Sound.

Table 2. Average harvest distribution of Skokomish River summer/fall chinook, for management years 1996 – 2000, as percent of total adult equivalent fishery mortality (TCChinook 02-3).

Years	Alaska	B.C.	Washington troll	Puget Sound net	Washington sport
1996-2000	1.7%	37.4%	9.0%	7.2%	44.7%

The total annual (i.e., management year) exploitation rate, computed by post-season FRAM runs, declined substantially between 1991 and 1998 (Figure 1). The subsequent increase in exploitation rate reflects increased abundance, due in part to improved marine survival, which has allowed higher harvest while still meeting escapement objectives.

Figure 1. Total fishery-related, spawner equivalent exploitation rates of Skokomish River summer/fall chinook for management years 1983 – 1998, estimated by post-season FRAM runs.



Management Objectives

The immediate and short-term objective for Skokomish River is to manage chinook salmon as a composite population (including naturally and artificially produced chinook). The composite population will be managed, in part, to achieve a suitable level of natural escapement; and to continue hatchery mitigation of the effects of habitat loss; and to provide to the Skokomish Tribe partial mitigation for its lost treaty fishing opportunity. Habitat recovery and protection measures will be sought to improve natural production. Over time, alternative management strategies will be explored that may lead to improved sustainable natural production, and reduced reliance on mitigative hatchery support for the Skokomish stock and fisheries.

The nominal escapement goal for the Skokomish River is 3,650. It is the sum of spawner requirements for 1,650 in-stream spawners (HCSMP; 1985) and 2,000 spawners required for the maintenance of on-station hatchery production (see 1996 Production Evaluation MOU, PNPTC-WDFW-USFWS; 2002 Framework Plan, WDFW-PNPTT). Recent composite escapements have been substantially above the 3,650 fish level, averaging 6,941 for the 1997 – 2001 period, and exceeding the 3,650 goal in four of the last five years. In the same period, natural escapement has averaged 1,332, and exceeded 1,650 twice. Escapements to the hatchery have averaged 5,709 fish and have exceeded the 2,000 fish goal in four of the last five years. (Table 1).

The escapement goal of 3,650, along with its component requirements for natural and hatchery spawners, (WDF Tech. Rept. 29, 1977; PSSMP, 1985; HCSMP, 1985; HCSMP Prod MOU, 1996) is intended to maintain full hatchery mitigation and meet current estimates of MSY escapement to natural spawning areas, under current habitat conditions.

A critical abundance threshold escapement of 1,300, represents the aggregate of 800 natural spawners and 500 adults returning to the hatchery rack. At these levels, the hatchery escapement component represents the minimum requirement to maintain production. The natural escapement component threshold is set at approximately 50% of the current MSY estimate and represents a level necessary to ensure in-system diversity and spatial distribution (Magnuson-Stevens Act, National Standard for Overfishing Review Threshold). In the 1997 – 2001 period, the critical threshold was exceeded in all years for this management unit. Component critical thresholds in these years were exceeded in all years for hatchery escapement, and in four of the last five years for natural escapement.

During the recovery period, pre-terminal fisheries in southern U.S. areas (SUS), will be managed to ensure a ceiling rate of exploitation of 15%, or less, as estimated by the FRAM model (est. of 1997-1999 SUS preseason impacts). Pre-terminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and commercial and recreational fisheries in Puget Sound, outside Hood Canal. Terminal fisheries are managed to achieve the escapement goal of 3,650. If the recruit abundance is insufficient for the goal to be met, OR regardless of the total escapement, the naturally spawning component of this population is expected to fall below 1,200 spawners, OR the hatchery component is expected to result in less than 1,000 spawners, additional terminal fishery management measures will be taken, with the objective of meeting or exceeding these spawner levels. The following management measures have been taken in recent years for this purpose, and will be considered in 2003:

- Commercial and recreational fisheries in northern Hood Canal areas (WDFW Areas 12 and 12B) will be reduced or eliminated in the months of July through September.
- Commercial and recreational fisheries in southern Hood Canal areas (WDFW Areas 12C and 12D) will be "shaped" to direct the majority of the fishing effort to the Hoodsport Hatchery zone, thus greatly reducing impacts to the Skokomish Management Unit. In 2000, approximately 90% of the total commercial harvest in Area 12C was directed at, and taken, in that zone.
- In the Skokomish River, Treaty Indian commercial fisheries will be limited in August and September, to areas upstream of the Skokomish delta milling area (upstream of the SR 106 crossing), and downstream of the U.S. 101 crossing.
- In the Skokomish River, recreational salmon fisheries will be limited, through September, to areas upstream of the mouth and downstream of the U.S. 101 crossing.

If, despite the implementation of the above measures, the projected escapement is expected to be less than 1,300 total spawners, OR regardless of the total escapement, the naturally spawning component of this population is expected to fall below the critical threshold of 800 spawners, OR the hatchery component is expected to result in less than 500 spawners, pre-terminal SUS fisheries will be constrained to minimize mortality, in accordance with conservation measures described in Appendix C, or more restrictive measures that have been evaluated and agreed-to by the co-managers for the year in question. In Hood Canal terminal areas, additional management measures will be taken, with the objective of meeting or exceeding these critical spawner levels.

All of the measures shall initially be based on preseason forecasted abundance and escapement projections and may be adjusted during the season, following any inseason reassessment of the terminal abundance. As of 2002, the Co-managers have investigated the feasibility of developing a sufficiently accurate method to derive in-season estimates of abundance, using available commercial and/or recreational, as well as hatchery and/or natural escapement data. However, no approach was found that would result in better estimates when compared to preseason forecasts.

This management regime recognizes the need to optimize natural production in the Skokomish River. However, production potential is currently severely constrained by reduced habitat capacity and quality in the South Fork, and by the influence of the hydroelectric and re-regulation dams on the North Fork. The current productive capacity of habitat has not been quantified in terms of the number of adults required to fully seed the available spawning area or optimize smolt yield.

Principles that underlie the current management intent for Skokomish River chinook include:

> Full recovery of natural productivity in the Skokomish River cannot occur under the current hydroelectric operating regime and degraded habitat status;
>
> The management regime will provide adequate seeding of existing habitat and insure the maintenance of in-system diversity and spatial distribution by assuring that (if available) at least 800, and up to 1,650 (the currently estimated level of MSY), natural spawners reach the spawning grounds;
>
> Natural production is dependent on the mitigative hatchery program to partly support natural escapement;
>
> Hatchery- and natural-origin spawners appear to be genetically similar, and have demonstrated their capacity to adapt to the Skokomish River environment.
>
> Access to harvest opportunity on returning adults produced by the enhancement program at George Adams Hatchery is mandated as partial mitigation for the effects of operation of the City of Tacoma's hydroelectric facility.
>
> The recovery objective for the ESU, which includes conservation and rebuilding of natural production that is representative of the geographic and genetic diversity that characterizes the ESU, is served, in part, by assuring that natural production of locally-adapted populations is recovered in the mid-Hood Canal streams (Duckabush River, Dosewallips River, and Hamma Hamma River) where habitat quality does not constrain to the extent that it does in the Skokomish River.

Management objectives for the Skokomish River management unit will evolve in response to improved understanding of natural productivity, and success in restoring the productive potential of habitat in the system.

Data gaps

- Continue to improve escapement estimates for the South and North Forks of the Skokomish River.
- Develop means to assess the contribution of Skokomish hatchery and natural origin adults to the fishery and to hatchery and natural escapements.
- Quantify the current natural productivity (in terms of recruits per spawners) and natural capacity (in terms of adults and juvenile migrants) of the system.

Mid-Hood Canal Management Unit Status Profile

Component Sub-populations

Hamma Hamma River summer/fall
Dosewallips River summer/fall
Duckabush River summer/fall

Geographic description

Chinook spawn in the Hamma Hamma River mainstem up to RM 2.5, where a barrier falls prevents higher access. Spawning can occur also in John Creek when flow permits access. A series of falls and cascades, which may be passable in some years, block access to the upper Duckabush River at RM 7, and to the upper Dosewallips River at RM 14. Spawning may also occur in Rocky Brook Creek, a tributary to the Dosewallips. Most tributaries to these three rivers are inaccessible, high gradient streams, so the mainstem provides nearly the entire production potential.

Life History Traits

Genetic characterization of the mid-Hood Canal MU has, to date, been limited to comparison of adults returning to the Hamma Hamma River in 1999 with other Hood Canal and Puget Sound populations. These studies, although not conclusive, suggest that Hamma Hamma returns are not genetically distinct from the Skokomish River returns, or recent George Adams and Hoodsport hatchery broodstock (A. Marshall, WDFW unpublished data). The reasons for this similarity are unclear, but straying of chinook that originate from streams further south in Hood Canal, and hatchery stocking, could be contributing causes.

Status

The Mid-Hood Canal MU is comprised of chinook local sub-populations in the Dosewallips, Duckabush and Hamma Hamma watersheds. These sub-populations are at low abundance (Table 1). Current chinook spawner surveys are typically limited to the lower reaches of each stream. In the Hamma Hamma, the majority of the chinook spawning habitat is currently being surveyed. In the Dosewallips and Duckabush, however, the areas surveyed are transit areas and do not include all spawning areas. Upper reaches of the Dosewallips and Duckabush have been more routinely surveyed since 1998, but few chinook adults or redds have been observed. Prior to 1986 no reliable estimates are available because all escapement estimates for these rivers were made by extrapolation from the Skokomish River.

Table 1. Natural spawning escapement of Mid-Hood Canal fall chinook salmon, 1990-2001.

River	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
HammaHamma	35	30	52	28	78	25	11	na	172	557	381	248
Duckabush	10	14	3	17	9	2	13		57	151	28	29
Dosewallips	na	42	41	67	297	76	na		58	54	29	45
Total	45	86	96	142	384	103	24		287	873	438	322

SASSI classified Hood Canal summer/fall chinook as a single stock of mixed origin (both native and non-native) with composite production (sustained by wild and artificial production) (Washington Dept of Fisheries et al. 1992). The combination of recent low abundances (in all tributaries except the Skokomish River) and widespread use of hatchery stocks (often originating from sources outside Hood Canal) led to the conclusion in SASSI that there were no remaining genetically unique, indigenous populations of chinook in Hood Canal. A study is currently underway to characterize the genetic profile of chinook juveniles and adults in the mid-Hood Canal MU.

The status of the mid-Hood Canal chinook sub-populations was not individually assessed in the SASSI document (WDF et al. 1993), rather the Hood Canal natural and hatchery stocks were aggregated into a single unit for which status was assessed to be healthy. It has been assumed that many of the naturally-spawning chinook in the Hamma Hamma, Dosewallips, and Duckabush rivers have, in recent years, been due to straying of hatchery spawners, as well as adult returns from hatchery fry released into these rivers.

Harvest distribution and exploitation rate trends:

The harvest distribution of mid-Hood Canal chinook, and recent fishery exploitation rates, cannot be directly assessed because none of the component sub-populations have been coded-wire tagged. However, it is reasonable to assume, given their similar life history, that tagged fingerling chinook released from the George Adams Hatchery on the Skokomish River, follow a similar migratory pathway and experience mortality in a similar set of pre-terminal fisheries in British Columbia and Washington. A summary of recent analyses of the Skokomish River data are shown in that profile.

Management of the terminal area fisheries in Hood Canal enables some separation of harvest between Skokomish/ Hoodsport and the mid-Canal natural MU. With only Hoodsport and Skokomish tags available to model terminal impacts, the selective intent of the terminal regime will be estimated based on the freshwater entry period for mid-Canal rivers, and the distribution of historical net catch among the sub-areas of Hood Canal.

It is reasonable to conclude that mid-Canal sub-populations experienced a decline similar to that of Skokomish River chinook, but their total exploitation rate has been lower, because the terminal area fishery, which can harvest a significant proportion of

Skokomish chinook, has been restricted to the southern end of Hood Canal since the early 1990's.

Management Objectives

The management objective for the mid-Hood Canal Management Unit is to maintain and restore sustainable, locally adapted, natural-origin chinook sub-populations. Management efforts will initially focus on increasing the abundance in the MU and its local, natural sub-populations Fisheries are being restricted to accommodate the escapement objectives.

The existence of historical, indigenous populations that have remained distinct and sustainable is at least questionable and while additional genetic sampling may help resolve any remaining uncertainty, the Co-managers' intent is to support their ongoing local diversity adaptation.

During the recovery period, pre-terminal fisheries in southern U.S. areas (SUS), will be managed to achieve a total rate of exploitation of 15%, or less, as estimated by the FRAM model (see Section IV). This pre-terminal exploitation rate is the same as that for the remainder of the Hood Canal management units because no means exist to separately assess the pre-terminal exploitation of the Mid-Hood Canal unit, and there is no indication that its pre-terminal exploitation pattern is different between Hood Canal MUs. Pre-terminal fisheries include the coastal troll and recreational fisheries managed under the Pacific Fisheries Management Council, and commercial and recreational fisheries in Puget Sound, outside Hood Canal. Terminal areas for this management unit include the northern Hood Canal marine areas (WDFW Areas 12 and 12B) as well as the freshwater areas in each river.

The migratory pathway and harvest distribution of mid-Hood Canal chinook is presumed to be similar to that of the Skokomish River indicator stock. The FRAM simulation model suggests that the terminal (Area 12C) and extreme-terminal (in-river) fisheries may harvest up to 25% of the Skokomish terminal run. However, terminal-area fisheries at the far southern end of Hood Canal, near the mouth of or in the Skokomish River, are not believed to harvest significant numbers of adults returning to the mid-Canal rivers of origin. Time and area restrictions are believed to be effective in relieving harvest pressure on the mid-Canal sub-populations.

When the escapement goal of 750 spawners (established as interim MSY in HCSMP) is not expected to be met, additional management measures will be considered for terminal area recreational and commercial fisheries, including season duration adjustments in marine areas, shaping of coho fisheries, and closure of recreational fisheries in the Dosewallips, Duckabush, and Hamma Hamma rivers. For example, terminal area harvest of the mid-Hood Canal management unit may be reduced by restricting commercial and recreational fisheries to the southern end of the Canal (Area 12C and the Skokomish River) during the passage of mid-Canal chinook, and/or shaping coho fisheries to occur only at the extreme end of the chinook freshwater entry period. Recreational fisheries can be similarly shaped to avoid directed take and minimize hooking mortality during fisheries directed at coho salmon. Additional restrictions may include elimination of freshwater fisheries in the Dosewallips, Duckabush and Hamma Hamma rivers during residency of adult spawners. These measures will be considered in order to ensure that the total SUS exploitation rate will not exceed 15%.

A critical abundance threshold of 400 chinook spawners has been established for the Mid-Hood Canal management unit, which is approximately 50% of the current MSY goal for the Mid-Canal rivers, in the Hood Canal Salmon Management Plan (1985). If escapement is projected to fall below this threshold, further conservation measures, which are described in Appendix C, will be implemented in pre-terminal and terminal fisheries to reduce mortality. The best available information indicates that escapement has been below the critical abundance threshold in three out of the last five years. The co-managers recognize the need to provide across-the-board conservation measures in this circumstance, and to avoid an undue burden of conservation falling on the terminal fisheries.

Unless genetic studies conclude that distinct populations persist in individual mid-Hood Canal streams, the primary focus of management will be to ensure that sufficient spawners escape to these systems to maintain self-sustaining sub-populations. These sub-populations will contribute geographic diversity to the ESU by their adaptation to the unique environmental conditions found in these drainages of the east slope of the Olympic Mountains.

Data gaps

- Continue to improve escapement estimates
- Test the accuracy of the pre-season forecasts
- Develop means to assess the origin composition of adults in the escapement
- For each sub-population, and the MU, reassess spawner requirements and quantify the current productivity (in terms of recruits per spawner) and capacity (in terms of adults and juvenile migrants).

Dungeness Management Unit Status Profile

Component Stocks

Dungeness River chinook

Distribution and Life History Characteristics

Chinook spawn in the Dungeness River up to RM 18.9, where falls, just above the mouth of Gold Creek, block further access. Spawning distribution , in recent years, has been weighted toward the lower half of the accessible reach with approximately two-thirds of the redds located downstream of RM 10.8. Chinook also spawn in the Graywolf River up to RM 5.1.

The entry timing of mature chinook into the Dungeness River is not described precisely, because of chronically low returns of adults. It may occur from spring through September. Spawning occurs from August through mid-October (WDF et al 1993). At the current low level of abundance, no distinct spring and summer populations are distinguishable in the return. Chinook typically spawn two weeks earlier in the upper mainstem than in the lower mainstem (WDF et al 1993). Ocean- and stream-type life histories have been observed among juvenile chinook in the system, with extended freshwater rearing more typical of the earlier-timed segment (Ames et al 1975). Hirschi and Reed (1998) found that a relatively large number of chinook juveniles overwinter in the Dungeness River.

Smolts from the Dungeness River primarily exhibit an ocean-type life history, with age-0 emigrants comprising 95 to 98 percent of the total (WDF et al 1993, Smith and Sele 1995, and WDFW 1995 cited in Myers et al 1998). Adults mature primarily at age four (63%), with age 3 and age 5 adults comprising 10% and 25%, of the annual returns, respectively (PNPTC 1995 and WDFW 1995 cited in Myers et al 1998).

Stock Status

The SASSI report (WDF et al 1993) classified the Dungeness spring/summer as critical due to a chronically low spawning escapement to levels, such that the viability of the stock was in doubt and the risk of extinction was considered to be high.

The nominal escapement goal for the Dungeness River is 925 spawners, based on historical escapements observed in the 1970's and estimated production capacity re-assessed in the 1990's (Smith and Sele 1994). This goal has not been achieved in the past 10 years. Since 1996, the mean escapement has been 182 (Table 1).

Chinook production in the Dungeness River is constrained, primarily, by degraded spawning and rearing habitat in the lower mainstem. Significant channel modification has contributed to substrate instability in spawning areas, and has reduced and isolated side channel rearing areas. Water withdrawals for irrigation during the migration and spawning season have limited access to suitable spawning areas.

The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a captive brood stock program to rehabilitate chinook runs in the Dungeness River. The primary goal of this program is to increase the number of fish spawning naturally in the river, while maintaining the genetic characteristics of the existing stock. The first returns of age-4 adults, from the brood year 1996 release of 1.8 million fingerlings, occurred in 2000. Uncertainty over the survival of these fingerlings has led managers to project abundance conservatively, (i.e., discount the potential return from supplementation).

In addition to the broodstock program, the local watershed council (Dungeness River Management Team) and a work group of state, tribal, county and federal biologists have been working on several habitat restoration efforts. Based on the 1997 report, "Recommended Restoration Projects for the Dungeness River" by the Dungeness River Restoration Work Group, local cooperators have installed several engineered log jams, and acquired small refugia riparian properties. Other projects including larger scale riparian land acquisition, dike setback, bridge lengthening and setback, as well as estuary restoration are in the planning, analysis and proposal phases.

Management Objectives

The management objective for Dungeness chinook is to stabilize escapement and recruitment, as well as to restore the natural-origin recruit population basis through supplementation and fishery restrictions. Pre-terminal harvest in Washington waters is constrained to a ceiling exploitation rate of 10% in the southern U.S (based on approximation of the 1997-99 mean SUS incidental rate, as estimated in FRAM). Directed terminal commercial and recreational harvests have not occurred in recent years, and incidental harvest in fisheries directed at coho and pink salmon have been regulated to limit chinook mortality (Table 2).

Direct quantification of the productivity of Dungeness chinook will require either the accumulation of sufficient coded-wire tag recoveries to reconstruct cohort abundance, or an alternate method of measuring freshwater (egg-to-smolt) and marine survival. Releases from the supplementation program are represented by coded-wire tagged groups, adipose fin marked groups, otolith marked groups and blank wire tag groups. Recoveries of these tags, otoliths, and marks will enable cohort reconstruction. However, given the degraded condition of spawning and rearing habitat in the lower mainstem, it must be assumed that current natural productivity is critically low. The supplementation program will continue through one full brood cycle (6 years).

The lack of stock specific historical tag information has necessitated the interim use of a neighboring representative stock in fishery simulation modeling of Dungeness chinook salmon. Tagged Elwha Hatchery fingerlings are used by the FRAM to estimate the harvest distribution and exploitation rates for all Strait of Juan de Fuca chinook management units. (See Elwha Profile, below). Also, for units with very low abundance, such as the Dungeness, the FRAM model's accuracy may be limited. However, the co-managers will continue to develop and adopt conservation measures that protect critical management units, while realizing the constraints on quantifying their effects in the simulation model.

Table 2. Spawning escapement of Dungeness River chinook 1986 - 2001.

Return Year	Escapement
1986	238
1987	100
1988	335
1989	88
1990	310
1991	163
1992	153
1993	43
1994	65
1995	163
1996	183
1997	50
1998	110
1999	75
2000	218
2001	453
1997-2001 Average: 181	

Lacking sufficient direct assessment of the productivity of Dungeness chinook, it may be appropriate to examine what is known about other Puget Sound management units with similar life history and similar status. The status of Nooksack River early chinook, in particular the South Fork Nooksack management unit, is also classified as critical, due to chronically low spawning escapement. Degraded habitat is known to constrain freshwater survival in the Nooksack system, as it does in the Dungeness. The recovery exploitation rate of the Nooksack units has been estimated to be 20 percent (NMFS 2000). The harvest objective for Dungeness (i.e., to maintain exploitation in southern U.S. fisheries below 10 percent), implies a total exploitation rate of 20 percent or less, given that approximately half of the harvest of Dungeness chinook may occur in southern fisheries.

The critical escapement threshold for the Dungeness River is 500 natural spawners, which is approximately 50% of the (presumed MSY) escapement goal. Whenever natural spawning escapement for these stocks is projected to be below this threshold, pre-terminal SUS fisheries will be managed to minimize mortality. Until the supplementation program is successful in rebuilding escapement to levels above this threshold, harvest will be constrained, in accordance with Appendix C, to minimize mortality. The current ceiling objective of 10% exploitation in southern U.S. fisheries reflects this approach.

Data gaps

- Describe freshwater entry timing
- Continue to collect scale or otolith samples to describe the age composition of the terminal run.
- Describe the fishery contribution and estimate fishery-specific exploitation rates from CWT recoveries.
- Estimate marine survival.
- Estimate annual smolt production per spawner (i.e. freshwater survival).

Elwha River Management Unit Status Profile

Component Stocks

Elwha River chinook

Geographic Distribution and Life History Characteristics

Fall chinook spawn naturally in the portions of the lower 4.9 miles of the Elwha River, below the lower Elwha dam, though most of the suitable spawning habitat is below the City of Port Angeles' water diversion dam at RM 3.4. Their productivity is low due to altered and degraded spawning and rearing habitat, and high water temperature during the adult entry and spawning season, which contribute to pre-spawning mortality (ref status reports).

Entry into the Elwha River begins in June and continues through early September. Spawning begins in late August, and peaks in late September and early October (WDF et al 1993). Elwha chinook mature primarily at age-4 (57%), with age-3 and age-5 fish comprising 13% and 29%, of annual returns, respectively (WDF et al 1993, WDFW 1995, PNPTC 1995 cited in Myers et al 1998).

Naturally produced smolts emigrate primarily as subyearlings. Roni (1992) reported that 45 to 83% of Elwha River smolts emigrated as yearlings, and 17 to 55 percent as subyearlings, but this study did not differentiate naturally produced smolts from hatchery releases of yearlings. The Elwha Channel facility no longer releases yearling smolts.

Status

Elwha River chinook were designated as "healthy" in the SASSI document (WDF et al 1993), which considered productivity in the context of currently available habitat for natural production. However, in the past decade, the total spawner goal of 2,900 was not met in any year (see Table 1). The stock is a composite of natural and hatchery production. In the Elwha River, chinook production is limited by two hydroelectric dams which block access to upstream spawning and rearing habitat. Recovery of the stock is dependent on removal of the two dams, and restoration of access to high quality habitat in the upper Elwha basin and certain tributaries. Chinook produced by the hatchery mitigation program in the Elwha system are considered essential to the recovery, and are included in the listed ESU.

The comanagers have concluded that recovery of the Elwha stock is not possible unless the dams are removed and access to pristine, productive habitat, which lies largely within Olympic National Park, is restored.

The nominal spawning escapement goal of 2,900 for Elwha River chinook has not been achieved, even in the absence of in-river fisheries, in the past 10 years. The average number of spawners over the last five years has been 2,105, which is significantly higher than the average of the preceding five years (1992-1996), which was 1,030..

Table 1. Total spawning escapement of Elwha River chinook, 1990 – 2001.

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2,956	3361	1222	1562	1216	1150	1608	2517	2358	1602	1851	2208

Pre-spawning mortality has been a significant factor affecting natural and hatchery production in the Elwha system. High water temperature during the period of freshwater entry and spawning is exacerbated by impoundment of the river behind the two upstream dams. It contributes directly to prespawning mortality, and in some years, promotes the infestation of adult chinook by *Dermocystidium*. Pre-spawning mortality has ranged up to 68% of the extreme terminal abundance (Table 2), largely due to parasite infestation.

Table 2. Prespawning mortality of Elwha River chinook.

Return Year	Hatchery Voluntary Escapement	In-River Gross Escapement	Gaff-Seine Removals	Hatchery Prespawn Mortality	In-River Prespawn Mortality	Total Prespawn Mortality
1986	1,285	1,842	505	376	482	27.4%
1987	1,283	4,610	1,138	432	1,830	38.4%
1988	2,089	5,784	506	428	50	6.1%
1989	1,135	4,352	905	148	412	10.2%
1990	586	2,594	886	160	64	7.0%
1991	970	2,499	857	108	N/A	3.1%
1992	97	3,762	672	26	2,611	68.3%
1993	165	1,404	771	7	0	0.5%
1994	365	1,181	749	61	269	21.3%
1995	145	1,667	518	37	625	36.5%
1996	214	1,661	1,177	147	120	14.2%
1997	318	2,209	624	3	7	0.4%
1998	138	2,271	1,551	51	0	2.1%
1999	113	1,512	609	23	0	1.4%
2000	177	1,736	1,021	62	0	3.2%
2001	195	2,051	1,396	38	0	1.7%

Harvest Distribution and Exploitation Rate Trend

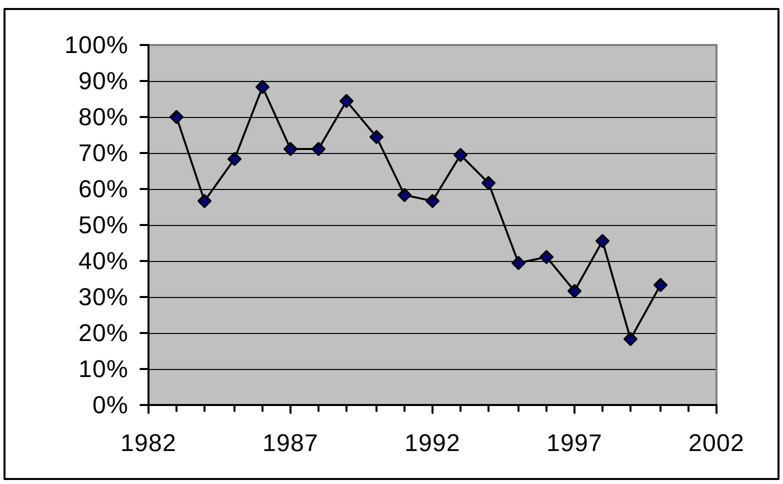
Based on recoveries of tagged fingerlings released from the local hatchery, Elwha River chinook are a far-north migrating stock, as evidenced by 10% and 69% of total mortality occurring in Alaskan and British Columbian fisheries, respectively (Table 3). Net fisheries in Puget Sound account for 4% of total fishing mortality, and Washington troll and sport fisheries account for 5%, and 12%, respectively.

Table 3. The average distribution of adult equivalent annual fishing mortality for Elwha River chinook, estimated from post-season FRAM runs .

Years	Alaska	B.C.	Wash. Troll	Puget Sound Net	Washington sport
1986 - 94	10.0%	69.2%	4.7%	3.8%	12.3%

Post-season FRAM runs indicate that the total exploitation rate of Elwha River chinook has shown a declining trend since 1988 (Figure 1). The average of rates from 1996 – 2000 is 53% lower than the average from 1983 – 1988.

Figure 1. Total adult-equivalent exploitation rate for Elwha River chinook, estimated by post-season FRAM runs.



Management Objectives

Fisheries in Washington waters, including those under jurisdiction of the Pacific Fisheries Management Council, when the escapement goal is not projected to be met, will be managed so as not to exceed a 'Southern U.S.' exploitation rate of 10% on Elwha chinook (based on approximation of the 1997-99 mean SUS incidental rate, as estimated in FRAM). Harvest at this level will assist in providing adequate escapement returns to the river to perpetuate natural spawning in the limited habitat available, and provide broodstock for the supplementation program. It represents a significant decline in harvest pressure from southern U.S. fisheries. The SUS exploitation rate on the Strait of Juan de Fuca management unit aggregate averaged 41% for return years 1990 – 1996. Actual SUS exploitation rates for more recent years have not been calculated, however they were projected to be 7%, 8.2%, 5.6% and,5.2% respectively, in the final pre-season FRAM simulation models for management years 1999 through 2002.

The critical abundance threshold for the Elwha River is 1,000 spawners, which represents a composite of 500 natural and 500 hatchery spawners. Whenever spawning escapement for this stock is projected to be below these levels, fisheries will be managed to achieve a lower rate in southern U.S. waters, in accordance with base fishery levels specified in Appendix C.

Data Gaps

- Estimates of total and natural smolt production from the Elwha River.

- Estimates of the age composition and description of life history of smolts.

Status Profile for the Western Strait of Juan de Fuca Management Unit

Component Stocks

Hoko River fall chinook

Geographic description

Fall chinook spawn primarily in the mainstem of the Hoko River, from above intertidal zone to RM 22, but primarily between RM 3.5 (the confluence of the Little Hoko River) to the falls at RM 10. Chinook may ascend the falls and spawn in the upper mainstem up to RM 22, and the lower reaches of larger tributaries such as Bear Creek (RM 0 to 1.2) and Cub Creek (RM 0 – 0.8), Ellis Creek (0 – 1.0), the mainstem (RM 0 – 2.5) and North Fork (RM 0 – 0.37), of Herman Creek, and Brown Creek(0 – 0.8). Chinook also spawn in the lower 2.9 miles of the Little Hoko River. Historically, chinook have also spawned in other Western Strait streams, including the Pysht, Clallam, and Sekiu rivers. Recent surveys of the Sekiu counted 52 and 12 chinook in 1998 and 1999, respectively. Their origin is unknown, but they are assumed to be strays from the Hoko system.

Currently, chinook from the Hoko Hatchery are being outplanted into the upper Hoko mainstem and tributaries of the upper and lower portions of the watershed, to seed high quality habitat, which has not been utilized consistently for spawning or rearing. Re-introduction to the Sekiu River, and other western Strait streams that once supported chinook, is also being planned.

Life History Traits

Based on scales collected from natural spawners and broodstock from 1988 – 1999, returning Hoko River adults are predominately age 5 (49%) and age 4 (31%) , with age 3 and age 6 adults comprising 8% and 10%, respectively, of the mean annual return (MFM 2000. The available data suggest that most smolts produced in the Hoko system emigrate as subyearlings (Williams et al cited in Myer et al 1998).

Status

The established escapement goal for Hoko River chinook is 850 natural spawners. This goal, first presented in 1978 in WDF *Technical Report 29*, is based on early estimates of freshwater habitat capacity. The total escapement goal is 1,050, which includes 200 brood stock for the supplementation and reintroduction program. For the Hoko chinook stock as a whole, the combined spawning escapement (natural plus hatchery) has averaged 1,021 spawners in the past ten years. Total returns to the river (terminal run size shown above) have exceeded 850 chinook more often than not since 1988 (8 of the last14 years).

Numbers of natural chinook spawners have significantly increased since the inception of the supplementation program in 1982, from counts of less than 200, before hatchery supplementation was initiated, to exceeding the natural escapement goal of 850 in three out of the last six years (the 1996 to 2001 average is 1,081 natural spawners). While natural-origin recruits and the recent and overall escapements have shown increasing trends in abundance since the early 1980s, the proportion of natural-origin spawners relative to the proportion of hatchery-origin spawners has declined in recent years. Nearly half the Hoko River natural spawners in most years may be attributed to the supplementation program (MFM 2000). Despite the recent escapements that have exceeded the goal of 850 natural spawners,, this goal has only been achieved in four of the last 14 years (1988 to 2001; Table 1).

Table 1. Natural spawning escapement of chinook and hatchery broodstock removals from the Hoko River, 1988 – 2001.

Return Year	Natural Spawners	Hatchery Brood Stock	Total Escapement
1988	686	90	776
1989	775	67	842
1990	378	115	493
1991	894	112	1,006
1992	642	98	740
1993	775	119	894
1994	332	96	428
1995	750	155	905
1996	1,228	37	1,265
1997	765	126	891
1998	1,618	104	1,722
1999	1,497	191	1,688
2000	612	119	731
2001	768	178	946
Average:	837	115	952
Goal:	850	200	1,050

Although the escapement goals set in Technical Report 29 have been commonly accepted over the past two decades, it is not certain that the spawner level of 850 is the optimum chinook escapement level for the Hoko River. Further analysis of habitat suitability and usage should be conducted to determine whether spawning or rearing habitat limits chinook production in the Hoko. Additional years of cohort reconstruction may also shed light on the stock-recruitment relationship for Hoko chinook, which may lead to revision in the escapement goal.

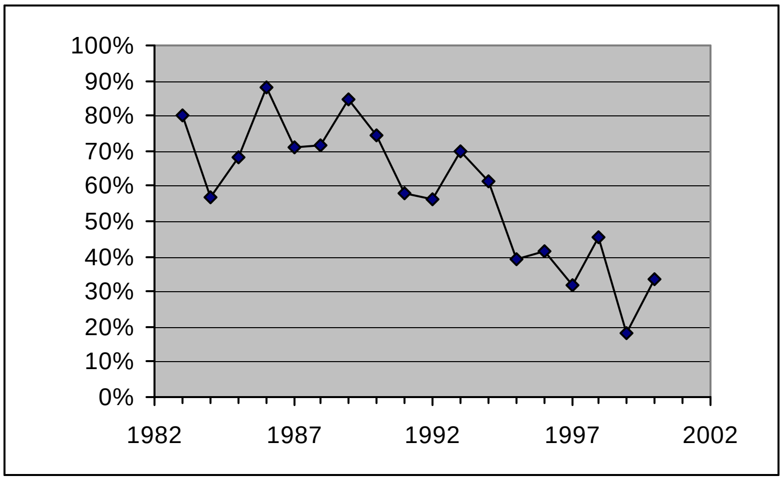
Harvest Distribution and Exploitation Rate Trends

The migration pathway, and harvest distribution, of Hoko River chinook has been described from recoveries of coded-wire tagged fish released from the Hoko Hatchery. The tag data suggest that Hoko chinook are harvested primarily by coastal fisheries in Southeast Alaska and British Columbia (Table 2).

Table 2. Harvest distribution of Hoko River chinook expressed as a proportion of total, annual, adult equivalent exploitation (TCChinook 02-3)

Years	Alaska	B.C.	Wash. Troll	Puget Sound Net	Washington sport
1996 - 2000	74.2%	25.3%	0.0%	0.6%	0.0%

Figure 1. Trend in total, adult equivalent, fisheries mortality for Hoko River chinook, estimated by post-season FRAM runs.



The average annual exploitation rates for Hoko chinook has declined 53 percent, from 1983-1987 to 1996-2000

Although Hoko chinook were harvested at rates that should be reasonable for most Puget Sound chinook, even this exploitation rate was higher than would allow for replacement of spawners. This low productivity of Hoko chinook is very likely related to degraded freshwater habitat, including recurrent flooding and erosion, with poor marine survival. Among the watershed problems that the Hoko faces are these:

- 98% of Hoko watershed has been clearcut
- 60% of the watershed is currently in a clearcut state (i.e., clearcuts <20 years old)
- 350 miles of roads in the 72-mile watershed. (M.Haggerty, personal communication, 2000.)

Management Objectives

Management guidelines include a recovery exploitation rate objective for the Western Strait of Juan de Fuca management unit and a critical escapement threshold. The recovery exploitation rate objective is a maximum of ten percent in southern U.S. fisheries. It represents a lower exploitation rate than these stocks have experienced on average, and a rate that is achievable (and has been achieved in recent years), through conservative fishery management (Table 2). Recent years have shown that the nominal escapement goal can be achieved, with favorable marine survival, under this management regime.

The critical escapement threshold for the Hoko River is 500 natural spawners. Whenever natural spawning escapement for this stock is projected to be below this level, the harvest management plan will call for fisheries to be managed to achieve a lower rate than the interim 10% ceiling SUS exploitation rate.

Data gaps

- Reconstruct more recent brood years from CWT data
- Derive a spawner/recruit relationship for Hoko chinook

Appendix B. Non-landed Mortality Rates

The fishery simulation model (FRAM) used by the co-managers for pre-season management planning and post-season assessment allows specification of non-landed mortality rates for different fisheries strata and gear types, in order to estimate total fisheries-related mortality for all component stocks. Non-landed mortality comprises a significant proportion of total fisheries mortality. This document summarizes the non-landed mortality rates that are currently specified by the FRAM chinook model (Table 1), and discusses the sources of these rates

When sub-legal fish (i.e. those less than the minimum allowable size) or species for which retention is disallowed are caught, a proportion (i.e. the releases mortality rate) subsequently die. This occurs frequently in commercial troll and recreational hook-and-line fisheries, for which regulations specify a minimum size limit, and may specify, for certain period, non-retention of chinook or coho. Non-retention of chinook may also be specified for certain net fisheries, where the fisherman tends the gear constantly (gillnets), or the gear design (seines) allows live capture and release of non-target species.

Drop-off or drop-out mortality is defined as that which occurs when fish are hooked or entangled by the gear, but they escape before being landed. The rate is applied to the number of landed fish.

Table 1 - Chinook Incidental Mortality Rates Assumed for FRAM Model Fisheries in Washington.

Fishery	**Release Mortality**	**Drop-off, Drop-out, and other**
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%	2% terminal; 3% preterminal
Purse Seine	45% immature 33% mature	0%
Beach Seine Skagit Bay pink fishery	 50%	
Reef Net	None Assessed	0%

1. Ocean troll and recreational fisheries

(a) Description of Sources of Incidental Mortality

Incidental mortalities in troll fisheries are related to the duration of retention and non-retention periods, size limit regulations, and gear type. Size limits have been used extensively for these fisheries and have changed only a few times since 1979. Recreational and troll fisheries have been allowed to retain fish larger than 24" since the mid- 1980's. Troll fishing techniques differ, depending on whether the target species is chinook of coho. When coho are targeted, encounters with chinook have been reduced, but not eliminated, by species-specific gear, location, and fishing technique. Other management measures to reduce incidental chinook catch, such as landing limits, ratio fisheries, or chinook non-retention fisheries are seldom utilized. Marine mammal predation, 'sorting', and other sources of mortality associated with hook and line gear are not accounted in FRAM. 'Sorting' refers to release of legal fish in order to retain a larger fish later.

(b) Estimates of Incidental Mortality

The effects of size limits on incidental mortality are modeled by a growth function to estimate what proportion of stock are of legal size at each time step. Encounter rates are calculated by the FRAM, using growth functions specific to each contributing stock to determine the proportion of legal and sub-legal fish, in each age class, present in each time step. Assuming that all ages are equally vulnerable to fishing, the fishery-specific exploitation rate is then applied to estimate legal and sub-legal encounters. Incidental mortality is then estimated by applying mortality rate appropriate to the fishery and gear type. FRAM also allows direct input of encounter rates if they are estimated from direct sampling of fisheries. With funding from the CTC, the Makah Tribe has monitored chinook encounter rates in troll fisheries in Washington Catch Areas 1 – 4 for 1998 - 2001. These data have been incorporated into pre-season fisheries modeling.

Release mortality associated with non-retention periods are calculated as ratios of non-retention days to normal retention days within the model base period. Drop-off mortality for hook-and-line fisheries is distinguished from landed catch by FRAM (i.e. may be reported separately). The current drop-off mortality rate is five percent. This value was derived from a negotiation process and is generally thought to include marine mammal interactions and illegal catch.

Historical estimates of incidental chinook mortality in troll and recreational fisheries, that are provided in the attached spreadsheets, were made by FRAM in 'validation' runs that reconstructed fisheries mortality, post-season, from known catch and stock abundance for the years 1983 – 1996. They are annual estimates, including impacts during the October – April time step that precedes the May – September period when most fishing occurs. These estimates express incidental mortality in the same terms as landed catch; they are not adjusted for adult equivalence. They provide a historical perspective on incidental mortality during the 1983-1985 base period, and under the more constrained fishing regimes of 1991 – 1996.

(c) Measures Taken to Reduce Incidental Mortalities

Incidental mortality has been reduced by requiring the use of barbless hooks in troll and recreational fisheries. During periods of chinook-directed fishing, trollers have been required to use large plugs to reduced interactions with sub-legal fish and coho. Time and area considerations are weighed in the structuring of ratio and non-retention fisheries to minimize incidental mortality to the extent possible.

(d) Future Reduction of Incidental Mortality

Further reduction of incidental mortality in chinook fisheries will primarily be accomplished by measures designed to reduce encounters through time and area restrictions. The status of chinook stocks in Washington State may require reduction of exploitation rates. Future studies may show reductions in release mortality for different hook types and sizes for troll and recreational fisheries.

2. Net Fisheries

(a) Description of Sources of Incidental Mortality

Drift and set gillnet fisheries are conducted in Grays Harbor and Willapa Bay on the Washington coast, throughout Puget Sound, and in freshwater. However, net fisheries directed at chinook currently occur only in a few areas where harvestable, hatchery-origin chinook may be targeted. These areas include Bellingham Bay and the Nooksack River, Tulalip Bay, Elliot Bay and the Green River, the Puyallup River, Nisqually River, southern Hood Canal and the Skokomish River, and other discrete areas in southern Puget Sound. Incidental mortality occurs in these fisheries as a result of net drop-out and marine mammal predation. Gillnet fisheries retain all fish because the mortality of released fish is believed to be high. Harbor seals and sea lions cause significant incidental mortality in many pre-terminal and terminal gillnet fisheries in Puget Sound, but this source is not accounted in current fishery models or planning.

Purse seine fisheries are conducted in Georgia Strait / Rosario Strait, Southern Puget Sound, and Hood Canal, and are primarily directed at sockeye, pink, coho, and chum salmon. The only seine fishery directed at chinook occurs in Bellingham / Samish Bay. Incidental mortality, in the context of this discussion, results from injury or stress during capture, or from handling the fish in order to release them. Mortality may be immediate or may occur after some delay from injury or disease.

Non-Indian reef net fisheries that target sockeye and, in some years, coho salmon are conducted in Puget Sound catch areas 7 and 7A. In recent years they have been required to release all chinook salmon, but no associated incidental mortality has been accounted in fishery planning. Reef net hauls catch relatively few fish, and the gear and handling cause relatively minor injuries (e.g. stress, scale loss), so incidental mortality is thought to be very low.

Marine mammal interactions incur significant incidental mortality in many Puget Sound gillnet fisheries, but they have not been generally quantified. A limited number of area-specific studies provide some quantification (PNPTC 1986; 1988?)

(b) Estimates of Incidental Mortality

Drop-out mortality for gillnet fisheries are accounted by FRAM as 3% of landed pre-terminal gillnet catch and 2% of terminal landed gillnet catch. Many factors affect the drop out rate, including mesh dimension, net material and hanging design, sea state, and the frequency of picking. Drop-out rates were derived by technical consensus among state and tribal biologists, because of lack of data from direct sampling. Gillnets fished in the traditional manner are assumed to have a release mortality of a hundred percent. Incidental mortality due to marine mammal predation is highly variable, but is thought to be substantial in many areas in Puget Sound. There has been no systematic sampling of these fisheries that might enable accurate quantification, though anecdotal evidence abounds, and there have been several efforts to document the incidence of scars on spawning chinook.

When chinook are released following capture in purse seine fisheries, immediate and delayed mortality is significantly lower for large chinook than for smaller chinook (Ruggerone and June 1996). Incidental mortality is accounted in the FRAM model as 45% for immature fish (i.e. those caught in fall coho and chum fisheries), and 33% for mature fish caught in sockeye and pink fisheries. Pre-season projections of encounters for any given fishery are based on historic catch, and differential mortality calculated for large and small fish and reported as part of landed mortality. Since FRAM aggregates the incidental mortality associated with all types of net gear for a given fishery, the expected distribution of catch among different gear types underlies the estimate. 'Drop-out' mortality is not accounted for purse seine, roundhaul seine, or beach seine fisheries.

Estimates of mortality in net fisheries, that were included in the previous transmittal to the CTC, were based on a study conducted by WDFW in 1976-1985 (Shepard 1987). Observed encounters per set were expanded to estimate mortality in chinook directed fisheries and encounters per landing in other fisheries. These estimates were previously reported to PSC, but vary widely from FRAM estimates due to differences in methodology. We suggest that FRAM estimates provide the most useful comparison between the base period and more recent year; these are provided in attached spreadsheets.

Estimates of gillnet drop-out mortality from the FRAM validation set, for 1979 – 1985, and 1991 - 1996, are reported for marine net fisheries in North and South Puget Sound, Strait of Juan de Fuca, Grays Harbor, and Willapa Bay. Mortality, during these intervals, in freshwater net fisheries is reported as 2% of the landed catch in each river. River fisheries in this report include the Nooksack, Skagit, Snohomish, Lake Washington (including the Ship Canal), Green, Nisqually, and Skokomish rivers in Puget Sound, and the Sooes, Quileute, Queets, and Quinault rivers on the Washington coast.

Release mortality from purse seine fisheries is hard to tease out of FRAM validation runs. It is calculated by spreadsheet outside of FRAM and input as part of the landed catch. For a given FRAM net fishery, release mortality is dependent on the relative volume of purse seine, beach seine, and gillnet catch; no additional release mortality is assigned to beach seine and gillnet catch.

(c) Measures Taken to Reduce Incidental Mortalities

Incidental chinook mortality has been reduced in gillnet fisheries by time and area restrictions that restrict effort during the chinook migration period, which has been specifically defined for all Puget Sound fishing areas. When migration periods for other salmon species overlap, (e.g. for pink or coho salmon), fisheries directed at those species are shortened to reduce chinook encounters.

Commercial net fishers may reduce marine mammal interactions by using 'seal bombs' or may obtain permits to shoot harbor seals and sea lions in some cases.

Since 1973, non-Indian fishery regulations have required that purse seines incorporate a strip of larger mesh at the top of the bunt to allow immature chinook to escape. In 1996, the minimum gill net mesh size for chum fisheries was increased to 6-1/4 from 5-3/4 inch mesh, in order to reduce the incidental catch of immature chinook. In 1997 all purse seine fisheries required release of all chinook. Gillnet fisheries were allowed to retain chinook because release mortality is assumed to be 100%. In 1998 shoreline closures in Rosario Strait (Area 7) were adopted, designed to reduce impacts on chinook salmon while still providing opportunities during sockeye and pink-directed fisheries. In 1999 purse seines were required to use brailers or hand dip nets to remove salmon from seine nets during sockeye and pink salmon fisheries in 7/7A to reduce by-catch mortality (R. Bernard, WDFW, pers comm. October 19, 2000).

(d) Future Reduction of Incidental Mortality

Further reduction in the incidental mortality of chinook in net fisheries will involve coordinated study and development of more selective gear, more effective release techniques, mitigation of marine mammal interactions, and, perhaps, reductions in fishing opportunity.

A study, funded under NMFS' Saltonstall-Kennedy program, is currently being conducted by WDFW to evaluate tangle nets as an alternative to conventional gillnet gear. Tangle nets are constructed of smaller-mesh, loosely hung, monofilament that catches salmon by the teeth or jaw, rather than behind the opercle and gills. Previous studies in British Columbia suggested that non-target species could be released from this gear with low associated mortality. Fishing power with respect to target species, and survival of non-target salmon species caught and released from tangle nets, are being analyzed at two sites in Puget Sound. It may be possible to improve the survival of chinook caught in purse seines with careful handling or by allowing fish to recover in a tank prior to their release.

In certain circumstances fishing opportunity, where species other than chinook are the target, may be further constrained, or planned to achieve a specific level of incidental mortality. These measures require accurate in-season monitoring to assess when the threshold of landed chinook catch has been achieved.

Appendix C. Minimum Fisheries Regime

PILB

Minimum Fishery Regulation Regime

Non-Treaty Ocean Troll Fishery:
- A ceiling catch number of 5,900 chinook.
- Area 3 and 4 closed.

Non-Treaty Ocean Recreational Fisheries:
- A ceiling catch number of 3,500 chinook.
- Chinook non-retention in Areas 4 and 4B.

Treaty Ocean Troll Fishery:
- A ceiling catch number of 15,000 chinook.
- Chinook only May 1 through June 30.
- All species July 1 through earlier of September 15 or ceiling.

Strait of Juan De Fuca Treaty Troll Fisheries:
- Open June 15 through April 15.
- Use barbless hooks only.

Strait of Juan De Fuca Treaty Net Fisheries:
- Setnet fishery for chinook open June 16 to August15. 1000 foot closures around river mouths.
- Gillnet fisheries for sockeye, pink, and chum defined by PST Annex; net fisheries closed mid-November through mid-June.

Strait of Juan De Fuca Non-treaty Net Fisheries:
- Closed year-around.

Area 5/6 Recreational Fishery:
- May 1-July 31 closed.
- Chinook non-retention August and September.
- October closed
- 1-chinook bag limit in November.
- December-February 15 closed
- 1-fish bag limit February 16-April 10
- April 11-30 closed

Strait of Juan De Fuca Terminal Treaty Net Fisheries:
- Hoko, Pysht, and Freshwater Bays closed May 1 – October 15.
- Elwha River closed March 1 through mid-September.
- Dungeness Bay closed March 1 through mid-September.
- Area 6D chinook non-retention mid-September through October 10.
- Close miscellaneous JDF streams March 1 through November 30.

Strait of Juan De Fuca River Recreational Fishery:
- Chinook non-retention in Elwha.
- Dungeness closed to salmon 12/1 through 10/15.
- Dungeness chinook non-retention 10/16 through 11/30.
- Close other streams.

Area 6/7/7A Treaty – Non-treaty Net Fisheries:
- Sockeye, Pink, and chum fisheries as defined by PST Annex provisions with the following adjustment measures;
- Net fisheries closed from mid-November through mid-June.
- Area 6A Closed.
- Non-treaty purse seine and reef net fisheries chinook non-retention.
- Non-treaty gillnet fishery chinook ceiling of 700.
- Non-treaty closure within 1500 feet of Fidalgo Island between Deception Pass and Shannon Pt; and within 1500 feet of Lopez and Decatur Islands between Pt Colville and

Area 7 Recreational Fishery:
- May 1-June 30 closed.
- 7/1-7/31 1 fish limit, Rosario Strait and Eastern Strait of Juan de Fuca
- closed; Bellingham Bay closed.
- 8/1-9/30 1 fish limit, Southern Rosario Strait and Eastern Strait Juan de
- Fuca closed Bellingham Bay closed.
- 8/1-8/15, Samish Bay closed.
- Chinook non-retention 10/1-10/31
- 11/1-11/30 1 fish limit.
- December-February 15 closed
- 1-fish bag limit February 16-April 10
- April 11-30 closed

Nooksack/Samish Terminal Area Fisheries:
- Closed to commercial fishing from April 15 through July 31 when either early run does not exceed 1,000 spawners.
- Closed to commercial fishing from April 15 through June 30 when both early runs exceed 1,000 spawners, but at least one run does not exceed 2,000 spawners.
- Ceremonial fishery in late May limited to 5 fish when either early run does not exceed 1,000 spawners.
- Additional ceremonial fisheries and subsistence fisheries limited to July 1-4 when
- either early run does not exceed 1,000 spawners.
- Bellingham Bay recreational fishery closed in July.
- Samish Bay recreational fishery closed August 1-15.
- Chinook non-retention in Nooksack River recreational fisheries.
- 2-chinook bag limit after October 1 in Nooksack River.
- 2-fish bag limit from July 1 to December 31 in Samish River.

Skagit Terminal Area Net Fisheries:

- Skagit Bay and lower Skagit River closed to net fishing from mid-February to August 22 in pink years, and until week 37 (~September 10) in non-pink years.
- Upper Skagit River closed to commercial net fishing from mid-March to August 22 in pink years, and until week 42 (~October 10) in non-pink years, unless there is an opening for Baker sockeye in July.
- Upper Skagit and Sauk-Suiattle fisheries on Baker sockeye require 5½ " maximum mesh, and chinook non-retention.
- Half of the Upper Skagit and Sauk-Suiattle share of Baker sockeye will be taken at the Baker Trap, rather than in river fisheries.
- No chinook update fishery or directed commercial chinook fishery.
- Treaty pink update fishery limited to 2 days/week during weeks 35 and 36, and Non-treaty update limited to 1 day/week, gillnets only.
- Pink fishery gillnet openings in the Skagit River limited to a maximum of 3 days/week, regardless of pink numbers. Beach seines may be used on other days, with Chinook non-retention.
- Up to 40% of the Upper Skagit share of pink salmon will be taken in Skagit Bay.
- Release chinook from beach seines in Skagit Bay.
- Chinook non-retention required in pink fisheries in the upper river.
- No Non-treaty commercial coho openings in Skagit Bay.
- Tribal coho openings delayed until Week 39 in the Bay and lower river, and until Week 42 in the upper river.
- Chinook test fisheries limited to 1 boat, 6 hrs/week.

Skagit River Recreational Fisheries:

- Chinook non-retention.

Area 8A and 8D Net Fisheries:

- Area 8A Treaty fishery chinook impacts incidental to fisheries directed at coho, pink, chum, and steelhead.
- Treaty pink fishery schedule limited to maintain chinook impacts at or below modeled rate.
- Area 8A non-treaty fishery chinook impacts incidental to fisheries directed at pink and chum.
- Non-treaty pink fishery limited to 1 day/week for each gear.
- Non-treaty purse seine fishery chinook non-retention.
- Area 8D Treaty chinook fisheries limited to C & S in May and June, and to 3 days/wk in July, August, and September.
- Area 8D non-treaty chinook impacts incidental to fisheries directed at coho and chum.

Stillaguamish River Net Fisheries:

- Treaty net fishery chinook impacts incidental to fisheries directed at pink, chum, and steelhead.
- Treaty pink fishery schedule limited to maintain chinook impacts at or below modeled rate.

Stillaguamish River Recreational Fisheries:

- Chinook non-retention.
- Use barbless hooks from September 1 to December 31.

Snohomish River Fisheries:

- Net fisheries closed.
- Chinook non-retention in river recreational fisheries.

Area 8-1 Recreational Fisheries:

- 5/1-8/31 closed.
- Chinook non-retention 9/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 8-2 Recreational Fisheries:

- 5/1-7/31 closed.
- Chinook non-retention 8/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.
- 1-chinook bag limit in Tulalip Bay in August and September.
- Tulalip Bay openings limited to 12:01 AM Friday to 11:59 AM Monday each week.

Area 9 Net Fisheries:

- Net fisheries limited to research purposes.

Area 9 Recreational Fisheries:

- 5/1-7/31 closed.
- Chinook non-retention 8/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 10 Net Fisheries:

- Closed from mid-November through June and August. Limited fishery in July possible only in years when harvestable Lake Washington sockeye are available.
- Treaty net fisheries chinook impacts incidental to fisheries directed at coho, and chum.
- Non-treaty coho fishery closed.
- Non-treaty purse seine fishery chinook non-retention.

Area 10A Treaty Net Fisheries:

- Limit chinook gill net fisheries to 3 test fishery openings and 1 day/wk update fisheries.
- Net fishery chinook impacts incidental to fisheries directed at coho, chum and steelhead, with coho opening delayed until chinook clear.

Area 10E Treaty Net Fisheries:

- Closed from mid November until last week of July.
- Chinook net fishery 5 day/wk last week of July through September 15.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Duwamish/Green River Fisheries:

- Chinook net fishery limited to 1 day/wk update fishery until run size updated.
- Net fishery chinook impacts incidental to fisheries directed at coho and steelhead. Coho fishery closed until chinook clear.
- Chinook non-retention in river recreational fisheries.

Lake Washington Terminal Area Fisheries:

- Net fishery chinook impacts incidental to fisheries directed at coho and sockeye. Coho net fisheries delayed until chinook clear.
- Cedar River and Issaquah Creek closed to recreational fishing.
- Chinook non-retention in Sammamish River, Lake Washington, Union, Portage Bay, and Ship Canal recreational fisheries.

Area 10 Recreational Fisheries:

- 5/1-6/30 closed.
- Chinook non-retention 7/1-10/31.
- 11/1-11/30 1 fish limit.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Area 11 Net Fisheries:

- Closed from end of November to beginning of September.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.
- Non-treaty purse seine fishery chinook non-retention.

Area 11A Net Fisheries:

- Closed from beginning of November to end of August.
- Net fishery chinook impacts incidental to fisheries directed at coho.

Puyallup River System Fisheries:

- Net fisheries closed from beginning of February to beginning of August.
- Limit gill net test fishery for chinook to 1 day a week, scheduled from mid-July
- through the end of August.
- Chinook net fisheries limited to 1 to 3 days/week and delayed until August 15 to protect White River spring chinook.
- Muckleshoot on-reservation fisheries on White River limited to hook and line C & S fishing for seniors, with a limit of 25 chinook.
- Net fishery chinook impacts incidental to fisheries directed at coho, chum, and
- steelhead.
- 2-chinook bag limit in river sport fisheries.
- Chinook non-retention before August 1 in Puyallup River sport fishery.
- Chinook non-retention before September 1 in Carbon River sport fishery.
- Chinook non-retention in White River.

Area 11 Recreational Fisheries:

- 5/1-5/30 closed.
- 1-fish limit June 1 – November 30.
- 12/1-2/15 closed.
- 1-fish limit February 16 – April 10.
- 4/11-4/30 closed.

Fox Island/Ketron Island Net Fisheries:

- Closed from end of October to August 1.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Sequalitchew Net Fisheries:

- Net fishery chinook impacts incidental to fisheries directed at coho.

Carr Inlet Net Fisheries:

- Closed from beginning of October through August 1.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Chambers Bay Net Fisheries:

- Closed from end of mid-October to August 1.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Area 13D Net Fisheries:
- Closed from mid-September to August 1.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Henderson Inlet (Area 13E) Net Fisheries:
- Closed year-around.

Budd Inlet Net Fisheries:
- Closed from mid-September to July 15.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Areas 13G-K Net Fisheries:
- Closed Mid-September to August 1.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.

Nisqually River and McAllister Creek Fisheries:
- Net fishery closed late September to late June.
- Chinook net fishery limited to 3 days/week.
- Net fishery chinook impacts incidental to fisheries directed at coho and chum.
- Nisqually River recreational closed February 1 through May 31.
- McAllister Creek recreational closed December 1 through May 31.
- Chinook non-retention in June recreational fishery.
- 2-chinook bag limit.

Area 13 Recreational Fisheries:
- 1-fish bag limit May 1-November 30.
- 12/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Hood Canal (12, 12B, 12C, 12D) Net Fisheries:
- Non-treaty fishery closed from end of November to mid-October.
- Hoodsport Hatchery Zone open in August to hook and line gear, and to beach seines.
- Chinook directed treaty fishery limited to Area 12C.

Area 9A Net Fisheries:
- Closed from end of January to beginning of September (Dependent upon pink fishery).

Area 12A Net Fisheries:
- Closed from mid-December to mid-August.
- Beach seines and hook & line gear chinook non-retention.
- Non-treaty limited to beach seines only.

Area 12 Recreational Fishery:

- 5/1-6/30 closed.
- Chinook non-retention 7/1-10/15.
- 10/16-12/31 1-fish limit.
- 1/1-2/15 closed.
- 1-fish bag limit February 16 – April 10.
- 4/11-4/30 closed.

Hood Canal Freshwater Net Fisheries:

- Close Dosewallips, Duckabush, and Hamma Hamma.
- Skokomish River chinook fishery starting August 1 limited to 2 to 5 days/week.

Hood Canal Freshwater Recreational Fisheries:

- Closed March 1 to May 31.
- Chinook non-retention from June 1 to February 29 in all rivers.
- Dosewallips, Duckabush, and Hamma Hamma closed in September and October.

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

PILB

INTRODUCTION

Continued declines in abundance of Pacific salmon (*Oncorhynchus* spp.) populations have focused increased attention on factors limiting their survival and abundance. While the decline in abundance of Pacific salmon stocks (National Research Council 1996) has been attributed to may factors, just recently have researchers focused their attention on the nutrient re-cycling role of returning adult salmon in maintaining productive freshwater ecosystems. Given that Pacific salmon accumulate the significant majority of their body mass while in the marine environment (Groot and Margolis 1991), returning runs of adult salmon potentially represent a substantial source of marine-derived nutrients (MDN) for freshwater and riparian communities (Larkin and Slaney 1996; Gresh et al. 2000; Murota 2002; Schoonmaker et al. 2002). Research has shown that the addition of nutrients to freshwater systems can influence community structure and increase stream productivity at several trophic levels (Kline et al. 1990; Piorkowski 1995; Quamme and Slaney 2002). Benefits include increased growth and density of juvenile salmonid populations (Johnston et al. 1990; Bradford et al. 2000; Ward and Slaney 2002). Gresh et al. (2000) estimate that the current contribution of MDN from adult Pacific salmon to rivers in the Pacific Northwest is as low as 6-7% of historic levels and that the resulting 'nutrient deficit' could be exacerbating continued declines in salmon abundance or impeding recovery.

The concept of a 'nutrient deficit' has several implications for current fisheries management, harvest strategies and recovery of depressed salmon stocks. It is asserted that current harvest management strategies for salmon stocks fail to consider the importance of MDN for maintaining properly functioning ecosystems and self-sustaining salmon populations (Micheal 1998; Cederholm et al. 2000; Gresh et al. 2000; Bilby et al. 2001). More directly, current escapement goals for salmon runs may be perpetuating a negative feedback loop in salmon population dynamics (Larkin and Slaney 1996, 1997). Ideally, research might quantify the nutrient input, and escapement density, necessary to optimize ecosystem function, viable salmon runs, and harvest. However, nutrient dynamics in aquatic systems are often complex (Northcote 1988; Polis et al. 1997; Bisson and Bilby 1998; Murphy 1998; Naiman et al 2000) and depend on numerous site-specific factors including the species of salmon, spawning density and location, stream discharge regimes, stream habitat complexity, basin geology, light, temperature and community structure. Researchers are just beginning to recognize and understand these complexities in relation to salmon and MDN. In this paper I will review the current state of knowledge on the relationship between Pacific salmon, MDN and stream ecosystem function in the context of determining 'ecologically based' salmon escapement goals.

NUTRIENT PATHWAYS

Adult salmon contain proteins, fats and other biochemicals comprised of marine- origin carbon, nitrogen and phosphorous (Mathisen et al. 1988). Returning adult salmon act as vectors in delivering nutrients of marine origin to terrestrial ecosystems through excretion (O'Keefe and Edwards 2002), gametes and carcasses (Mathisen et al. 1988). In general, stream biota incorporate salmon-derived nutrients through three primary pathways: 1) trophic transfer following uptake of inorganic nutrients by primary producers; 2) streambed microfaunal uptake of dissolved organic matter released by salmon carcasses; and 3) direct consumption of salmon carcasses, eggs and fry (Cederholm et al. 1999). Additionally, high flow events and scavenging by birds and mammals (Cederholm et al. 1989, 2000; Ben-David et al. 1998) can deliver salmon-derived nutrients to riparian and upland communities (Garten 1993; Wilson and Halupka 1995; Helfield and Naiman 2001; Hocking and Reimchen 2002; Reimchen et al. 2002).

MDN STABLE ISOTOPE AND PROTEIN STUDIES

Applied relatively recently to the issue of salmon and MDN, stable isotope analysis has allowed researchers to quantitatively identify nutrient sources and further understand nutrient pathways in freshwater systems. Carbon, nitrogen, and phosphorous are typically considered principal nutrients that limit ecosystem productivity (Gregory et al. 1987; Peterson and Fry 1987; Murphy 1998). While phosphorous has only one stable isotope, limiting our ability to distinguish the origin of phosphorous, carbon (C) and nitrogen (N) have two stable isotopes. The isotopic properties of carbon and nitrogen provide natural tracers for determining differences in stable isotope abundance in trophic food webs. Stable isotope ratios are typically expressed as $\delta^{13}C$ and $\delta^{15}N$ values and represent the level of enrichment or depletion of the heavier isotope C or N relative to a standard (Peterson and Fry 1987). Spawning salmon contain higher proportions of the heavy isotopes carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$, Mathisen et al 1988; Piorkowski 1995; Bilby et al. 1998). Nitrogen is especially applicable in salmon-derived nutrient studies due to the dichotomous nature in N sources between Pacific salmon (oceanic N) and terrestrial and freshwater systems (atmospheric N_2, Peterson and Fry 1987; Kline et al. 1997).

Kline et al. (1990) developed an isotope-mixing model to investigate the incorporation of MDN in Sashin Creek, southeastern Alaska. The isotope-mixing model allows for determination of percent contribution of marine nitrogen across trophic levels. The study design compared isotope ratios between a lower reach, accessed primarily by pink salmon (approximately 30,000 adults annually), and an upper control reach isolated from anadromous fish. Isotope values indicate that standing crop of periphyton in the anadromous section was dependent on marine N, with levels greater than 90% immediately after spawning and near 50% at other times of the year. The sustained marine N signal in periphyton further indicated nutrient retention. Stonefly nymphs and caddis fly larvae also showed high levels of enrichment in April possibly due to overwintering retention and trophic transfer through periphyton and decomposers (e.g. fungi). The isotope model suggested that turbellarians were incorporating marine N through direct consumption of salmon eggs. In rainbow trout, high levels of $\delta^{15}N$ were found with increasing isotope values as the size of trout increased. Using a dual isotope method, Kline et al. (1990) concluded that trout from the enriched section were likely incorporating a portion of marine N from autochthonous production (dependent on primary producer uptake of remineralized nutrients) as well as direct feeding on salmon carcasses and eggs. Researchers surmise that MDN have a trophic-wide effect in the anadromous section of Sashin Creek. They also note that the use of fertilizers to alleviate nutrient loss in streams may not adequately substitute for salmon carcasses and eggs that are directly fed upon by consumers and decomposers, a point further developed in this review.

Since the Kline et al. (1990) study, numerous investigators have used stable isotope methods to distinguish MDN pathways in lotic systems (Bilby et al. 1996, 1998, 2001; Helfield and Naiman 2001; Piorkowski 1995; Winter et al. 2000). These studies show similar results indicating incorporation of MDN in food webs with anadromous runs of salmon. However, results do not universally indicate the degree of importance or pathways of MDN across different lotic systems. In an in-depth ecosystem study on five creeks in southcentral Alaska, Piorkowski (1995) used stable isotopes to distinguish marine N in stream food webs. The five study creeks are used by multiple species of anadromous salmon of which Piorkowski (1995) found different isotopic composition between adult salmon species with chinook salmon being significantly more enriched in $\delta^{15}N$ (due to increased ocean residence time) as compared to pink, coho and chum salmon. Isotope samples were collected from organisms at several trophic levels. Samples from sites with adult salmon returns indicated that the diets of grayling, rainbow trout, and coho salmon fry were predominately comprised of salmon tissue and eggs. Also, examination of stream macroinvertebrates revealed increased taxa richness and diversity in anadromous stream sections compared with non-anadromous sections. Despite this, results failed to detect a significant marine N signal between control and treatment sites in samples of riparian vegetation, algae, and stream macroinvertebrates (grazers) and implies that marine N was not significantly incorporated through pathways of primary production. Piorkowksi (1995) notes that results markedly differ from the Sashin Creek study (Kline et al. 1990) and are likely due to two important considerations: 1) Sashin Creek received a much larger run of salmon utilizing a smaller stream area; and 2) total dissolved nitrogen content in Sashin Creek was likely much lower given intense precipitation (nutrient flushing), causing the system to be more dependent on seasonal pulses of salmon-derived nutrients.

Many headwater streams in the Pacific Northwest exhibit low levels of primary and secondary productivity (Gregory et al. 1987; Bilby and Bisson 1992), and are systems typically preferred by adult coho salmon for spawning (Sandercock 1991). Bilby et al. (1996) compared isotope ratios in four tributaries of the Snoqualmie River, Washington, to determine the influence of coho salmon carcasses on food webs of headwater streams. Overall, the study suggests that even modest inputs of MDN can influence small streams. $\delta^{15}N$ and $\delta^{13}C$ values were similar between anadromous and non-anadromous streams prior to coho salmon spawning; during and shortly after spawning, elevated $\delta^{15}N$ values were found in stream biota (epilithic organic matter and stream invertebrates) and riparian foliage. Juvenile coho salmon more than doubled their weight following the appearance of spawning adults. Using an isotope model assuming no direct consumption on salmon carcasses and eggs (resulting in a conservative estimate without trophic fractionation), juvenile coho salmon were enriched approximately 30% with marine N. As well, researchers found rapid uptake of MDN through chemical sorption by streambed gravel. Chemical uptake of dissolved organic matter by streambed substrate was similar in both light and dark controlled experiments. Bilby et al. (1996) stress the importance of chemical sorption for initial nutrient uptake in headwater streams where primary production is limited during winter due to cold temperatures, low light levels, and frequent scouring by high flow events.

Carcass tissue and eggs appear to be an important food source for juvenile fish during winter periods and may play a critical role when other food items are less available. In four streams in southwestern Washington, Bilby et al. (1998) observed significant increases in density, weight and condition factor of juvenile steelhead and coho salmon following addition of hatchery spawned coho carcasses (with some eggs remaining). In enriched stream sections, 60-96% of stomach contents of juvenile steelhead and coho salmon were comprised of carcass flesh and eggs (with eggs being the preferred food item) while carcass material was present. Also, diet content of juvenile coho salmon had five times the amount of invertebrate biomass as compared to non-enriched areas. While significant increases in density and condition factor of juvenile coho salmon and steelhead were observed in carcass enriched areas, fish were not marked to confirm site fidelity throughout the study period. Even so, increased fish size and condition factor has implications for higher survival for both juvenile coho salmon (Bell 2001; Brakensiek 2002; Hartman and Scrivener 1990; Quinn and Peterson 1996; Holtby 1988) and steelhead (Ward and Slaney 1988) and subsequent returns of adults (Hager and Noble 1976; Bilton et al. 1982).

Findings by Wipli et al. (in review) further corroborate conclusions by Bilby et al. (1998) on the importance of salmon carcasses and eggs for juvenile coho salmon. In experimental and natural streams in Southeast Alaska, Wipfli et al. (in review) found strong positive correlations between salmon carcass loading rates and growth of juvenile coho salmon, cutthroat trout and Dolly Varden char. Over a 60 day experiment, juvenile coho salmon gained over 60% of fish body mass in study reaches with the highest carcass loading rates (4 carcasses / m^2). Similarly, cutthroat trout and Dolly Varden char exhibited growth rates over five times higher in carcass rich areas as compared to control areas. Nutritional status of juvenile coho salmon was evidenced by concentrations of triacylglyceride (TAG) and ratios of marine-based to terrestrial-based fatty acids in juvenile samples; both percent TAG and fatty acid ratios increased with increasing density of carcasses. TAG concentrations in juvenile fish correspond to storage of marine-derived long-chain n-3 fatty acids and indicates direct benefits of salmon carcasses to growth and nutritional status of stream salmonids.

BOTTOM-UP EFFECTS OF NUTRIENT ADDITIONS

Studies reviewed thus far indicate that stream delivery of MDN and biogenic material from returning adult salmon provide an immediate food resource for fish and can influence lotic food webs. Addition of nutrients can certainly have a bottom-up effect in freshwater systems, boosting primary production and ultimately benefiting fish populations (Johnston et al. 1990; Bradford et al 2000; Ward et al. 2002; Wilson et al. 2002). This management concept has seen successful application in lake enrichment programs in Alaska and British Columbia where returning runs of sockeye salmon have increased as a result of manual application of nutrients. The extensive knowledge and management success in sockeye rearing lakes is due, in part, to the relative simplicity of these systems in food web and nutrient dynamics, as compared to fluvial systems (Kline et al. 1997; Kyle et al. 1997). Sockeye salmon rearing lakes have generally been identified as oligotrophic systems, primarily limited by phosphorous. Ratio additions of nitrogen and phosphorous have successfully elevated lake rearing capacities for juvenile sockeye salmon through increased zooplankton production (Hyatt and Stockner 1985; Kyle et al. 1997; Bradford et al. 2000). British Columbia has carried this management tool further and begun fertilizing large river systems in efforts to boost declining steelhead and coho salmon populations. Results so far show overall stimulation of system productivity with increased density and growth of juvenile coho salmon and steelhead as well as earlier age at outmigration of steelhead (Johnston et al. 1990; McCubbing and Ward 2000; Ward and Slaney 2002). Whether manual fertilization of large river systems can recover coho salmon and steelhead runs remains to be seen. While certainly a management and research tool, it is questionable if manual nutrient supplementation programs can adequately replace ecosystem function of spawning adult salmon.

Examples of manual supplementation studies are raised to illustrate issues of trophic capacity in relation to fish production. Productivity can be defined as the capacity of a system to produce a product of interest (Bisson and Bilby 1998). A nutrient limited system can mean food limited in the interest of fish production (Chapman 1966; Dill et al. 1981; Johnston et al. 1990). While adult salmon carcasses and eggs provide a direct food resource for fish populations, salmon-derived nutrients can potentially influence fish production through autotrophic and heterotrophic pathways as well (see Vannote et al. 1980, Bilby and Bisson 1992). Wipfli et al. (1998) conducted highly replicated tests of adding salmon carcasses in experimental and natural stream channels in Alaska to assess responses in primary production. Biofilm production (a food source for aquatic invertebrates) increased approximately 15 times in the carcass enriched section (with an approximate return run size of 75,000 pink salmon) compared to the upstream control section. Further, total macroinvertebrate densities increased up to 8 and 25 times in artificial and anadromous stream sections, respectively, as compared to control sections. Similar results were found in a follow-up study by Wipfli et al. (1999), and also suggest a threshold level of response in biofilm production (over a two-month study period) in relation to carcass loading rates (up to 1.45 kg, the lowest carcass loading rate in artificial channels). Both studies (Wipfli et al. 1998, 1999) show trophic responses to MDN and suggest potential growth benefits to fish through increased availability of fish food organisms (see also Perrin et al. 1987, Johnston et al. 1990, Perrin and Richardson 1997, Quamme and Slaney 2002). Wipfli et al. (1999) caution however, that the capacity for stream systems to retain marine nutrients and the long-term effects of 'excessive' carcass loadings for stream productivity have yet to be sufficiently addressed by researchers (O'Keefe and Edwards 2002).

STREAM RETENTION OF SALMON CARCASSES

Stream incorporation of marine-derived nutrients necessitates that salmon carcasses are retained for a sufficient period of time. Cederholm and Peterson (1985) investigated winter retention of coho salmon carcasses in several small streams on the Olympic Peninsula in western Washington. They initially released 180 carcasses throughout nine streams with varying abundance of large woody debris. One week following releases, 78 (43%) of the study carcasses were identified of which 80% were within 200 m of initial placement. Carcass retention was positively correlated with increases in large woody debris. The researchers speculated that carcass retention could be even higher in unlogged streams where large woody debris loading was higher as compared to their study streams.

In a similar follow-up study on carcass retention in Olympic Peninsula streams, Cederholm et al. (1989) released 945 tagged coho salmon carcasses, of which 174 were implanted with radio transmitters to more definitively determine the fate of mobilized carcasses. Few study carcasses were flushed beyond 600 m with a median travel distance of 49.5 m from initial placement. Again, large woody debris was influential in retaining salmon carcasses with the majority of carcasses found in pools. Cederholm et al. (1989) also assessed retention during high flows by depositing 25 radio-tagged carcasses at the beginning of a flood event (estimated discharge 6.20 m^3/s). Following the flood event, 21 of the 25 radio-tagged fish were located within 600 m of initial placement, with a median travel distance of 66 m. Ten of the radio-tagged carcasses were found on stream banks well above low flow levels. In a different study, Glock et al. (1980) investigated retention of chum salmon carcasses on a much larger system, the Skagit River in Washington. Although carcasses drifted as far as 39 km within the first five days, the majority of carcasses (20%) were located within 1.5 km of initial placement. Habitat, discharge, amount of large-woody debris, and species of salmon appear to be important factors in considering retention of salmon carcasses in fluvial systems.

The study by Cederholm et al. (1989) also revealed significant predation by mammals and birds on salmon carcasses. Approximately 22 taxa of mammals and birds were documented consumers of salmon carcasses. Surveys identified 374 partially eaten study carcasses removed from stream channels with 88% of these carcasses located within 15 m of the stream bank. Cederholm et al. (2000) provide a more extensive review of wildlife-salmon relationships that documents over 138 species having a ‘strong’ positive life-history relationship to Pacific salmon. This and other research suggests the ecological relationships between salmon and wildlife (Wilson and Halupka 1995; Ben-David et al 1998; Wilson et al. 1998). Further, wildlife species appear to play a significant role in the removal of salmon carcasses from lotic systems where nutrient benefits may be more realized in riparian and upland communities (Cederholm et al. 2000; Garten 1993; Helfield and Naiman 2001; Reimchen et al. 2002).

ECOSYSTEM BASED ESCAPEMENT MANAGEMENT

Although research to date provides evidence of the role of salmon-derived nutrients in ecosystem function, this complex relationship is poorly understood. Further understanding of the ecosystem context of returning adult salmon and MDN will require both the synthesis of several scientific disciplines and human values. Given the high cultural and economic value of salmon, and the public mandate to recover natural salmon populations, fisheries managers must insure that harvest practices do not impede recovery. Research on salmon and MDN frequently implies that current harvest management strategies exacerbate the risk of further decline in salmon populations, due to removal of salmon and nutrients bound for terrestrial systems. However, the science of quantifying salmon escapement goals necessary to properly functioning ecosystems is still in infancy.

Nonetheless, research is beginning to focus on quantifying nutrient input levels necessary to improve juvenile salmon survival. Bilby et al. (2001) used stable isotope levels from juvenile coho salmon collected throughout western Washington to test for a marine N threshold level in juvenile fish. Representative of 26 stream reaches from 12 different watersheds, juvenile coho salmon samples were collected in late February and early March over a seven-year period. Juvenile samples were only collected in known areas where no other anadromous fish spawn. Cutthroat trout were collected above anadromous barriers in the same systems that juvenile coho salmon samples were collected. Isotope values from cutthroat trout represented $\delta^{15}N$ background levels used to establish site-specific ratio index measures of marine N enrichment in relation to $\delta^{15}N$ values from juvenile coho salmon. Also, tissue samples were collected from hatchery returns of adult coho salmon throughout the region to relate $\delta^{15}N$ values from cutthroat trout and juvenile coho. Adult returns of coho salmon to each creek were determined using spawner count and stream habitat data; average weights from adult hatchery returns were used to estimate biomass (wet-weight kg / m^2) of spawners in each study creek.

Bilby et al. (2001) found that $\delta^{15}N$ values were consistently higher, by study site, for juvenile coho salmon as compared to cutthroat trout. However, isotope values revealed considerable variation between study streams for both cutthroat trout (ranging from 4.5‰ to 8.5‰, the per mil deviation of $^{15}N/^{14}N$ from air N_2, Peterson and Fry 1987; Kline et al. 1990) and juvenile coho salmon (5.8‰ to 11.7‰). Cutthroat $\delta^{15}N$ values suggest other sources of marine N, or possibly nutrient fractionation (Peterson and Fry 1987; Kline et al. 1990). Variation in isotope values reveals the need to establish basin-specific background isotope levels when using isotope methods.

Using the relationship between estimated carcass abundance and ^{15}N index values of enrichment in juvenile coho salmon, Bilby et al. (2001) found that enrichment levels increased with increasing carcass abundance. The relationship also revealed a point of diminishing enrichment of marine N in juvenile coho salmon above carcass abundance levels of 0.10 kg/m^2; in locations where carcass abundance was less than 0.10 kg/m^2, enrichment index values averaged 0.19 ± 0.11(one standard error) as compared to 0.48 ± 0.13 in areas with carcass abundance above 0.10 kg/m^2. Carcass abundance of 0.10

kg/m^2 approximately equals 120 fish/km^2, above which marine N in juvenile coho salmon rapidly approached a 'saturation level'. Based on previous findings (Bilby et al. 1996, 1998), researchers in this study assumed that juvenile coho salmon were primarily incorporating marine N through direct consumption of salmon carcasses and eggs. Given this premise, the saturation level found in coho salmon parr could be interpreted as the maximum level of dietary enrichment for this trophic interaction. Based upon spawner escapement data and research findings, Bilby et al. (2001) conclude that the majority of coho salmon spawning streams in western Washington are well below capacity for incorporating more marine-derived nutrients.

From both a research and management perspective, there are numerous limitations to applying results from Bilby et al. (2001) as a standard for salmon escapement goals (many of which the researchers acknowledge). First, study sites were purposely chosen to only include areas with spawning coho salmon and no other returns of anadromous salmonid species. This implies that results may only be applicable in such areas and questions if marine nutrient dynamics would be similar in systems with returning runs of multiple salmon species. The temporal distribution of spawning by numerous species of salmon can mean prolonged input of marine nutrients, which may be more effectively incorporated within a system (due to nutrient flushing) at a lower density of spawners for a given species. Second, juvenile coho salmon alone are probably not an appropriate indicator for determining whether productivity in a system is nutrient limited (Simberloff 1998). The marine N signal found in juvenile coho salmon has been primarily attributed to direct consumption of salmon carcasses and eggs. If this is indeed the primary mechanism for nutrient uptake then isotope values from juvenile coho salmon are less revealing of other pathways for incorporation and trophic distribution of MDN within a system. Third, uncertainty remains as to whether increasing the input of salmon-derived nutrients to fluvial systems will subsequently result in higher returns of adult salmon. Results from the Bilby et al. (2001) study would suggest this due to higher $\delta^{15}N$ index values in juvenile coho salmon from systems with higher carcass densities. The effects of hatchery-origin salmon, that spawn naturally, must also be considered.

Gaps remain in our understanding of nutrient dynamics in fluvial systems. While it appears that salmon-derived nutrients can benefit sockeye salmon, cutthroat trout and coho salmon populations, at this time there are no research publications that directly establish the relationship between MDN and chinook salmon. 'Ocean-type' juvenile chinook, which comprise most of the production in Puget Sound, generally spend between three to nine months in freshwater before outmigrating (Healey 1991), a much shorter period than coho and steelhead (Montgomery et al. 1996; Healey 1991). Degraded spawning habitat and winter flow conditions, with direct influence on egg survival and emergence, may be more critical to chinook production than inputs of MDN. Upon outmigrating from the freshwater environment, juvenile chinook salmon may reside in estuarine environments for extended periods of time where conditions are critical for early growth and survival (Simenstad 1997; Simenstad et al. 1985).

Numerous questions arise in considering the potential role of MDN for ocean-type chinook salmon populations. Whether newly emerged chinook salmon fry actively feed on salmon carcasses and eggs has not been established and further questions if carcasses are retained for a sufficient period of time, especially in large river systems with peak winter flow events. The immediate benefits of MDN for chinook salmon fry is most likely limited given the relatively short time juveniles reside in freshwater. However, the River Continuum Concept (Vannote et al. 1980) suggests that upstream inputs of MDN affect downstream communities. This concept questions nutrient dynamics and source-sink effects within a river basin.

Ultimately, the benefits of MDN for juvenile chinook salmon may be more fully realized in estuaries (Simenstad 1997). That said, in some instances the eutrophication of estuaries associated with agricultural and urban development may be negatively affecting fish habitat and survival (Bricker et al. 1999). Currently, little is known about the effects of salmon and MDN on estuaries.

At a watershed scale, the connectivity of nutrient cycles and the pathways involved needs further investigation. Such considerations question the relative importance and actual contribution of MDN from different species of spawning salmon. In many river systems throughout the Pacific Northwest, returns of chum and pink salmon comprise the majority of spawner biomass. These species typically spawn in the lower portion of stream and river systems. This implies that chum and pink salmon contribute substantial inputs of MDN to environments used by ocean-type juvenile chinook salmon. Whether survival of juvenile chinook salmon is limited by nutrient deficiencies needs to be evaluated in a multi-species context. Furthermore, the relative contribution by adult returns of different salmon species to both ecosystem function and salmon populations with unique life-history strategies needs to be more fully recognized.

In considering the importance of MDN to ecosystem function and sustaining salmon populations, the large returns of adult salmon runs recently experienced throughout the Pacific Northwest dictates that an experiment is now in-progress. The current scenario provides unique research opportunities to assess if marine nutrient inputs are limiting salmon populations. This will necessitate that isotope methods are further developed and tested (see Kline 2002) to properly reveal MDN in food-web dynamics. Assessment of watershed nutrient levels will be necessary to determine regional variation. Identification of bottlenecks in survival to salmon populations will require careful monitoring of population dynamics across fish life-stages. Long-term studies on a larger spatial scale need to be initiated before we can properly understand the contributions of salmon and MDN to ecosystem function. The multiple values associated with salmon necessitates that this understanding be further developed and integrated between numerous disciplines before ecosystem based escapement goals for Pacific salmon can be a realized and effective management approach.

PILB

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

PILB

Accurate estimates of chinook spawning escapement are essential to management of Puget Sound chinook stocks. They represent the most immediate post-season monitoring of stock abundance and are essential to subsequent forecasting and reconstruction of cohort strength. Total escapement is also an invaluable measure for survival and productivity measurements, which is important in developing escapement goals and recovery objectives. With the availability of other relevant data, abundance reconstruction enables the estimation of cohort survival (returns per spawner), which, in turn, is the basis for setting harvest exploitation rate objectives. It is appropriate, therefore, to scrutinize the survey and computation methods utilized to estimate escapement with respect to the accuracy and precision of the resulting estimates.

The listing of the Puget Sound chinook has created further determination to improve escapement estimates. However, it is important to realize that accurate and precise estimates of escapement come at a cost. Given the limits on staff and funding, along with logistic limitations, a careful triage is required to determine where existing deficiencies should be addressed. The co-managers' chinook harvest management plan includes a mandate to insure effective monitoring of the productive status of Puget Sound chinook stocks.

There has not been a formal Puget Sound-wide review of escapement estimation methods since Smith and Castle (1994). However, a summary of escapement methods is documented each year, concurrently with preseason forecasts. A critical assessment of escapements has been a major task of the Chinook Technical Committee (CTC) of the Pacific Salmon Commission, especially those populations used as indicator stocks. Concerns about Puget Sound estimates has focused on the following issues:

1) accuracy and precision of estimates of total or partial escapement (including the testing of inherent assumptions);
2) Natural Management Units lacking estimates of total escapement;
3) currency of escapement goals: females or PED, vs total;
4) straying – contribution of hatchery-origin adults;
5) accounting of natural returns to hatchery rack;
6) age composition of escapement.

This document summarizes current methods in estimating escapement along with a description of recent work intended to compare and improved escapement estimates.

Existing Methods

Spawner surveys, with the intent of estimating abundance, are conducted in all waters where naturally sustainable populations exists (category 1 and 2 watersheds). In addition, some category 3 watersheds are also surveyed. There are two basic types of surveys—census and index. Census surveys are conducted where all fish (carcasses or redds) can be counted. This implies that all redds and/or fish are visible and all spawning areas can be viewed so that there is no expansion of the estimate to account for unsurveyed areas. In the case of a redd census, all redds must be visible and all spawning areas must be viewed. In some areas, a marked redd census is used, where redds are marked, usually with a colored stone, to avoid recounting the redd during subsequent surveys.

Weirs can also provide opportunity to census returning fish. However, weirs are generally associated with the collection of hatchery brood stock and not natural spawning populations. In cases where excess fish are passed upstream, fish can be counted directly. Other situations include Baker Dam, which has a trap-and-haul facility to pass fish over the dam, as does the Mud Mountain Dam (Buckley Trap) on the White River. On the Snohomish system, chinook are trapped and hauled over Sunset Falls. Although counting sites such as these may provide accurate estimates of fish passing a single point, estimates may not necessarily reflect of spawning success.

With watershed that are too large to survey their entire length, and/or all potential spawning sites, index areas are used to estimate total spawner abundance. These are selected (non-random) sites where chinook are likely to concentrate. Although index areas may represent only a portion of the watershed, they usually incorporate a significant component of the spawning population. Index areas can be used to estimate either fish (carcasses or live fish) and/or redds. Surveys are conducted periodically throughout the spawning period, and include such information as location, time, date, water conditions, number of redds, live and dead counts, along with collecting scales for age data. Counts are conduct on foot or by floating the index areas. In the case of redd counts, aerial surveys are often used either exclusively or in conjunction with ground surveys.

Once the counts are completed and data assimilated, the actual estimates are usually calculated using peak counts, cumulative counts or area-under-the-curve (AUC). Peak count estimates are simply the highest number of observations made within a specific time period, such as one day. Once that number is identified it is expanded to account for such factors as non-surveyed areas, fish per redds, visibility, etc. Cumulative counts involve enumerating observed fish and/or redds over a period of time, usually the spawning period, and summing the observations. This usually requires some sort of marking program to prevent recounting. A more sophisticated variation of this is AUC which accounts for the entire duration of fish presence, using specific observation dates that are compared to the total spawning duration. This produces a curve of the counts that has typically been constructed for either redds or fish. This method has been widely used by many previous management biologists for various northeast Pacific salmon (Ames and Phinney 1977, Bue et al. 1998, Hilborn et al. 1999, Hill 1997, Liao 1994, Smith and Castle 1994). In the case of redds, the left side of the curve, the last date before the first redd is formed defines the beginning of the curve (i.e. the last date with zero redds). Ground observation and interpolation may be needed to specify this date. Straight lines are typically used to connect each subsequent count of visible redds, although some researchers have attempted curvilinear fits (Ames 1984). On the right side of the curve, the first date where the count is judged to be zero (known or interpolated from ground observation) forms the end of the curve. The area-under-the-curve (AUC) is the sum of the areas between each subsequent count, beginning and ending with the zero count dates, a method known as trapezoidal approximation (Hahn 1998, Hahn et al. 2001, Hilborn et al. 1999, Hill 1997). Each segment AUC is simply the sum of the two adjacent counts divided by two then multiplied by the number of days between the count dates plus one (i.e. simply subtract the earlier date from the later date). The total AUC is the sum of the segment AUCs. For redds, the primary variables are redd-life (the duration of redd visibility) and fish per female (since it is the female that builds the redd).

Nearly all escapement estimates of Puget Sound chinook are translated into total escapement for the watershed. The systems where escapement estimates reflect only the index areas are North Lake Washington tributaries and Skokomish River. Within the Lake Washington system, counts at the Ballard Locks estimate annual returns, but do not account for fall-back or pre-spawning mortality. Ballard counts also cannot be used to estimate escapement to individual watersheds. Skokomish mainstem counts are used to provide relative comparisons with two tributaries (Hunter and Vance creeks), which are generally not surveyed.

Can present methods for estimating total escapement be improved?

There are four basic ways that may potentially improve escapement estimates: 1) expand indices (area of surveys), 2) conduct more frequent surveys, 3) re-establish base years by calibrating expansion factors or total estimates by comparing it with alternate methods, or by 4) testing basic assumptions such as expansion factors, spawner density, redd life, fish per female, adults per redd, etc.

Parameters such as confidence intervals and standard deviations have generally not been applied with any significance to escapement estimates. Exceptions include some of the work funded through the Chinook Technical Committee (CTC) of the Pacific Salmon Commission, such as those conducted on the Stillaguamish, Snohomish and Green rivers. Attention has focused on gaining more confidence of some basic assumptions, such as redd life and fish per redd. In many large river systems in Puget Sound chinook escapement is assessed by making repeated counts of redds, plotting these counts against time, then calculating the total number of redds from the area under the curve. Each redd has been assumed to represent one female and 1.5 males in calculating escapement. Whether made by aerial, boat, or foot survey, redd counts are subject to errors associated with visibility, insufficient survey frequency, observer error, false redds, superimposition, and the inability of distinguishing chinook redds from pink salmon redds. Assumptions regarding redd life and sex composition have been based on a few supporting, mostly old, studies, with the standard assumption for redd life as 21 days (Ames and Phinney 1997 and Orrell 1976 and 1977). Because the cumulative effects of these sources of error have not been quantified, the accuracy and precision of the resulting estimates is unknown.

A recent study (Hahn et al 2001) examined redd estimators, as applied to chinook escapement to the Skagit and Stillaguamish rivers, and reached the following conclusions:

- The accuracy and precision of redd census ranged from very good (C.V. 10 – 15%) to uncertain, depending on conditions in each stream or river. Aerial surveys (particularly helicopter) were accurate in some streams, and varied from foot or boat surveys in others. More frequent aerial surveys were believed necessary to accurately define the spawning curve in some systems.

- The secondary assumption that females build only one redd was generally supported by field observations, though the potential for multiple redds per female or false redds exists in certain streams.
- Estimates of sex composition based on carcass counts or gillnet test fisheries engender significant, but unquantified bias. Thus the assumption that 1.5 males per female was not validated. Males and small chinook are undersampled by carcass surveys and gillnet samples.
- Intensive foot surveys to mark and monitor redds found that redd life varied significantly from 21 days in some systems.
- Covariance between the area under the curve and redd density is presumed, but should be quantified.
- Mark / recapture methods for estimating escapement and its variance, such as have been employed in the North Fork Stillaguamish River and Green River in recent years, are affected by several factors that bias their result. The resulting estimates (Conrad 1993, 1994, 1995, 1996, 1997; Nason 1999) were substantially lower than concurrent redd count-based estimates, and were probably affected by unequal probability of capture, non-random mixing and loss of marked carcasses from the study reach. However, recent studies on the Green River show mark and release estimates to be higher than the standard redd and carcass estimates (Hahn et al. 2000).

Redd census techniques employed successfully in large river systems are usually supplemented by carcass counts and/or redd surveys in tributaries where aerial census may be impossible. Estimates of total escapement for a given stock may therefore be composed of several techniques. Details for each management unit are summarized within each watershed section.

CTC funded studies have specifically been devoted to improving estimates. On the Skagit attempts have been made to compare the existing escapement estimates with a live mark-recapture estimate. The primary objective of the study was to estimate the drainage-wide escapement of chinook salmon returning to the Skagit basin and to evaluate the fishwheel and beach seine sites in the lower Skagit River for capturing adult chinook salmon. The study was conducted for two years (2000 and 2001), and it was determined that these two methods alone would not capture enough fish to generate a reliable mark-recapture estimate of escapement (Smith et al, 2002). For 2002, the primary objective remains as a mark-recapture study. However, the planned method of capture included tangle nets and angling. In addition, radio-telemetry was also planned to investigate the distribution and behavior of chinook after capture and release.

Another mark-recapture study has also been underway on the Green River for three years (2000, 2001 and 2002). Adults are captured with a beach seine and released, with subsequent recapture within the spawning areas. This study has proved more successful than the Skagit study in that the number of marks and recaptures has been high enough to provide credible estimates. Studies have also been conducted on the Stillaguamish and Snohomish river systems. Final reports for all years should be forthcoming shortly

Oregon has used similar methods in assessing their coastal fall chinook populations. Standard index areas have been chosen based on survey history as well as being a valid representative of spawning escapement. which is indexed as the peak count of live and dead fish observed in a given survey area. Because standard survey sites were not chosen from a randomized sampling design, spawner density estimates obtained from these sites are used only to provide relative abundance (Jacobs 2001).

However, for coho Oregon uses a different approach. A review of the Oregon Coast Naturals (OCN) spawning survey program by Oregon State University Department of Statistics led to the initiation of the OCN escapement methodology study in 1990. This study involved the development and experimental implementation of a stratified random sampling (SRS) approach, which consists of randomly selecting spawning survey sites from geographical strata and estimating spawner abundance from visual counts in these survey sites (ibid). This approach follows EPA's Environmental Monitoring and Assessment Program (EMAP), which is similar to that of the National Park monitoring. The basis of this program is to avoid bias through random selection of sampling units and to use a sampling design that estimates population attributes that can produce reliable, absolute values of population abundance.

Some discussion has been initiated regarding its use for Washington chinook. However, there are several major disadvantages in implementing this sort of method. Among the most critical would be that present index areas would no longer be used, thus making past data unusable for comparison purposes. Because chinook spawn in specific areas, a large number of sampling sites would be required to provide adequate observations, and there would likely be many samples with no observations. The cost of identifying new sites and their subsequent monitoring would be more expensive and require additional staff to carry out than with current methods.

In general, assumptions regarding uniform spawning density have not been tested. This assumption applies not only to waters outside index areas but also to different times. Chinook will spawn in different areas in different years, depending upon changing environmental conditions, run size, human factors, etc., and the use of a single constant, or expansion factor, may not provide accurate estimates or be comparable from year to year. Survey conditions can also change, making it more or less difficult in observing fish and redds. In problem areas, estimates can be improved by expanding index areas. However, it should be noted that, in terms of recovery assessment, annual trends are as important as the escapement numbers, and changing survey procedures may result in estimates that are not comparable to previous surveys. In such cases, the importance of accurate estimates versus precise trend information must be weighed.

One remedy is to incorporate supplemental areas, which are spawning sites that are not included as index areas. Another method is to survey the entire watershed where chinook spawn. This is only feasible in smaller rivers where access is available throughout the entire length of the watershed or, in larger rivers, by using aerial-redd surveys where conditions allow complete view of the river substrate.

In summary, escapement estimates can be improved, but it is unlikely that there are new methods that will replace the current ones. Actual improvement of any population estimate will likely have unique requirements specific to the watershed. Some watersheds, for example, are inherently difficult to survey regardless of available resources. However, before a decision is made to invest resources to further improve an estimate, it is importance to weigh the needed information and the status of the stock against the potential benefits and costs..

Refining escapement goals

Fixed escapement goals have been used as the performance standard for harvest management. However, they were merely averages of escapements for various years during the 1960s and 70s (Ames et al 1977) and did not necessarily reflect habitat productivity nor maximum sustain yield, upon which harvest goals were based. Because of the need to closely monitor the performance of the annual harvest regime, harvest management plans now calls for developing exploitation rate objectives for as many management units as possible, based on current and potential productivity. Basically this requires estimating the productivity (stock:recruit) function for the populations and implies that harvest rates can be associated with an escapement range for a given watershed.

Nevertheless, the question of escapement objectives remains under consideration within at least three forums. The Technical Recovery Team, which is coordinated through NMFS, has defined a number of parameters necessary for recovery. Among them is abundance of natural-origin recruits, which is expected to include both ESU and specific watershed criteria. The Ecosystem Diagnosis Treatment (EDT) process has also developed an initial review of some Puget Sound watersheds and identified escapement ranges based on properly functioning conditions (Molbrand 2000, Anonymous 2002). Finally the Chinook Technical Committee has been involved with a review of escapement goals throughout Washington (Hahn et al 2001). All of the above review sources have started releasing results, and it is expected that additional information will be forthcoming. It is expected that escapement objectives will change as new information, such as habitat productivity, stray rates and other hatchery/wild interactions, become available.

The need to estimate escapement accurately is not lessened under this exploitation rate management system since escapement abundance remains a primary measure of stock health. If the harvest regime operates as planned, and abundance is close to what is forecasted, the escapement should also conform to pre-season expectations. The co-managers are committed to assessing the performance of the harvest regime annually, and modifying fishery regulations as necessary to assure that exploitation rate objectives are met. Over the longer term, regular assessment of stock productivity, for which accurate assessment of survival and productivity is essential, will also modify the harvest objectives to insure that recovery will not be hindered.

Straying

Estimating the contribution of first-generation, hatchery-origin adults to natural spawning is essential to understanding the natural productivity of any chinook population. Natural productivity (i.e. survival) can only be estimated by distinguishing hatchery and natural-origin components of harvest and escapement. In most Puget Sound systems, hatchery production is directed towards harvest augmentation, whereas only a few programs are directed at recovery. The concern is that hatchery fish may intermingle and interbreed with natural-origin chinook, resulting in direct interactions, such as competition for food and space and/or indirect interactions such as reduced fitness due to genetic modifications. Various studies with salmonids species have reported potential genetic and behavioral hazards to natural production caused by the interactions with hatchery fish. (Ames et al 1984; Fleming and Gross 1995; Pearson and Hopley 1999; Reisenbichler 19??; Chilcote 2002).

Hatchery-origin adults are usually distinguished by some identifying mark, either externally, such as a fin clip (which may signify that the fish also carries a coded-wire tag), or internally, such as an otolith mark. Double index tagging (DIT) programs, which are intended to estimate mortality in selective fisheries of unmarked fish, involve coded-wire tagging two equal-size groups of hatchery releases, only one of which is externally marked by an adipose clip.

Estimation of stray rates is made more certain if hatchery production is mass-marked, which allows spent adults or carcasses to be quickly examined. Where DIT programs exist, unmarked fish will pass through an electronic tag detector to recover CWTed fish. Studies in the Green River suggest that carcass sampling provides superior estimates of the contribution of hatchery fish to natural spawning as compared to sampling extreme terminal (freshwater) catch. In the case of otoliths marks, otoliths are dissected from a sample of unmarked carcasses to establish the presence of this mark group. Otolith marking has been used successfully to estimate the stray rates of Tulalip Hatchery fall chinook into adjacent watersheds (Rawson et al. 2001).

In the case of recovery programs, it is not desirable to mark hatchery fish since they are liable to be harvested during selective fisheries. However, an internal or external mark (other than an adipose clip) would still allow the ability to identify hatchery returns in the escapement. This has been the case for Nooksack and White River spring chinook as well as for Dungeness River chinook. Selective fishing for chinook has not yet been widely implemented by the Washington co-managers, but mass marking programs have been initiated not just in anticipation of future selective recreational fisheries, but as a way to better determine hatchery/wild interactions and stray rates. In turn this will help address the productivity characteristics of the watershed.

Age and sex composition

Estimating spawning escapement and cohort reconstruction require information on the age and sex composition of the return. Escapement estimates, as discussed above, rest on assumptions about the number of redds that each female builds, and pre-spawning mortality. Reconstruction of the cohorts comprising brood year abundance requires estimates of the age composition of annual returns. The age and sex of returning adult chinook may be determined by sampling terminal or extreme terminal (i.e. freshwater) fisheries, carcasses of spawned-out fish, or fish returning to hatcheries.

Terminal fisheries, carcass surveys, hatchery rack collections are all used to obtain samples. However, each of these sampling methods may engender bias into the result. Gillnet gear that is designed to target chinook is often selective of larger fish, and may not catch jack males. The catchability of each size class of chinook may also vary under different conditions of flow and turbidity in the river. Terminal fishing occurring in the bays adjacent to the river mouth can be equally selective, and may intercept significant numbers of fish destined to other systems. Hahn et al (2001) concluded that larger sample sizes from terminal fisheries would improve estimates. Recreational catch may also be selective, but it may be logistically difficult to obtain large enough sample sizes. In addition, recreational fisheries may not operate across the entire migration period nor target within terminal areas.

Carcass sampling tends to undersample small fish and males, but studies differ in their conclusions in this regard (Conrad 1996; various studies cited in Hahn et al 2001). The magnitude of true bias is usually unknown, because carcass retrieval can only be compared with other, possibly biased, samples, such as those from fisheries or hatchery racks. The fieldwork involved is labor and time intensive, and frequently complicated by high flow, turbidity, and debris. 'Carcass life' (i.e. the time window available to sampling) is often affected by predators removing carcasses before they can be sampled, and by fish moving or being swept out of the sampling area. Carcass weirs have not been employed in Puget Sound streams.

Hatchery racks allow sampling throughout the entire migration period, allowing scales or other samples can be collected at frequent intervals. However, hatchery returns may not be representative of wild populations, particularly where non-indigenous stocks have been used. For many wild stocks there is no associated hatchery program, precluding rack and brood stock sampling. These include the South Fork Nooksack springs, Skagit falls (though broodstock collection for a PSC Indicator Stock has begun), Lake Washington / Cedar, and Mid-Hood Canal rivers.

General principals that apply to sampling the return include

1. Sampling should encompass the entire migration period.
2. Sampling should be representative of single stocks or populations; i.e. avoid mixed stock sampling if origins are unknown.

3. managers and biologist should be aware of the various biases associated with sampling.
4. Sampling should be random but represent the population.
5. Sample sizes should be large enough to ensure statistical confidence.

Summary of chinook escapement methods

Smith and Castle (1994) documented escapement estimate methods within Puget Sound and the Straits of Juan de Fuca. In general, these methods continue to apply. However, for most watersheds, there are on-going efforts to maintain and improve spawner estimates. The following reflects the current methods as of 2002.

Hoko: (Ground surveys, redd census)
The Makah Tribe and WDFW conduct surveys using cumulative redd counts for the mainstem and tributaries found between river miles 1.5 to 21.7, which represents the entire range where chinook spawn in the Hoko basin. Redd counts are multiplied by 2.5 adults/redd. There are ten mainstem reaches plus 13 reaches within tributaries, which include the Little Hoko River, a tributary to the lower mainstem, and Browne's, Herman, N.F. Herman, Ellis, Bear and Cub Creeks, which are tributaries to the upper mainstem. The Makah Tribe also surveys the mainstem and other independent tributaries in the Sekiu basin, including Carpenter, S. Fork Carpenter, and Sunnybrook Creeks, and unnamed tributaries (WRIA 19.0215, 19.0216, and 19.0218). The escapement estimates for these two rivers are based on total natural escapement for the Hoko basin, plus broodstock capture, and total escapement in the Sekiu basin.

Elwha: (Ground surveys, redd census using AUC)
Spawning chinook are limited to the lower 4.8 river miles below the dam. The preferred method of estimating adult escapement, in the mainstem, is plotting visible redds versus date and calculating the area under the curve, resulting in redd-days, which are divided by the 21-day redd life. The resulting redd total is added to the number of redds counted by the Lower Elwha Tribe in the 1 mile, Hunt's Road side channel index. The total redd count is then multiplied by 2.5 adults/redd.

Dungeness: (Ground surveys, redd index counts)
Since 1986, cumulative redd count surveys have been conducted from RM 0 to 18.7 in the mainstem Dungeness and from RM 0 to 5.0 in the Gray Wolf mainstem. Counts are multiplied by 2.5 adults/redd. A captive brood program has been underway in this system since 1992, with the first releases from this production effort occurring in 1995. The various families and year classes are uniquely marked with cwt and otoliths. Hence surveys also sample for these items.

Nooksack, North Fork: (Ground surveys, carcass index counts)
The primary difficulty is the turbid conditions that usually exist in the north fork, making redd counts impossible. Estimates are cumulative carcass counts in established index areas in the north and middle forks. Total estimate is scaled to a single year when carcass

and redd counts were visible throughout the duration of the spawning period. With the return of otoliths marked fish, their sampling has become routine. Recent changes to production goal at Kendall Hatchery has led to the elimination of the summer/fall release program and reduction in the release of native, spring stock. Past escapement estimates have been complicated by spawn timing overlap of native and introduced stocks.

Nooksack, South Fork: (Aerial and ground surveys, redd census)
There are at least three groups of chinook that can be identified as spawning in the South Fork: 1) South Fork natives, identified by DNA and lack of other distinguishing marks, 2) North Fork natives as strays from the Kendall Creek hatchery restoration program (otolith marks, CWT) or natural strays (DNA) and 3) Green River /Soos Creek chinook as strays originating from hatchery programs past and present (DNA, adipose clips and CWTs). A total chinook estimate is derived from redd surveys conducted on foot by teams of two, done weekly from the middle of August until the first week in November in all sections of the river and in 2.6 miles of tributary streams. Redds are counted, and expanded by a factor of 2.5 chinook per redd (i.e. 1 female and 1.5 males per redd) to obtain a total estimate. Because of high flows late in the survey season, the confidence in the total estimate deteriorates. Native chinook are estimated from the numbers of redds detected prior to September 29. An initial estimate of the North Fork native chinook is calculated from the proportions of carcasses which can be identified by otolith mark, or CWT and fin clip as coming from the recovery program. This estimate is subtracted from the total early native chinook estimate to provide an estimate of the South Fork native chinook spawning population**.**

Samish: (Ground surveys, redd/carcass census)
This system is considered a Category 3 watershed, which, historically, did not possess as sustainable chinook population. However, large numbers of summer/fall chinook (introduced) fish are released from Samish Hatchery each year. As a result, natural spawning does occur in the river below the hatchery. In addition, fish surplus to hatchery needs are released above the hatchery. This stock is managed for harvest augmentation and is managed only for achieving hatchery brood needs. Estimates are made using peak visible redd counts, multiplied by 0.95 to estimate true redds and then by 2.5 fish per redd. If river conditions are not conducive for redd counts; carcass counts are made on weekly basis. Fish spawning above the hatchery are counted as they are passed upstream over the rack.

Skagit: (Mainstem-aerial surveys, redd index counts; tributaries-ground surveys, redd census and index counts)
The entire Skagit and known spawning areas in the Sauk and Cascade rivers have been surveyed by helicopter on either a weekly (odd years) or biweekly (even years) basis. During odd years, surveys are concentrated within the first half of the run with a straight line connecting the peak to the end of redd visibility. This is due to the large numbers of pink salmon spawning in the same location as chinook salmon. Earlier chinook spawners are located in the upper Sauk, Suiattle and Cascade rivers. Later spawners typically spawn in the mainstem Skagit, associated tributaries and the Sauk River.

For the earlier-timed chinook, data from 1994 to present is not comparable to previous escapement estimates. This is due to a new escapement methodology, using expanded cumulative redd counts, which is thought to represent the total spawner population better than the pre-1994 method using peak live plus dead counts. (Rebecca Bernard, Skagit System Co-op, personal communication).

Studied funded through the Chinook Technical Committee (CTC) has provided initial assessments of the validity of the current escapement estimates. Work conducted in 1998 and 1999 showed that the 21-day redd life was a valid assumption for Skagit chinook (Hahn et al. 1998) But work still remains in testing the 2.5 fish per redd. To accomplish this, and to establish as base year for future estimates, the basic plan was to proceed with a mark and recapture study, using a fish wheel to capture adult chinook. This fish wheel was used for two years without success (too few fish were captured). In 2002 attempts were be made to use a combination of collection methods including tangle nets, angling and radio-telemetry (CTC January 8, 2002).

Lower Skagit Mainstem fall**:** Data are total escapement estimates based on redd counts from the mainstem Skagit between the town of Sedro Woolley and the mouth of the Sauk River and in Finney and Day creeks. Three fixed wing aerial surveys are conducted from RM 15.6 to RM 67.1. There is a turbidity problem downstream of the Sauk, which questions the assumption of old surveys of 100% visibility. AUC estimates for three reaches using Sept 15 as start date on lower reach and Sept 1 for upper two reaches. End dates are December 1 for lower and middle reach and Nov 15 for upper reach. The old method used Sept 1 - Dec 1 for all reaches. Tributary census is conducted in Finney, Johnson, Jackson creeks.

Upper Skagit Mainstem/Tributaries :This stock was formerly known as Upper Skagit Mainstem/Tribs summer chinook. In the 2002 SaSI revision, the run-timing designation ("summer") has been dropped from most Puget Sound chinook stock names because timing designations have been applied inconsistently to Puget Sound chinook stocks. Total escapement estimates are based on redd counts from the mouth of the Sauk River to Newhalem, the lower Cascade River (RM 0.0 to 6.5) and in Illabot, Diobsud, Bacon, Falls and Goodell creeks. Surveys include three helicopter flights of upper mainstem, plus two helicopter flights and three ground surveys on the lower Cascade (RM 0.0 – 0.9), using Aug 15 to Nov 1 as AUC period (previous assumption has been Nov 8).

Lower Sauk (fall**):** Total escapement estimates are based on redd counts from the mouth of the Sauk upstream to the town of Darrington (RM 0.0 to 21.1). Aerial counts below mouth of Suiattle are not conducted due to turbidity. This sediment concentration is believed to inhibit spawning downstream, and past estimates assumed 22% of redds occur below RM 13.2. However, a simulation based on 1996 flights suggested that the majority of fish spawn below RM 13.2. Three flights are made above confluence (RM 13.2 – 21.1 Darrington Br.), with foot surveys of Dan Creek slough, which is now part of the mainstem. The estimate is a redd census above RM 13.2 plus assumed number downstream plus tributary counts times 2.5 fish per female.

Upper Sauk spring: Total escapement estimate is based on redd counts from the town of Darrington up to the forks (RM 21.2 to 39.7), in the North Fork Sauk from the mouth upstream to the falls and in the South Fork Sauk from the mouth to about RM 2.5. A new escapement methodology was developed beginning in 1994, using expanded cumulative redd counts, which are thought to represent the total spawner population better than peak live-plus-dead counts. (Rebecca Bernard, Skagit System Co-op, personal communication). The new estimates are not comparable to the estimates in the 1992 SASSI.

Surveys include five helicopter surveys and six ground surveys to monitor redds and count carcasses. Foot 'census' is thought to underestimate numbers due to width and depth of some reaches, and the fact that foot counts consistently yield lower numbers than aerial counts. Aerial-based AUC determined endpoints of Aug 15 and Nov 1. Redd life arbitrarily assumed to be mean of values derived from foot survey (22.9 days) and back-calculation from aerial AUC (37.5 days) = 30.2 days. Total escapement is based on 2.5 fish per redd. Other samples have show different female to male ratios such as the lower river test fishery (1.65) and carcass surveys (1.42).

Suiattle: Total escapement estimates are based on redd counts in Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, Milk creeks. As mentioned above, new escapement methodology was developed beginning in 1994. Prior to 1994 four index areas (Big, Tenas, Buck, Sulphur) were used, averaging peak live-plud-dead count/mile from these areas. Since 1994 cumulative redd counts have been used. Index areas now include Big, Buck (excluded summer strays – early Oct), Circle, Downey, Lime, Milk, Straight, Sulphur and Tenas creeks along with Whitechuck River. The estimate assumed no redds in the turbid portion of the mainstem. Of all systems in this study, Siuattle thought to have highest potential for multiple redds per female. However, the present estimate remains based on 1 female per redd, or 2.5 fish per redd.

Upper Cascade springs: Total escapement estimate for this stock is based on redd counts from the mainstem Cascade River above RM 7.8, the lower reaches of the north and south forks of the Cascade, and in Marble, Found, Kindy, and Sonny Boy creeks. As with the other early stock, new escapement methodology was developed beginning in 1992. Data for the estimates originated from five surveys conducted on foot and two helicopter flights (RM 7.8 – 18.6). Redds are multiplied by 2.5 fish per redd.

Stillaguamish: (Ground and aerial surveys, redd census using AUC (NF) and peak counts (SF))

Smith and Castle 1994 mentioned that the Stillaguamish escapement estimate used the same method as Skagit (aerial survey calibrated by foot surveys of index reaches). One to three flights have been used, with assumed starting dates for redd visibility. Redd counts were summed at 21-day intervals to get cumulative total redds times 2.5 fish per redd. Studies began in 1998 to improve the accuracy and precision spawning estimates by testing redd life and the number of female per redd. Aerial surveys were increased as well as the foot surveys, and both were compared throughout the sampling period.

North Fork Stillaguamish summer: Escapement estimates are made using cumulative redd counts within the mainstem and North Fork derived by graphing visible redds versus survey date.Although there were some discrepancies between redd count on the foot versus floot surveys, Hahn (2001) concluded that the estimates of chinook redds and of female spawners were precise and accurate. Seventy-five percent of the redds were censused with surveys every three to five days; water remained low and clear during this time with little canopy overhang, and good estimates of redd life were made (20-day).

South Fork Stillaguamish fall Escapement estimates are based on peak redd counts multiplied by 2.5 fish/redd. Tributaries surveyed include Boulder, Squire and Jim creeks. Assumption include: zero redds below the confluence of the North and South forks, 2.5 fish per redd and 21-day redd life. Hahn et al (2001) stated precision and accuracy of the fall chinook estimate was uncertain. The primary problem in the AUC method was due to the inability to measure redd life. Low redd density and poor visibility at times also attribute to this uncertainty.

Snohomish River: (Aerial and ground surveys, redd census using AUC; direct census for Sunset Falls, index on Sultan)

Skykomish This stock now includes Snohomish summer, Wallace Summer and Bridal Vail Creek fall chinook stocks as well as a portion of the Snohomish fall chinook stock. Spawning occurs throughout the mainstem Skykomish and Snohomish rivers, Wallace River, Bridal Vail Creek Sultan River, Elwell Creek and in the North and South Fork Skykomish including fish passed above Sunset Falls. Natural spawning also occurs in the Wallace River, but many of these spawners originate from the Wallace River Hatchery, located at the confluence of May Creek and Wallace River. Escapement estimates are derived using cumulative redd curves from aerial surveys in index area RM 20.5-49.6 on Skykomish mainstem and South Fork to Sunset Falls. Calculation uses 21-day intervals. Additional surveys are conducted on Wallace River using cumulative redd counts times 2.5 fish/redd and .95 (true redds). Estimate is based on mid-Sept visible redds / total escapement ratio in prior year. Added to this is the number of fish trucked above Sunset Falls.

Snoqualmie*:* The Snoqualmie stock is composed of Snohomish fall chinook, which spawn in the Snoqualmie River and its tributaries, including Tolt and Raging rivers and Tokul Creek. Spawning also takes place in Pilchuck and Sultan rivers. Spawn timing occurs from mid-September through October. Snoqualmie escapement is based on aerial survey of 10.1 miles of index out of 39.6 miles of river below Snoqualmie Falls, and calculated using area under the curve. Redd days are divided by 21-day redd life times 0.95 and 2.5 fish per redd. No expansion factor is used.

Both sets of estimates are intended to be total estimates although there are some small tributaries that are not surveyed nor included in the final estimate. However, it is considered to be less than five percent of the surveyed areas.

Cedar River: (Ground surveys, live counts using AUC)
Cedar River escapement is estimated using live counts, plotting counts versus survey dates and calculating the area under the curve. Counts are obtained from float surveys throughout the river length below the dam. Redds have been enumerated since 1999, and at some point redd counts may be used to produce escapement estimates.

North Tributaries: (Ground surveys, live counts in index areas using AUC):
Spawning ground index areas have been established in Bear and Cottage creeks. Since 1998 other portions of the Bear Creek watershed are also surveyed annually, but are not part of the index areas used for estimates. There is no expansion to unsurveyed areas in other north tributaries. Escapement for Bear and Cottage creeks is based on live counts and area under the curve methodology. The index areas are: Bear Ck--RM 1.3 to 8.8, Cottage Lake Ck.-- RM 0-2.3.

Issaquah Creek: (Ground surveys, carcass and live fish counts using AUC):
This watershed is believed not to have historically possessed a sustainable population of chinook and is classified as a Category 3 system. Returns to Issaquah Creek are believed to be entirely the result of hatchery production. Many more fish return beyond brood stock needs and the surplus is allowed to spawn naturally. Escapement estimates on Issaquah Creek are calculated as the sum of the individual carcass counts plus the live count from the last survey. For the East Fork, the estimate is based on live counts and area under the curve methodology.

Green River: (Aerial and ground surveys, redd index counts)
There are a considerable number of hatchery fish released from this watershed each year, and, as a result, the proportion of hatchery strays among natural spawners is high. Based upon CWT recoveries from carcasses sampled on the spawning grounds, the estimated annual proportion of hatchery strays averages about 60 percent, and ranges from about 25 to over 90 percent of the total natural spawners.

The standard method used to estimate the annual natural spawning escapement in the system employs the use of a single 1.6 mile index reach (River Mile 41.4 to 43.0) where individual redds are counted and marked weekly by raft to obtain a season cumulative redd count. Concurrent weekly aerial counts of visible redds are made in all reaches (including the index reach) from RM 29.7 to 47.0. At the end of the spawning season, the highest (peak) weekly aerial count of visible redds in the index reach is compared to the cumulative total of redds in the index reach, and an adjustment factor is derived. The peak weekly aerial count from non-index reaches is adjusted by this factor, and an estimate of cumulative redds is obtained for the reaches surveyed only by air. This estimate, when combined with the cumulative redds in the index, yields the total estimated redds for the surveyed portion of the mainstem Green.

An expansion factor of 2.6 is then applied to the surveyed mainstem redds to estimate the total redds for the entire system, including tributaries. This expansion factor was derived by Ames and Phinney (1977) after comparing their estimates of escapement in the surveyed reaches in 1976 and 1977 to estimates of total escapement in the system obtained from independent mark-recapture studies conducted by the Muckleshoot Tribe and the U.S. Fish and Wildlife Service in those years. Total system redds are multiplied by 2.5 fish/redd to convert system redds to the escapement estimate of individual chinook.

Beginning in 1999, funding originating from the Pacific Salmon Commission has been directed at improving spawning estimates on the Green River. Objectives have included estimating population size using live mark and recapture, developing new redd index expansion, comparing area under the curve method, testing chinook redd visibility, estimating number and proportion of hatchery-origin chinook and age composition. This work continues through 2002.

Puyallup (fall): Ground surveys, cumulative redd counts (even years), AUC (odd years)

With the large hatchery releases into Puyallup River, it is likely that some unquantified proportion of natural spawning fish are hatchery origin. Thus the extent of natural sustainability is unknown. Puyallup basin hatchery chinook production is currently 100% adipose marked, which will help determine natural production levels and stock status.

Annual spawning ground surveys are reliable in the South Prairie Creek system (considered to be the most productive portion of the watershed) and in the mainstem tributaries, where fish and redds are observable. In other spawning areas Puyallup mainstem and Carbon), the glacial effect on water visibility prevents creditable observation in most years. Historically, estimates were based on the 1975 and 1976 tagging studies, which used South Prairie Creek index peak live count multiplied by a factor of 37 to estimate total escapement. However, there has been a lack of confidence in this method, and beginning in 1999 estimates were calculated using a different method. This involved using South Prairie Creek cumulative redd counts during even years, while odd years would be based on area under the curve (AUC) using live counts. This difference was needed to adjust for the presence of pink salmon during odd years. Redd based estimates can also be calculated for the following Puyallup River tributaries: Fennel, Canyon, Kapowsin and Clarks creeks. In 2000, the tributary escapement ratio was applied to the mainstem Puyallup to estimate Year 2000 spawners. For the Carbon, in 1999 water conditions were conducive for good redd counts within some river reaches. Reaches with incomplete data were expanded using South Prairie Creek spawn timing-curve. In 2000, river conditions did not allow counts, and an indirect estimate of relative returns between 1999 and 2000 were used. Although this method is considered an improvement over the old method, escapement estimates previous to 1999 are not comparable to recent year estimates. .

White River Spring Chinook: (Trap census over dam, no estimate below dam)
Although there has been a significant increase in the number of chinook returning to the White River, it is largely due to the successful hatchery program. There is no evidence that the population has re-established itself naturally or achieved self-sustainability. Improvements have been made in the upper watershed related to habitat and fish passage,

but those actions have not been necessarily credited with the increased abundance levels. There is also concern that the increased numbers of chinook are, at least partially, attributable to a fall stock that has become more predominate. Recent year spawning information shows that the fall run of chinook has increased in abundance. However there has been no estimate of total escapement. Those fish passed over the dam are counted, but fish spawning below the dam are not surveyed. However, chinook are enumerated in Boise Creek and the lower White River below Buckley Trap.

Nisqually: (Ground surveys, fish and redd index, peak counts)
Given that a large number of hatchery fish are released into this watershed, it is believed that a significant proportion of natural spawners are hatchery strays, but no direct information is available to verify this. This system is difficult to survey since it is glacial fed. Abundance estimates are fair at best; stock origin information is poor.

Since 2000, all hatchery chinook have been marked, making it possible to determine the hatchery/wild composition of natural chinook spawners in the future. Spawning surveys are conducted on Nisqually mainstem from RM 21.8 to 26.2 and on Mashel from RM 0 to 3.2 to obtain peak redd count on the Nisqually and peak fish count of the Mashel. An expansion factor of 2.5 is used for the Nisqually relative to the Mashel, followed by a 6.82 expansion for both systems. Ohop Creek (RM 4.6-6.3) has also been surveyed for cumulative redd counts and carcass sampling the last two years (2001 and 2002).

Skokomish: (Ground counts, fish and cumulative redd counts in index areas)
As described in the current co-managers' Puget Sound Comprehensive Chinook Management Plan, the immediate and short-term objective is to manage Skokomish River chinook salmon as a composite population, comprised of naturally and artificially produced chinook. Hence, natural production is dependent on the chinook hatchery program to partly support natural production. Based on the sampling of adult chinook carcasses on the natural spawning grounds, chinook released from the George Adams Hatchery on Purdy Creek or from Endicott Ponds on the lower Skokomish River stray in substantial numbers onto Skokomish system natural spawning areas. Hatchery chinook releases are not currently mass-marked, but they are now double-index tag groups. In addition, genetic (allozyme) analysis results to date suggest that there is no significant genetic differentiation between Skokomish natural spawners and George Adams hatchery chinook (A. Marshall, WDFW memo dated May 31, 2000).

Chinook spawning takes place in the mainstem Skokomish River up to the confluence with the South and North Forks at RM 9, in the South Fork (primarily up to RM 5.5), and in the North Fork from RM 9 to 17 (where Cushman Dam blocks further access). Natural escapement estimates are based on counts of chinook redds in index areas in the mainstem Skokomish (RM 2.2 to 9.0), North Fork (R.M. 9.0 to 12.7), and South Fork (R.M. 0 to 2.2). In addition, escapement estimates are made for tributaries including Purdy Creek, Vance Creek, and Hunter Creek.

Since 1991, live and dead adults, along with visible redds were counted in Skokomish River index areas using foot and raft surveys (Smith and Castle 1994). Surveys were done every 10 to 14 days from late August through October. In one index area of the Skokomish (RM 8 to 9), new redds were flagged and visible redds were counted each survey, cumulative redds for the season was determined, and escapement for this index was estimated as cumulative redds times 2.5 adults/redd. For each remaining section, the peak count of visible redds in a section was multiplied by the ratio in the RM 8 to 9 index of cumulative redds :: number of visible redds at peak which was then multiplied by 2.5 adults/redd to estimate escapement for a section.

Since 1991, escapements to Hunter Creek and Vance Creek were estimated using the spawners/mile for RM 0.8 to 2.2 in the South Fork and the available habitat in each creek (i.e., 1.7 miles for Hunter Creek and 0.5 miles for Vance Creek). Escapements to Purdy Creek were based on the counts of live chinook downstream of George Adams Hatchery (Smith and Castle 1994).

To improve escapement estimates, (1) surveys were scheduled every 7 to 10 days beginning in 1998, (2) new redds and visible redds were counted each survey in more sections of the mainstem Skokomish (RM 5.3 to 6.3, 6.3 to 8, and 8 to 9) and South Fork (RM 0 to 2.2) beginning in 2000, (3) a helicopter flight was made most seasons during peak spawning to count redds and adult chinook in the South Fork upstream of RM 2.2, and (4) foot surveys were made in Hunter and Vance creeks to spot check chinook abundance and better determine escapement there.

Coded-wire tag (CWT) data and age and sex composition data have been routinely collected for chinook returning to George Adams Hatchery. More intensive sampling has been done since 1998 on the natural spawning grounds; however, more frequent sampling would improve sample sizes. The mass marking of chinook released from the hatcheries would improve the ability to determine both the level of straying by hatchery chinook and natural chinook productivity in the Skokomish River system.

Mid-Hood Canal: (Ground surveys, live peak fish counts in index areas)
The Mid Hood Canal management unit is comprised of chinook populations of the Hamma Hamma, Duckabush, and Dosewallips watersheds. All of these populations are at low abundance. As described in Smith and Castle (1994), chinook escapement for the Hamma Hamma, Duckabush and Dosewallips rivers was estimated as (peak count of live fish in each stream) x (escapement for Skokomish RM 8-9 index / peak live count for Skokomish RM 8-9 index) x (available habitat / surveyed habitat in each stream). This method was used since few chinook adults or redds were counted and chinook spawner surveys were limited to the lower reaches of each stream.

In the Hamma Hamma River, most of the chinook spawning area is currently being surveyed. A cooperative supplementation program was initiated in 1995 to rebuild chinook abundance. Since 1998, abundance has increased and escapement was estimated from counts of live chinook using the area-under-the curve (AUC) method.

In the Dosewallips and Duckabush rivers, the reaches surveyed are spawning and transit areas, but do not include all spawning areas. Upper reaches have been occasionally surveyed in the Dosewallips and Duckabush since 1998, but few adults have been observed. It has been possible to count chinook redds in the upper Dosewallips and Duckabush river reaches (especially in years without pink salmon). However, counts of live chinook are conducted on in the lower reaches since chinook redds cannot be identified due to concurrent spawning of summer chum salmon. Current escapement estimates are derived from counts of live chinook adults and chinook redds.

It has been assumed that many of the naturally-spawning chinook in the Hamma Hamma, Duckabush, and Dosewallips rivers have, in recent years, been due to straying of hatchery spawners as well as adult returns from hatchery fry released into these rivers. However, sampling for CWTs and age information indicate that few hatchery adults have been recovered. The mass marking of chinook released from the hatcheries would improve the ability to determine both the level of straying by hatchery chinook and natural chinook productivity in these rivers. In addition, a smolt trap was installed on the Hamma Hamma River in 2002 with one objective being to assess natural chinook productivity.

Priorities

In attempt to identify priorities for improving escapement estimates, recovery goals and objectives must be clearly stated. The basic template should refer to the ESU as a whole rather than individual stocks. Since recovery can represent any number of different outcomes, the process must be iterative and based on the outcomes of strategies that may be experimental. However, regardless of the specific results, the basic guidelines of a healthy ESU can be stated.

In the draft Viable Salmon Population and the Recovery of the Evolutionary Significant Units (NMFS 1999) National Marine Fisheries provided a review of the various parameters that relate to populations and ESU viability guidelines. Seven major items were identified:

1) ESU should contain multiple populations
2) Some populations in an ESU should be geographically widespread,
3) Some populations should be geographically close together,
4) Populations should not all share common catastrophic risks,
5) Populations that display diverse life histories and phenotypes should be maintained (i.e. create circumstances that will protect the integrity of the individual populations),
6) Some populations should exceed VSP guidelines,
7) Evaluations of ESU status should take into account uncertainty about ESU-level processes.

These guidelines can be translated into the following statement:

A healthy ESU is one that possesses multi-populations that represent diverse life histories and abundance levels that will not only sustain natural spawning populations but provide consistent and sustainable fisheries.

With the development of the recovery process, watersheds have been identified according to historical presence of chinook and the present status of native (indigenous) stocks. Category 1 watersheds are those that possess indigenous stocks; Category 2 are those that once possessed sustainable indigenous chinook populations but they have either been lost or no longer sustainable; Category 3 watersheds are those that historically never possessed sustainable populations of chinook.

Using this concept as a basis for identifying priorities regarding estimates of escapement, Category 1 watersheds would be of high priority, as would those in Category 2. Within the first category, highest priority would go to those stocks that are at critical abundance levels and where escapement estimates are considered unreliable (imprecise and inaccurate). Perhaps the single stock that best fits this would be the South Fork Nooksack stock. Another concern would be White River spring chinook. Both of these populations have been recently infiltrated with other stocks, which is causing some concern regarding genetic integrity in the direction of recovery. Cedar River chinook is another population that needs close scrutiny. Although the escapement greatly improved in 2001, previous years returns were in dramatic decline, with the 2000 estimate of 120 adults. For other systems like the Skagit, Stillaguamish and Snohomish, as mentioned, additional studies have been underway to test some of the major assumptions, and it is believed that this will improve accuracy and precision of current methods. On the Green, the mark and recapture program is already providing some interesting results when compared to the traditional method. Analysis of the differing escapement estimates for 2001 and 2002 will help determine the course within this watershed. An important component on the Green is determining stray rates. Since all hatchery fish have now been marked, our ability to estimate natural-origin recruits and habitat productivity will certainly improve.

As important as accurate escapement estimates is the need to identify hatchery stray from natural-origin recruits. This is especially true for Category 2 watersheds where past management direction has focused on hatchery production at the expense of natural sustainability. For Nisqually and Puyallup chinook, marking of hatchery fish and subsequent evaluation of natural production must be maintained as an important objective. One difficulty common to both of these systems is inability to survey mainstem spawning reaches because of glacial turbidity. One way of addressing the problem on the Nisqually is to use a “change in ratio” method, which commercial and recreational fisheries in the lower mainstem relative to the two hatcheries. Data collection for this method began in 2001

Past management for Skokomish River has also been hatchery-oriented, and to date there has been no attempt to determine stray rates and natural productivity. Future plans do include marking all hatchery fish, but this has not yet been implemented. It would also be useful to test the assumptions for Vance and Hunter creeks, which are estimated indirectly. A production study on the Hamma Hamma is currently underway that involves intensive spawner surveys as well as smolt out-migration

Appendix F. **Fishery Selectivity on Biological Characteristics of Salmon**

PILB

The direct *juvenescence* or *fishing-down* effect (shift toward younger ages and smaller fish) that must result from size-selective fishery harvest has been recognized for nearly 100 years (see Ricker's (1975, p. 260) discussion of Baranov's 1918 paper). But it seems only very recently that the possible *genetic* impacts of selective fisheries on fish populations have generated widespread concern among fishery scientists and ecologists. For example, Conover and Munch (2002) published a highly visible article noting that "current models and management plans for sustainable yield ignore the Darwinian consequences of selective harvest." In a similar vein, in the leading European quantitative fisheries journal, Law (2000) noted that "Fisheries managers should be alert to the evolutionary changes caused by fishing, because such changes are likely to be hard to reverse ...." Although this general concern may appear to be very recent, astute fisheries scientists have long speculated concerning the possible genetic impacts of selective fisheries on chinook salmon populations. Indeed, nearly 100 years ago Rutter (1904) expressed concern that gillnet fisheries in California's Sacramento River, selective for larger and older chinook salmon, might generate long-term selection toward age two male jacks and small adults due to selection against survival and reproduction of larger and older adults. More recently, but still a full thirty years before the recent Conover and Munch paper, Ricker (1980, 1981) published extremely provocative reports concerning the possibility that size-selective fisheries on chinook salmon might, in the long-term, result in age composition of chinook salmon populations that would be composed almost exclusively by age 2 male jacks and age 3 adult females. Thus, it is accurate to state that the potential long-term consequences of selective fisheries on chinook salmon have been recognized for almost 100 years. Yet, it is also accurate to state that fishery management plans have not yet attempted to address these potential long-term consequences. In part this is because much of the evidence for selective effects of fishing (e.g., change in the size or age composition of catch or spawners) is circumstantial, and is strongly influenced by other factors such as marine productivity.

Selective Fisheries

It is important to define more explicitly and carefully a number of terms and concepts. In particular, it is critical to define carefully just what one means by "selective fishing", to distinguish among the kinds of selective fishing to which chinook salmon populations may be exposed, and finally to distinguish between the rather immediate and direct *fishing-down* consequences of selective fishing and the potential long-term genetic consequences of selective fishing.

Generally, a fishery is characterized as *selective* whenever different components of a population of fish are exploited at different rates in recreational or commercial fisheries. Traditionally, most fisheries have been *sex-selective* (e.g., only males may be harvested in the commercial fishery for Dungeness crabs, *Cancer magister*) and/or *size-selective (*e.g., groundfish fisheries in which regulated codend mesh size theoretically allows small fish to escape whereas large fish are trapped in the codend; or the minimum size limit for male Dungeness crabs). In fisheries for chinook salmon, there are no sex-selective fisheries of which we are aware, but most fisheries are size-selective. For example, ocean commercial and recreational fisheries typically have minimum size limits, thereby generating greater exploitation rates on larger and older fish than on younger and smaller fish. Terminal gillnet fisheries typically select for fish that are within an intermediate size range that usually dominates runs. Often, such terminal gillnet selection is almost *"age-selective"* fishing. For example, in California's Klamath River the Native American gillnet fishery uses a mesh size that deliberately targets age 4 fish; most age 3 and younger fish pass through nets whereas many age 5 fish are too large to be caught by gill nets.

The above examples of selective fisheries apply within individuals populations of fish. Other types of selective fisheries operate in the peculiar context of ocean and freshwater fisheries for salmon. First, in both ocean and terminal fisheries, salmon managers must grapple with the so-called "mixed stock" harvest problem (see, e.g., Bevan 1987). In the ocean, a large number of salmon stocks originating from different river basins may be vulnerable to fishing at similar times and locations and may therefore suffer similar ocean exploitation rates. Optimal harvest policies would instead call for application of *stock-specific* exploitation rates that depend on the underlying stock productivity which, of course, must vary among salmon stocks. For a variety of reasons, the time, location or physical attributes of fish that may be caught in ocean fisheries may be deliberately structured so as to be *stock-selective.* For example, ocean fisheries off California and Oregon are structured so that the overall ocean exploitation rate on Klamath River fall chinook is quite low (to allow for terminal harvest in recreational and Indian fisheries), whereas ocean exploitation rates for chinook salmon originating from the Sacramento River (with no Indian terminal fisheries) are much higher. Mixed-stock fisheries are often constrained so that the exploitation rate appropriate to commingled weak stocks is not exceeded.

Similar, but often unintentional, *stock-selective* fisheries may take place in freshwater as a consequence of regulations. For example, in a large river system with a large number of distinct chinook salmon stocks, each with its own distinct river entry pattern, open and closed periods for fisheries may result in differential exploitation rates being applied to different stocks. If harvest in not allowed until a substantial number of fish have escaped to spawn, then it seems inevitable that exploitation rates are lower for those stocks that enter earlier as compared to those stocks that enter when fisheries are open. The most extreme examples of stock-selective fisheries for chinook salmon are those that call for the release of all fish with adipose fins present clips, whereas a certain number of fish (specified by bag or possession limits) may be retained so long as adipose fins are not present. These policies are deliberately designed to produce, at least in theory, greater exploitation rates for hatchery fish (often marked) than for wild fish (typically unmarked). Finally, ocean fisheries may also be *species-selective* as, for example, results when coho salmon must be released if caught whereas chinook salmon may be retained.

The "fishing-down" process and long-term genetic selection

The "theory of a fishery", as first advanced by Baranov (1918; see Ricker 1978), recognized *fishing-down* as an inevitable consequence of size-selective fishing when only fish above a certain minimum size limit were legal targets of exploitation. The direct cumulative effect of removing larger and older fish is to shift the age structure of a fish population toward younger and smaller fish. Although these historical results were obtained for typical iteroparous (repeat spawning) teleost fish, similar results obtain for a semelparous (single spawning) chinook salmon population subjected to a size-selective ocean fishery (Hankin and Healey 1986). In classical fisheries population models, growth rates of fish are fixed and independent of population density, and fishing down-effects are therefore predictable and reversible. The extent to which genotypes of a populations are changed by selective fishing must be related to the harvest rates imposed by these fisheries and their duration. If selective fishing were eliminated, then one would expect the age and size structure of a population to return to exactly the state that existed prior to introduction of size-selective fishing. (Possible to make a general statement that selective effect is dependent on the harvest or exploitation rate, so that reducing the rate would reduce the effect?)

Concerns regarding the potential genetic impact of fishing have arisen in part because minimum size limits theoretically result in differential exploitation rates being applied to *fast-growing* as opposed to *slow-growing* fish. If growth rates of fish were genetically inherited and if realized size at age were highly correlated with genetically inherited growth rates, then the greater mortality on fast-growing fish and resulting dominance of slow-growing fish among spawners would, over the long-term, result in selection for slow-growing fish.. If such fishery-induced genetic changes took place, then a population would not return to its original state if fishing were eliminated entirely. Instead, if fishing were relaxed or eliminated slow-growing fish could become the norm. Exactly this kind of selective fishery result was documented, under a controlled laboratory setting, in *Menidia menidia* by Conover and Munch (2002). These laboratory results may or may not be relevant to "real" fish populations and fisheries, however.

Long-term genetic changes in chinook salmon genetics due to selective fisheries

***Size-Selective Fisheries*.**

In ocean fisheries for chinook salmon, minimum commercial size limits typically mean that only a fraction of the age 3 adults from a given stock are vulnerable to commercial capture. If those age 3 fish that are above the legal size limit were genetically programmed "fast-growing" fish, then one might imagine that selective fisheries would be generating long-term selection for reduced growth rates, as described above.

Possible fishery-induced selection for reduced growth rates would, however, be complicated by several factors in chinook salmon fisheries. First, the actual size that a salmon reaches at a particular age may not be highly correlated with a genetically determined "growth rate" for several reasons. The realized size of a fish at a given age must reflect unknown interactions between inherent growth rate, variability in supply and quality of food, and variability in environment (especially variability in water temperature). Actual size at age may not, in general, be highly correlated with some underlying "growth rate"

Second, long-term genetic selection due to size-selective ocean fisheries may be stronger for (reduced) age at maturity than for growth rate. As shown by Hankin et al. (1993) and others, age at maturity is an inherited trait in chinook salmon. Generally, older aged parents will produce progeny that mature at older ages, whereas younger aged parents will produce progeny that mature at younger ages. This kind of effect is especially pronounced for age 2 males (jacks). If jacks are used as parents, there will be a strong tendency for male progeny to also mature as jacks. Therefore, if younger aged salmon spawned randomly on the spawning grounds, then size-selective fisheries for chinook might select for earlier age at maturity.

Third, for chinook salmon (see Hankin 1993 and references therein) there is substantial evidence that age at maturity depend in part on size at age. For a fixed age, say age 2, fish that are smaller are less likely to mature at that age than are fish that are larger. Through this interaction between size at age and maturity, size-selective fisheries, through removal of fish that are larger at age, might instead select for fish that mature at later ages!.

Finally, spawning behavior of chinook salmon may to some extent alleviate the kind of long-term genetic shift toward younger age at maturity that might be expected to result from size-selective fisheries. Baxter (1991) found that larger and older chinook salmon, especially males, enjoyed greater reproductive success on spawning grounds that younger and smaller males. Thus, even if size-selective fisheries generated substantial shifts toward younger aged spawners, this kind of size-dependent mating success might at least partially buffer against such fishery-induced shifts to younger ages.

Ricker (1976) and Henry (1972) calculated the loss in potential yield that results from size-selective ocean fishery capture of immature and maturing chinook salmon as compared to terminal fishery capture of mature fish only. Calculated losses range from 30-50% of total yield. In two important reports, Ricker (1980, 1981) examined changes in average size of chinook salmon (and other Pacific salmon species) and presented a number of plausible hypotheses that might explain the apparent decline in average size of harvested chinook salmon. Included among these hypotheses was the possibility that size-selective fisheries had selected for long-term genetic changes in age at maturity. Hankin and Healey (1986) presented analysis of an age-structured Ricker stock-recruitment model and, among other things, attempted to calculate the maximum possible changes in mean age of spawning populations that could be explained as a direct consequence of *fishing-down* effects. They contrasted these calculated values with observed changes in mean ages in some populations. Hard (in press) used age-structured quantitative genetics models to assess the possible long-term genetic effects of size-selective fishing on chinook salmon populations

Stock-Selective Fisheries.

There seems little doubt that certain stock-selective fisheries must have long-term genetic effects on chinook salmon populations. Suppose, for example, that a terminal fishery were regulated by allowing harvest to take place only after a certain number of fish were estimated to have escaped to spawn. In that case, the fishery-related mortality rate would be much less for fish (or stock type) in the early part of the run than for fish (or stock type) in the late part of the run. Because run timing (stock type) is known to be an inherited trait, such fishery harvest policy should, in the long-term, unintentionally select for early-returning fish (or for a particular stock type). (See Nicholas and Hankin 1988 for examples of this phenomenon in a hatchery setting.)

Lawson and Sampson (1986) examined the potential impacts of stock-selective ocean fisheries on non-catch mortalities of species (e.g., coho vs chinook) or stock types (e.g., hatchery vs wild) that may not be landed in stock-selective fisheries. Such prohibited species or stock types would be captured but then released. Ricker (1958) presented modeling results showing that total yields in mixed stock ocean fisheries were considerably less than those that could be achieved if stocks could be managed and harvested separately. (This same theme was later noted by Hilborn (1985).
Evidence for Inheritance of Traits

Donaldson and Menasveta (1961) provide evidence that growth rate, survival rate, disease resistance and temperature tolerance are all traits which are subject to deliberate artificial selection in a hatchery setting. Ricker (1972) provides an extensive review of older studies that provide evidence that age at maturity and other traits are inherited trait, but also presents information on environmental influences on these same traits. By contrasting the rates of production of jacks in two chinook salmon stocks reared in a hatchery environment under controlled conditions, Hard et al. (1985) provide evidence that the tendency to produce age 2 male jacks is an inherited trait. Hankin et al. (1993) summarize evidence that age at maturity (all ages) is an inherited trait based on age-specific mating experiments carried out at Oregon's Elk River Hatchery. These analyses attempt to account for the fishery-induced biases that might result from differential mortality on older-maturing as compared to younger-maturing fish. Both Hankin (1993) and Hard et al. (1985) provide evidence that jacking rate does not depend on growth rate alone, but size nevertheless has an important effect (Hankin 1993, Silverstein et al. 1998), with faster-growing fish (at age) generally maturing earlier. If growth rates are sufficiently enhanced in hatchery environments, then mature yearling chinook can apparently be produced (Clark and Blackbird 1994). Heath et al. (1994a) carried out known matings designed to assess inheritance of jacking rate with male parents that were jacks or non-jacks. They found a significant sire age effect, but did not find that jacking was related to growth rate. Heath et al. (1994b) used DNA probes to show that allele distributions differed between maturing and immature chinook salmon of the same age and stock. Heath et al. (1999) presented experimental evidence for a maternal effect (via female egg size) on offspring size during early life (first several months, but thereafter no effect could be detected.

Behavior and Life History
Numerous papers have stressed the possible importance of large size in naturally spawning populations of chinook salmon. Baxter (1991) observed spawning behavior of fall chinook salmon in northern California and found that larger-sized males enjoyed much greater spawning success than smaller-sized males. Females exhibited behaviors suggesting their preference for mates that exceeded their size. Berejikian et al. (2000) found that there was a greater amount of time between successive nests for females

paired with small males than with large males and suggested that this behavior might be an important means of achieving mate choice (i.e., finding a preferred larger-sized male. Healey and Heard (1984) examined variation in fecundity of chinook salmon among many chinook populations. Using life history models, they found that age-specific increases in fecundity would not "justify" the old ages at which many chinook salmon spawn. Presumably, there are some additional important benefits of large size and late age at maturation.

Egg size of chinook salmon varies across populations and within populations. Within a given population, egg sizes are generally larger for larger and older fish than for smaller and younger fish. Silver stein and Hershberger (1992) found that females with larger egg sizes were more likely to produce progeny that matured precociously. Healey (2001) reported that stream type chinook salmon, that typically spend more than a full year in freshwater prior to ocean entry, have smaller eggs and generally make a smaller reproductive investment than do ocean type chinook salmon, that typically enter saltwater during their first year of life.

Detecting Selective Effects of Fishing

Ricker (1980, 1981), previously mentioned, presented evidence for declines in average size and age of Pacific salmon, including chinook salmon, and listed a number of possible explanations for these declines. More recently, Bigler et al. (1996) found a decreasing average body size in 45 of 47 salmon populations in the Northern Pacific. They found that body size was inversely related to population abundance and speculated that enhancement programs during the 1980s and 1990s have increased population sizes but reduced growth rates due to competition for food in the ocean. Clearly, these kinds of causes could result in the same kinds of reductions in size at age as might be caused by long-term genetic selection against fast-growing fish.

There is substantial cause for concern regarding long-term genetic effects of both stock-selective and size-selective fishing on chinook salmon stocks. Of these two kinds of selective fisheries, the effects of stock-selective fisheries seem most clear and most easily minimized. If terminal fisheries consistently result in substantial removal of specific temporal components of a stock's spawning run, then it seems inevitable that there will be strong selection against perpetuation of these temporal components. This kind of effect would seem avoidable by regulating open and closed terminal fishing periods so that continuous fishing periods are always short (say, no more than 3 days duration), and so that the duration of fishing periods is always short compared to the duration of closed periods. Terminal net fisheries in Puget Sound are scheduled in this manner – pulsed openings scheduled over the duration of the run.

It seems clear that size-selective ocean fishing on immature chinook salmon can shift the age distribution of adult spawners toward smaller and younger fish. A long-term genetic shift to younger aged spawners would result (1) *If* chinook salmon mated randomly, without regard to age, on spawning grounds, and (2) *if* age at maturity were independent of growth rate. However, (3) larger and older male chinook salmon (and possibly females) generally have greater mating success than smaller and younger male chinook salmon (and possibly females); (4) fast-growing chinook salmon tend to mature at younger ages than slow-growing chinook salmon, but are selected *against* in size-selective ocean fisheries; and (5) size at age may have only a weak correlation with some inherent genetically inherited "growth rate". Together, items (3)-(5) may reverse or ameliorate the kinds of long-term genetic effects that one might expect if items (1) and (2) were valid. Most of these potential long-term genetic effects again seem avoidable. If ocean fishing for chinook salmon were prohibited by regulation (see Ricker 1976 for one example calculation of the improved yield that could result!), and if all sizes and ages of chinook salmon were equally vulnerable to terminal fisheries (e.g., by fishing gill nets of variable mesh sizes in Indian fisheries), then it would seem unlikely to expect any long-term genetic changes in age at maturity of chinook salmon stocks.

The absence of explicit consideration of possible long-term genetic impacts of selective fishing in management plans for chinook salmon stocks probably reflects the ambiguity and complexity of potential impacts for this species. No chinook salmon stocks have yet been reduced to the extreme scenario (only jacks and age 3 females) sketched by Ricker (1980, 1981), but it is also certainly true that one would be hard-pressed to find a stock of chinook salmon for which one might claim that the largest fish seen today are as large as those seen 100 years ago. Of course, given classical fishing-down effect that results from ocean fisheries, one would not expect to see these large fish even if there were no long-term genetic changes in age or size at maturity.

2003-4 State/Tribal Agreed-to Fisheries Document
(May 1, 2003 – April 30, 2004)

I. Treaty/Non-Treaty Ocean Fisheries (FRAM #0319 & #1603)

Treaty Troll Quota	60,000 chinook; 90,000 coho
Non-Treaty TAC	124,000 chinook; 300,000 coho
NT Troll TAC	64,400 chinook; selective fishery impacts associated with a landed catch of 75,000 marked hatchery coho
Recreational TAC	59,600 chinook and selective fishery impacts associated with a landed catch of 225,000 marked hatchery coho

TREATY TROLL

Areas 2, 3, 4 & 4B

5/1-6/30 Chinook directed fishery with sub quota of 30,000 chinook;

7/1-9/15 All salmon species with sub quota of 30,000 chinook or quota of 90,000 coho; chum release 8/1-9/30.

NON-TREATY TROLL

U.S./Canada border to Cape Falcon

5/1-6/30 All salmon except coho with 40,000 chinook quota; the fishery will be managed to provide remaining quota of 800 chinook for a June 26-30 open period with a 50 fish per vessel landing limit for the 5-day open period. Columbia and Cape Flattery Control Zones closed. Trip limits, gear restrictions, and guidelines may be implemented or adjusted in-season. Vessels must land and deliver their fish within 24 hours of any closure of this fishery and within the area or in Garibaldi. State regulations require that fishers south of Cape Falcon intending to fish within this area and/or fishers fishing within this area intending to land salmon in Garibaldi notify Oregon Department of Fish and Wildlife before transiting the Cape Falcon line.

U.S.-Canada Border to Cape Falcon

July 3 thru earliest of Sept. 14 or preseason chinook guideline of 24,400 or coho quota of 75,000. All salmon except no chum retention north of Cape Alava during August and September (all retained coho must have a healed adipose fin clip). Fishery is 5-days open/2 days closed. Landing limits of 75 chinook per vessel for the period July 3-7, 150 chinook per 5-day open period for the remainder of the season. Columbia and Cape Flattery Control Zones closed. Beginning August 16, Grays Harbor Control Zone closed. Trip limits, gear restrictions, and guidelines may be implemented or adjusted in-season. Vessels must land and deliver their fish within 24 hours of any closure of this fishery and within the area or in Garibaldi. State regulations require that fishers south of Cape Falcon intending to fish within this area and/or fishers fishing within this area intending to land salmon in Garibaldi notify Oregon Department of Fish and Wildlife before transiting the Cape Falcon line.

NON-TREATY RECREATIONAL

Area 1: Leadbetter Point to Cape Falcon (Oregon)

6/29-9/30 (112,500 coho sub quota) Open Sun-Thursday; 2 fish per day, only one of which may be a chinook; retained coho must have a healed adipose fin clip; chinook minimum size limit 26 inches; chinook guideline: 12,700; closed in Columbia Control Zone; closed between Cape Falcon and Tillamook Head beginning Aug 1.

Buoy 10

8/1-8/15 Open 7 days/week; 2 fish per day, only one of which may be a chinook; retained coho must have a healed adipose fin clip; release sockeye and chum, and unmarked coho. Barbed hooks allowed.

8/16-9/30 Open 7 days/week; 3 fish per day, only one of which may be a chinook; retained coho must have a healed adipose fin clip; release sockeye and chum, and unmarked coho. Barbed hooks allowed.

10/1-12/31 Open 7 days/week; 6 fish per day, 3 adults, only one of which may be a chinook; retained coho must have a healed adipose fin clip; release sockeye, chum, and unmarked coho. Barbed hooks allowed.

1/1/04-3/31/04 Open 7 days/week; 6 fish per day, 2 adults; retained coho must have a healed adipose fin clip; release sockeye, chum, unmarked coho and unmarked chinook. Barbed hooks allowed.

North Jetty

Open 7 days per week when Area 1 or Buoy 10 area is open. When Buoy 10 area or Area 1 is open, the daily limit and minimum size restrictions follow the most liberal regulations of those areas. Barbed hooks allowed.

Area 2: Queets River to Leadbetter Point

6/22-9/14 (83,250 coho sub quota) Open Sun-Thur; 2 fish per day, only one of which may be a chinook; retained coho must have a healed adipose fin clip; chinook minimum size limit 26 inches; chinook guideline: 40,600. Beginning August 16, Grays Harbor Control Zone closed.

Area 2-1 (east of a line from Leadbetter Point to Cape Shoalwater): Willapa Bay

6/22-8/15 Open concurrent with Area 2, when Area 2 IS OPEN FOR SALMON. Area 2 rules apply.

8/16-1/31/04 6 fish limit, 2 adults; 12" min size limit; single-point barbless hooks required.

Area 2-2 (east of line between tips of exposed jetties): Grays Harbor

West of Buoy 13 line

Open concurrent with Area 2, when Area 2 IS OPEN FOR SALMON THROUGH AUGUST 15 ONLY. Area 2 rules apply.

East of Buoy 13 line

6/22-9/15 Closed for salmon.

9/16-11/30 6 fish limit, 2 adults, release adult chinook; 12" min size limit; single-point barbless hooks required.

Westport Boat Basin and Ocean Shores Boat Basin

8/16-1/31/04 6 fish limit, 4 adults; 12" min size limit; barbed hooks allowed; night closure and non-buoyant lure restriction.

Area 3: Cape Alava to Queets River

6/22-9/14 (5,750 coho sub quota) Open 7 days/week; 2 fish per day plus one additional pink salmon, no more than one of which may be a chinook; retained coho must have a healed adipose fin clip; chinook minimum size limit 26 inches; chinook guideline: 2,300.

9/20-10/5 (100 coho sub quota; 100 chinook sub quota) Fishery restricted to inside the area defined by a line from Teahwhit Head northwesterly to "Q" buoy to Cake Rock then true east to the shoreline. Regulations as described above.

Area 4: US/Canada border to Cape Alava and east to Sekiu River

6/22-9/14 (23,400 coho sub quota) Open 7 days/week; 2 fish per day plus one additional pink salmon, only one of which may be a chinook. Chum non-retention during August and September. Retained coho must have a healed adipose fin clip; chinook minimum size limit 26 inches; chinook guideline: 3,900; chinook non-retention east of Bonilla-Tatoosh line except chinook retention allowed July 1-31. Closed to salmon angling east of a true North-South line through Sail Rock, July 1-31; and closed to salmon angling inside the area bounded by a line from Kydaka Point to Shipwreck Point August 1-September 14.

II. PUGET SOUND including STRAIT OF JUAN de FUCA and SAN JUAN ISLANDS fisheries

STRAIT OF JUAN DE FUCA

Areas 5, 6, 6C Treaty Troll (Ntrty Closed)

NOTE: For Area 4B: 5/1-10/31 see Ocean Troll. For 11/1-12/31 and 1/1-4/15 see below.

5/1-6/15	Closed
4/16/04-4/30/04	Closed
6/16-9/15	Open for salmon, chum release; South of Angeles Pt./ Observatory Pt. line closed; Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock closed; Hoko Bay closed, inside the area bounded by a line from Kydaka Point to Shipwreck Point; 1,000 foot closure around stream mouths; Area 6 closed east of line true north from Green Point.
9/16-4/15	Open for all salmon; in Area 6 coho release 9/16-12/31, chum release through 9/30; 1,000-foot closures around stream mouths

Areas 4B, 5, & 6C Treaty Net (Ntrty Closed)

Chinook	Open for setnet gear only, 6/16 through 8/16 in Areas 4B and 5; 7 days a week; Hoko Bay closed, inside the area bounded by a line from Kydaka Point to Shipwreck Point and South of Angeles Pt./ Observatory Pt. line closed. Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock closed. 1,000-ft. closure around stream mouths.
Sockeye/Pink	Start to be determined (7/20 est); end no later than 9/7.
Coho	Open for gillnets 4 days per week from end of Fraser Panel control, through wb 10/5; 1,000 ft. closure around stream mouths. The gillnet catch number listed in FRAM #0319 will be used as management target and will not be greatly exceeded.
Chum	Open for gillnets, 5 days per week, wb 10/12 through wb 11/2; 1,000-foot closure around stream mouths.

Area 5 Recreational

5/1-6/30	Closed
7/1-7/4	2 fish limit; chinook, unmarked coho, and chum release. South of the Kydaka Pt./Shipwreck Pt. line - closed to salmon angling.
7/5-7/31	2 fish limit, (chinook 22" min size); unmarked chinook, unmarked coho, and chum release; Area 5 & 6 season quota of 3,500 landed chinook, afterwards, chinook release. Unlawful to bring into the boat salmon that are not going to be retained. South of the Kydaka Pt./Shipwreck Pt. line – closed to salmon angling.
8/1-8/14	4 fish limit, no more than a total of 2 may be chinook and coho (chinook 22" min size); unmarked chinook, unmarked coho, and chum release; Area 5 & 6 season quota of 3,500 landed chinook, afterwards, chinook release. Unlawful to bring into the boat salmon that are not going to be retained. South of the Kydaka Pt./Shipwreck Pt. line – closed to salmon angling.

8/15-8/31	4 fish limit, no more than a total of 2 may be coho; chinook, unmarked coho, and chum release. South of the Kydaka Pt./Shipwreck Pt. line – closed to salmon angling.
9/1-9/30	2 fish limit; chinook, unmarked coho, and chum release. South of the Kydaka Pt./Shipwreck Pt. line – closed to salmon angling.
10/1-10/31	Closed
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size).
12/1-2/13	Closed
2/14-4/10	1 fish limit (chinook 22" min size).
4/11-4/30	Closed

Area 6 Recreational

5/1-6/30	Closed
7/1-7/4	2 fish limit; chinook, unmarked coho, and chum release. South of Angeles Pt./ Observatory Pt. line – closed to angling. Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock – closed to salmon angling. Dungeness Bay closed.
7/5-7/31	2 fish limit, (chinook 22" min size); unmarked coho, chum, and chinook release, except W. of true N/S line through "2" buoy near tip of Ediz Hook retention of marked chinook allowed; Area 5 & 6 season quota of 3,500 landed chinook, afterwards, release chinook. Unlawful to bring into the boat salmon that are not going to be retained. South of Angeles Pt./ Observatory Pt. line – closed to angling. Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock – closed to salmon angling. Dungeness Bay closed.
8/1-8/14	4 fish limit, no more than a total of 2 may be chinook and coho (chinook 22" min size); unmarked coho, chum, and chinook release, except W. of true N/S line through "2" buoy near tip of Ediz Hook retention of marked chinook allowed. Area 5 and 6 season quota of 3,500 landed chinook, afterwards, release chinook. Unlawful to bring into the boat salmon that are not going to be retained. South of Angeles Pt./ Observatory Pt. line – closed to angling. Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock – closed to salmon angling. Dungeness Bay closed.
8/15-8/31	4 fish limit, no more than a total of 2 may be coho; chinook, unmarked coho, and chum release. South of Angeles Pt./ Observatory Pt. line – closed to angling. Pt. Angeles Hbr. W. of line from tip of Ediz Hook to ITT Rayonier Dock – closed to salmon angling. Dungeness Bay closed.
9/1-9/30	2 fish limit; chinook, unmarked coho, and chum release. Dungeness Bay closed.
10/1-10/31	Closed, except Dungeness Bay (see: Dungeness Bay Recreational below.)
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size)
12/1-2/13	Closed
2/14- 4/10	1 fish limit (chinook 22" min size). Dungeness Bay closed.
4/11-4/30	Closed

STRAIT of JUAN de FUCA TERMINAL AREAS

Area 6D (Dungeness Bay)

Chinook		Closed
Pink		Closed
Coho	Trty:	Open 9/21 through wb 10/26; additional week possible based on in-season information; chinook and chum release and gillnets may fish daytime only, through 10/10; 1,500 ft closure around each river mouth.
	Ntrty:	Open 9/29 through 10/31; additional week possible based on in-season information; for skiff gillnet gear; 7am - 7pm, 5 days each week (M-F); chinook and chum release by cutting ensnaring meshes; 1,519.03 ft. (1/4 nautical mile) closure around each river mouth.
Chum		Closed

Dungeness River Treaty (Ntrty Closed)

Chinook	Closed
Pink	Closed
Coho	To be determined in-season. Fishing up to 3 days/wk, for coho only, may occur no earlier than 10/16 and will be restricted to areas below US Hwy 101 using species selective (non-gillnet) gear.
Chum	Closed
Steelhead	Open starting wb 12/14 through wb 2/22.

Elwha River Treaty (Ntrty Closed)

Chinook	Closed except Ceremonial Harvest of 1 fish in July
Coho	Open 9/14 through 11/8; days per week to be determined in-season.
Chum	Closed
Steelhead	Open starting wb 12/7 through wb 2/22.

Eastern SJF Misc. Treaty (Ntrty Closed)

Steelhead	Open starting wb 12/14 through wb 2/22.

Western SJF Misc. Treaty (Ntrty Closed)

Steelhead	Open starting wb 12/7 through wb 2/22; Lyre R. closed below Susie Creek through 1/3.

Dungeness Bay Recreational:

5/1-9/30	Closed
10/1-10/31	Two fish limit, coho only
11/1-4/30	Closed

Freshwater Recreational Salmon Fisheries:

Dungeness River:
(mouth to hatchery intake pipe at RM 11.3)

10/16 – 12/31 4 fish limit, marked coho only; 12” min size.

Elwha River:
(mouth to Aldwell Lake Dam)

6/1/03 - 2/29/04 Trout and other game fish open, except closed for all species 6/1-9/30 from mouth to marker at outfall of WDFW rearing channel.

10/1 – 11/15 6 fish limit, coho only; no more than 4 adults; 12 inch min. size. Closed waters – 50 yards above to 50 yards downstream of Elwha Tribal Hatchery outfall.

Hoko R:
(mouth to cement bridge (mile 7.0) on Hoko/Ozette Hwy.)

Closed to salmon. Fly fishing gear only 9/1-10/31 for trout and other game fish.

All other STRAIT OF JUAN DE FUCA REGION freshwater:
Closed to salmon angling.

SAN JUAN ISLANDS/POINT ROBERTS AREA

Areas 6, 7, & 7A Net

Chinook — Closed

Sockeye
- Trty: Schedule to be determined. July, August ceremonial and subsistence fishery
- Ntrty: Schedule to be determined. Purse seine chinook, coho, and chum NR; gill net 715 chinook maximum.

Pink
- Trty: Purse seine and gill net: dependent upon Fraser Panel.
- Ntrty: Purse seine, gill net and reef net: dependent upon Fraser Panel.

Coho
- Trty: Closed
- Ntrty: Reef net: 7 days/wk beginning end of Fraser Mgmt (Wk ?) through chum mgmt Wk 46 (wb 11/9); chinook NR; unmarked-coho release through 9/30, then coho non-selective; see note about chum tissue collection during the period 9/16-9/30. Otherwise, chum retention prohibited until after 9/30.

  * Note: Evaluation reef net fishery with chum retention 9/16-9/30 approved by NOAA-Fish.

Chum
- Trty: Wks 42 (wb 10/12)-Wk 45 (wb 10/19); fishing pattern (2,1) dependent upon ISU and quotas.

Ntrty: Wks 42 (wb 10/12) - Wk 45 (wb 11/2); Purse seine brailing required, chinook and coho NR; (GN chinook and coho NR, live box, and limited soak time restrictions wk 42 only); fishing pattern: 1,1,1,1; dependent upon ISU and quotas. Reef nets through wk 46 (wb 11/9), 7 days per week through 11/15. See comments in coho fishery section regarding reef net chum tissue collection study 9/16–9/30 and chum retention allowance effective beginning 10/1.

Subsistence Trty: 2/16-4/10 subsistence fishery.

Area 7 Recreational

5/1-6/30	Closed
7/1-7/31	2 fish limit, 1 chinook (chinook 22" min size); Closed waters - Rosario Strait (easterly of line from Lummi Rks/Peapod Rks/Lydia Shoal due S to Black Rock, southerly to the eastern most point on James Island, and southerly to the marker on Bird Rocks, westerly to the marker across to Lopez Pass), E. Strait of Juan de Fuca, and Bellingham Bay closed.
8/1-9/30	4 fish limit, no more than a total of 2 may be chinook and coho, 1 chinook (chinook 22" min size), release unmarked coho, release chum; Closed waters - S Rosario Strait and E Strait of Juan de Fuca (E of boundary line drawn true S of Salmon Bank buoy), Bellingham Bay closed 8/1-8/15; Samish Bay closed.
10/1-10/31	2 fish limit, release chinook; Samish Bay closed 10/1-10/15.
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size).
12/1-1/31	Closed
2/1-3/31	1 fish limit, (chinook 22" min size).
4/1-4/30	Closed

NOOKSACK/SAMISH TERMINAL REGION

Bellingham Bay (Areas 7A, 7B, 7C, 7D) Net

Chinook/Pink Trty: Areas 7B, 7C, & 7D: August 3 through September 6 (Wks 32-36), minimum 5" gill net mesh; open weekly 4 PM Sunday to 4 PM Friday; closed south and west of a line from Oyster Creek to the fisheries marker on Samish Island, except that hand pull gill nets may fish from 4:00 PM Sunday - 4:00 PM Wednesday south to a line from Oyster Creek to Fish Point on Samish Island; fishing pattern: 5,5,5,5,5.

Ntrty: Areas 7B & 7C: Wks 34 (wb 8/17)-Wk 36 (wb 8/31); PS limited to 2 boats in first week, (subsequent seine openings dependent upon seine total catch in previous week); brailing required; PS coho and sockeye NR; PS fishing pattern: 1,(1,1); GN wks 34-36; fishing pattern: 1,3,3.

Coho Trty: Areas 7B, 7C: September 7 through October 25 (Wks 37-43), open Sunday 4 PM - Thursday 4 PM. 4,4,4,4,4,4,4.
Areas 7B and 7D on reservation: September 7 through October 25, (Wks 37-43 open Saturday 4 PM through Friday 4 PM. 6,6,6,6,6,6,6.

Ntrty: Area 7B: Wks 37 (wb 9/7)-Wk 43 (wb 10/19); PS/GN; fishing pattern: 3,3,7,7,7,7,7.

Chum	Trty:	Areas 7B, 7C, & 7D: October 26 - December 15 (Wks 44-51); open 3 days/wk. 3,3,3,3,3,3,3,2.
	Ntrty:	Area 7B: Wks 44 (wb 10/26)-Wk 49 (wb 11/30); PS/GN; 5 days/wk. Whatcom Creek Zone (east of line from Post Point to flashing red light at west entrance of Squalicum Harbor) open 7 days per week. Beach Seine: Wks 42 (wb 10/12)-Wk 46 (wb 11/9); 5 days/wk. E. of Governors Pt. to Bellingham airport.
Steelhead	Trty:	Areas 7B, 7C, & 7D and Samish R. up to the Edison Bridge: December 16 - January 15; open Sunday 4 PM through Friday 4 PM.

Nooksack River Treaty Net (Ntrty Closed)

NOTE: Nooksack Tribal river fishery openings will be 00:01 a.m. (Lummi openings at 4:00 p.m.) and will close at 4:00 p.m. (concurrent with Lummi), on a weekly basis.

Chinook/Pink	April, May limited ceremonial chinook harvest, less than 5 chinook. July 2-3; fishery is open for 24 hours; permitted subsistence fishery, not to exceed 50 chinook including April-May. August 3 - September 6 (Wks 32-36); minimum 5" gill net mesh; Open 4 PM Sunday and close 4 PM Friday except Wk 32 open Sunday 4 to Wednesday 4. 3,6,6,6,6. The river is divided into five zones during this period. These zones open on subsequent weeks, proceeding up river, to protect migrating spring chinook.
Coho	September 7 – October 25; open Saturday 4 PM through Friday 4 PM; 6 days/wk. 6,6,6,6,6,6,6
Chum	November 27-28 limited subsistence harvest. October 26 - December 15 (Wks 44-51); open 3 days/wk. 3,3,3,3,3,3,3,2
Steelhead	December 16 - January 15; open Sunday 4 PM through Friday 4 PM.

Bellingham Bay Terminal Area Recreational

5/1-8/15	Closed
8/16-10/31	4 fish limit, 2 chinook (chinook 22" min size); Samish Bay closed thru 10/15.
11/1-4/15	Same as Area 7
4/16-4/30	Closed

Freshwater Recreational Salmon Fisheries:

Nooksack River and North Fork:		
(from Lummi Indian Reservation boundary to Mt. Baker High School bus barn at Deming)		
	8/1 – 8/31	2 fish limit, pink only, 12" min size; Selective gear rules, except fishing from boats equipped with a motor allowed. Open only downstream of the Guide Meridian Bridge (Hwy 539). All Species-night closure.
	9/1 – 12/31	2 fish limit, 12" min size, release chinook and unmarked coho. All Species-night closure and non-buoyant lure restriction 9/1-11/30.
(from Mt. Baker High School bus barn at Deming to confluence of North and South forks)		
	10/16 – 12/31	2 fish limit, 12" min size, release chinook and unmarked coho. All Species-night closure and non-buoyant lure restriction 10/1-11/30.
(from confluence of North and South forks to Maple Creek on North Fork)		
	10/1 – 10/31	2 fish limit, 12" min size, release chinook and unmarked coho. All Species-night closure and non-buoyant lure restriction 8/1-11/30.
Nooksack River, South Fork:		
(from mouth to Skookum Creek)	10/16 – 12/31	2 fish limit, 12" min size, release chinook and unmarked coho. All Species-selective gear rules 6/1–2/29, and night closure 8/1-10/31.
Samish River:		
(from mouth to Thomas Rd. Bridge)	7/1 – 12/31	2 Fish limit, 12" min size. All Species-night closure and non-buoyant lure restriction 8/1-12/31.
(from Thomas Rd. Bridge to I-5 Bridge)	10/1 – 12/31	2 Fish limit, 12" min size. All Species-night closure and non-buoyant lure restriction 8/1-12/31.
Dakota Creek:		
(mouth to Giles Road Bridge)	10/1 – 12/31	2 fish limit, 12" min size
Whatcom Creek:		
(mouth to yellow markers below foot bridge below Dupont St. in Bellingham)		
	8/1 – 12/31	6 fish/2 adult limit, 12" min size. All Species – night closure and non-buoyant lure restriction 8/1-12/31.

All other NOOKSACK/SAMISH TERMINAL REGION freshwater:
Closed to salmon angling.

SKAGIT TERMINAL REGION

Skagit Bay (Area 8) Net

[Note: Fishing schedules for Skagit Bay and Skagit River are preseason projections. Schedules may be changed in-season as necessary to meet management objectives.]

Chinook Closed

Pink Trty: Wk 35 (wb 8/24)-Wk 38 (wb 9/14); fishing pattern: 4,4,7,1; beach seine chinook release.

*Pink fishery schedule for Skagit Bay and Skagit River is the maximum number of days that could be fished if there is an inseason increase in Treaty harvestable above the preseason forecast. The increased schedule was modeled for purposes of examining whether, assuming an increase in harvestable and number of fishing days, chinook impacts would exceed the guidelines of the Puget Sound Chinook Resource Management Plan.

Test Fishery (Hoypus Point): Wk 35 (wb 8/24)-Wk 37 (wb 9/7); fishing pattern: 3,3,3; 2 sets/day; chinook release.

Ntrty: Wk 35 (wb 8/24)-wk 36 (wb 8/31), PS and GN, fishing pattern: 1,1. PS and GN fish together (daylight hours).

Coho Terminal Treaty HR target 20%.
Trty: Swinomish-Wk 39 (wb 9/21) - Wk 40 (wb 9/28); fishing pattern: 2,2. Upper Skagit - Wk 39 (wb 9/21) - Wk 41 (wb 10/5); fishing pattern: 3,3,3.
Ntrty: Closed.

Chum Trty: Swinomish - Wk 45 (wb 11/2); fishing pattern: 2. Upper Skagit - Wk 45 (wb 11/2) - Wk 46 (wb 11/9); fishing pattern: 2,2.
Test: Wk 44 (wb 10/26) - Wk 45 (wb 11/2); 1 boat at jetty 4 day/wk 44, 1 boat in bay 1 day/wk 44; 2 boats 1 day/wk 45.
Ntrty: Dependent upon ISU. Begin Wk 45 (wb 11/2); PS chinook NR; PS and GN fish together (daylight hours).

Steelhead Trty: Begins Wk 49 (wb 11/30).

Skagit River Treaty Net (Ntrty Closed)

Chinook — Areas 78C and 78D :closed.

Sockeye — Area 78C: Fishery dependent on ISU; If surplus, Sauk- Suiattle open Wk 28 (wb 7/6) – Wk 29 (wb 7/13), fishing pattern: 1,1, chinook release, further openings depend on update.

Area 78D: Fishery dependent on ISU; If surplus, Upper Skagit open in Baker River down to Dalles Pool, Wk 28 (wb 7/6) – Wk 29 (wb 7/13), fishing pattern: 1,1, chinook release, further openings depend on update.

Pink — Area 78C: Swinomish Wk 35 (wb 8/24)-Wk 38 (wb 9/14); fishing pattern: 4,4,7,1. Upper Skagit and Sauk-Suiattle Wks 35 (wb 8/24)-Wk 38 (wb 9/14); fishing pattern 4,4,7,7; chinook release.

Area 78D: Wks 35 (wb 8/24)-Wk 38 (wb 9/14); fishing pattern 4,4,7,7; chinook release.

Coho — Terminal Treaty HR target 20%.

Area 78C: Swinomish - Wks 39 (wb 9/21) - Wk 40 (wb 9/28); fishing pattern: 2,2. Upper Skagit and Sauk-Suiattle - Wks 39 (wb 9/21) - Wk 41 (wb 10/5); fishing pattern: 3,3,3; chinook release through 10/11.

Area 78D: Upper Skagit - Wks 39 (wb 9/21) - Wk 41 (wb 10/5); fishing pattern: 3,3,3. Chinook released or used for broodstock through 10/11; Skagit River closed above O'toole Creek.

River Test

Chinook — (Blakes) Wk 19 (wb 5/4)-Wk 35 (wb 8/24); 1 boat, 6 hours/wk.

Coho — (Blakes & Spudhouse) Wk 34 (wb 8/17)-Wk 45 (wb 11/2); 2 boats, 12 hours/wk

Coho — (Area 2) Wk 35 (wb 8/24)-Wk 44 (wb 10/26); 2 setnets, 24 hours/wk

Chum — Area 78C : Swinomish - Wk 45(wb 11/2); fishing pattern: 2. Upper Skagit and Sauk-Suiattle – Wk 45 (wb 11/2) – Wk 46 (wb 11/9); fishing pattern: 2,2

Area 78D Upper Skagit – Wks 45 (wb 11/2) – Wk 46 (11/9); fishing pattern: 2,2

Fishing after week 45 in both areas depends on update.

Steelhead — Swinomish Area 78C: Begins Wk 49 (wb 11/30)

Upper Skagit/Sauk-Suiattle Area 78D: Begins Wk 50 (wb 12/7)

Swinomish Channel Treaty Net (Ntrty Closed)

Coho — Closed, unless Area 8 open.

Chum — Open with Area 8.

Area 8-1 Recreational

5/1-7/31	Closed
8/1-9/30	4 fish limit, no more than a total of 2 may be coho and chum, chinook release.
10/1-10/31	2 fish limit, chinook release.
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size)
12/1-1/31	Closed
2/1-3/31	1 fish limit, (chinook 22" min size)
4/1-4/30	Closed

Freshwater Recreational Salmon Fisheries:

Baker River: (mouth to Hwy 20 Bridge)	7/1 – 7/31	2 fish limit, sockeye only, 12" min size.
Cascade River: (mouth to Rockport-Cascade Road Bridge)	9/16 – 11/30	4 fish limit, marked coho only, 12" min size.
Skagit River: (mouth to Memorial Hwy. Bridge (Hwy 536 at Mt. Vernon))	8/16 – 10/31	4 fish limit, no more than a total of 3 may be coho and no more than 2 may be chum; 12" min size, release chinook.
	11/1 – 12/31	2 fish limit, 12" min size, release chinook.
(From Memorial Hwy Bridge to Gilligan Creek)	8/16 – 10/31	4 fish limit, no more than a total of 3 may be coho and no more than 2 may be chum; 12" min size, release chinook.
	11/1 – 12/31	2 fish limit, 12" min size, release chinook.
(From Gilligan Creek to Dalles Bridge at Concrete)	9/16 – 10/31	4 fish limit, no more than a total of 3 may be coho and no more than 2 may be chum; 12" min size, release chinook. All Species – night closure and non-buoyant lure restriction 7/1-11/30.
	11/1 – 12/31	2 fish limit, 12" min size, release chinook. All Species – night closure and non-buoyant lure restriction through 11/30.

(From Dalles Bridge at Concrete to Cascade River)

7/1 – 7/31	2 sockeye only; 12" min size; open only downstream of a point 200' above the E bank of the Baker River. All Species-night closure and non-buoyant lure restriction 7/1-11/30. Closed Waters – between a line projected across the thread of the river 200'above the east bank of the Baker River and a line projected across the thread of the river 200' below the west bank of the Baker River 6/16-6/30 and 8/1-8/31.
9/16 – 10/31	4 fish limit, no more than a total of 3 may be coho and no more than 2 may be chum; 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction through 11/30.
11/1 – 12/31	2 fish limit, 12" min size, release chinook. All Species – night closure and non-buoyant lure restriction through 11/30.

All other <u>SKAGIT TERMINAL REGION freshwater</u>:
Closed to salmon angling.

STILLAGUAMISH/SNOHOMISH TERMINAL REGION

<u>Areas 8A Net</u>

Chinook	Trty:	Closed (Ceremonial set-aside of up to 100 chinook, July-September period)
	Ntrty:	Closed
Pink	Trty:	Wks 33 (wb 8/11)-Wk 36 (wb 9/1); max 3 days per week
	Ntrty:	Wk 34 (wb 8/17)-Wk 35(wb 8/24); PS release chinook, GN fish at night, PS/GN fishing pattern: 2,2.
Coho	Trty:	Wks 37 (wb 9/7)-Wk 42 (wb 10/12); 3 days per week.Update fishery weeks 37-40 Manage for CCMP breakpoints and rates.
	Test:	Wk 37 – wk 48; 1 day per week, 2 GN landings per week
	Ntrty:	Wks 41 (wb 10/5)-Wk 42 (wb 10/12); PS limited participation wk 41 (2 boats), PS release chinook, fishing pattern: 1,1; GN fish at night, GN fishing pattern: 1,3. Manage for CCMP breakpoints and rates.
Chum	Trty:	Wks 43 (wb 10/19) - Wk 48 (wb 11/23); 3 days per week; Manage for Stillaguamish and Snohomish harvest rates and minimum escapement goals based on in-season update.

	Ntrty:	Wks 43 (wb 10/19)-Wk 48 (wb 11/23); manage for Stillaguamish and Snohomish harvest rates and minimum escapement goals based on in-season update; PS release chinook; PS fishing pattern: 1,2,1,2,1,2, GN fishing pattern: 3,4,3,4,3,4
Steelhead	Trty:	Begins Wk 49 (wb 12/1); based on steelhead plan to be developed
	Ntrty:	Closed

Areas 8D Net

Chinook	Trty:	May, June ceremonial and subsistence fishery; Wk 27 (wb 6/29) - Wk 38 (wb 9/14); Open noon Monday thru 11:59 pm Thursday for GN, BS and RH gear, setnet gear may open outside of these times.
	Ntrty:	Closed
Coho	Trty:	Wk 39 (wb 9/21) - Wk 45 (wb 11/2); open to target Tulalip hatchery coho
	Ntrty:	Wks 39 (wb 9/21)-Wk 45 (wb 11/2); PS chinook release; PS fishing pattern: 1,1,1,1,1,2,1; GN fish at night; GN fishing pattern: 3,3,3,3,3,4,3. Open concurrent with Ntrty 8A during Wks 43-Wk. 45. Closed east of the line from Mission Point to Hermosa Point.
Chum	Trty:	Wk 46 (wb 11/9) - Wk 50 (wb 12/7); open to target Tulalip hatchery chum. Managed to allow for hatchery egg take needs based on Tulalip hatchery escapement updates and projections. All Area 8D fisheries will close concurrently as agreed to by regional co-managers to ensure egg take requirements are met.
	Ntrty:	Wks 46 (wb 11/9)-Wk 48 (wb 11/23); open to target Tulalip hatchery chum. PS fishing pattern: 2,1,2; GN fishing pattern: 4,3,4. Closed east of the line from Mission Point to Hermosa Point. Managed to allow for hatchery egg take needs based on Tulalip hatchery escapement updates and projections. All Area 8D fisheries will close concurrently as agreed to by regional co-managers to ensure egg take requirements are met.

Stillaguamish River Treaty Net (Ntrty Closed)

Chinook	Closed
Pink	Wks 33 (wb 8/10)-Wk 38 (wb 9/14); max 5 days per week
Coho	Open Wk 39 (wb 9/21) - Wk 43 (wb 10/19); max 5 days per week
Chum	Wks 44 (wb 10/26)-Wk 52 (wb 12/21); 5 days per week
Steelhead	To be determined

Snohomish River Treaty Net (Ntrty Closed)

Chinook, Pink, Coho, Chum	Closed
Coho Test	Closed

Area 8-2 Recreational

5/1-7/31	Closed
8/1-9/30	4 fish limit, no more than a total of 2 may be coho and chum, chinook release.
10/1-10/31	2 fish limit, chinook release.
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size).
12/1-2/13	Closed
2/14-4/10	1 fish limit, (chinook 22" min size).
4/11-4/30	Closed

Tulalip Special Area Recreational Fishery

Same as Area 8-2 Recreational, except during the period 7/4-9/29:

7/4-9/29	Open 12:01 AM Friday – 11:59 AM Monday each week. Open within Tulalip Special Area boundaries only. Closed east of the line from Mission Point to Hermosa Point. 2 fish limit, (chinook 22" min. size).

Freshwater Recreational Salmon Fisheries:

Snohomish River: (mouth to confluence of Skykomish and Snoqualmie rivers, including all channels)	8/16 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction 8/1-11/30.
Snoqualmie River: (mouth to Snoqaulie Falls, including all channels)	9/1 – 12/31	2 fish limit, 12" min size, release chinook and pink. All Species- selective gear rules 6/1-11/30, except motors allowed; night closure 9/1-11/30.
Skykomish River: (From mouth to Lewis St. Bridge in Monroe	9/1 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size, release chinook. Fishing from any floating device prohibited 11/1-2/29 from the boat ramp below Lewis Street Bridge at Monroe to 2500' downstream. All species - night closure and non-buoyant lure restriction 8/1-11/30.
(From Lewis St. Bridge in Monroe to Wallace River)	6/1 – 7/31	1 fish limit, 12" min size, marked chinook only. All species - night closure and non-buoyant lure restriction 6/1-11/30. Managed for hatchery broodstock. Evaluation by co-managers by June 30, about possibility of earlier fishery closure.

	9/1 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size, release chinook. All species - night closure and non-buoyant lure restriction through 11/30.
(From Wallace River to the forks)	9/1 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size, release chinook. All species – night closure and non-buoyant lure restriction 8/1–11/30. Closed Waters – from 1500' upstream to 1000' downstream of Reiter Ponds outlet 6/1 to 8:00 a.m. 8/1 and within this 2,500' section, fishing from any floating device within this area prohibited 8:00 a.m. 8/1-3/31.

Wallace River:

(mouth to 200' upstream of water intake of salmon hatchery)

	9/1 – 11/30	2 fish limit, coho only, 12" min size.

Stillaguamish River:

(river and all sloughs downstream of Warm Beach-Stanwood Hwy)

	9/1 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction 8/1-11/30.

(Warm Beach-Stanwood Hwy upstream to forks)

	9/1 – 12/31	4 fish limit, no more than a total of 2 may be coho and chum, 12" min size. All Species-night closure 8/1-11/30 and selective gear rules except motors allowed 6/1-11/30. Closed Waters – from water control structure/barrier dam (downstream of I –5) 200'downstream.

All other <u>STILLAGUAMISH/SNOHOMISH TERMINAL REGION freshwater</u>:
Closed to salmon angling.

ADMIRALTY INLET AREA

<u>Area 9 Net</u> Closed

Area 9 Recreational

5/1-7/15	Closed
7/16-7/31	2 fish limit, chinook and chum release.
8/1-8/31	4 fish limit, no more than 2 may be coho, chinook and chum release.
9/1-9/30	2 fish limit, chinook and chum release.
10/1-10/31	2 fish limit, chinook release.
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size)
12/1-1/31	Closed
2/1-4/15	1 fish limit, (chinook 22" min size)
4/16-4/30	Closed

Edmonds Pier Recreational

Year-round 2 fish limit, 1 chinook (22" min size), release chum 8/1-9/30.

Hood Canal Bridge Recreational

Year-round 2 fish limit, 1 chinook (22" min. size), release chum 8/1-10/15, release chinook 7/1-8/31.

SOUTH SOUND REGION

Area 10 Net

Chinook Closed

Sockeye
- Trty: Fishery dependent upon ISU (Ballard lock counts)
- Ntrty: Closed

Coho
- Test: Gillnet: Wks 37 (wb 9/8)-Wk 39 (wb 9/22); 3 boats, 3 sites; fishing pattern: 2,2,2
- Trty: Closed, unless ISU indicates harvestable abundance. Quota based on tiered sharing formula, Wks 37(wb 9/8)-Wk 41(wb 10/6).
- Ntrty: Closed

Chum
- Test: Purse Seine: Wks 41 (wb 10/6)-Wk 45 (wb 11/3); 1 site, fishing pattern: 1,1,1,1,1
- Trty: Quota based on tiered sharing formula; Wks 42 (wb 10/13)-Wk 48 (wb 11/24) fishing pattern – ISU dependent.
- Ntrty: Wks 42 (wb 10/12)-Wk 46 (wb 11/9); PS chinook and coho NR; PS fishing pattern: 1,1,1,1,1; GN fishing pattern: 3,3,3,3,3. ISU Dependent.

Area 10A Treaty Net (Ntrty Closed)

Chinook	Test: Gillnet: 7/16, 7/23, 7/30; 5 sites (Wednesday nights, if possible). Wk 32 – 33; 1 day/wk. Reference terminal management plan.
Coho	Wks 37 (wb 9/7)-Wk 44 (wb 10/26); fishing pattern: 5 days/wk
Chum	Wks 45 (wb 11/2)-Wk 49 (wb 11/30); fishing pattern to be determined.
Steelhead	Wks 50 (wb 12/7)-Wk 52 (wb 12/21); evaluation fishery for ISU; fishing pattern: 3,3,3

Area 10E Treaty Net (Ntrty Net Closed)

Chinook	Wks 30 (wb 7/20)-Wk 38 (wb 9/14); fishing pattern: 7days/wk. Possible extension for Sinclair Inlet
Coho	On-Reservation only; Wks 38 (wb 9/14)-Wk 43 (wb 10/19); setnet/beach seine; 7 days/wk.
Chum	Wks 43 (wb 10/19)-Wk 48 (wb 11/23); schedule dependent upon ISU

Duwamish/Green River (Area 80B) Treaty Net (Ntrty Closed)

Chinook	Wk 32 – 33; 1 day/wk. Reference terminal management plan.
Coho	Closed until chinook clear or coho predominate. Clearance fishery on lower river (up to 16th Avenue Bridge) begins 9/11; 6 sites; upper river begins 9/18; 3 sites. Open 5 days/wk after chinook clearance.
Chum	Wks 46 (wb 11/9-Wk 49 (wb 11/30); fishing pattern to be determined.
Steelhead	Wks 50 (wb 12/7)-Wk 52 (wb 12/21); evaluation fishery for ISU, fishing pattern: 3,3,3

Lake Washington System (includes lake, ship canal, & Lake Sammamish)
Areas 10F, 10G, 10C, 10D Treaty Net (Ntrty Closed)

Sockeye	Dependent upon ISU (lock counts)
Chinook	10F, 10C & 10G closed; 10D will be based on ISU (lock counts)
Coho	The coho fisheries in the four following areas are dependent upon the ISU (if lock counts project run size < 10,000 coho entering the lake, then no coho fishery): Lower ship canal (below Ballard Locks): Closed until chinook clearance as seen in lock counts; anticipated pattern 3 days/wk. Upper ship canal (above Ballard Locks): Species composition test fishery in mid September, 3 sites, or chinook clearance as seen in lock counts, radio tag data may also be used for chinook clearance. North end Lake Washington (North of Hwy. 520 bridge): Species composition test fishery in mid-September (7 sites) or limited commercial fishery. Lake Sammamish: Chinook and Coho fisheries will be based on ISU from the Ballard Lock counts.

Area 10 Recreational

5/1-6/15	Closed
6/16-6/30	Catch-and-release in waters N of Meadow Pt./Pt. Monroe line. Unlawful to bring salmon into the boat.
7/1-10/31	2 fish limit, chinook release, release chum 8/1-9/15; Shilshole Bay (East of Meadow Point/West Point line) closed 7/1-8/31; Outer Elliott Bay (E of West Pt./Alki Pt line

	to Pier 91/Duwamish Head line) closed to salmon angling 7/1-8/31; Inner Elliott Bay (E of Pier 91/Duwamish Head line) closed to salmon angling 7/1-8/31 except for indicated openings identified in "Elliott Bay Recreational" section below and Elliott Bay fishing piers open. Special gear restrictions in Duwamish Waterways area when open. See "Sinclair Inlet Recreational" section below for chinook retention fishery.
11/1-11/30	2 fish limit, 1 chinook (chinook 22" min size)
12/1-12/15	Closed
12/16-2/29	1 fish limit, (chinook 22" min size); Agate Pass closure beginning 1/1.
3/1-4/30	Closed

Elliott Bay Recreational

7/11-8/17	Open E of Pier 91/Duwamish Head line, weekly 12:01 a.m. Friday – 11:59 p.m. Sunday, 7/11–8/17, 2 fish limit, (chinook 22" min size), release chum beginning 8/1. Special gear restrictions in Duwamish Waterways area when open.
8/18-8/31	Closed
9/1-4/30	Same as Area 10.

Sinclair Inlet Recreational

7/1-9/30	Open S of Manette Bridge, S of line drawn true W from Battle Point, and W of line drawn true S from Point White; 2 fish limit, (chinook 22" min size), release chum 8/1-9/15.

5/1-6/30 and 10/1-4/30 same regulations as Area 10.

Area 10 Piers Recreational; Seacrest Pier, Pier 86, Waterman Pier, Bremerton Boardwalk, Illahee State Park Pier

Year-round	2 fish limit, 1 chinook (22" min size), release chum 8/1-9/15

Area 10 Freshwater Recreational Salmon Fisheries:

Green River:

(1st Avenue Bridge to S.W. 43rd St./ S. 180th St Bridge)

9/16 – 12/31	6 fish/2 adult limit, 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction Sept. 16-Nov. 30. Fishing from any floating device prohibited 11/1-2/29.

(S.W. 43rd St./ S. 180th St Bridge to the S. 277th Bridge in Auburn)

10/1 – 12/31	6 fish/2 adult limit, 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction 10/1-11/30. Fishing from any floating device prohibited 11/1-2/29.

(S. 277th Bridge to Auburn-Black Diamond Rd Bridge)

	10/16 – 12/31	6 fish/2 adult limit, 12" min size, release chinook. All Species-night closure and non-buoyant lure restriction 10/16-11/30. Fishing from any floating device prohibited 11/1-3/15.

(from Auburn-Black Diamond Rd Bridge to Tacoma Headworks Dam)

	11/1 – 12/31	2 fish limit, 12" min size, chum only. All Species-night closure and non-buoyant lure restriction 8/1-11/30. Closed Waters- within 150' of the Palmer Ponds outlet rack and within 150' of the mouth of Keta (Crisp) Creek.
Soos Creek: (mouth to bridge near hatchery residence)	10/11 – 11/2	2 fish limit, 12" min size, coho only. Juvenile anglers (under 15 years old) only, 1 single hook; night closure through 10/31.
Lake Washington: (North of Hwy 520 Bridge and East of the Montlake Bridge)	9/16 – 10/31	2 fish limit, coho only, 12" min size.
Lake Sammamish:	8/16 – 11/30	2 fish limit, 12" min size, release sockeye. Closed: waters within 100 yards of the mouth of Issaquah Creek are closed to salmon fishing.

All other SOUTH SOUND AREA 10 REGION freshwater:
Closed to salmon angling.

Area 11 Net

Chinook Closed

Coho Trty: Commercial fishery open beginning Wk 37 (wb 9/7); ISU dependent; gillnets 7 nights/wk. Could close any time.

Ntrty: Closed

Chum Trty: Commercial fishery open Wks 42 (wb 10/12)-Wk 46 (wb 11/15); gillnets 7 nights/wk, could close at anytime.

Ntrty: Wks 42 (wb 10/12)-Wk 46 (wb 11/9); PS chinook and coho NR; PS fishing pattern: 1,1,1,1,1; GN fishing pattern: 3,3,3,3,3. ISU Dependent.

Area 11A Net Treaty Net (Ntrty Closed)

Chinook and Chum	Closed
Coho	Commercial fishery open Wks 36 (wb 8/31)-Wk 45 (wb 11/8); 3 nights/wk

Puyallup River (Area 81B) Treaty Net (Ntrty Closed)

Chinook	Test Fishery: Wks 30 (wb 7/20)-Wk 34 (wb 8/23); 1 day/wk, drift net only. Commercial fishery begin Wks 33 (wb 8/10)-Wk 35 (wb 8/30); fishing pattern: 1,1,1
Coho	Commercial fishery begin Wks 36 (wb 8/31)-Wk 42 (wb 10/18); fishing pattern: 2,3 ,3,4,4,4,4.
Chum	Test fishery Wks 43 (wb 10/19)-Wk 46 (wb 11/165); 1 day/wk, drift net only.
Winter Chum	Commercial fishery begin Wks 47 (wb 11/16) – Wk 53 (wb 12/31), no more than 24 total days.
Steelhead	Incidental to chum fishery – see chum schedule.

White River (Treaty)

Sp Chinook	Traditional fish drive. Ceremonial and subsistence fishery.
Coho/Chum	Begin 9/1, traditional fish drive; ceremonial and subsistence fishery. No directed commercial fishery.
Steelhead	Ceremonial and subsistence fishery.

Area 11 Recreational

5/1-5/31	Closed
6/1-10/31	2 fish limit, (chinook 22" min size); Commencement Bay (E of Cliff House Restaurant/Sperry Dock line) closed to salmon fishing through 7/31.
11/1-12/31	2 fish limit, 1 chinook (chinook 22" min size)
1/1-2/13	Closed
2/14-4/10	1 fish limit (chinook 22" min size)
4/11-4/30	Closed

Dash Point Dock, Point Defiance Boathouse Dock, Les Davis Pier, Des Moines Pier and Redondo Pier

Year-round	2 fish limit; 1 chinook (22" min size)

Area 11 Freshwater Recreational Salmon Fisheries:

Carbon River: (mouth to Voight Creek)	9/1 – 11/30	6 fish/4 adult, no more than 2 adults may be marked chinook; 12" min size, release unmarked chinook, and release chum. All Species night closure, non-buoyant lure restriction, and single point barbless hooks 8/1-11/30.
Puyallup River: (from 11th St. Bridge to Carbon River)	8/1 – 12/31	6 fish/2 adult limit, 12" min size.

All other SOUTH SOUND AREA 11 REGION freshwater:
Closed to salmon angling.

Fox Island/Ketron Island (Area 13) Treaty Net [1] (Ntrty Closed)

Chinook	8/1-9/15, 7 days/wk
Coho	9/16-10/20, 7 days/wk
Chum	Closed unless opened by Medicine Creek Treaty tribes' agreement

Sequalitchew (Area 13) Treaty Net (Ntrty Closed)

Chinook and Chum	Closed
Coho	Wks 39 (wb 9/21)-Wk 42 (wb 10/12); 4 days/wk

Carr Inlet (Area 13A) Treaty Net [1] (Ntrty Closed)

Chinook	8/1-9/15, 7 days/wk, open in sections
Coho	9/16-10/27, in-season monitoring to meet hatchery escapement need
Chum	10/28-12/8, 7 days/wk

Chambers Bay (Area 13C) Treaty Net [1] (Ntrty Closed)

Chinook	Wks 31 (wb 7/27)-Wk 41 (wb 10/5); 7 inch mesh for set-nets; 5 days/wk
Coho	Wks 42 (wb 10/12)-Wk 44 (wb 10/26); 2 days/wk; schedule not to exceed one day per week per gear type (alternating beach seine and set net)
Chum	Wks 45 (wb 11/2)-Wk 48 (wb 11/23); 5 days/wk

Area 13D Treaty Net (Ntrty Closed)

Chinook	8/1-9/10 or earlier date dependent on in-season management needs; 7 days/wk
Coho	9/10-12/31 or earlier date dependent on in-season management needs:

Peale Pass (13D-3) - 7 days/wk
Pickering Pass (13D-2) - 7 days/wk
Dana Pass (13D-1) - 7 days/wk
Southern Case (13D-4) - 7 days/wk

Chum	Open approximately 10/27; 2-3 days per week; managed weekly by updates (~10/11)

Area 13E Net Closed to all fishing

Budd Inlet (Area 13F) Treaty Net (Ntrty Closed)

Chinook	7/15-9/10 or earlier date dependent on in-season management needs; 7 days/wk
Coho	9/10-11/9 or earlier date dependent on in-season management needs; 7 days/wk
Chum	Open approximately 11/1, 2-3 days per week, managed by weekly in-season updates

[1] Based on Medicine Creek Treaty tribal proposal annual regulations. Individual tribal regulations may deviate from this schedule.

Eld Inlet (Area 13G) Treaty Net (Ntrty Closed)

Chinook	8/1-9/10; opening dependent upon in-season data, outer portion only
Coho	Closed
Chum	Open approximately 11/1, 2-3 days per week, managed by weekly escapement updates

Totten Inlet (Area 13H) Treaty Net (Ntrty Closed)

Chinook	8/1-9/10; schedule dependent on in-season data
Coho	Closed
Chum	Open approximately 10/10, 2-3 days per week; managed by weekly escapement updates

Little Skookum Inlet (Area 13I) Treaty Net (Ntrty Closed)

Chinook	8/1-9/10; schedule dependent upon in-season data
Coho	Closed
Chum	Open approximately 12/1, 2-3 days per week; managed by weekly escapement updates

Hammersley Inlet (Area 13J) Treaty Net (Ntrty Closed)

Chinook	8/1-9/10 or earlier date dependent on in-season management needs
Coho	Closed
Chum	Open approximately, 9/18-12/25, 2-3 days/wk; managed by weekly escapement updates

Northern Case Inlet (Area 13K) Treaty Net (Ntrty Closed)

Chinook	8/1-9/10
Coho	9/10-12/31 or earlier date dependent on in-season management needs
Chum	Open approximately 9/18-12/25; 2-3 days/wk; managed by weekly escapement updates

Nisqually River (Area 83D) Treaty Net (Ntrty Closed)

Chinook/Pink	Wks 27 (wb 6/29)-Wk 39 (wb 9/21); 3 days/wk; The Nisqually Indian Tribe will manage the Nisqually River chinook run to attain an 1,100 naturally spawning escapement goal. This will be achieved by running an in-season update and adjusting the fishing schedule accordingly.
Coho	Wks 40 (wb 9/28)-Wk 47 (wb 11/16); 3-4 days/wk
Chum	Wks 48 (wb 11/23)-Wk 5 (wb 2/1); 4 days/wk

McAllister Creek (Area 83F) Treaty Net (Ntrty Closed)

Chinook/Pink	Wks 27 (wb 6/29)-Wk 40 (wb 9/28); 3 days/wk
Coho	Wks 41 (wb 10/5)-Wk 48 (wb 11/23); 3-4 days/wk
Chum	Wks 49 (wb 11/30)-Wk 5 (wb 2/1); 4 days/wk

Area 13 Recreational

5/1-5/31	2 fish limit, 1 chinook (chinook 2" min size). Carr Inlet (N of Penrose Pt./Green Pt. line) closed.
6/1-6/30	Closed
7/1-10/31	2 fish limit, chinook 22" min size; release unmarked coho 7/1-10/31; Carr Inlet (N of Penrose Pt./Green Pt. Line) closed 7/1-7/31,except open to fly-fishing-only for marked hatchery coho; Minter Creek mouth closed through 9/30; Lower Budd Inlet closure zone 7/16-10/31
11/1-12/31	2 fish limit, 1 chinook (chinook 22" min size)
1/1-4/30	1 fish limit, (chinook 22" min size). Carr Inlet (N of Penrose Pt./Green Pt. line) closed 4/16-4/30.

Fox Island Pier Recreational

Year-round	2 fish limit, 1 chinook (22" min size); release unmarked coho 7/1-10/31

Area 13 Freshwater Recreational Salmon Fisheries:

Chambers Creek Estuary:		
(downstream of markers 400' below Boise-Cascade Dam to Burlington Northern Railroad Bridge)	7/1 – 11/15	6 fish/2 adult limit, 12" min size, release unmarked coho.
Deschutes River:		
(from Old Hwy 99 Bridge on Capitol Blvd in Tumwater to Henderson Blvd Bridge)	7/1 – 11/30	6 fish/2 adults limit, 12" min size, release coho.
(upstream of Henderson Blvd Bridge)	7/1 – 11/30	6 fish/2 adults limit, 12" min size, release coho, selective gear rules.
Kennedy Creek:		
(mouth to northbound Hwy. 101 Bridge)	10/1 – 11/30	6 fish/2 adults limit, 12" min size, release coho, barbless hooks required. Night closure and non-buoyant lure restriction 10/1-12/31.
McAllister Creek:		
(mouth to Olympia-Steilacoom Rd Bridge)	7/1 – 11/30	6 fish/4 adult limit, 12" min size.
McClane Creek:		
(from a line 50' north of and parallel to the Mud Bay Rd. Bridge to a line 100' upstream of and parallel to the south bridge on Hwy.101)	7/1 – 11/30	6 fish/2 adults limit, 12" min size, release coho.
Minter Creek:		
(mouth to hatchery rack)	11/1 – 12/31	4 fish limit, 12" min size, chum only.

Nisqually River:
(mouth to the military tank crossing bridge, one mile upstream of the mouth of Muck Creek)
7/1 –1/31 6 fish/2 adults limit, 12" min. size.

All other SOUTH SOUND AREA 13 REGION freshwater:
Closed to salmon angling.

HOOD CANAL REGION

Hood Canal Mainstem (Areas 12, 12B, 12C, 12D)
Treaty: 1,000 feet closure around streams which are closed to net fishing. Beach seines and hook and line gear release chum through 9/30 (through 10/10 if within 500' of western shore of Areas 12B and 12C).
Nontreaty: See WAC 220-47-307 for Nontreaty exclusion zones.

Chinook:
Trty: Areas 12, 12B and 12D: Closed
Area 12C: Open wb 7/20; through wb 8/17 no more than 5 days/wk. Gillnets restricted to 7" min mesh starting 8/1.
Area 12H: Open wb 7/27 through wb 9/21; hook and line gear continuous; beach seines daylight hours Tues and Thur each week; possible in-season modifications; chum release.
Ntrty: Closed

Pink See 12H above

Coho Trty: Area 12: Open wb 9/21 through wb 10/12; gillnets may open no earlier than 9/25; beach seines for coho only (release all chinook and chum through 9/30) may start no earlier than 9/18.
Area 12B: Open wb 9/28 through wb 10/19; gillnets may open no earlier than 10/1; 500 foot closure along western shore through 10/10; beach seines for coho only (release all chinook and chum through 9/30) may start no earlier than 9/23.
Area 12C: Open wb 9/28 through wb 10/19; no more than 4 days/wk through wb 10/12 (possible in-season adjustments); gillnets may open no earlier than 10/1, with 500 foot beach closure from Ayock Pt. to approx. 2,000 feet south of Lilliwaup (at the large house, north of Octopus Hole) through 10/10; beach seines for coho (release all chum through 9/30) may start no earlier than 9/23.

Area 12D (west of Madrona Pt. - local name): Open wb 9/28 through wb 10/19; gillnets may open no earlier than 10/1. Weekly schedules identical to Area 12C.

Ntrty: Closed

Chum Trty: Area 12: Open wb 10/19 through wb 11/16, but no later than 11/20.
Areas 12B – 12C: Open wb 10/26 through wb 11/23, but no later than 11/27.

Area 12D: Closed.

Area 12H: Hook and line gear open from wb 10/26 through wb 11/30; beach seines open Tuesday and Thursday of each week (except Tue.-Wed. in wb 11/23), given hatchery escapement control measures; potential additional fishing days pending discussions with WDFW.

Ntrty: Area 12-12B: Open Wks 43 (wb 10/19) through wk 47 (wb 11/16), but no later than 11/20; PS release chinook; PS fishing pattern: 1,2,1,1,0; GN fishing pattern: 3,3,3,3,3-two of three days each week restricted to north of Quatsap Point.

Area 12C : Open Wks 46 (wb 11/9) through wk 48 (wb 11/23) purse seine release chinook; PS fishing pattern: 1,1,1; GN fishing pattern: 1,1,1; potential additional GN days pending discussion with PNPTC and Skokomish Tribe; BS (Hoodsport Hatchery Zone) fishery in wks 46-48 pending discussions with PNPTC and Skokomish Tribe.

Area 12D: Closed

Port Gamble (Area 9A)

Chinook		Closed
Coho	Trty:	Open wb 8/24 through wb 10/26, gillnet only.
	Test:	Open wb 8/3 through wb 9/21, gillnet only.
	Ntrty:	Open Wks 35 (wb 8/24) through wk 43 (wb 10/19); GN only; 2 days wk 35, then 7 days/wk; release chinook; release chum through 9/30; release fish not to be retained by cutting ensnaring meshes; logbooks required.
Chum	Trty:	Open wb 11/2 through wb 11/30.
	Ntrty:	Closed
Steelhead	Trty:	Open wb 12/7 through wb 1/25.

Quilcene/Dabob (Area 12A)

Coho	Trty:	Open wb 8/24 through wb 10/5; chum and chinook release from hook and line and beach seine gear through 9/30; beach seines 5 days/wk daylight hours; hook and line open continuous; gillnets closed before 9/1 and limited to 1 day/wk 9/1 through 9/30. Gillnets will close if 12A summer chum escapement projected <1,500. Additional gillnet time may be added between 9/16 and 9/30 if coho harvest needs require it and 12A summer chum escapement projected >2,500. Beach seines prohibited, along the shore from the mouth of Little Quilcene River to Point Whitney.
Ntrty:		Open Wks 35 (wb 8/24) through wk 40 (wb 9/28); BS gear only; 5 days/wk (M-F) 7 am–7 pm; chinook and chum release. Beach seines prohibited, along the shore from the mouth of Little Quilcene River to Point Whitney.
Chum	Trty:	To be determined in-season.
	Ntrty:	Closed

Skokomish River (Area 82G) Treaty (Ntrty Closed)

Note: Hook and line gear and beach seines release chum through 10/15.

Chinook	Open wb 8/3 through wb 9/14; no more than 4 days/wk; closed to gillnets below SR 106.
Coho	Open wb 9/21 through wb 11/9; no more than 4 days/wk, through wb 10/26, (possible inseason modifications); closed to gillnets below SR 106 through 9/30.
Chum	Open wb 11/16 through wb 11/30.

Big Quilcene River (Area 82F) Treaty (Ntrty Closed)

Coho	Openings to be determined in-season, for coho only, as necessary, from wb 9/7 through wb 9/28; from U.S. Hwy 101 to the Quilcene Hatchery rack, hand held gear only (dipnets, hand lines, etc.)
Chum	Closed

Dosewallips R., Duckabush R., Hamma Hamma R., Union R. Closed

Tahuya R., Dewatto R. Treaty (Ntrty Closed) Closed

Area 12 Recreational

ENTIRE AREA

5/1-6/30	Closed
7/1-8/31	North of Ayock Pt. – Closed except see Quilcene/Dabob Bay Recreational below.
9/1-10/15	North of Ayock Pt. – 4 fish limit, coho only.
7/1-10/15	South of Ayock Pt. - 4 fish limit, 2 chinook (chinook 22" min size); release chum.

ENTIRE AREA

10/16-12/31	4 fish limit, 1 chinook (chinook 22" min size).
1/1-2/13	Closed
2/14-4/10	1 fish limit (chinook 22" min size).
4/11-4/30	Closed

Hood Canal Bridge Recreational

Year-round	2 fish limit, 1 chinook (22" min. size), release chum 8/1-10/15.release chinook 7/1-8/31

Quilcene/Dabob Bay Recreational

5/1-8/15	Closed
8/16-10/15	4 fish limit, coho only.
10/16-12/31	4 fish limit, 1 chinook (22" min size).
1/1-2/13	Closed
2/14-4/10	1 fish limit (chinook 22" min size).
4/11-4/30	Closed

Hoodsport Hatchery Zone Recreational

Same as Area 12 except:

7/1-12/31	4 fish limit, only 2 chinook greater than 24"; chum release 7/1-10/15; night closure.

Hood Canal Freshwater Recreational Salmon Fisheries:

Dewatto River: (mouth to Dewatto-Holly Rd. Bridge)	9/16 – 10/31	2 fish limit, 12" min size, coho only. Single point barbless hooks required.
Dosewallips River: (mouth to Hwy. 101 Bridge)	11/1 – 12/15	2 fish limit, 12" min size, chum only
Duckabush River: (mouth to Mason Co. PUD #1 overhead electrical distribution line)	11/1 – 12/15	2 fish limit, 12" min size, chum only
Quilcene River: (from Rodgers St. to Hwy 101 Bridge)	8/16 – 10/31	4 fish, 12" min size, coho only, selective gear rules and night closure.
Skokomish River: (mouth to Hwy. 101 Bridge)	8/1 – 9/30	1 fish limit, 12" min size, release chum. All Species-night closure, non-buoyant lure restriction, and single point barbless hooks required 8/1-11/30.
	10/1 – 10/15	6 fish/4 adult, only 1 of which may be an adult chinook, 12" min size, release chum. All Species-night closure, non-buoyant lure restriction, and single point barbless hooks required through 11/30.
	10/16 – 12/15	6 fish/4 adult, only 1 of which may be an adult chinook, 12" min size. All Species-night closure, non-buoyant lure restriction, and single point barbless hooks required through 11/30.
Tahuya River: (mouth to marker 1 mile above N. Shore Rd. Bridge)	9/16 – 10/31	2 fish limit, 12" min size, coho only. Single point barbless hooks required.

All other <u>HOOD CANAL REGION freshwater</u>:

Closed to salmon angling.

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CARR INLET

Management periods (Carr Inlet, Area 13A):

Spring chinook	April 13 – August 9
Summer/fall chinook	August 10 – September 15
Coho	September 16 – October 25
Chum	October 26 – December 6

Gear types:

Marine drift gill nets - 1,800' maximum length, minimum 5" mesh size. Each drift gill net shall be buoyed at the outer end with a buoy not less than 20" in diameter; each buoy must be lit and marked in letters no less than 1" in height with owner's full name and Tribe name. No drift gill net shall be left unattended.

Marine set gill nets - 900' maximum length, minimum 5" mesh size.
Marine set nets shall be tended not less than once every 24 hours. Each end not attached to shore must be marked with a floating buoy not less than 20" in diameter; each buoy must be lit and marked in letters no less than 1" in height with owner's full name and Tribe name. All set nets must be attached to the shore or anchored. No set net may extend more than 100' directly offshore (east) of the outermost oyster stakes at the mouth of Minter Bay.

Beach seines - 900' maximum length, with 3" minimum and 4" maximum mesh size.

Any gear not listed above is illegal.

Fishing violations:

The following actions may be subject to penalties and/or fines, in accordance with tribal fishing ordinances adopted by the Medicine Creek Treaty tribes.

- Wantonly wasting or destroying food fish;
- Disposing of litter into the water or onto the shore while participating in the in-common fisheries of the Medicine Creek Treaty Tribes.

Fishing areas:

Carr Inlet (13A) - all marine waters north of a line projected from Green Point on the east shoreline of Carr Inlet to Penrose Point (Signal Tower No. 4) on the Longbranch Peninsula and south of the state highway 302 bridge and causeway, excluding the waters of Minter Bay, described below.

Upper Carr Inlet- those waters of Carr Inlet, north of a line from Allen Point to the southernmost point of land on the eastern shore of Glenn Cove.

Middle/Lower Carr Inlet- those waters of Carr Inlet, south of a line from Allen Point to the southernmost point of land on the eastern shore of Glenn Cove.

Burley Lagoon - those marine waters north of the state highway 302 bridge and causeway are closed to all fishing gear unless specifically opened by regulation.

Minter Bay - those marine waters inside (westerly) of the outermost oyster stakes at the mouth of Minter Bay, and outside (easterly) of the road bridge at the upper end of the bay. No net may extend more than one half of the way across the boat channel in Minter Bay to allow efficient movement of oyster boat traffic in and out of Minter Bay.

During the summer/fall chinook management period, the area within a 1,000' radius offshore of (and including) the outermost oyster stakes at the mouth of Minter Bay, including Minter Bay, shall be closed to all fishing. No nets shall be tied off to the poles of the oyster stakes.

During the coho management period, modification to the Minter Creek closure will be made according to in-season information. If modified, the 1,000' Minter Creek closure will include only those waters within and including the outermost oyster stakes at the mouth of Minter Creek, including Minter Bay. No nets shall be tied off to the poles of the oyster stakes.

During the normal chum management period, those waters within and including the outermost oyster stakes at the mouth of Minter Creek, including Minter Bay will remain closed. No nets shall be tied off to the poles of the oyster stakes.

Glen Cove - During the normal chum management period, all waters within a 100 yard radius of the mouth of Glen Cove and all waters west of a line projecting north from the Thompson Spit to the opposite shore are closed to all fishing to protect naturally spawning chum salmon.

Lay Inlet - All waters east of the access bridge (between the mainland and Raft Island) on the south side of Raft Island, and east of a line on the north side of Raft Island running from the westerly-most large dock on Raft Island (below the large white house with the multi-terraced yard) northerly to the multi-platform stairway at the east end of the rock bulkhead, are closed to all fishing.

Weekly fishing schedule:

Spring chinook
CLOSED for conservation purposes.

Summer/fall chinook
All gears: OPEN ***7 days per week, 24 hours per day beginning at 12:00 noon on the dates specified below.*** **CLOSED** ***effective 12:00 noon, September 15.*** In 2003, the Medicine Creek Tribes propose to coordinate the management of the Carr Inlet (Area 13A) fall chinook fishery by filing joint regulations that are in accordance with this preseason fishery management plan. Lower and middle Carr Inlet shall open **August 1, 2003** for drift and set gill nets, and beach seines. The upper portion of Carr Inlet shall open **August 11, 2003**. The waters within a 1000' radius of the mouth of Minter Creek, including Minter Bay, shall be closed until September 16, the beginning of the coho management period. The Lay Inlet and

Burley Lagoon closures will be in effect throughout summer/fall chinook management period. Harvest will be regulated with escapement needs prevailing.

Coho

All gears: OPEN *7 days per week, 24 hours per day beginning 12:00 noon, September 16*. CLOSED *effective 12:00 noon, October 27. Burley Lagoon may open on, or after, October 10 at 12:00 noon for harvest of coho milling in the area.* Any openings of Burley Lagoon will be of limited duration and structured to facilitate sampling. Any beach seine opening in the Burley Lagoon area will be a day light hours selective coho fishery only. Beach seines fishing the Burley Lagoon area are required to release chinook, chum and all non-adipose-clipped coho. Minter Bay may be opened on an occasional basis for harvest of coho. When open, the fishery will be limited to set nets only, with a 100' maximum length. The Lay Inlet closure will remain in effect throughout coho management. Harvest will be regulated in-season with hatchery escapement needs prevailing.

Normal chum

All gears: OPEN *7 days per week, 24 hours per day, beginning 12:00 noon, October 28*. CLOSED *effective 12:00 noon, December 8 unless otherwise agreed.* The Glen Cove closure will be used, and Burley Lagoon will close during the chum management period to protect native chum spawning locally. The Lay Inlet closure will remain in effect through chum management.

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FOX ISLAND PENS FISHING AREA

Management periods (Fox Island, Area 13):

Spring chinook	April 13 – June 28
Summer/fall chinook	June 29 – September 20
Coho	September 21 – October 18
Normal chum	October 12 – November 29
Late chum	November 30 – January 18

Gear types:

Marine drift gill nets - 1,800' maximum length, minimum 5" mesh size. Each drift gill net shall be buoyed at the outer end with a buoy not less than 20" in diameter; each buoy must be lit and marked in letters no less than 1" in height with owner's full name and tribal name. No drift gill net shall be left unattended.

Marine set gill nets - 900' maximum length, minimum 5" mesh size. Marine set nets shall be tended not less than once every 24 hours. Each end not attached to shore must be marked with a floating buoy not less than 20" in diameter; each buoy must be lit and marked in letters no less than 1" in height with owner's full name and tribal name. All set nets must be attached to the shore or anchored.

Beach seines - 900’ maximum length, with a 3" minimum and a 4" maximum mesh size.

Fishing areas:

Fox Island Pens Fishing Area - all marine waters of Hale Passage and Wollochet Bay inside and northerly of a line drawn from the old ferry dock to the point on the opposite shore at the southern and easterly entrance to Wollochet Bay and south of the Fox Island Bridge.

Weekly fishing schedule:

NOTE: The agreed to coho and chinook fishing schedules have been made consistent with those in the Carr Inlet Fishing Area for management, enforcement and catch sampling reasons.

Spring chinook
CLOSED for conservation purposes.

Summer/fall chinook
All gears: OPEN *7 days/week, 24 hrs/day, beginning at noon, August 1*. CLOSED as of 12:00 noon September 15.

Coho
All gears: OPEN *7 days/week, 24 hrs/day, beginning at noon, September 16*. CLOSED as of 12:00 noon October 20 to protect naturally spawning chum in deep South Puget Sound (Areas 13A-K).

Normal/late chum
CLOSED.

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CHAMBER'S BAY FISHING AREA

Management periods (Chamber's Bay, Area 13C):

Summer/fall chinook	July 13 – October 11
Coho	October 12 – November 29
Normal chum	October 12 – November 29
Late chum	November 30 – January 18

Gear types:

Beach seines **-** 900' maximum length, with a 3" minimum and a 4" maximum mesh size.

Fishing area:

Chambers Bay (13C) - all waters easterly of a line 100' east of the railroad trestle at the mouth of Chambers Bay to within 400 feet of the dam and causeway.

Weekly fishing schedule:

Summer/fall chinook
Beginning ***July 27:***
Beach seines: **OPEN 3** ***days per week, from 6:00 a.m. Sundays to 6:00 a.m., Wednesday.***
Ending: ***October 11.***
The preseason forecast will be used to determine the harvestable number. In September, the managers will discuss the status of the escapement to determine whether modification of the fishing schedule and/or the harvestable number is warranted. If no revision to the fishing schedule is made, the area will close when the harvestable number has been reached, and will re-open when escapement needs have been satisfied, or when the chinook management period has ended.

Coho
Beginning ***October 12:***
Beach seines: **OPEN 2** ***days per week, from 6:00 a.m. Sundays to 6:00 a.m., Tuesdays.***
Ending: ***November 1.***
NOTE: The above schedule may change, to ensure fishable conditions.

Normal chum
Beginning ***November 2:***
Beach seines: **OPEN 3** ***days per week, from 6:00 a.m. Sundays to 6:00 a.m., Wednesday.***
Ending: ***November 29.***

Late chum
CLOSED to all gear types.

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GENERAL

Unless otherwise agreed by all parties, the following procedure for opening and closing fisheries for all species will be implemented during the fishing season.

1. In-common fisheries will close automatically when conservation concerns arise. The fishery biologists for the Medicine Creek Tribes (Nisqually, Squaxin Island, Puyallup) will be responsible for monitoring the fisheries and making technical recommendations to the tribal representatives who will then vote on those recommendations.

2. When the end of the management period for one species is reached, the fishery will close for that species and automatically reopen for the species whose management period immediately follows. No policy approval is needed under this situation.

3. Substantive changes in regulations, i.e. changes in gear type, fishing time, etc., must be approved by the policy representatives and fish committees of all three Medicine Creek Tribes.

PUGET SOUND SAMPLING PROGRAM OPERATING PLAN

March 21, 2003

I. GENERAL SAMPLING OBJECTIVES AND PROCEDURES

The basic mission of the Puget Sound Sampling Program is to provide the historical time series needed for monitoring salmon stocks and managing the salmon fisheries of the State. These databases provide recreational and commercial fisheries statistics.

A. SAMPLING OBJECTIVES

The Puget Sound Sampling Program has the following sampling objectives in order of priority:

1) *Provide catch per unit effort and species composition of recreational salmon fisheries. This sampling activity is also described as "Baseline Sampling". Baseline information is used in conjunction with the catch record card (CRC) system to compute catch by species and area. Baseline catch information is also collected for marine fish.*

2) *Sampling for coded wire tags (CWT) in sport and commercial fisheries. The objective is to provide stock specific estimation of population parameters, such as fishery contribution and marine survival as part of the Coast-Wide CWT program.*

3) *Sampling for chum age composition.*

4) *Sampling for chinook age composition.*

5) *Obtaining adipose mark rates from selective fisheries.*

6) *Other goals consist of biological sampling for length, sex and genetic stock identification (GSI) to provide valuable information about return by age and sex, size and stock composition.*

Puget Sound Sampling also conducts catch estimates for Terminal Area Fisheries and quota management, when requested.

Since 1998, all coho are sampled electronically for CWTs and since 2001 all chinook are also sampled electronically, because the adipose fin-clip is no longer the visual indicator of the CWT. New information will be collected to meet the data needs of selective fisheries management, such as the adipose mark status of landed tagged and untagged coho/chinook, and marked/unmarked ratios in the fishery.

B. BASELINE SAMPLING

1) Goals

The main objective of the sport fishery baseline sampling program is to provide auxiliary data for the Salmon Catch Record Card System, species composition to estimate sport harvest by species and CPUE (salmon per angler trip) to estimate total effort.

2) Objectives

a) *Species Composition*

b) *Catch per Unit Effort*

c) *Estimate marked to unmarked ratios in selective fisheries*

d) *Estimate unmarked retention error*

3) Sampling unit

The basic sampling unit for species composition is a salmon.

The basic sampling unit for CPUE is an interview.

4) Sampling strata

Strata are set per catch record card area and time. Duration of a stratum can range from one week to several months based on angler effort and success (see table 1).

Strata have, in the past, been area-week, however sampling goals have not been met for area-week, typically where sport harvests are small, e.g. during the winter in Areas 12 and 13.

In order to provide minimally biased estimates of harvest by species and total effort, weekly strata should only be defined for Areas 5, 6, 9 and 10 during the months June-October. These months represent the time period of highest effort, and also during these months, species composition changes as fisheries move from targeting chinook to targeting coho salmon. Otherwise sampling goals should be achieved between months or combination of months. From November through May most of the sport harvest is chinook, although chum are taken in November in certain areas.

Table 1 Typical Puget Sound Recreational Sampling Strata

Area	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April
5	Month	Week	Week	Week	Week	Week	2 Months		Month	Month	Month	Month
6	Month	Week	Week	Week	Week	Week	2 Months		Month	Month	Month	Month
7	Month	Month	Month	Month	Month	Month	2 Months		Month	Month	Month	Month
81	Month	Month	Month	Month	Month	Month	2 Months		Month	Month	Month	Month
82	Month	Month	Month	Month	Month	Month	2 Months		Month	Month	Month	Month
9	Month	Week	Week	Week	Week	Week	Month	Month	Month	Month	Month	Month
10	Month	Week	Week	Week	Week	Week	Month	Month	Month	Month	Month	Month
11	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month	Month
12	5 Mo.	Month	Month	Month	Month	Month	2 Months		5 Months			
13	2 Months		Month	Month	Month	Month	2 Months		2 Months		2 Months	

5) Sample size

Sample size is set at 120 fish per stratum for estimation of species composition and 100 boats per stratum for the estimation of CPUE. Depending upon fishing seasons, fishing effort and sampling effort in any given year, strata may be grouped differently when sampling goals cannot be reached in each stratum.

6) Assumptions

Species composition of sampled sites can be applied to the entire CRC area.

Anglers answer questions accurately and do not conceal fish.

7) Data collection

The baseline sampling program is geographically stratified by catch record card areas, Areas 5-13 in Puget Sound. The species composition and CPUE data are collected through angler interviews at landing sites within each area and combined for area estimates. Indices of angler success (CPUE and catch distribution) can be estimated from these data, however it should be noted that the objective of the sampling program is to provide estimates for entire catch record card areas, and is not designed to provide information on small or localized fisheries within a catch record card area.

Since 1992, sampling efforts have focused on high impact sites to ensure that sample sizes are adequate for analysis. Catch and release data is now being included in all sport sampling interviews in order to assess total salmon mortality in sport fisheries. Mark status of landed salmon is recorded during the interview to assess marked to unmarked ratios and unmarked retention error in selective fisheries.

8) Analysis

Strata are analyzed for achievement of sampling goals. Sampling goals are typically not met in areas and months with low effort. Area 13 catch from October through March rarely exceeds 100 salmon, so even if every fish could be sampled, monthly strata would not be met. Strata falling short will be lumped whenever possible to ensure that CPUE estimates are based on at least 100 boats, otherwise effort estimates may be highly biased. Species composition is applied to total catch (from the CRC system) to arrive at estimates of total catch by species in a catch record card area, and CPUE is used to estimate angler-effort.

C. CWT SAMPLING

1) Goal

Sampling for coded-wire-tags (CWT) in sport and commercial fisheries represents one part of the coast-wide CWT Program, the objective of which is to provide for stock specific estimation of population parameters, such as fishery contribution and marine survival. The CWT program is also important to brood-stock programs and the evaluation of hatchery and supplementation programs.

2) Sampling unit

The basic sampling unit is a coho or a chinook salmon

3) Sample size

The sampling goal for commercial fisheries is 20% of the chinook and coho harvest per area per week.

The recreational sampling goal for coho and chinook is 10% of the harvest per area and per month.

4) Assumption

CWT composition of the sample can be applied to the entire fishery (harvested catch).

5) Data collection

Coho and chinook will be sampled electronically for the presence of a tag, because the adipose fin clip is no longer the external indicator of a tag.

If a tag is detected, the sampler will remove the head for analysis in the lab. Adipose mark status is recorded for tagged and untagged coho/chinook during sampling.

In order to achieve the coho and chinook CWT goal of 10%, sampling levels were increased starting in 1998 and again in 2001.

Table 2 Puget Sound Sampling Program Goals for Sample Size

Objective	Gear	Samples per stratum
CRC Species composition	Recreational	120 fish per area-stratum (includes sampling for encounters and % marked)
CRC CPUE	Recreational	100 boats per area-stratum
CWTs	Commercial	20% of harvest by species-area-week
	Recreational	10% of harvest by species-area-stratum
Chum age and length	Gillnet	200 fish per area-week
	Purse seine	200 fish per area-week
Chinook age and length	Recreational	N/a
	Gillnet	150 fish per area-week
	Purse seine	150 fish per area-week

D. BIOLOGICAL SAMPLING - CHUM AGE AND LENGTH COMPOSITION

1) Goal

Major sampling goal is to obtain biological information about returning salmon stocks, such as age, length, sex ratios and stock composition.

2) Objective

The objective of this sampling activity is to estimate the age composition of the catch of chum salmon in Puget Sound. These data are crucial to the estimation of return by age class used in forecasting chum returns in Puget Sound. The forecast depends on an unbroken time series of return by age data. Each year's data contributes to three brood-year's return by age estimates, and so the loss of one year's sampling impacts three years.

3) Sampling unit

The basic sampling unit is one chum salmon.

4) Sample size

Sample size is 200 chum per area, commercial fishery, week, and gear. Gill net gear, Indian and non-Indian can be considered one gear stratum, but purse seines must be sampled separately.

5) Data collection and estimation

Chum age is determined by scale analysis. Samplers remove two scales per fish for analysis in the lab. Samples are combined from all sampled fisheries to estimate the total age composition.

Estimation of return by age class necessitates estimation of numbers by age for catch and escapement by stock. The Puget Sound chum salmon stocks are divided into several stocks by geographic and temporal characteristics. Estimation of brood year return requires that harvest and escapement in each year be allocated to age classes. These estimates, with parent year escapement and other auxiliary variables are used for forecasting return by age.

E. BIOLOGICAL SAMPLING - CHINOOK AGE AND LENGTH COMPOSITION

1) Goal

Major sampling goal is to obtain biological information about returning salmon stocks, such as age, length, sex ratios and stock composition.

2) Objective

The objective of this sampling program is to estimate the age composition of chinook catch, especially the proportion of yearlings in Puget Sound recreational fisheries.

3) Sampling unit

The sampling unit is a chinook.

4) Sample size

All chinook in sport fisheries are sampled.

Table 3 Chinook Scale Sampling Priorities for Commercial Fisheries in Puget Sound

Fishery	Chinook Goal	Priority	Comment
4B, 5, 6, 6C, 7, 7A	none	none	
7B	150/wk/gear	high	7B/C/D can be combined

7C	150/wk/gear	high	7B/C/D can be combined
7D	150/wk/gear	high	7B/C/D can be combined
Nooksack River	150/wk/gear	very high	keep separate from bay if you can
8A C&S	150/wk/gear	high	keep separate from bay
8D	150/wk/gear	high	keep separate from 8A
10A	150/wk/gear	high	keep separate from river
10E	150/wk/gear	high	
Duwamish/Green River	150/wk/gear	very high	keep separate from bay
Lake Washington	150/wk/gear	very high	
Puyallup River	150/wk/gear	very high	
White River C&S	150/wk/gear	very high	
13	150/wk/gear	low	low because of small catch
13A	150/wk/gear	med	
13C	150/wk/gear	med	
13D-K	150/wk/gear	low	13D-K can be lumped
Nisqually River	150/wk/gear	very high	
Mc Allister	150/wk/gear	low	
12H (Hood Canal Hatchery)	150/wk/gear	med	
Skokomish River	150/wk/gear	very high	

Generally, the highest priortity should be given to freshwater directed fisheries and fisheries with chinook catch greater than 300. Low Priority is given to small catches in marine areas.

5) Data collection and estimation

Chinook age is determined by scale analysis. Samplers remove three scales per fish for analysis in the lab. Samples are combined from all sampled fisheries to estimate the total age composition.

Currently use of chinook salmon age composition in sport fisheries is limited. The major use of the data is made in chinook model evaluation. Primary focus of interest is the proportion of yearlings in sport catch.

F. OTHER STUDIES - IN-SEASON CATCH ESTIMATES

The Puget Sound Sampling Program carries out other sampling related activities, as requested. Examples are baseline marine fish sampling, genetic stock identification sampling (GSI), marine fish and shellfish sampling, and collection of commercial fish tickets.

1) Goal

Estimate harvest and effort in fisheries managed by a quota or ceiling and in Terminal Area Fisheries (if requested).

2) Sampling Unit

The basic sampling unit is an angler trip.

3) Sampling Strata

Sampling is stratified into weekend and weekday periods.

4) Sample Size

Sampling size will be established based on previously tested designs for Terminal Area Fisheries and will be sufficient to provide total estimates of harvest and effort to be within 15% of the point estimate at a 95% confidence level.

5) Assumption

Boat survey is an unbiased estimate of proportion of anglers accessing fisheries from non-sampled sites.

The proportion of total effort accessing the fishery at site A represents the proportion of total catch landed at site A.

All anglers exiting at a sampled site are interviewed and all anglers accurately report their harvest.

6) Data Collection and Estimation

An exit survey method is the most efficient and least biased method of conducting catch estimates.

All anglers exiting a fishery at pre-selected high use sites are interviewed, thus providing a census of harvest and effort for that site on that day. Missed anglers are counted, and the average harvest effort per angler is used to estimate their harvest and effort.

Sites are chosen for sampling according to their “size”. The size measure is the proportion of the effort that on average uses that site to access the fishery. Boat surveys are used to obtain size measure. Each boat survey covers the entire open area.

Entire days are sampled.

Total harvest is estimated first for each day, expanding over all sites. Then the daily average for weekend days and weekdays is estimated and expanded over all day in these two strata.

II. MONITORING SELECTIVE FISHERIES IN PUGET SOUND

A. INTRODUCTION

In order to minimize sport angler impact on weak wild coho and chinook salmon stocks, selective fisheries, where adipose marked coho/chinook are harvested while coho/chinook with the adipose fin intact are required to be released, are being proposed for various areas in Puget Sound. If such fisheries are approved, it is desirable to monitor fisheries in-season to determine how many salmon are being encountered, what percentage of salmon encountered are marked, how many chinook are encountered relative to coho, and unmark retention error.

Conducting monitoring of this type requires new methods and additional resources. The existing sampling program, operating mostly at recreational boat launches, is not designed to measure all of these parameters.

B. STUDY DESIGN

1) Objectives

a) Estimate the marked to unmarked proportion encountered in the fishery.

b) Estimate the number of salmon released by species relative to the number of salmon retained.

c) Estimate unmarked retention error.

d) Estimate the species composition.

2) Sampling Strategies

A number of strategies will be employed to meet the sampling objectives. More than one strategy may be used by area to collect the necessary information. Not each strategy is equally suitable to reach all stated sampling objectives. Fishing effort and success, the presence of charters, the cooperation of volunteers, etc., will determine which approach should be used to collect the necessary parameters. In areas with low coho/chinook catch, none of the strategies may provide enough information to get a good estimate of marked to unmarked rations. In these areas, rather than spending resources on hook-and-line test fisheries, we will use sampling resources to get the best possible dock-side sample of baseline information, CWTs and unmarked recognition error (see details below).

(a) Dock-Side Interviews:

Several of the parameters mentioned above have been estimated for years using dock-side angler interviews, such as the number of salmon released relative to the number of salmon retained and the number of chinook encountered relative to the number of coho. Unmarked retention error can be estimated with this method, by recording the number of unmarked and landed coho/chinook observed dock-side during a selective fishery for that species. Beginning in 1999 we also collect information about the mark status of coho/chinook released when under “wild coho/chinook release management”.

(b) Volunteer Trip Reports:

Anglers will be approached by WDFW with the request to fill out trip reports while fishing in selective fisheries. Volunteers will record the number of fish hooked up by species, the number of fish that drops off, the number of marked and unmarked coho/chinook, as well as legal and sub-legal chinook.

(c) Charter Boat Ride-Alongs:

WDFW observers will record the outcome of each hook-up on a charter boat during a selective fishery. The following data will be collected: Date, area, species hooked, result of hook-up (fish landed, released, dropped-off), mark status, size (legal versus sub-legal), fish alive or dead at release. Any seabirds hooked or marine mammals encountered will also be documented. Sampling is conditional on a sufficient number of anglers fishing on charters.

(d) Hook-and-Line Test Fishery:

WDFW technicians conduct a recreational test fishery in selective fishing areas. These samplers observe the outcome of individual hook-ups and record all important fisheries parameters.

(e) Non-selective fisheries:

Marked to unmarked ratios from non-selective fisheries could be compared to adjacent selective fisheries, when appropriate.

3) Sample Size

Sample size is set at 100 coho/chinook encounters per area and week. Our goal is to define a stratum as a one week period for each fishery, but in some cases where samples are hard to obtain, strata may be combined to get the necessary sample size. It is apparent from prior years in-sample data and catch record card estimates that a goal of 100 samples per week will likely not be achieved in Areas 7, 8.1, 12 and 13, even when lumping several weeks. In these areas we will concentrate our resources on dock-side sampling.

For the test fishery, the sampling goal is set at a minimum of 100 salmon encounters per stratum (management regime).

4) Assumptions

The major assumptions necessary are:

1. Test fishery and charter boat hook-ups are representative of the fleet.
2. Volunteers filling out trip reports fish in a manner representative of the fishing fleet.
3. Volunteers can correctly identify salmon and mark status.

5) Estimating Marked to Unmarked Proportion of Coho/Chinook

The marked to unmarked coho/chinook ratio, is the most important new information that will be collected for selective fisheries.

An independent estimate of marked to unmarked ratios, can be applied to information of the numbers of coho/chinook released, collected during dock-side interviews, to compute estimates of marked to unmarked ratios of released coho/chinook.

*Marked Salmon Released = Number of Salmon Encounters * Proportion Marked – Marked Salmon Landed*

*Unmarked Salmon Released = Number of Salmon Encounters * Proportion Unmarked – Unmarked Salmon Landed*

All strategies from above can be used to get an estimate of marked to unmarked ratios.

Dock-side interviews and volunteer observers will be our primary source of information in areas with low, spread-out angler effort and success. WDFW samplers working at standard sampling sites will ask anglers if they would volunteer to make records of their next fishing trip (and subsequent trips thereafter). Volunteers will record an entry for every fish hooked up.

Volunteer trip reports will be compared to dock-side interviews and data from charter ride-alongs, and test fisheries to evaluate how representative they are for an area.

Another source of information of marked to unmarked coho/chinook ratios can come from non-selective fisheries in the vicinity of a selective fishery, e.g. southern area 11 ratios could be applied to area 13. Ratios from purse seine fisheries, if representative of the ratios in the sport fishery, can also be a source of data.

6) Estimate the Number of Coho/Chinook Released

Information of the number of coho/chinook released has been collected for several years during dock-side interviews. This information is also collected during charter ride-alongs and volunteer trip reports. To determine which method will be used for an area see table one.

7) Estimate Unmarked Retention Error

Unmarked retention error occurs when anglers land unmarked salmon during a mark selective fishery for that species. Unmark retention error is defined as the number of unmarked salmon landed relative to the number of unmarked salmon encountered. A special effort will be made to get a good dock-side estimate of unmarked retention error to validate model inputs of selective fisheries in Puget Sound. Additional samplers will be available to boost dock-side sampling rates.

Unmarked salmon concealed by anglers that are aware of non-compliance will not be detected with dock-side sampling.

8) Estimate the Number of Salmon Encountered by Species

Information of the number of salmon encountered by species has been collected for several years during dock-side interviews. This information is also collected during sampling methods 2-4. To determine which method will be used for an area see table one.

Monitoring Selective Recreational Fisheries in Puget Sound

Area	Strategies
5	Test fishery Charter ride-alongs (if available) Boost sampling rates Volunteer Trip Reports
6	Volunteer Trip Reports Charter ride-alongs (if available) Boost sampling rates Test fishing
7	Volunteer Trip Reports Boost sampling rates Mark Ratio from Treaty Gill Net Fishery
8.1	Volunteer Trip Reports
8.2	Volunteer Trip Reports Charter ride-alongs
9	Volunteer Trip Reports Charter rid-alongs (if available) Test fishing
10	Volunteer Trip Reports Charter ride-alongs (if available) Test fishing
11	Volunteer Trip Reports

12	Volunteer Trip Reports Boost sampling rates
13	Volunteer Trip Reports Boost sampling rates

Appendix D: Estimates of Encounter Rates and Releases of Sublegal Chinook in the 2003 Washington Troll Salmon Fishery (Leon and Peterschmidt, 2003)

This document may be downloaded from the WDFW website at:
http://wdfw.wa.gov/fish/papers/ps_chinook/harvest/2003-03_annual_report_apdx_d.pdf

DRAFT 03/17/04

2003 Chinook Selective Fishery,
Marine Areas 5 and 6

By

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March 17, 2004

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EXECUTIVE SUMMARY

During the summer of 2003, a pilot recreational chinook salmon ("chinook") fishery that was limited to retention of marked (adipose clipped) hatchery chinook salmon occurred in Marine Area 5 and the western portion of Marine Area 6. Marine Areas 5 and 6 are located in Washington waters of the Strait of Juan de Fuca. The Chinook Selective Fishery was scheduled to begin on July 5, 2003 and continue for 41 days or until a quota of 3,500 chinook were kept, whichever occurred first. The fishery started on July 5, 2003 and ran continuously for 30 days through August 3. We estimated total effort, catch per angler trip, number of fish kept, the percentage of marked chinook salmon (mark rate), and the percentage of fish greater than the 22" minimum size encountered.

We estimated fishing effort at 24,618 angler trips during the Chinook Selective Fishery. Those anglers retained an estimated 3,507 chinook and released 14,752. In addition, an estimated 5,335 hatchery coho and 5,650 pink salmon were kept during this fishery. The majority of the fishing effort (79%) and chinook kept (72%) occurred in Area 5. In Area 5, the number of chinook kept per angler trip was 0.13. An estimated 5,175 anglers participated in the Chinook Selective Fishery in Area 6. In Area 6, the number of chinook kept per angler trip was 0.19. The estimated mark rate for legal-size chinook (greater than or equal to 22") based on test fishing during the Chinook Selective Fishery was 44% in Area 5 and 48% in Area 6. Angler effort during the Chinook Selective Fishery in 2003 was approximately double the effort associated with the 2002 fishery during the same time frame, but with a combination of 'non-selective' and 'release all' regulations applied to chinook.

Since the Chinook Selective Fishery in Areas 5 and 6 was a pilot fishery and included a new regulation requiring anglers to release salmon without bringing the fish on board their vessel, we initiated a program to educate anglers about proper methods of releasing fish and fish identification. Anglers were offered a "dehooker" and a pamphlet describing selective fisheries, how to identify salmon species and how to use the dehooker. Anglers were also asked to avoid netting fish they were going to release if possible. Compliance with existing regulations, and the new regulation prohibiting bringing salmon on board a vessel if they were going to be released, was good. Officers contacted 620 anglers during the selective fishery, issuing 7 citations for retaining wild chinook salmon, and no citations for bringing fish to be released on board a vessel.

INTRODUCTION

In recent years, abundant runs of hatchery salmon have been mixed with depressed runs of wild salmon in both marine and freshwater environments. Providing opportunities to harvest those abundant hatchery stocks while protecting wild stocks has been challenging. One tool for allowing harvest of abundant hatchery fish while limiting impacts on wild stocks is "Selective Fishing". In recreational selective fisheries, anglers are generally allowed to retain fin clipped ("marked") hatchery fish and are required to release unclipped ("unmarked") fish. These unmarked fish are typically wild fish, but may include certain unmarked hatchery fish. While selective coho salmon *Oncorhynchus kisutch* ("coho") fisheries have occurred in Oregon, Washington, and British Columbia at various times since 1998, and selective chinook salmon *O. tshawytscha* (“chinook”) fisheries have occurred in freshwater areas since 2000, a selective chinook fishery had not been conducted in marine waters.

During the summer of 2003, a selective chinook recreational fishery was implemented in waters of the Strait of Juan de Fuca with the objective of increasing meaningful recreational opportunity while meeting conservation goals for Puget Sound chinook salmon defined by the Puget Sound Chinook Harvest Management Plan. The Northwest Treaty Tribes and the Washington Department of Fish and Wildlife reached agreement to consider selective chinook sport fishing in this area for the 2003 and 2004 seasons as part of a pilot program for the purpose of collecting information necessary to enable evaluation and planning of future potential chinook mark-selective fisheries. It was thought that a pilot fishery limited in time and area, as described below, would allow managers to determine the success of monitoring and sampling programs for collection of essential information.

The Chinook Selective Fishery started on July 5, 2003 and ran continuously through August 3, 2003 in Marine Area 5 and the western portion of Marine Area 6. Marine Areas 5 and 6 (hereafter: Areas 5 and 6) are located in Washington waters of the Strait of Juan de Fuca, running from the Sekiu River easterly to Low Point, and from Low Point to approximately Whidbey Island, respectively (Figure 1). Area 6 was open only from Low Point easterly to Ediz Hook. We restricted the Area 6 fishery to this location because the eastern portion of Area 6 has many more boat ramps and other access points, and would have required substantially more sampling effort to obtain precise estimates of harvest and effort. Additional closures to help achieve fishery objectives were established: 1) in the eastern half of Marine Area 4; 2) near the mouths of the Sekiu and Hoko rivers; 3) near the mouth of the Elwha River; and 4) in Port Angeles Harbor.

Anglers were allowed to retain two marked (adipose fin clipped) chinook salmon $\geq$ 22” (56 cm) as part of their daily limit, and were required to immediately release, unharmed, any unmarked chinook caught. Integral to the selective fishery was a new regulation that, “Any salmon to be released may not be brought on board a vessel”. Education efforts were undertaken to provide anglers with alternative methods for proper release of fish, other than netting the fish and bringing them into the boat. During the Chinook Selective Fishery anglers were also allowed to retain pink *O. gorbuscha* (“pink”), sockeye *O. nerka*, and marked hatchery coho salmon.

The season was scheduled to run from July 5, 2003 through August 14, 2003 (41 days), or until a quota of 3,500 hatchery chinook salmon were caught and retained by anglers. The fishery was closed by emergency regulation effective at 11:59 p.m., August 3, 2003 because the quota was expected to be reached.

METHODS

We estimated total effort, catch per angler trip, number of fish harvested, the percentage of adipose fin clipped chinook (mark rate), the total number of chinook released and the proportion 22" or longer (legal-size). Coded wire tags and biological samples were collected from harvested fish and from all chinook caught on test fishing boats for possible future genetic analysis of stock composition.

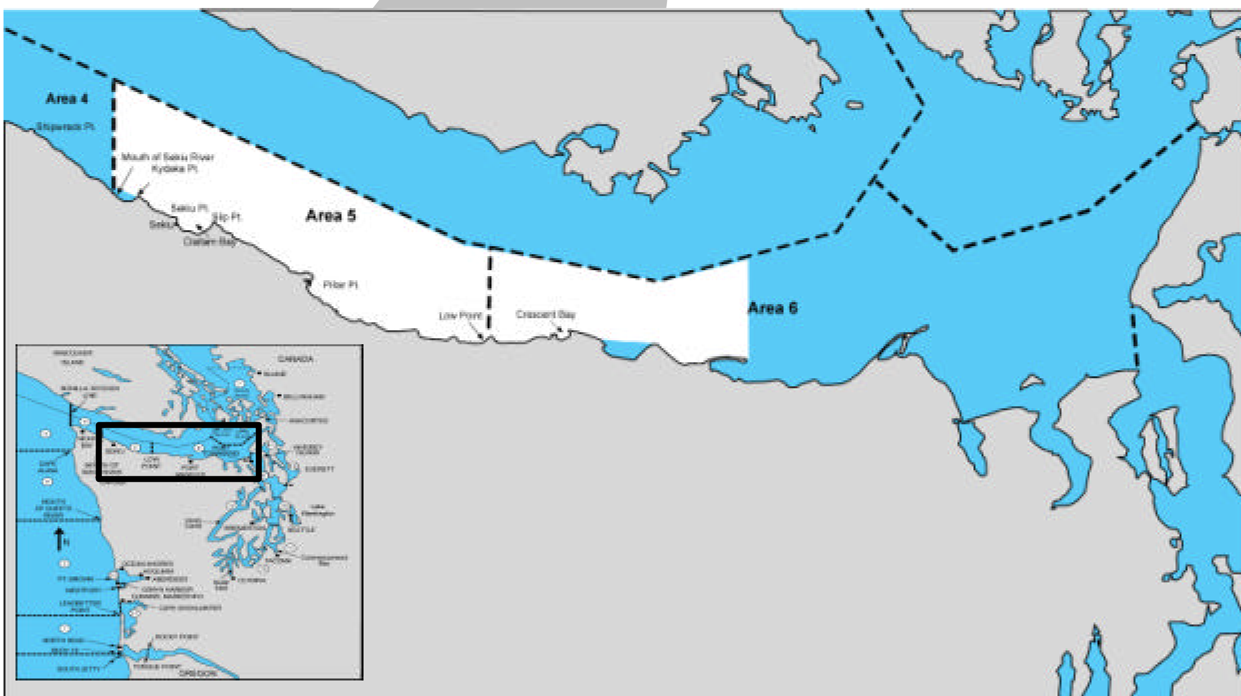

Figure 1. Location of the 2003 Chinook Selective Fishery (shown in white) in Marine Areas 5 and 6.

Effort and Catch

Effort and catch were estimated by creel surveys generally following the procedures outlined in "Puget Sound salmon sport catch estimation study-1990" (Washington Department of Fisheries and Northwest Indian Fisheries Commission 1992), except that expansion factors were determined in-season, rather than using previously determined effort levels. Four boat surveys were conducted between July 5 and August 3 in Area 5, and 11 in Area 6, to determine the proportion of effort (or "size") for each access site. While on the water, boats were approached and the skipper was asked where they would tie up at or exit the fishery that day. All boats were surveyed or counted from a selected set of docks or access points during a day. Harvest and effort observed at the two sampled sites were then expanded to all access sites based on their "size" to estimate total harvest for the day. Sample data were combined and expanded to create stratum estimates of harvest. The formula for expanding effort and harvest was:

$$\frac{[(1 - \text{proportion}_2) \text{ X } (\text{catch}_1/\text{proportion}_1) + (1 - \text{proportion}_1) \text{ X } (\text{catch}_2/\text{proportion}_2)]}{(2\text{-proportion}_1 - \text{proportion}_2)}$$

For example, if 18 fish are censused at Van Ripers and the Van Ripers proportion of effort (size) is 20% of the Area 5 effort, while 31 fish are censused at Olson's and the Olson's proportion of effort is 50%, then the total Area 5 catch for one day is calculated as follows:

Estimated catch = [(1 – 0.50) X (18/0.20) + (1 – 0.20) X (31/0.50)]/(2-0.2-0.5) = 73.

Therefore the total estimated catch for all of Area 5 would be 73 fish. Effort would be expanded in a similar manner.

Weeks were divided into three strata: Monday through Thursday, Friday, and Saturday and Sunday. Each week, two days from the Monday though Thursday stratum were randomly selected for sampling. Every Friday, Saturday, and Sunday were sampled. For each sampling day an AM and a PM period were sampled. Morning shifts started at 7 AM and ended at 2 PM. Afternoon shifts started at 2 PM and ended at 9 PM, except that sampling shifts were adjusted earlier or later if boats were returning before or after normal shift times, such that all boats returning to a selected access site were sampled or counted. For each sampling day, two access sites (ramps or docks) in each Area were selected by computer program for sampling. The computer program selects sampling sites based on their "size" or effort (i.e. the proportion of angler effort that on average uses the site; Murthy 1957, Cochran 1977). Thus a total of four shifts were sampled per selected day in each Area. Access sites in Area 5 were divided into sampled and non-sampled sites. Access sites with low effort were excluded in the sample. All anglers and fish exiting the fishery through the sampled sites were counted. If any boats were not sampled, they were counted, and catch and effort estimates were expanded appropriately.

Harvest and effort estimates are based on the following assumptions: 1) Boat surveys are unbiased estimates of the proportion of anglers accessing fisheries from non-sampled sites; 2) The proportion of total anglers accessing the fishery at site 'A' represents the proportion of total catch landed at site 'A'; 3) All anglers exiting the fishery at a sampled site are accounted for and that anglers accurately report their harvest; and 4) Catch per unit effort (c/f) does not differ significantly between sampled and non-sampled sites.

Numbers of fish encountered but released during the Chinook Selective Fishery were also estimated based on shoreside interviews of anglers, as part of the catch and effort sampling program. Anglers were asked to report numbers of fish released by species. These survey data were expanded to represent total fishery estimates of released salmon using the same methods as previously described for estimating total fishery estimates of catch and effort. For the chinook released that the angler did not know the mark status, we used the mark rates from the test fishery for sublegal (< 22") chinook to apportion those unknown chinook into marked and unmarked categories.

Samplers collected coded wire tags from harvested fish. Fish bearing coded wire tags were also measured for fork length and scales were collected.

Test Fishing

Two "test" fishing boats were used to determine the species composition, percent of fish encountered that were adipose clipped (mark rate), the percentage of fish that were legal-size, and to collect scales, tissue samples, coded wire tags and fork lengths. We converted fork lengths to total lengths for analysis using the recommended equations presented in Conrad and Gutmann (1996). A 1 cm^2 tissue sample was collected from the dorsal fin or the caudal fin, and placed in a solution of ethanol. Tissue samples were collected for possible future genetic analysis of stock composition. Scales were collected following procedures outlined by the International North Pacific Fisheries Commission (1963). The percentage of legal-size chinook caught by test boats was calculated for the period July 3 through August 14. We calculated mark rate by statistical week for the period July 3 through August 14. We then used a weighted weekly average to estimate an overall mark rate. We used a chi-squared test to determine if a significant difference occurred between Area 5 and Area 6.

Two samplers, utilizing one rod each, fished from each boat. One test boat fished out of Sekiu (Area 5) from July 3 through August 14, and one boat fished out of Port Angeles (Area 6) from July 3 through August 14. The Sekiu boat fished 28 of the 30 open days during the Chinook Selective Fishery and the Port Angeles boat fished 27 days during the same time period. In addition, the Sekiu test boat fished 1 day in July prior to the Chinook Selective Fishery, and 8 days during the period of August 4 – 14, immediately following the Chinook Selective Fishery, during which they continued to target chinook. The Port Angeles boat fished 1 day prior to the Chinook Selective Fishery and an additional 11 days (August 4 – 14) immediately following the Chinook Selective Fishery, during which they continued to target chinook.

Samplers fishing from the test boats attempted to fish methods similar to the "average" angler in order to represent the fishery. Samplers attempted to capture chinook from July 3 through August 14 through their choice of area to fish, depth, gear type and fishing methods. Samplers fished only with artificial lures. No bait (e.g. herring) was used. In this respect, a portion of the fishery was not represented, as some anglers fish predominately with bait.

Additional test fishing directed at coho was conducted in Area 5 in late August and into September. Few chinook were encountered compared to test fishing directed at chinook during July and early August.

Voluntary Trip Reports

Additional information on mark rates and the percentage of fish that were legal-size was obtained from Voluntary Trip Reports (VTR's). We calculated mark rate by statistical week for the period July 3 through August 14. We then used a weighted weekly average to estimate an overall mark rate. Volunteer trip report forms were issued to interested anglers prior to and during the fishing season. Anglers were asked to record date, number of anglers, target species, which Area they were fishing in, each fish hooked, whether the fish was kept or released, the species of fish if they could positively identify it, approximate total length, and whether the fish was adipose fin clipped or not. Volunteers also collected a few tissue samples for possible future genetic analysis.

RESULTS AND DISCUSSION

Effort and Catch

We estimated that anglers made 24,618 trips during the Chinook Selective Fishery (July 5 – August 3). Those anglers kept an estimated 3,507 chinook, 5,335 hatchery coho and 5,650 pink (Table 1). Area 5 accounted for 79% of the effort (19,444 angler trips) and 72% of the kept chinook (2,535) for a rate of 0.13 chinook kept per angler trip. Area 6 accounted for 5,174 angler trips and 972 kept chinook for a higher catch rate of 0.19 chinook kept per angler trip. Area 5 anglers released an estimated 13,019 chinook, 22,310 coho, 3,209 pink and 744 unidentified salmon. Area 6 anglers released an estimated 1,732 chinook, 455 coho, 183 pink and 38 unidentified salmon.

The Chinook Selective Fishery appears to have doubled the amount of effort in Areas 5 and 6, and greatly increased the number of days anglers could fish for chinook, versus 2002. In 2002, anglers were only allowed to harvest chinook (marked and unmarked) during five days of the summer season (July 8, 9, 10, 11 and 22) in Area 5. For comparison with 2003, from July 1 through August 3, 2002, an estimated 10,905 anglers participated in the Area 5 fishery, and kept 1,790 chinook and 1,988 coho, while releasing 2,922 chinook and 5,006 coho. There is no directly comparable information for Area 6 in 2002 since chinook retention was not allowed and the entire area was open. However, observations from Washington Department of Fish and Wildlife (WDFW) samplers suggest that effort was at least double in the portion of Area 6 that was open during the Chinook Selective Fishery compared to the same time period in 2002 (Larry Bennett, WDFW, Personal Communication).

Effort was initially very high in Area 5, declined precipitously during the second week of the season, and then rose modestly until the closure of the Chinook Selective Fishery (Figure 2). In Area 6, effort mostly declined modestly throughout the fishery (Figure 3). Chinook harvest declined from the first week to the second, and then increased sharply during the fourth week in Area 5 (Figure 4), but essentially increased throughout the duration of the fishery in Area 6 (Figure 5). Consequently, the number of chinook kept per angler in Area 5 was fairly consistent during the fishery, except during late July when it increased (Figure 6), while the number of chinook kept per angler essentially increased throughout the fishery in Area 6 (Figure 7).

Table 1. Recreational salmon catch estimate during the Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3, 2003. The released numbers are based on angler interviews.

	Trips		Harvested			Released			
Fishery	Boats	Anglers	Chinook	Coho	Pink	Unidentified	Chinook	Coho	Pink
Area 5	8,026	19,444	2,535	5,230	5,210	744	13,019	22,310	3,209
Area 6	2,646	5,174	972	105	440	38	1,732	455	183
Total	10,672	24,618	3,507	5,335	5,650	782	14,751	22,765	3,392

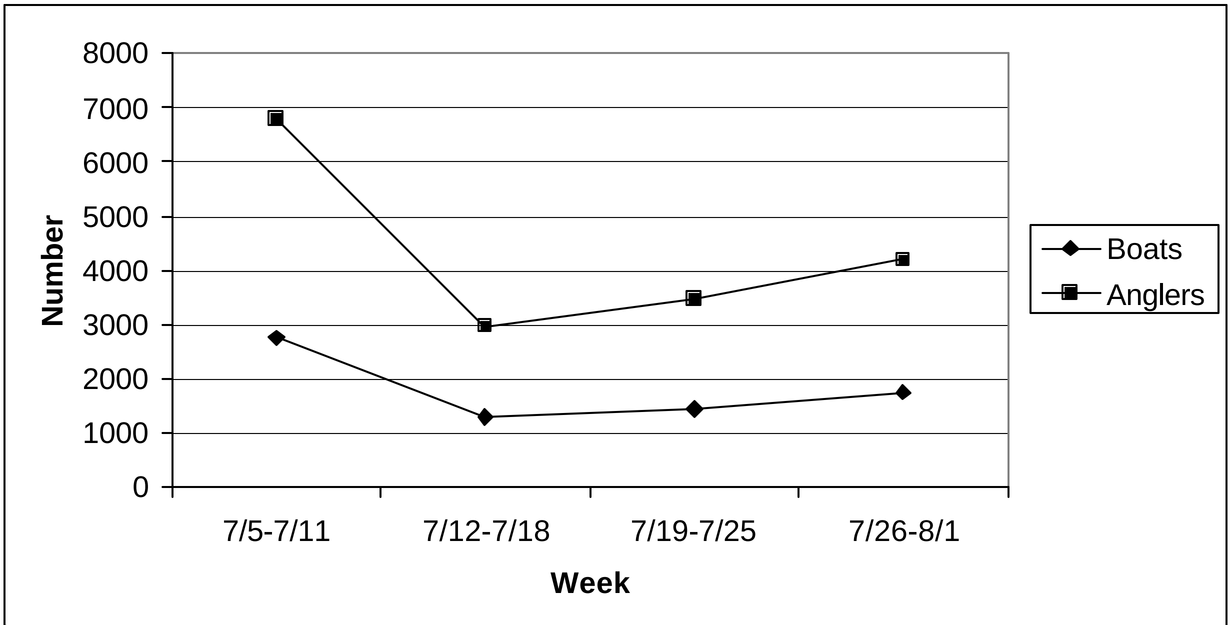

Figure 2. Angler effort in Marine Area 5, by week, for the 2003 Chinook Selective Fishery.

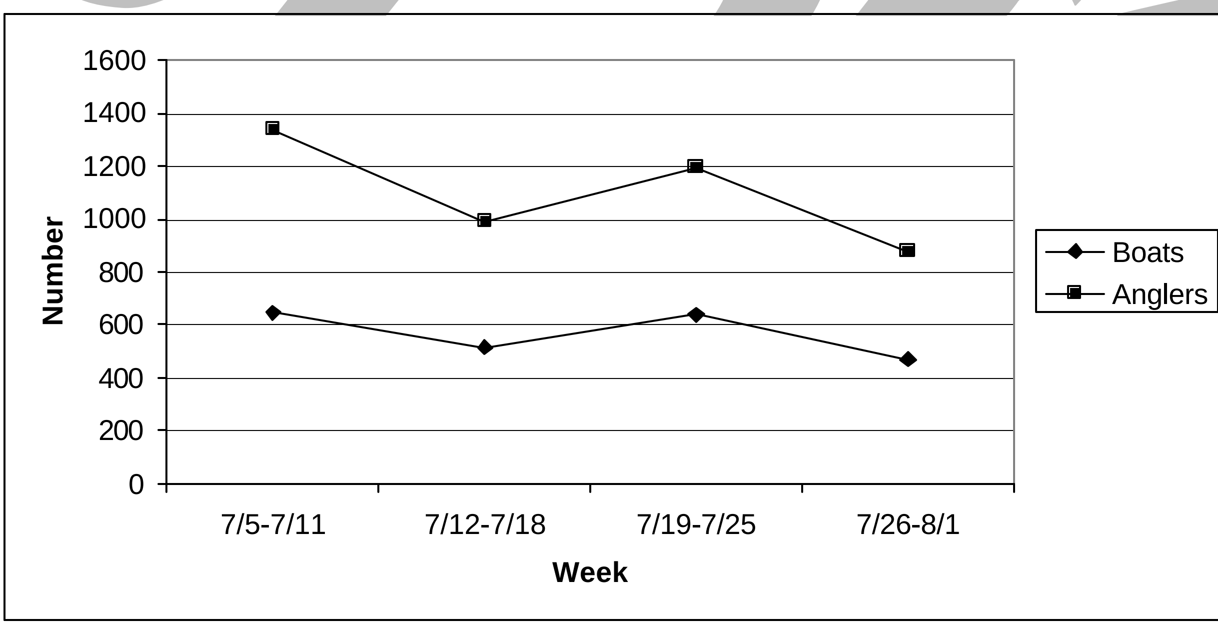

Figure 3. Angler effort in Marine Area 6, by week, for the 2003 Chinook Selective Fishery.

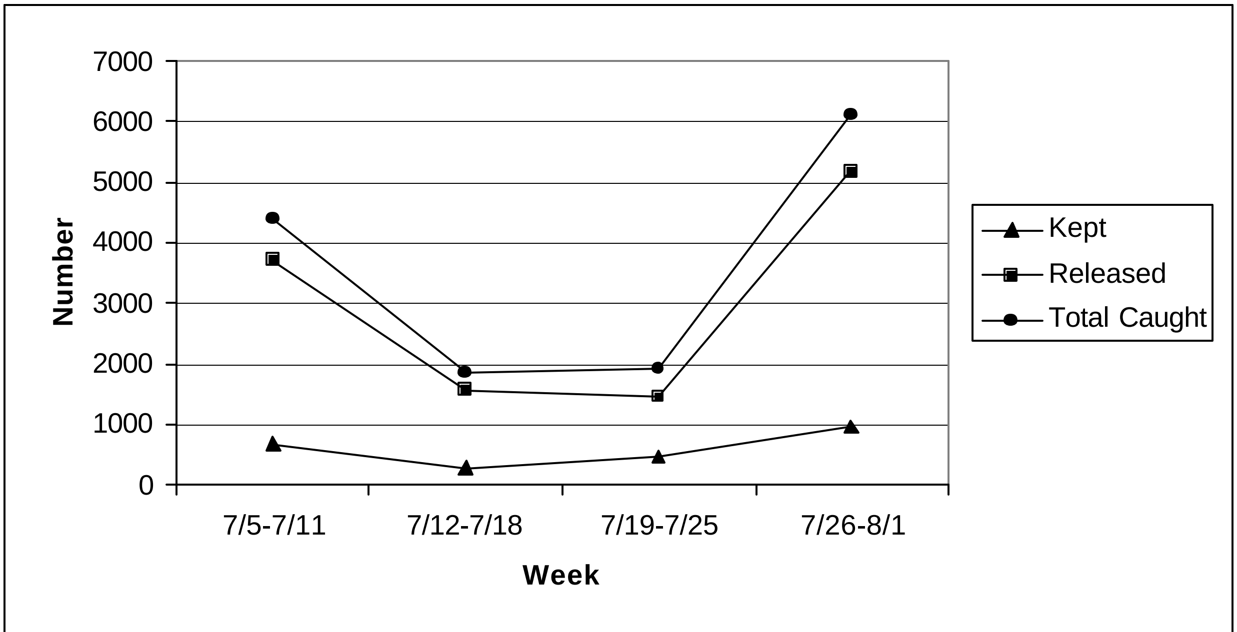

Figure 4. Catch of chinook salmon in Marine Area 5, by week, for the 2003 Chinook Selective Fishery. All chinook released are included in the "Released" data.

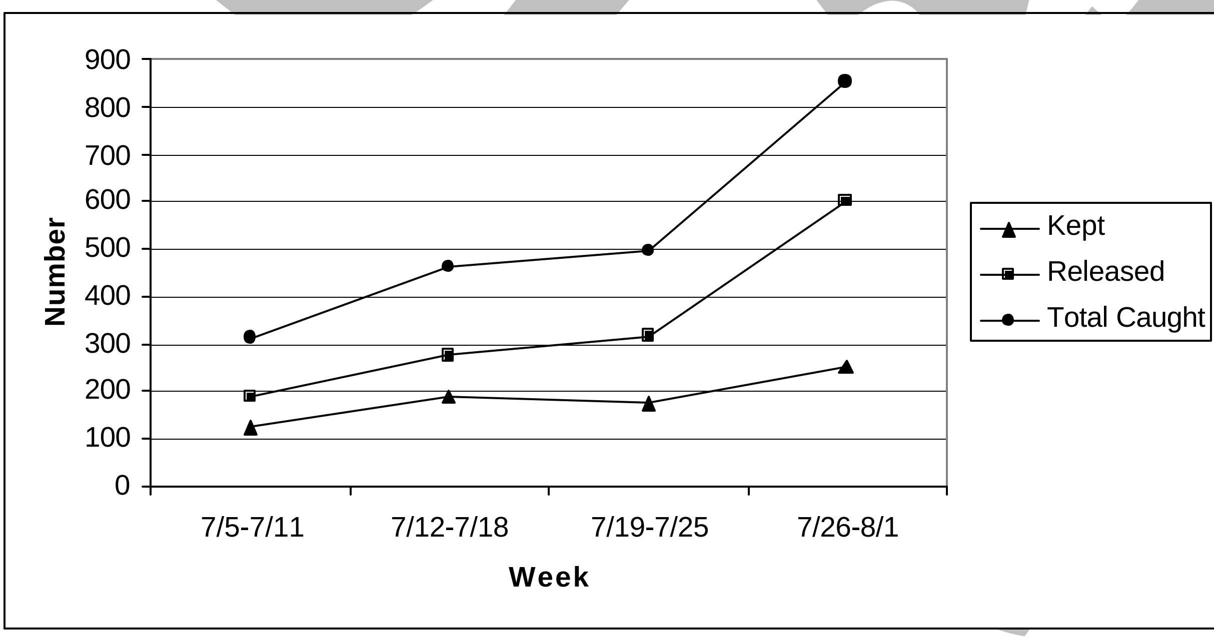

Figure 5. Catch of chinook salmon in Marine Area 6, by week, for the 2003 Chinook Selective Fishery. All chinook released are included in the "Released" data.

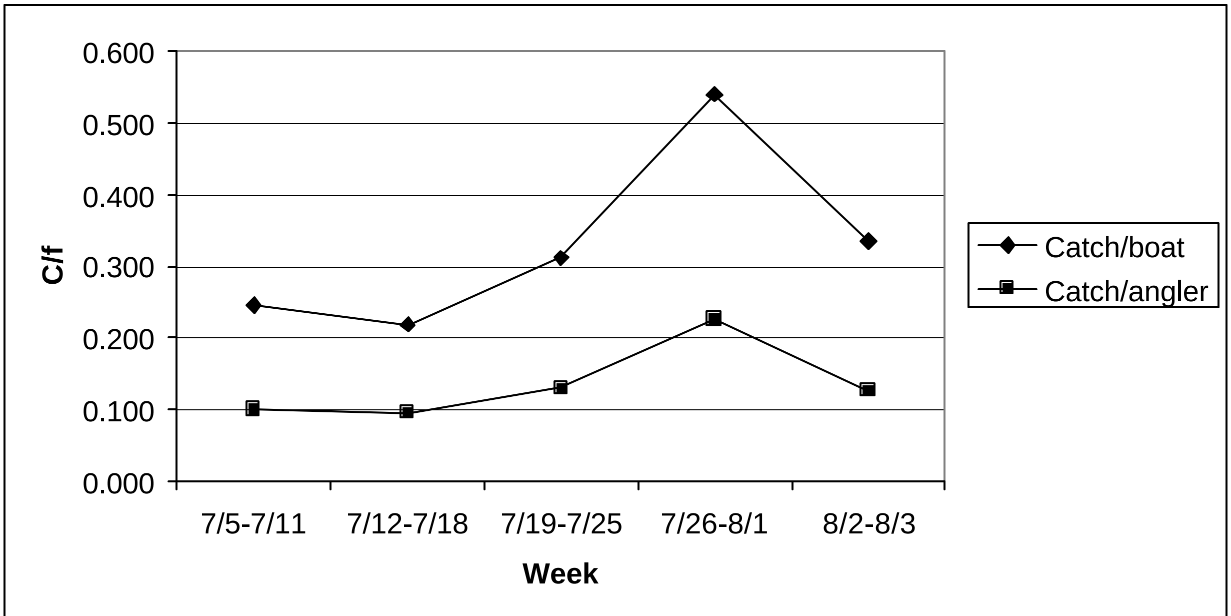

Figure 6. Catch per unit effort (C/f) for kept chinook salmon in Marine Area 5, by week, for the 2003 Chinook Selective Fishery. Note the last week includes only two days.

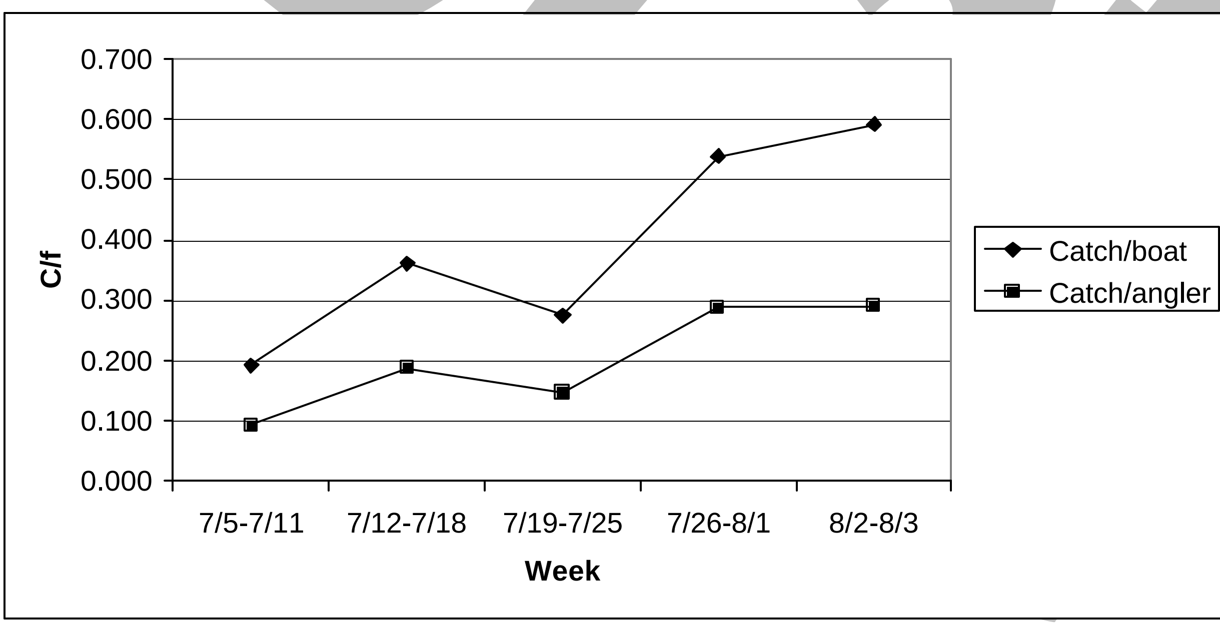

Figure 7. Catch per unit effort (C/f) for kept chinook salmon in Marine Area 6, by week, for the 2003 Chinook Selective Fishery. Note the last week includes only two days.

Mark Rate and Percent Legal

Test Fisheries

During the Chinook Selective Fishery (July 5-August 3), samplers fishing from the test boats caught 335 chinook in Area 5 and 148 chinook in Area 6 (Table 2). Most of the fish caught in Area 5 were between 40 and 75 cm (16 and 30"), whereas most of the fish caught in Area 6 were between 70 and 100 cm (28 and 39") (Figures 8 and 9). A significantly (X^2 = 99.8, ρ > 0.0001) higher percentage of legal-size chinook were caught in Area 6 (94%) versus Area 5 (46%). During the Chinook Selective Fishery time period, 44% of the legal-size fish were marked in Area 5 and 48% of the legal-size chinook were marked in Area 6 (Table 2). Based on these data, anglers could retain nearly one of every two legal-size chinook they encountered during the fishery. The mark rate for legal-size chinook in Area 5 generally declined from early July through mid-August while the mark rate of legal-size chinook in Area 6 generally increased during the same time period (Figure 10). The mark rate on sublegal chinook was 27% for Area 5 and 29% for Area 6.

Based on the continued test fishing in Area 5 directed at coho, the mark rate on chinook immediately following the closure of the Chinook Selective Fishery was not dissimilar from that observed during the fishery (Figure 10).

Table 2. Number of marked and unmarked, legal-size and sublegal-size chinook salmon caught by test boats during the Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3, 2003. Percent marked is a weighted weekly average and may not match exactly with the marked and unmarked values presented in the table.

	Legal-size			Sublegal-size			Total		
	Marked	Unmarked	% Marked	Marked	Unmarked	% Marked	Marked	Unmarked	% Marked
Area 5	67	88	44	48	132	27	115	220	35
Area 6	63	76	48	3	6	29	66	82	47

Voluntary Trip Reports (VTR's)

Anglers returned Voluntary Trip Reports (VTRs) from 139 boat trips in Areas 5 and 6 between July 5 and September 25. Of those, 53 (38%) were from one charter boat fishing out of Sekiu, and another 25 (18%) were from WDFW biologists fishing during their own time. The North Olympic Peninsula Chapter of Puget Sound Anglers contributed 36 (26%) of the reports. Based on the timing of the trips taken, and the size and species of the fish noted, most of the chinook data appear to be from reliable sources.

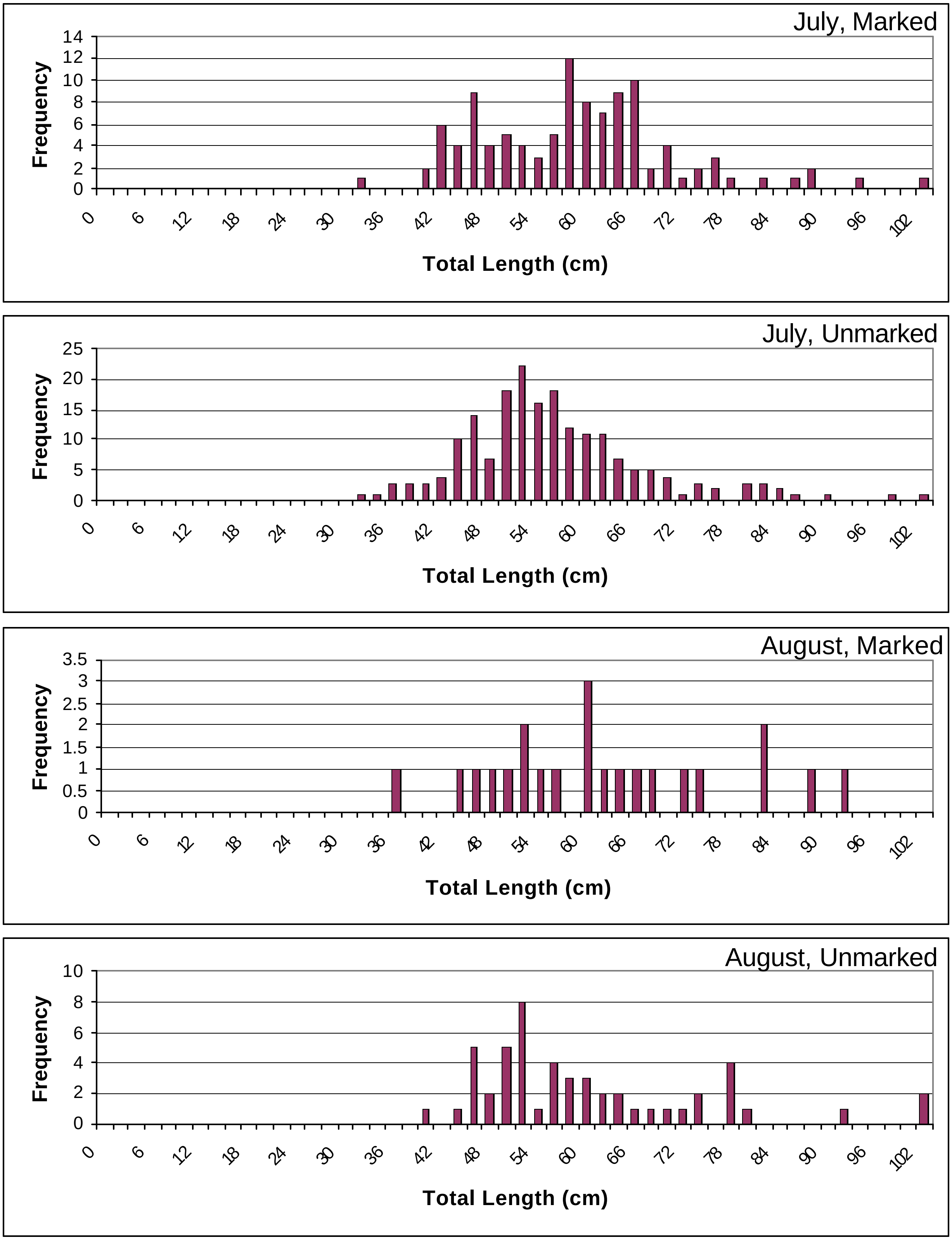

Figure 8. Length frequency histograms of chinook salmon caught by test fishing boats sampling from July 5 through August 3, 2003, in Marine Area 5.

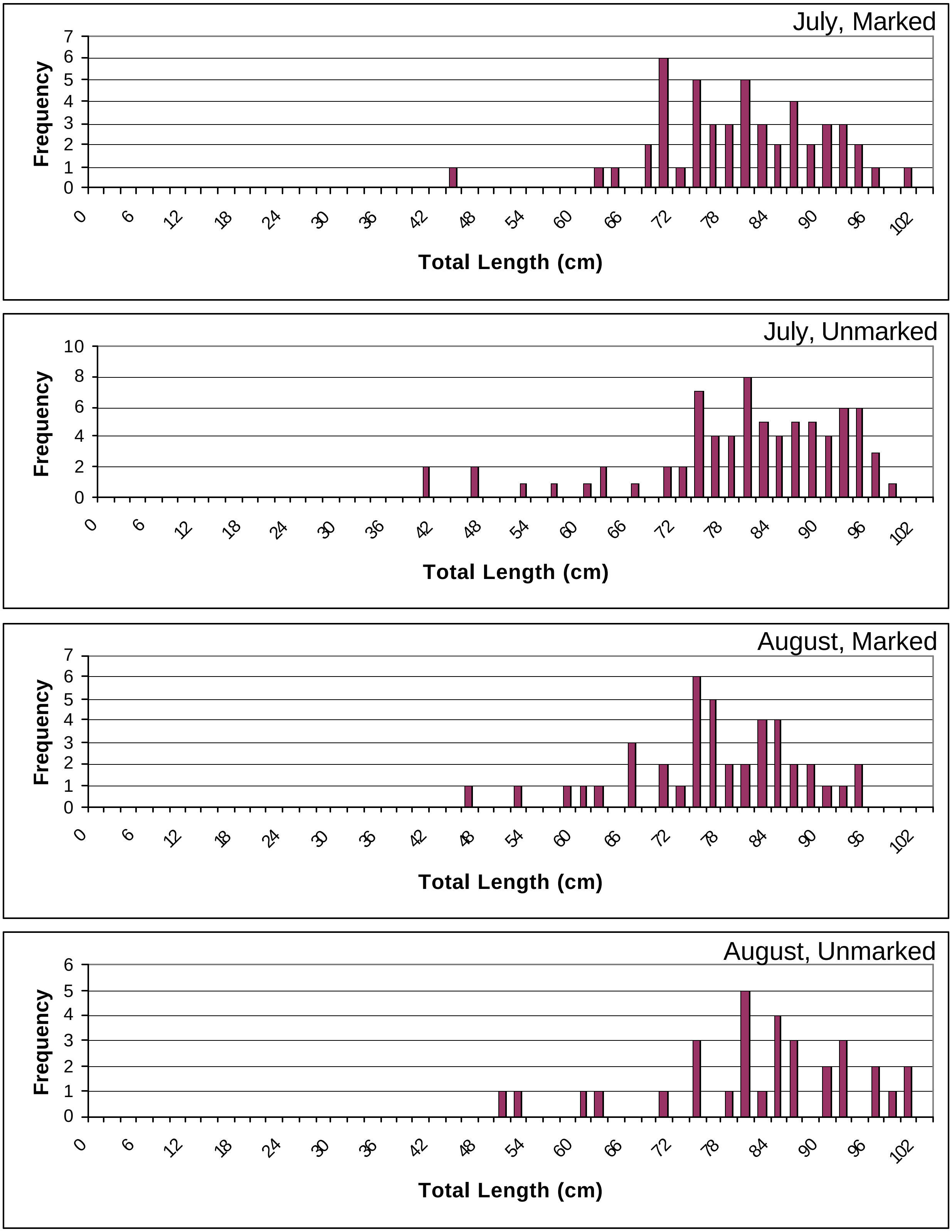

Figure 9. Length frequency histograms of chinook salmon caught by test fishing boats sampling from July 5 through August 3, 2003, in Marine Area 6.

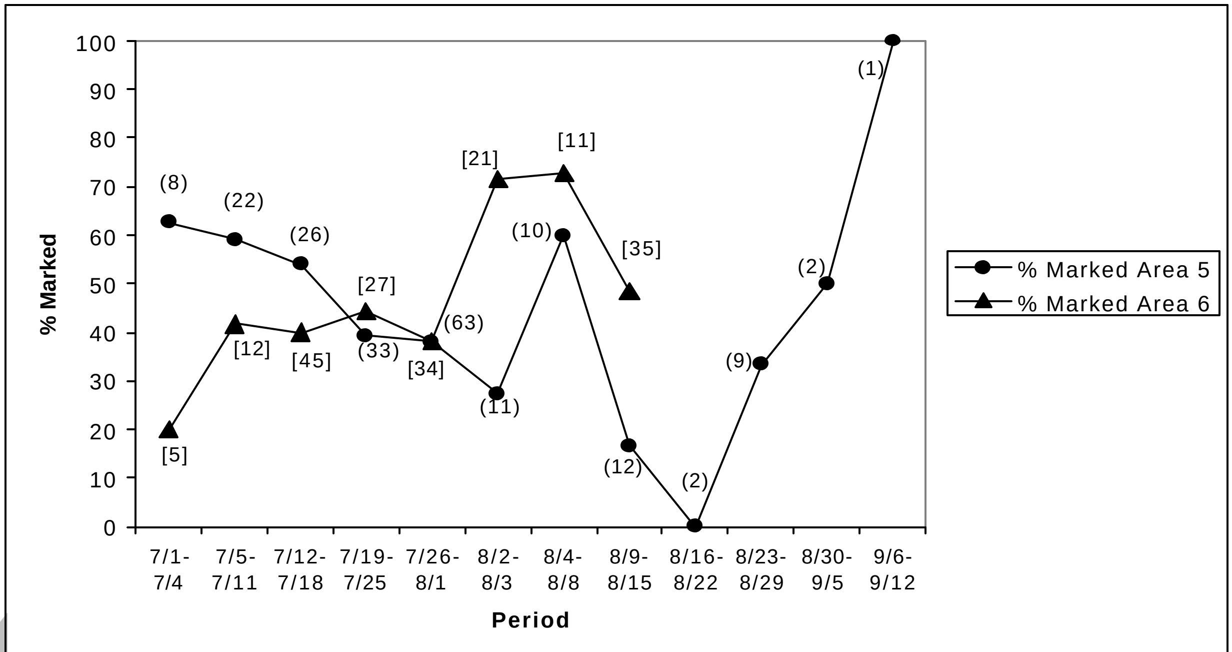

Figure 10. Mark rate (% adipose fin clipped) of legal-size chinook caught by WDFW test boats in Marine Areas 5 and 6 during 2003. Sample sizes for Marine Area 5 are in ( ), while sample sizes for Marine Area 6 are in [ ]. The Chinook Selective Fishery was from July 5 through August 3.

During the Chinook Selective Fishery the VTR's showed 179 chinook encountered in Area 5 and 80 chinook encountered in Area 6 (Table 3). In Area 5, 47% of the chinook were legal-size compared to 46% from the test fishing. In Area 6, 84% of the chinook encountered were legal-size compared to 94% from test fishing. The VTR information showed 42% of the legal-size fish were marked in Area 5 contrasted with 44% in the test fishery. In Area 6 the VTR results showed that 48% of the legal-size fish were marked which compared favorably with 48% observed in the test fishery. The mark rate on sublegal chinook for Area 5 was 40%. We were unable to calculate a weighted weekly average mark rate for sublegal chinook in Area 6 because the number of samples was too low. The mark rates of legal-size chinook were generally similar between VTR's and test boats (Figures 11 and 12).

Overall, the information on legal-size vs. sublegal-size chinook and mark rates was very similar to the test fishery results. This was likely due to the reports being filled out by anglers who were both experienced and conscientious.

Table 3. Number of marked and unmarked, legal-size and sublegal-size chinook salmon caught by volunteers during the Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3, 2003. Percent marked is a weighted weekly average and may not match exactly with the marked and unmarked values presented in the table.

	Legal-size			Sublegal-size			Total		
	Marked	Unmarked	% Marked	Marked	Unmarked	% Marked	Marked	Unmarked	% Marked
Area 5	37	48	42	30	64	40	67	112	40
Area 6	29	38	48	5	8	--[a]	34	46	48

a. The sample size was too low to calculate a weighted weekly average percent marked.

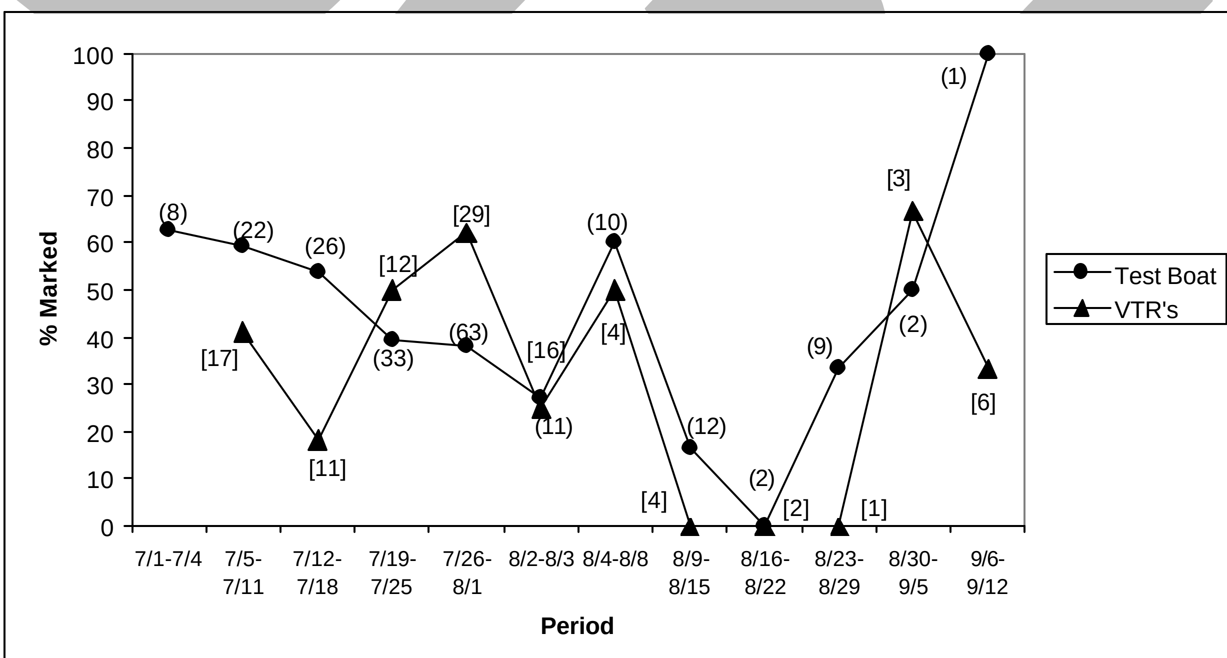

Figure 11. Mark rate (% adipose fin clipped) of legal-size chinook salmon caught by WDFW test boats and anglers recording their catch on Voluntary Trip Reports (VTR's) in Marine Area 5 during 2003. Sample sizes for test boat are in ( ), while sample sizes for VTR's are in [ ]. The Chinook Selective Fishery was from July 5 through August 3.

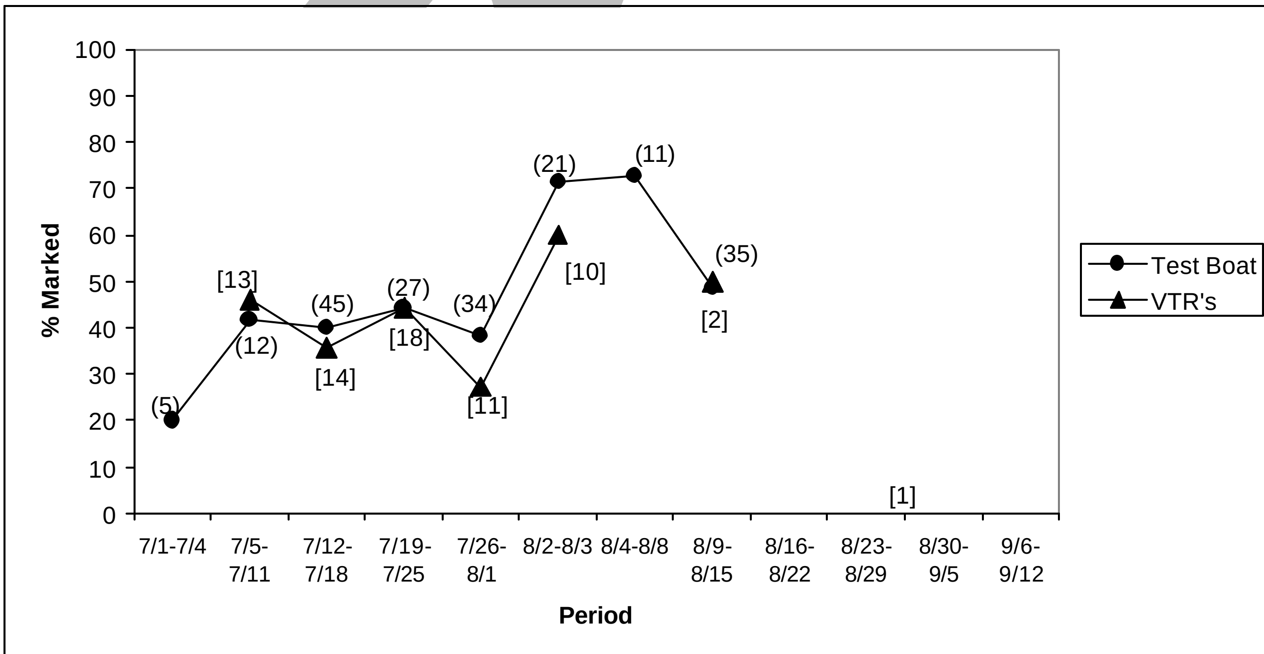

Figure 12. Mark rate (% adipose fin clipped) of legal-size chinook salmon caught by WDFW test boats and anglers recording their catch on Voluntary Trip Reports (VTR's) in Marine Area 6 during 2003. Sample sizes for test boat are in ( ), while sample sizes for VTR's are in [ ]. The Chinook Selective Fishery was from July 5 through August 3.

Summary of chinook kept and released during the Chinook Selective Fishery.

A total of 3,507 chinook were kept during the Chinook Selective Fishery. Of this total, 3,427 were marked and 82 were unmarked (Table 4). A total of 14,752 chinook were released during the Fishery based on angler interviews and the appropriate expansions. Of the total number of chinook released, 1,147 were marked and 14,026 were unmarked. This summary table uses the total chinook encounters estimated from the creel surveys, with encounters apportioned by the percentage of chinook in each category as measured during the test fishery.

Table 4. Estimates of chinook caught and released, by mark status, during the Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3, 2003.

	Total Caught	Marked Caught	Unmarked Caught	Total Released	Marked Released	Unmarked Released	Total Encounters	% Marked of Total Chinook Encounters
Area 5	2,535	2,477	59	13,019	2,913	10,105	15,555	21%
Area 6	972	950	23	1,733	311	1,423	2,705	36%
Total	3,507	3,427	82	14,752	1,147	14,026	18,759	

SALMON HANDLING REGULATION AND EDUCATION

Since anglers were required to release salmon without bringing the fish on board their vessel, we initiated a program to educate anglers about the new regulation, alternative methods of releasing fish, and fish identification. A WDFW biologist contacted anglers 3 or 4 days each week starting at first light and working until an 8 or 10 hour shift was completed. The intent was to contact anglers before they started fishing, although some anglers were contacted after their fishing trip. Shifts alternated between Sekiu and Port Angeles, and sites were selected where creel surveys were not being conducted to avoid confusing anglers with multiple Washington Department of Fish and Wildlife (WDFW) employees or "bothering" them multiple times. After identifying himself as a WDFW employee, anglers were queried as to their knowledge of techniques for releasing salmon. Receptive anglers were given a pamphlet describing selective fisheries and how to identify salmon species, and a "dehooker". The dehooker was designed to release recreational caught salmon without handling the fish or putting them in a net, and as a tool for easily determining whether chinook salmon exceeded the 22" minimum length. The dehooker is constructed from a 22" long, ½" diameter, wood dowel with a teacup hook in the end (Figure 13). Anglers unfamiliar with the dehooker were given a demonstration and instructed in the proper use of the dehooker. Anglers were also asked to avoid netting fish they were going to release.

Response to the new regulation and education efforts was mixed. Many of the experienced anglers had already developed their own methods to minimize handling stress and maximizing survival of released fish, including not using nets. These anglers were generally appreciative of the education effort, even though they gained little from the effort. Some experienced anglers liked the dehooker and preferred it to potentially dropping their own tools in the water. For some anglers, any attempt to limit their ability to handle fish was poorly received. Many of these anglers felt that it was unreasonable to handle fish without bringing them into the boat, while others felt that not using a net was impossible. They generally cited the following reasons: they didn't want to lose a fish (maybe their only chinook caught during the day) while trying to identify whether it was legal to keep or not; the fish were too wild and active to handle unless they were in a net; and/or the conditions were too rough to safely handle fish over the side of the boat without a net. Some of the anglers who had not used a dehooker in the past were pleased with how well it worked, and a few asked for additional dehookers to share with friends.

COMPLIANCE WITH REGULATIONS

Compliance with existing regulations, and the new regulation prohibiting bringing salmon on board a vessel if they were going to be released, was considered an integral part of a successful fishery. WDFW enforcement division conducted additional patrols and emphasis patrols to monitor compliance. Between July 5 and August 3, officers contacted 620 anglers in Area 5 and 226 anglers in Area 6. From those contacts, officers issued 5 citations and 3 warnings in Area 5, and 2 citations in Area 6, for retention of unmarked chinook. Two warnings were issued in Area 5 for bringing a salmon to be released on board a vessel, while no warnings or citations were issued for this regulation in Area 6. From the perspective of protecting wild chinook and ensuring proper handling during release, the high compliance rate suggests that these objectives were obtained.

SUMMARY

The first year of the pilot marine chinook selective sport fishery was successful with respect to the stated management objective of increasing meaningful recreational opportunity within conservation constraints for Puget Sound chinook. Anglers were allowed to fish for and retain chinook for 30 days in Areas 5 and 6, compared with only 5 days in Area 5 in 2002. Angler effort in Area 5 during 2003 was double the effort in 2002 during the same time frame, and likely was also double in Area 6. The rate of marked and retainable fish was greater than the pre-season expectation. Using data from the test fishery sampling during the Chinook Selective Fishery nearly half, or one in two of the legal-size chinook encountered were marked and could be retained by anglers. Compliance with fishing regulations was good during the fishery, and in general, programs aimed at public education to increase the awareness of proper fish release techniques were successful.

The pilot fishery was also successful with respect to the management objective of implementing monitoring and sampling programs to obtain information of management importance for evaluation and planning of potential future selective chinook fisheries.

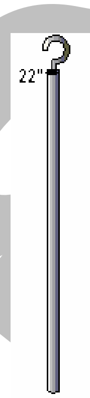

Figure 13. Schematic of "dehooker" given to anglers participating in the 2003 Chinook Selective Fishery in Marine Areas 5 and 6.

ACKNOWLEDGEMENTS

We thank the following individuals who contributed to this study. Donalynn Olson of Olson's Resort was extremely helpful in assisting WDFW with accommodations and office space. Chris Mohr and Harold VanRiper of Van Ripers Resort provided valuable advice and guidance regarding the fishery, and graciously provided a location for storage of WDFW equipment. The North Olympic Peninsula Chapter of Puget Sound Anglers spent many long hours assembling the dehookers, saving WDFW thousands of dollars. Numerous WDFW staff contributed to data collection and analysis. Larry Bennett, Connie Warren, and their crew collected much of this data and were quick to provide assistance with the education efforts. Mark Baltzell compiled the Voluntary Trip Reports and completed the necessary data analyses. Justin Secrist provided maps and other figures.

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Appendix A

Coded Wire Tag Impacts

To determine the number of mortalities of unmarked coded wire tagged chinook resulting from the fishery, we analyzed recovered coded wire tags and separated out tags from double index groups. We then utilized the methods described by WDFW (2002) to estimate the number of unmarked chinook with coded wire tags that would have been encountered, and applied a 15% selective fishing mortality rate to estimate the number of mortalities. Because the fishery sampling rate changed throughout the fishery and among areas, we estimated encounters and mortalities for each recovered double index tag individually, and then summed the estimated mortalities for each hatchery and brood year. Variance and standard error were also estimated with methods described by WDFW (2002), and were estimated for individual tags, then summed for each hatchery and brood year.

The estimated unmarked mortalities was calculated by:

$$\hat{U}_a^{MSF} = l^{REL}\,\hat{M}_a^{MSF}\,sfm$$

with associated variance:

$$Var(\hat{U}_a^{MSF}) \approx \left(l^{REL}\right)^2 sfm^2 \hat{M}_a^{MSF}\,\frac{1-s}{s}.$$

where:

sfm = selective fishing mortality rate,

$U_{a,i}^{MSF}$ = aged a unmarked but tagged mortalities from stock i in the mark-selective fishery,

$M_{a,i}^{MSF}$ = aged a marked and tagged mortalities from stock i in the mark-selective fishery,

s = sampling rate of the catch (0.20),

l^{REL} = unmarked to marked ratio at release for fish in a DIT group, and

V(U) = variance of estimator U.

Thirty six double index tags were recovered in Areas 5 and 6 from July 5 through August 3 (Appendix Table A-1). We estimated the selective fishing mortality on unmarked double index tagged chinook at 20 fish (Appendix Table A-2).

Appendix A

Table A-1. Observed harvested chinook salmon with Double Index Tag (DIT) coded wire tags during the 2003 Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3.

Area	Recovery Date	Tag Code	Brood Year	Rearing Hatchery	Release Site	Release Agency	Fork Length (CM)
05	Jul 21 2003	184124	1999	H-CHILLIWACK R	R-CHILLIWACK R	CDFO	
05	Jul 26 2003	184614	2000	H-CHILLIWACK R	R-CHILLIWACK R	CDFO	
05	Aug 1 2003	184916	2001	H-CHILLIWACK R	R-CHILLIWACK R	CDFO	56
05	Aug 1 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	68
06	Aug 3 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	78
05	Jul 25 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
05	Jul 27 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
06	Jul 6 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	75
05	Jul 13 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	57
06	Jul 25 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	54
06	Jul 26 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	78
06	Jul 30 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
06	Jul 30 2003	210153	1999	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	97
05	Aug 2 2003	210279	2000	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	55
06	Aug 3 2003	210279	2000	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	81
05	Jul 20 2003	210279	2000	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
05	Jul 26 2003	210279	2000	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
05	Jul 26 2003	210279	2000	GROVERS CR HATCHERY	GROVERS CR HATCHERY	SUQ	
05	Aug 1 2003	630171	1999	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	87
06	Aug 3 2003	630171	1999	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	79
05	Jul 8 2003	630171	1999	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	56
06	Jul 26 2003	630171	1999	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	77
06	Jul 30 2003	630171	1999	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	73
06	Jul 18 2003	630173	1999	SAMISH HATCHERY	FRIDAY CR + SAMISH R	WDFW	77
06	Aug 3 2003	630189	2000	NISQUALLY HATCHERY	CLEAR CR 11.0013C	NISQ	73
06	Jul 6 2003	630189	2000	NISQUALLY HATCHERY	CLEAR CR 11.0013C	NISQ	67
05	Jul 27 2003	630197	1999	MARBLEMOUNT HATCHERY	CASCADE R 03.1411	WDFW	
06	Jul 18 2003	630197	1999	MARBLEMOUNT HATCHERY	CASCADE R 03.1411	WDFW	76
05	Jul 7 2003	630668	2000	WALLACE R HATCHERY	WALLACE R 07.0940	WDFW	57
06	Jul 27 2003	630669	2000	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	
05	Jul 13 2003	630669	2000	SOOS CREEK HATCHERY	BIG SOOS CR 09.0072	WDFW	55
05	Aug 2 2003	630683	2000	GEORGE ADAMS HATCHRY	PURDY CR 16.0005	WDFW	69
05	Jul 27 2003	630683	2000	GEORGE ADAMS HATCHRY	PURDY CR 16.0005	WDFW	
06	Jul 24 2003	630683	2000	GEORGE ADAMS HATCHRY	PURDY CR 16.0005	WDFW	60
05	Jul 11, 2003	630687	2000	NISQUALLY HATCHERY	CLEAR CR 11.0013C	NISQ	56
05	Aug 1 2003	630687	2000	NISQUALLY HATCHERY	CLEAR CR 11.0013C	NISQ	53

Appendix A

Table A-2. Observed number of Double Index Tagged (DIT) chinook kept by anglers, and the estimated mortality of unmarked DIT chinook due to catch and release mortality, during the 2003 Chinook Selective Fishery in Marine Areas 5 and 6, July 5 through August 3.

Hatchery	Brood Year	DIT Tagged fish Observed	Estimated Harvest of Marked DIT fish	Estimated Angler Releases of UnMarked DIT fish	Estimated Mortality of Unmarked DIT fish	Variance of Estimated Mortality of DIT Fish	Standard Error of Estimated Mortality of DIT Fish
George Adams	2000	3	11.15	11.25	1.7	0.71	1.44
Grovers Creek	1999	10	35.01	34.90	5.2	2.16	4.42
Grovers Creek	2000	5	19.60	19.87	3.0	1.34	2.57
Chilliwack	1999	1	4.07	4.00	0.6	0.27	0.52
Chilliwack	2000	1	4.07	4.08	0.6	0.28	0.53
Chilliwack	2001	1	4.08	4.00	0.6	0.27	0.52
Marblemount	1999	2	6.54	6.66	1.0	0.38	0.83
Nisqually	2000	4	14.67	14.97	2.2	1.06	1.90
Samish	1999	1	2.47	2.61	0.4	0.09	0.30
Soos Creek	1999	5	18.9	19.33	2.9	1.36	2.48
Soos Creek	2000	2	8.62	8.99	1.3	0.78	1.18
Wallace	2000	1	5.62	5.55	0.8	0.57	0.76
Total		36			20.4		

Appendix B:
2003 Recreational Catch Estimate from Creel Survey for the Area 5 and 6 Chinook Selective Fishery

July 5 - August 3

	Chinook Retained			Chinook Released			
Area 5	**Marked**	**Un-marked**	**Total**	**Marked**	**Unmarked**	**Unknown**	**Total**
Estimate	2477	59	2535	483	10499	2038	13019
Variance	64195	131572	67377	7503	1351834	191650	2107802
Area 6	**Marked**	**Un-marked**	**Total**	**Marked**	**Unmarked**	**Unknown**	**Total**
Estimate	950	23	972	40	1613	80	1732
Variance	8386	17822	9436	105	24427	839	30128
Total	**3426**	**81**	**3507**	**523**	**12112**	**2118**	**14751**
Variance	72580	149393	76813	7608	1376260	192490	2137930

Weekly Catches

	Chinook Retained			Chinook Released				
Area 5	**Marked**	**Un-marked**	**Total**	**Marked**	**Unmarked**	**Unknown**	**Total**	**Week**
Estimate	251	12	263	62	894	229	1184	27
Variance	4502	9934	5432	829	30241	3660	66616	
Estimate	613	17	630	232	2657	709	3598	28
Variance	14915	29805	14890	4771	518188	42625	614519	
Estimate	242	2	244	23	1008	116	1147	29
Variance	2675	5406	2731	307	42620	3084	49256	
Estimate	595	11	606	73	2131	156	2360	30
Variance	20055	41913	21858	1163	422427	8080	561365	
Estimate	775	16	792	94	3808	829	4730	31
Variance	22048	44514	22466	434	338358	134201	816047	
Total	2477	59	2535	483	10499	2038	13019	
Variance	64195	131572	67377	7503	1351834	191650	2107802	

	Chinook Retained			Chinook Released				
Area 5	**Marked**	**Un-marked**	**Total**	**Marked**	**Unmarked**	**Unknown**	**Total**	**Week**
Estimate	43	0	43	2	98	0	99	27
Variance	14	29	14	1	2372	0	2381	
Estimate	144	2	146	7	197	6	210	28
Variance	430	856	426	7	171	9	198	
Estimate	164	4	168	0	266	11	277	29
Variance	260	552	292	0	2193	12	2331	
Estimate	237	5	243	19	488	18	525	30
Variance	1211	2524	1313	63	6142	33	6429	
Estimate	361	11	372	12	564	44	620	31
Variance	6472	13861	7390	34	13550	785	18787	
Total	950	23	972	40	1613	80	1732	
Variance	8386	17822	9436	105	24427	839	30128	

Appendix C:

Chinook Mortalities in the Recreational Chinook Selective Fisheries in Areas 5 and 6

July 5 - August 3, 2003

Area 5

Total Encounters (E) **15555** (2535 Retained + 13020 Released from Creel Estimate)

V(E) 2175179

Test fishing proportions are used to split total encounters into legal marked/legal un-marked/sub-legal marked/sub-legal unmarked

	Test Fishery	V(TF)	Encounters	Retained	V(Ret)	Mort Rate	Mortality	Released	sfm	Mortality	Total Mort	VAR	StErr	LCI	UCI	%SE
% legal marked	0.198	0.0025	3076	2477	64195	100%	2476.5	600	15%	90	2566	61885	249	2079	3054	0.097
% legal Unmarked	0.254	0.0044	3948	59	131572	100%	58.6	3890	15%	583	642	122189	350	-43	1327	0.544
% sub-legal marked	0.149	0.0022	2314					2314	20%	463	463	22972	152	166	760	0.328
% sub-legal unmarked	0.400	0.0037	6216					6216	20%	1243	1243	50030	224	805	1682	0.180
Total			**15555**				**2535**			**2379**	**4915**					

Area 6

Total Encounters (E) **2705** (972 Retained + 1732 Released from Creel Estimate)

V(E) 39564

Test fishing proportions are used to split total encounters into legal marked/legal un-marked/sub-legal marked/sub-legal unmarked

	Test Fishery	V(TF)	Encounters	Retained	V(Ret)	Mort Rate	Mortality	Released	sfm	Mortality	Total Mort	VAR	StErr	LCI	UCI	%SE
% legal marked	0.438	0.0027	1186	950	8386	100%	949.5	237	15%	35	985	6675	82	825	1145	0.083
% legal Unmarked	0.486	0.0095	1314	23	17822	100%	22.5	1292	15%	194	216	14651	121	-21	454	0.560
% sub-legal marked	0.027	na	74					74	20%	15	15	na	na	na	na	na
% sub-legal unmarked	0.048	na	131					131	20%	26	26	na	na	na	na	na
Total			**2705**				**972**			**270**	**1242**					

Computation of Variance on Total Mortality

E = Encounters

PPN Test = Proportions legal marked or legal unmarked or sub-legal marked or sub-legal unmarked from test fishery

sfm = Selective Fishery Mortality Rate

Variance = (1-sfm)^2 * V(Ret) + (E^2 * V(TF) + V(Tot Enc) * PPN Test^2) * sfm^2

Appendix D:
2003 Area 5 and 6 Chinook Selective Fishery Mark Rate Summary by Method

July 5 -August 3

	VTR			Test			Creel
Area 5	**Legal**	**Sub-Legal**	**Total**	**Legal**	**Sub-Legal**	**Total**	**Total**
Mark Rate	**0.421**	**0.399**	**0.396**	**0.442**	**0.271**	**0.347**	**0.21397**
Variance	0.0145	0.0797	0.0060	0.0130	0.0067	0.0087	0.0008
Area 6	**Legal**	**Sub-Legal**	**Total**	**Legal**	**Sub-Legal**	**Total**	**Total**
Mark Rate	**0.478**	**na**	**0.478**	**0.478**	**0.293**	**0.466**	**0.358**
Variance	0.0111	na	0.0122	0.0064	na	0.0051	0.0015

Weighted Mark Rate Computation

W_i = Catch week i

X_i = Mark Rate week i

$$\frac{\sum W_i X_i}{\sum W_i}$$

Computation of Variance of Weighted Mark Rate

W_i = Catch week i

X_i = Mark Rate week i

$\overline{X}$ = Weighted Mark Rate

$$\frac{\sum W_i (X_i - \overline{X})^2}{\sum W_i - 1}$$

Appendix E:
Area 5 Chinook Mark Rates from Voluntary Trip Reports (VTR)

Chinook Encounters from VTRs by Legal/Sub-legal and Marked/Un-marked

Week		27	28	29	30	31	Grand Total
Legal	Marked	4	4	1	10	18	**37**
	Unmarked	4	8	7	9	20	**48**
Sublegal	Marked	2	6	9	3	10	**30**
	Unmarked	8	1	8	17	30	**64**

Rates	27	28	29	30	31	Average Rate
Legal Mark Rate	50%	33%	13%	53%	47%	**39%**
Sublegal Mark Rate	20%	86%	53%	15%	25%	**40%**
Combined Mark Rate	33%	53%	40%	33%	36%	**39%**
% Legal & Marked	22%	21%	4%	26%	23%	**19%**
% Legal & Un-Marked	22%	42%	28%	23%	26%	**28%**
% Sub & Marked	11%	32%	36%	8%	13%	**20%**
% Sub & Un-Marked	44%	5%	32%	44%	38%	**33%**

Weighted Rates	27	28	29	30	31	Weighted Mark Rate	Variance
% Catch	0.104	0.249	0.096	0.239	0.312		
Legal MR	0.0519	0.0828	0.0120	0.1258	0.1479	**0.421**	0.0145
Sub MR	0.0208	0.2130	0.0510	0.0359	0.0781	**0.399**	0.0797
Comb MR	0.0346	0.1308	0.0385	0.0797	0.1121	**0.396**	0.0060
% Legal & Marked	0.0231	0.0523	0.0039	0.0613	0.0721	**0.213**	0.0034
% Legal & Un-Marked	0.0231	0.1046	0.0270	0.0552	0.0801	**0.290**	0.0059
% Sub & Marked	0.0115	0.0785	0.0347	0.0184	0.0400	**0.183**	0.0116
% Sub & Un-Marked	0.0461	0.0131	0.0308	0.1042	0.1201	**0.314**	0.0239

Appendix F:
Area 6 Chinook Mark Rates from Voluntary Trip Reports (VTR)

Chinook Encounters from VTRs by Legal/Sub-legal and Marked/Un-marked

Week		27	28	29	30	31	Grand Total
Legal	Marked	3	6	4	9	6	**28**
	Unmarked	3	13	5	13	4	**38**
Sublegal	Marked				5		**5**
	Unmarked		2		6		**8**

Rates	27	28	29	30	31	Average Rate
Legal Mark Rate	50%	32%	44%	41%	60%	**45%**
Sublegal Mark Rate		0%		45%		**23%**
Combined Mark Rate	50%	29%	44%	42%	60%	**45%**
% Legal & Marked	50%	29%	44%	27%	60%	**42%**
% Legal & Un-Marked	50%	62%	56%	39%	40%	**49%**
% Sub & Marked				15%		**15%**
% Sub & Un-Marked		10%		18%		**14%**

Weighted Rates	27	28	29	30	31	Weighted Mark Rate	Variance
% Catch	0.044	0.150	0.173	0.250	0.383		
Legal MR	0.0221	0.0474	0.0769	0.1021	0.2298	**0.478**	0.0111
Sub MR	na	na	na	na	na	**na**	na
Comb MR	0.0221	0.0429	0.0769	0.1059	0.2298	**0.478**	0.0122
% Legal & Marked	0.0221	0.0429	0.0769	0.0681	0.2298	**0.440**	0.0205
% Legal & Un-Marked	0.0221	0.0929	0.0962	0.0983	0.1532	**0.463**	0.0079
% Sub & Marked	na	na	na	na	na	**na**	na
% Sub & Un-Marked	na	na	na	na	na	**na**	na

Appendix G:
Area 5 Chinook Mark Rates from Test Fishery

Chinook Encounters from Test Fishery by Legal/Sub-legal and Marked/Un-marked

Week		**27**	**28**	**29**	**30**	**31**	**Grand Total**
Legal	Marked	6	12	19	8	22	**67**
	Unmarked	2	14	21	14	37	**88**
Sublegal	Marked	5	10	13	7	13	**48**
	Unmarked	5	34	29	20	44	**132**

Rates	**27**	**28**	**29**	**30**	**31**	Average Rate
Legal Mark Rate	75%	46%	48%	36%	37%	**48%**
Sublegal Mark Rate	50%	23%	31%	26%	23%	**30%**
Combined Mark Rate	61%	31%	39%	31%	30%	**38%**
% Legal & Marked	33%	17%	23%	16%	19%	**22%**
% Legal & Un-Marked	11%	20%	26%	29%	32%	**23%**
% Sub & Marked	28%	14%	16%	14%	11%	**17%**
% Sub & Un-Marked	28%	49%	35%	41%	38%	**38%**

Weighted Rates	27	28	29	30	31	Weighted Mark Rate	Variance
% Catch	0.104	0.249	0.096	0.239	0.312		
Legal MR	0.0778	0.1147	0.0457	0.0869	0.1165	**0.4417**	0.0130
Sub MR	0.0519	0.0565	0.0298	0.0620	0.0712	**0.2714**	0.0067
Comb MR	0.0634	0.0781	0.0376	0.0732	0.0942	**0.3465**	0.0087
% Legal & Marked	0.0346	0.0426	0.0223	0.0390	0.0592	**0.1978**	0.0025
% Legal & Un-Marked	0.0115	0.0497	0.0247	0.0683	0.0996	**0.2538**	0.0044
% Sub & Marked	0.0288	0.0355	0.0153	0.0342	0.0350	**0.1487**	0.0022
% Sub & Un-Marked	0.0288	0.1207	0.0341	0.0976	0.1185	**0.3996**	0.0037

Appendix H:
Area 6 Chinook Mark Rates from Test Fishery

Chinook Encounters from Test Fishery by Legal/Sub-legal and Marked/Un-marked

Week		**27**	**28**	**29**	**30**	**31**	**Grand Total**
Legal	Marked		10	18	16	19	**63**
	Unmarked		15	24	23	14	**76**
Sublegal	Marked				1	2	**3**
	Unmarked			1	2	3	**6**

Rates	**27**	**28**	**29**	**30**	**31**	Average Rate
Legal Mark Rate		40%	43%	41%	58%	**45%**
Sublegal Mark Rate			0%	33%	40%	**24%**
Combined Mark Rate		40%	42%	40%	55%	**44%**
% Legal & Marked		40%	42%	38%	50%	**42%**
% Legal & Un-Marked		60%	56%	55%	37%	**52%**
% Sub & Marked				2%	5%	**4%**
% Sub & Un-Marked			2%	5%	8%	**5%**

Weighted Rates	27	28	29	30	31	Weighted Mark Rate	Variance
% Catch		0.157	0.181	0.261	0.401		
Legal MR	0.0000	0.0628	0.0776	0.1072	0.2307	**0.4783**	0.0064
Sub MR	0.0000	0.0000	0.0000	0.1033	0.1901	**0.2934**	na
Comb MR	0.0000	0.0628	0.0758	0.1057	0.2215	**0.4658**	0.0051
% Legal & Marked	0.0000	0.0628	0.0758	0.0995	0.2004	**0.4385**	0.0027
% Legal & Un-Marked	0.0000	0.0942	0.1011	0.1430	0.1476	**0.4859**	0.0095
% Sub & Marked	0.0000	0.0000	0.0000	0.0062	0.0211	**0.0273**	na
% Sub & Un-Marked	0.0000	0.0000	0.0042	0.0124	0.0316	**0.0483**	na

Appendix I:

Area 5 Chinook Mark Rates from Creel Survey (unexpanded interview data)

Week	27	28	29	30	31	Grand Total
Retained Chinook Sampled	71	112	57	149	194	583
Retained Chinook Marked	68	108	56	148	189	569
Released Chinook	357	655	272	648	1236	3168
Released Chinook Un-marked	265	489	239	580	1034	2607
Released Chinook Marked	23	48	6	19	32	128
Released Chinook Unknown Mark Status	69	118	27	49	170	433
Mark Rate	25%	24%	21%	22%	18%	22%

Weighted Rates	**27**	**28**	**29**	**30**	**31**	Weighted Mark Rate	Variance
% Catch	0.104	0.249	0.096	0.239	0.312		
Mark Rate	0.026	0.060	0.020	0.053	0.055	0.214	0.0008

Area 6 Chinook Mark Rates from Creel Survey (unexpanded interview data)

Week	27	28	29	30	31	Grand Total
Retained Chinook Sampled	23	73	68	81	120	365
Retained Chinook Marked	23	72	66	79	116	356
Released Chinook	32	107	121	214	248	722
Released Chinook Un-marked	31	100	116	191	225	663
Released Chinook Marked	1	4	0	11	5	21
Released Chinook Unknown Mark Status	0	3	5	12	18	38
Mark Rate	44%	43%	36%	32%	35%	36%

Weighted Rates	**27**	**28**	**29**	**30**	**31**	Weighted Mark Rate	Variance
% Catch	0.044	0.150	0.173	0.250	0.383		
Mark Rate	0.019	0.064	0.062	0.079	0.132	0.358	0.0015

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2003 Carbon River Selective Chinook Fishery
Angler Creel Survey Report

Fish Management
District 11

March 15, 2004

Washington Department of FISH AND WILDLIFE

Washington Department of Fish and Wildlife
Fish Program
600 Capitol Way North
Olympia, Washington 98501

DRAFT

INTRODUCTION

The Washington Department of Fish and Wildlife (WDFW) conducted a creel survey of a chinook selective fishery on the Carbon River in the fall of 2003. This survey was designed to estimate angler effort, numbers of salmon kept and released by species, and percent of chinook that were marked (adipose fin clipped).

WDFW implemented a pilot chinook selective recreational fishery on the Carbon River in 2003, which was one of very few selective salmon fisheries occurring in freshwater in Washington. Regulations, detailed in the Sport Fishing Rules 2003/2004 pamphlet can be summarized as follows:

> Salmon fishing was open from the mouth of the Carbon River to Voights Creek (approximately 4 miles), from September 1 through November 30, 2003. Daily limit 6 salmon. No more than 4 adults may be retained, of which no more than 2 may be adult hatchery chinook. Release wild adult chinook and chum.

This survey provided initial data sets for angler participation and catch numbers during the salmon fishery in the Carbon River.

METHODS

Data Collection

We used a random stratified creel survey conducted at two access sites to monitor Carbon River recreational fishery. Sampling was stratified by weekday and weekend days, as well as by time of day (1st half of daylight period, 2nd half of daylight period). Sampling occurred during three randomly selected weekdays and both weekend days during each of the nine weeks of the survey. The creel survey period was from September 2 through October 31, covering two of the three months that salmon fishing is open on the Carbon River. A total of 41 of the 60 days of the survey period were sampled: 15 weekend days and 26 weekdays. Expected chinook catches after October 31 were likely negligible.

We did not sample the opening day of the fishery, September 1. However, angler effort and fish encounters were expanded to account for this day by using data collected on Saturday, September 6. September 6 was the first weekend day sampled, and would most closely represent angler effort and fish encounters that occurred on September 1.

Sampling days were stratified into AM and PM strata. Each stratum represented half of the available fishing hours each day. The WDFW imposes a nighttime closure for all fisheries on the Carbon River, thus limiting the available fishing hours. Therefore, a total of four sampling strata were established, weekday AM, weekday PM, weekend AM, and weekend PM.

Creel surveys were conducted at two access sites to the Carbon River. The recreational salmon fishery on the Carbon River is open from the mouth upstream approximately four miles to the confluence with Voights Creek. This primarily shore-based fishery is accessed through two primary access sites (the Sewage Treatment Facility at river mile 2.0 and the Grange Hall at river mile 3.8). These two sites were selected to conduct angler interviews and periodic counts of vehicles.

To collect data needed to estimate angler effort and fish encounters, WDFW interviewed anglers at the Sewage Treatment Facility and Grange Hall access sites. Anglers returning to vehicles were asked what time they started and stopped fishing, what species they were targeting, how many of each species they caught and kept, how many they released, and whether the fish they encountered were adipose-fin clipped. Anglers were also questioned to determine the number of anglers per vehicle.

Periodic vehicle counts were conducted at the two access sites. At the beginning and end of each stratum, surveyors counted vehicles at the access sites, then again roughly every two hours through the stratum. A total of four counts were made for each stratum.

Angler effort and fish encounters were estimated using data collected during angler interviews and vehicle counts. These data were used to estimate weekly catch and effort in the fishery. Weekly effort was estimated by averaging effort estimates from AM and PM strata, then expanding by weekday and weekend day strata.

Data Analysis

We estimated angler effort using vehicle counts and anglers per vehicle. Each stratum was divided into three time segments as dictated by the time of each vehicle count. The number of vehicles from each count was multiplied by the number of anglers per vehicle (as observed in the angler interviews during that stratum) to estimate the number of anglers participating in the fishery during that time segment. This was then expanded to angler hours by multiplying the number of anglers participating in the fishery during each time segment by the duration of the time period within each segment (between vehicle counts). Total angling hours for each time segment were then summed to estimate total angling hours for the stratum.

After calculating angler effort, fish encounters were estimated. Harvest Per Unit Effort (HPUE) and Catch Per Unit Effort (CPUE) were estimated from data collected during angler interviews and vehicle counts. The total number of reported fish kept by anglers and fish encounters were divided by the total angling hours for each stratum to estimate HPUE and CPUE. To estimate total fish kept and encountered, HPUE and CPUE were multiplied by the estimated total angling hours per strata.

We supplemented the creel survey by conducting a total count of all anglers on the river and all vehicles at access sites. On October 8, a WDFW surveyor walked the 4-mile stretch of the Carbon River open to the recreational salmon fishery with a Garmin GPS 76 and counted and mapped all anglers. From the mouth of the Carbon River upstream to the confluence with Voights Creek, 105 anglers were counted and mapped. On this same day, 61 vehicles were counted at access sites. An interesting result of this effort is that anglers were evenly distributed throughout the four-mile area.

RESULTS

This survey provided initial data sets for angler effort and fish encounters during the recreational salmon fishery on the Carbon River. Since 2003 was the first year WDFW conducted a creel survey on the Carbon River, the agency expected to learn more about angler effort patterns. Data used to estimate angler effort and fish encounters came from 1,842 anglers interviewed during the survey.

Anglers spent an estimated 55,981 hours fishing the Carbon River from September 1 through October 31, 2003 (Figure 1). These anglers kept an estimated 1,287 chinook, 3,966 coho, and 2,936 pink salmon (Table 1). They also reported releasing 1,718 chinook, 3,253 coho, and 11,225 pink salmon.

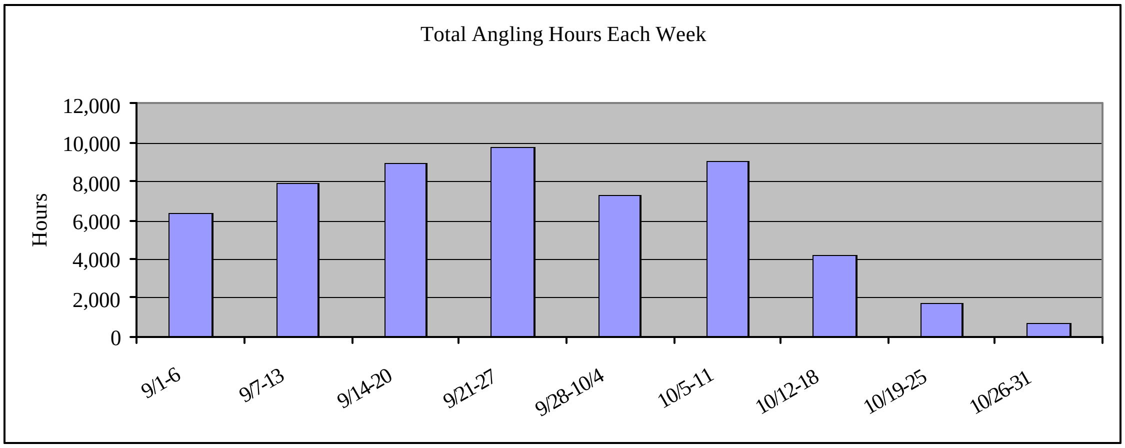

Figure 1. Total estimated angler hours each week.

Table 1. The actual number of chinook observed during the creel survey and the expanded number for the fishery.

Origin	Kept fish		Released fish	
	Observed	Expanded	Reported	Expanded
Marked	171	1,202	135	832
Unmarked	9	79	105	635
Mark status unknown [1/]	1	6	33	251
Total	181	1,287	273	1,718

Note 1/ - The one "observed chinook" with unknown mark status, was covered in a bag and the angler refused to be sampled. It was recorded as a chinook because of its large size.

Biological data were collected from 178 of the chinook kept. Of these chinook, only two were less than 24 inches. Therefore, jack chinook contribution to the number of chinook kept was very low.

The estimated retention of 79 unclipped chinook was expanded from nine unclipped fish observed during angler interviews. Biological samples were collected on six of these fish and all were longer than 24 inches. Of the few anglers retaining unmarked chinook, most seemed to be unaware of the newly implemented chinook selective fishery regulation.

Figures 2 and 3 illustrate the trend of chinook encounters during the 2003 Carbon River fishery.

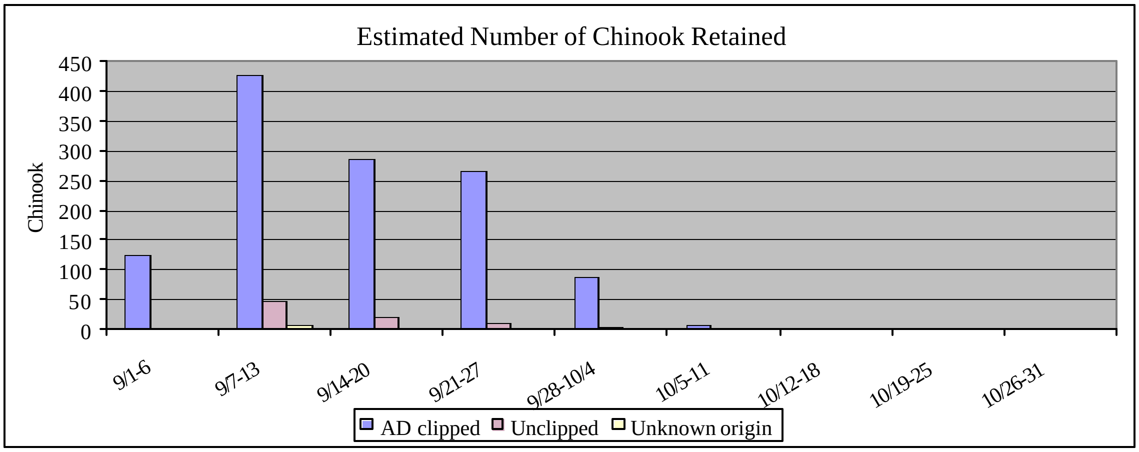

Figure 2. Estimated number of chinook kept by week during the 2003 recreational salmon fishery on the Carbon River.

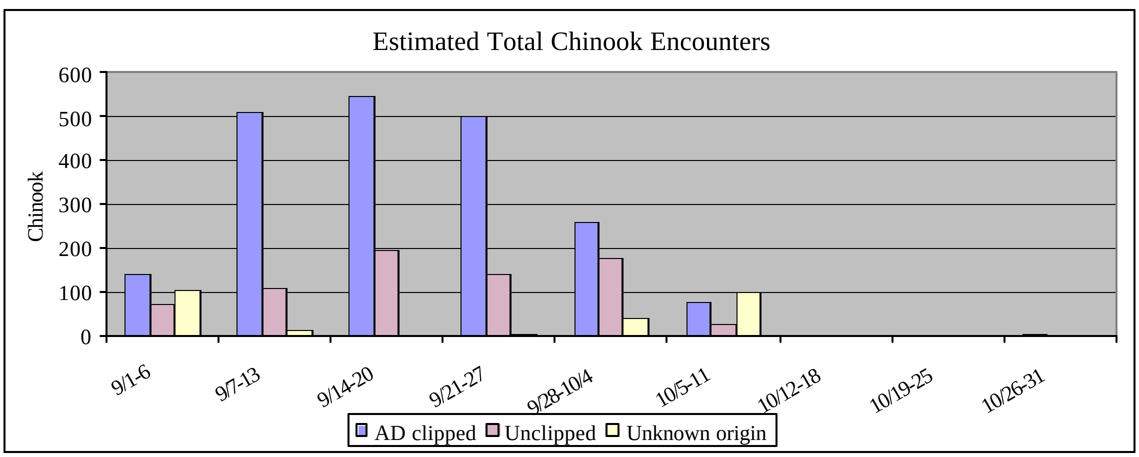

Figure 3. Estimated total chinook encounters by week during the 2003 recreational salmon fishery on the Carbon River

Coho and pink salmon were also kept during the 2003 recreational Carbon River salmon fishery. An estimated 3,966 coho were kept during September and October and another 3,253 were released (Table 2).

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Table 2. The actual number of coho and pink salmon observed during the creel survey and the expanded number for the fishery.

Origin	Coho				Pink salmon			
	Kept fish		Released fish		Kept fish		Released fish	
	Observed	Expanded	Reported	Expanded	Observed	Expanded	Reported	Expanded
Marked	410	3,439	60	588				
Unmarked	57	485	6	52				
Mark status unknown	3	42	242	2,613				
Total	470	3,966	308	3,253	346	2,936	1,559	11,225

Note 1/ - The three "observed coho" with unknown mark status were filleted on the river prior to being sampled by the interviewer.

Figures 4 and 5 illustrate the trend of coho encounters during the 2003 Carbon River fishers.

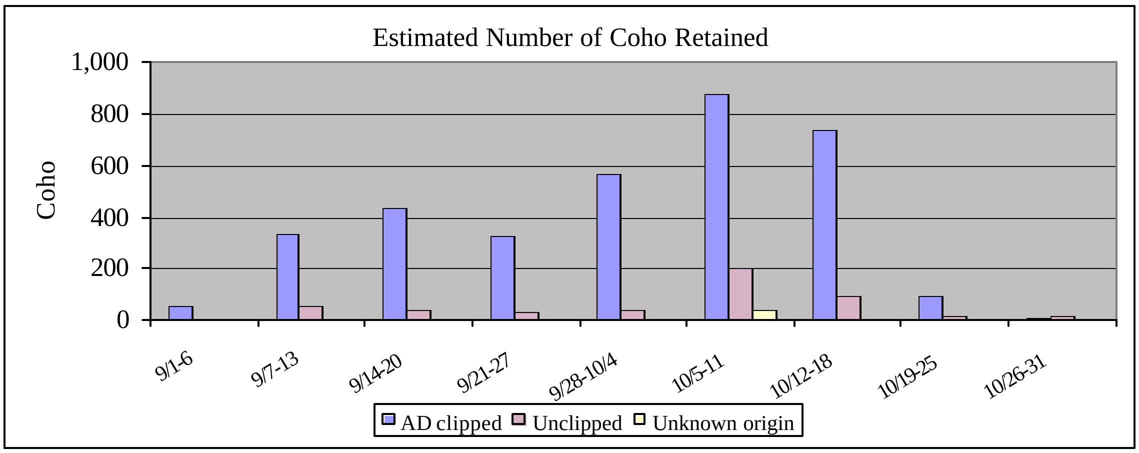

Figure 4. Estimated number of coho retained by week during the2003 recreational salmon fishery on the Carbon River.

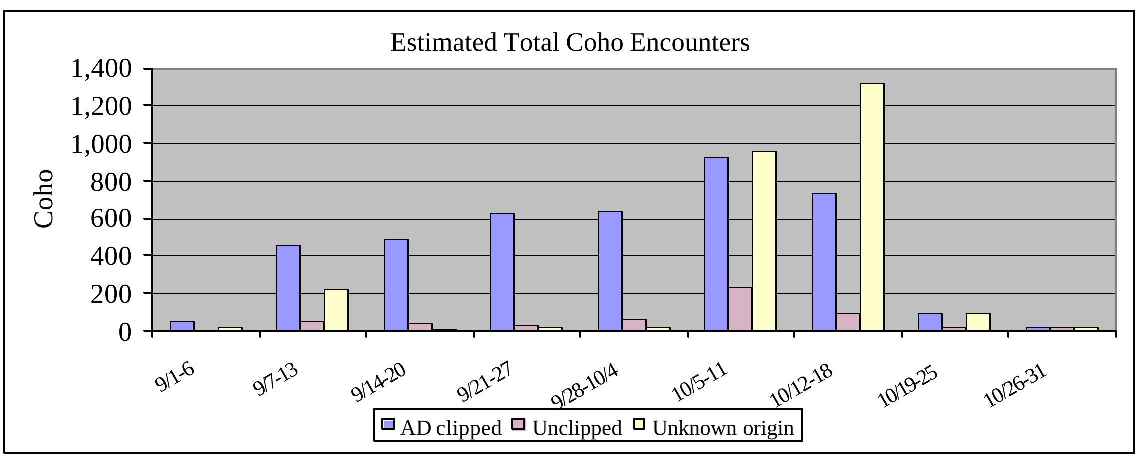

Figure 5. Estimated total coho encounters by week during the 2003 recreational salmon fishery on the Carbon River.

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An estimated 2,936 pink salmon were kept during September and October. More impressively, anglers reported releasing an estimated 11,225 pink salmon during the fishery.

The preliminary 2003 escapement estimate for pink salmon in the Puyallup River is nearly 200,000. This is by far the largest run of pink salmon in over 30 years. Since 1971 the average run size of pink salmon to the Puyallup River system has been about 40,000 fish, ranging from about 108,000 in 1989 to a low of about 3,000 in 1997. The total encounters of pink salmon in 2003 are indicative of the large run size (Figure 6).

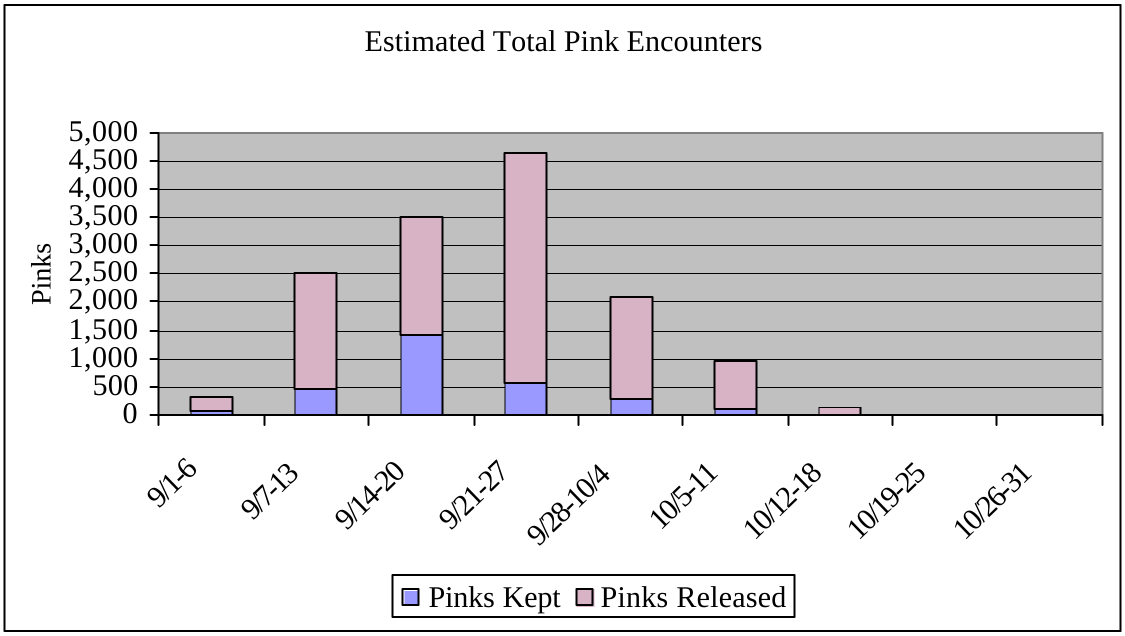


Figure 6. Estimated total encounters of pink salmon during the 2003 recreational salmon fishery on the Carbon River.

DISCUSSION

This was the first year WDFW conducted a creel survey of the recreational salmon fishery on the Carbon River. The creel survey design worked well for the Carbon River selective chinook fishery, and a significant amount of data was collected.

Only a few sites provide anglers access to the Carbon River. Therefore the creel survey employed a random stratified method at access sites to monitor the 2003 recreational salmon fishery. Access site creel surveys are preferred over other angler contact survey methods for several reasons. First, data collected are based on complete fishing trips rather than incomplete trips, thus avoiding any trip length biases that may be associated with other survey types. Second, access site surveys minimize angler intrusions. Data are collected after anglers have completed fishing activities and they may be more receptive to interview questions. Third, memory of anglers is more reliable when anglers are fresh off the fishery.

The number of angler trips is a common measure of effort during a fishery. This measure was not used to calculate fish catch during this creel survey, however it is worth discussing. Angler trips provide a way to compare angler effort between fisheries. An estimated 14,281 angler trips occurred during the salmon fishery on the Carbon River in 2003. The number of angler trips was calculated by dividing the total weekly angler hours estimated for each stratum by the average angler trip length. The average angler trip length was estimated by dividing the total number of anglers interviewed each stratum by the total number of hours they reported fishing.

A few questions arose during 2003 monitoring of the Carbon River recreational fishery.

- What impact does non-anglers parking at access sites have on angler effort estimates?
- What impact did the large pink salmon run size have on angler effort?
- What contribution does the third access site has on effort and fish encounters?

It is likely that non-angler vehicles parking at the access sites biased angler effort and encounter estimates high. Vehicle counts at access sites were used to estimate angler effort, which was then used to estimate fish encounters. Construction activities (repaving of highway) occurred near the access sites and construction workers were using the access sites for parking. It was difficult to identify non-angler vehicles in the access sites. However all vehicles were counted during vehicle counts and attempts were made to identify angler and non-angler vehicles.

The 2003 pink salmon run to the Puyallup River may have influenced angler effort. The 2003 pink salmon run was by far the most abundant in 30 years. Fifty-one percent of the anglers interviewed said they were targeting “salmon” as opposed to chinook and coho. Anglers may have taken advantage of the large pink salmon runsize and fished when they otherwise might not have.

Angler effort and fish encounter estimates may be biased low due to the discovery of a third access site late in the survey period. Supplemental vehicle counts were conducted during the last three weeks of the survey period at this third site. These counts indicate that as much as 16 percent of angler effort for the fishery comes from this access site. A very limited amount of data was collected from this site and was not used in the expansion of angler effort and fish encounters.

RECOMMENDATIONS

To help answer the questions that arose during this creel survey, monitoring of the Carbon River recreational salmon fishery should continue for at least one additional year. The creel survey of the 2003 recreational salmon fishery provided valuable baseline information for angler effort, fish encounters, and impacts; however, trends and comparisons cannot be made. Future monitoring efforts will need to better address whose vehicles are in the access sites, anglers or non-anglers. It will also be important to include the third access site in any additional surveys. Another consideration is to conduct total count and angler distribution surveys once each weekend day and weekday throughout the survey period. These will provide valuable information on angler distribution on the river and trends in access site use.

The result of monitoring the 2003 recreational salmon fishery on the Carbon River indicates that this is a popular and successful fishery. With proper management, this fishery will continue in popularity. However, it is important to understand the impacts of the fishery on the local salmon stocks. Continued monitoring in the short term will provide the necessary information to properly manage this fishery to provide angling opportunities as well as protect local stocks.

Summary of 2003 South Sound chum in-season management

- The 2003 pre-season forecast for South Sound chum entering Area 4B was 448,365 (K. Adicks 9/9/03).
- The NOF fishing package for Areas 10/11 included treaty openings in weeks 42-48 and non-treaty openings in weeks 42-46. The Apple Cove Point purse seine chum test fishery was scheduled for weeks 41-45.

Week 41

- Test fishing at Apple Cove Point in week 41 caught 443 chum in six sets (appendix Table 1). The catch was 75% male and 80% 4-year-olds (appendix Table 2).
- No reliable test fishery models are available due to the limited time series from week 41.
- There were no non-treaty openings in week 41, and hence no non-treaty catch models.
- **No action was taken to update the run size from the pre-season forecast of roughly 448,000 South Sound chum entering Area 4B.**

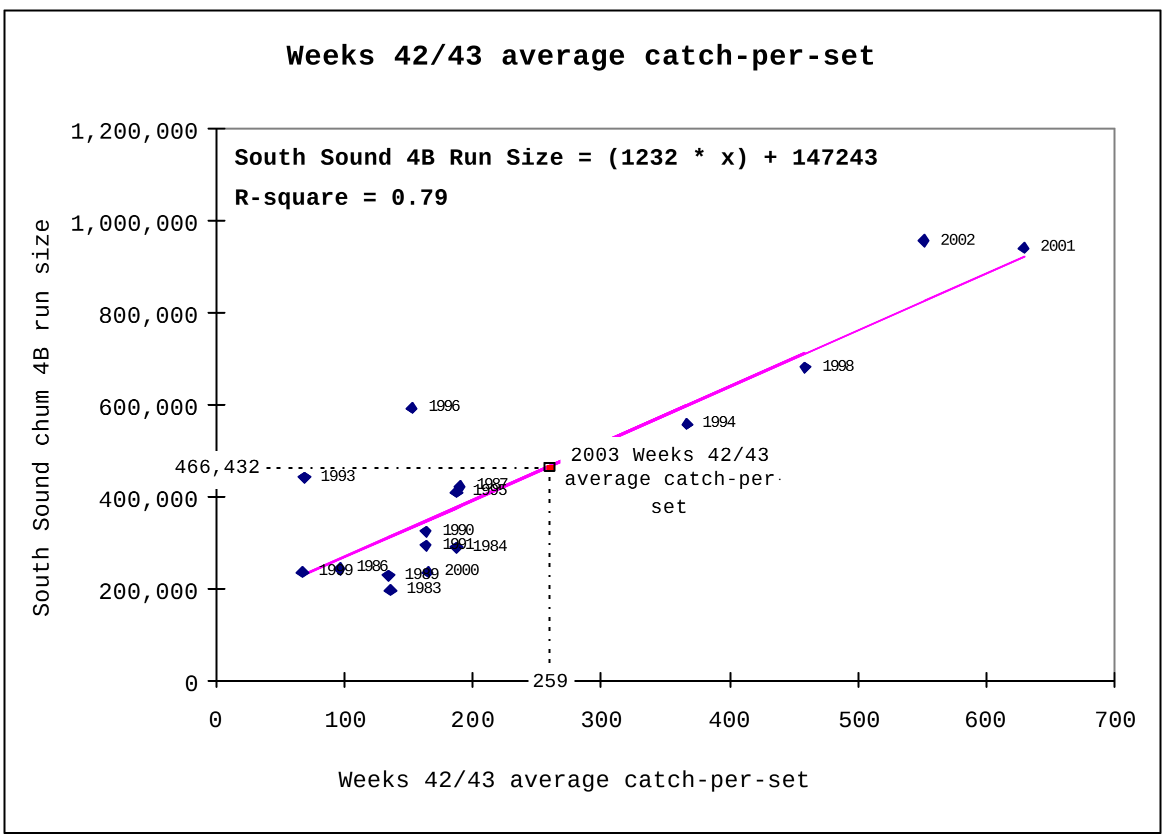
Week 42

- Test fishing at Apple Cove Point was lower than expected, likely due to unfavorable tides. A total of 426 chum were caught in seven sets (app. Table 1). The catch was 62% male and 83% 4-year-olds (app. Table 2).
- The best week-42 test fishery model predicted a 4B run size of roughly 288,000 chum.
- The non-treaty PS opening on 10/13 caught about 32,000 chum.
- Treaty fisheries in areas 10 & 11 had caught roughly 7,000 chum to date.
- **Again no action was taken to update the run size from the pre-season forecast of 448,000 chum.**

Week 43

- The Apple Cove Point test fishery caught 2,744 chum in six sets (app. Table 1). The catch was 52% male and 82% 4-year-olds (app. Table 2).
- The best week-43 model produced an estimate similar to the pre-season forecast (Figure 1).

Figure 1. Week-43 Apple Cove Point chum test fishery regression model.



- The non-treaty purse seine fleet took about 14,000 in 34 landings this week, for a cumulative total of about 61,000 in areas 10 & 11.
- The models of non-treaty catches may have been affected by low commercial effort relative to recent years, but one model that accounts for effort predicted a 4B run size of SS chum of 484,000.
- **Again this week, it was agreed to hold the line on the pre-season forecast (448,000).**
- The state added a second purse-seine opening in week 44 (on Thursday, 11/30).

Week 44
- The Apple Cove Point test fishery caught just 275 chum in five sets (app. Table 1). Again, tides were unfavorable. The catch was 60% male and 75% 4-year-olds (app. Table 2).
- Regression models predicted 4B run sizes of South Sound chum ranging from 363,000 to 434,000.
- Two days of non-treaty purse seine opening in areas 10 & 11 netted 57,000 chum in 70 landings, for a cumulative non-treaty total (gill nets included) of just under 125,000.
- The week 43-44 non-treaty cumulative purse seine catch model was deemed strongest and predicted just slightly above the pre-season forecast (Table 1).

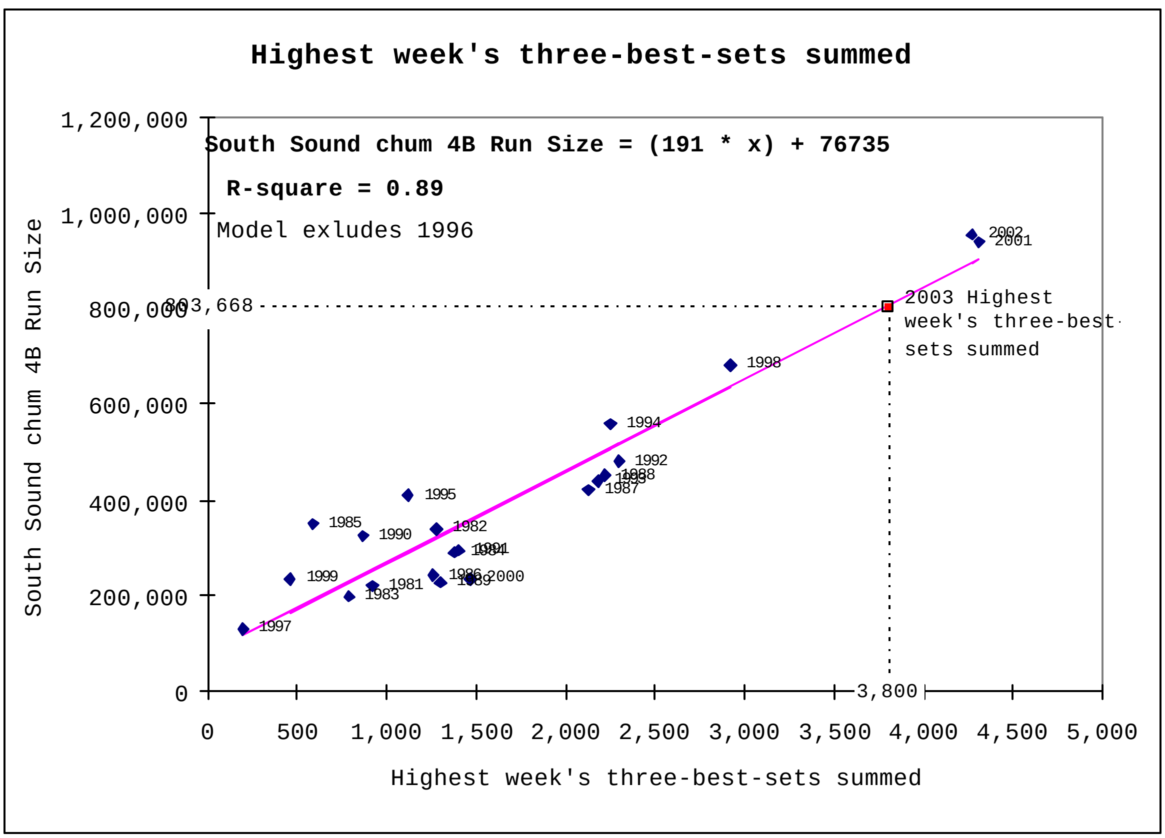
Table 1. Week-44 non-treaty purse seine catch regression model

Model	Years	R Square	Slope	Intercept	03 Input	Prediction
WK 43+44 NT Purse Seine Catch	90-97, 99-2002	0.8	3.943	204,044	65,257	461,352

- **The anticipated 4B run size was updated to 461,000 South Sound chum.**

Week 45
- The Apple Cove Point test fishery unexpectedly caught 4,876 chum in five sets (app. Table 1). 37.5% were males, 82% were 4-year-olds (app. Table 2).
- The strongest week-45 test fishery model predicted a 4B run size of roughly 803,000 chum (Figure 2).

Figure 2. Week-43 Apple Cove Point chum test fishery regression model.



- The Non-treaty purse seine fishery in Area 10/11 caught 44,055 chum in 35 landings on Monday, and 35,894 chum in 18 landings on Wednesday, bring the total non-treaty catch thus far (purse seine and gillnet) to 200,593 chum. The strongest week-45 non-treaty purse seine catch model predicted a 4B run size of roughly 638,000 south sound chum (Table 2).

Table 2. Week-45 non-treaty purse seine catch regression model

Model	Years	R Square	Slope	Intercept	03 Input	Prediction
WK 43-45 Purse Seine Cumulative Catch/Landing	90-02 w/out 97	0.84	501.5	210,461	853	638,241

- **The South Sound 4B run size was updated to reflect the prediction of this model: 638,000 chum.**
- The state added a Wednesday opening in Area 10/11 to their Week 46 schedule.
- Tit was decided that the Apple Cove Point test fishery should be extended into week 46, if the charter vessel could be available.

Week 46

- The Apple Cove Point chum test fishery was not extended into week 46, because the chartered seiner could not be available.
- Non-treaty purse seiners had openings on Monday and Wednesday in Areas 10/11 (concurrent with Hood Canal). The 2-day catch was 46,383 chum in 43 landings (26 on Monday and 17 on Wednesday). The average catch-per-landing was up compared to the previous week at 975. More vessels fished in Area 11 than in Area 10. The non-treaty total catch-to-date (seiners and gill-netters combined) was 258,212.
- There is not a long time series of non-treaty catches in Week 46 for predictive modeling. However, revised non-treaty catch data from Week 45 incorporated into the prior week's favored update model (weeks 43-45 cumulative catch/landing) predicted a higher run size estimate: roughly 700,000 chum. Considering that last week's 2 best ACP test fishery models produced estimates that straddled this one (600,000 and 800,000), **the run size estimate for SS chum entering Area 4B was revised upward from 638,000 to 700,000.**
- The state proposed adding 2 purse seine openings in Week 47 in an effort to take their remaining share (roughly 50,000). This is later than was planned pre-season, though within the management period for normal fall chum (through week 48). The pre-season NOF fishing package had them fishing only through week 46. It was concluded that since the normal chum management period for areas 10 & 11 runs through 11/29/03 (the end of week 48), adding days in week 47 could be allowed. The management period for late (winter) chum would not begin until 11/30/03 (week 49), therefore little or no impacts we expected on the late Nisqually run at this point. It was agreed that non-treaty seining would be open on Monday, followed by a conference call on Tuesday to consider the second opening on Wednesday or Thursday.

Week 47

- No new models were available for in-season updates. **The final 2003 South Sound chum in-season run-size estimate remained 700,000 fish.**
- During week 46, WDFW had proposed fishing on Monday and Wednesday of week 47. On Tuesday morning (11/18), the state reported very low fishing effort in their Monday fishery, likely due to sagging prices. In response to this, and to the large non-treaty allocation remaining (some 40,000 chum), they requested to open for a third day in week 47 (Friday), though again very little effort was expected.
- No non-treaty openings were proposed for week 48 at that time. However, on Friday (11/21), the state propose extending their gillnet schedule into week 48 (but not purse seine). After some initial disagreement and miscommunication, WDFW and Nisqually Natural Resources reached a compromise, and the state fished a gillnet schedule in week 48 that was less than their original proposed extension.

Appendix

Table 1.

Apple Cove Point Chum Test Fishery Catch									
Test fishing date	**Mgt week**	**Total catch**	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Set 6**	**Set 7**
8-Oct-03	41	443	14	14	56	133	107	119	
15-Oct-03	42	426	65	24	58	17	148	93	21
22-Oct-03	43	2,744	369	310	271	687	814	293	
29-Oct-03	44	275	149	1	124	0	1		
6-Nov-03	45	4,876	633	1,013	1,929	858	443		

Table 2. Sex and age makeup of chum test fishery catch.

Apple Cove Point Chum Test Fishery Scale Samples					
2003	Week 41	Week 42	Week 43	Week 44	Week 45
Unknown Age	2.5%	0.5%	0.0%	0.0%	0.0%
3	14.0%	13.0%	17.5%	21.6%	16.5%
4	79.5%	83.0%	81.5%	75.0%	82.0%
5	3.0%	3.5%	1.0%	3.3%	1.5%
6	1.0%	0.0%	0.0%	0.0%	0.0%
% Male	**75%**	**62%**	**52%**	**60%**	**37.50%**
Sample Size	200	200	200	120	200

Table 3. Soft-TFT data on 2003 South Sound chum catches-to-date in all South Sound areas (12/2/03).

Sum of FISH	TRIBE_NAME							
WEEK	**Suquamish**	**Tulalip**	**Muckleshoot**	**Puyallup**	**Nisqually**	**Squaxin Island**	**Washington Non-treaty**	**Grand Total**
33	3		46					**49**
37	14		14					**28**
38	11		15					**26**
39	81		9			4		**94**
40	144		7		92	92		**335**
41	3,394		44	41		104		**3,583**
42	3,233		277			242	38,339	**42,091**
43	12,139		3,465			348	23,013	**38,965**
44	5,250	3,332	2,556			250	63,507	**74,895**
45	9,609	13,668	5,116	105		577	90,078	**119,153**
46	6,071		17,990	573		287	53,432	**78,353**
47	9,496		10,263	1,641		48	20,484	**41,932**
48	4,188			1,299	54	84	53	**5,678**
49	912			345				**1,257**
Grand Total	**54,545**	**17,000**	**39,802**	**4,004**	**146**	**2,036**	**288,906**	**406,439**

Northwest Indian Fisheries Commission

6730 Martin Way E. Olympia, Washington 98516-5540

Phone : (360)438-1180 **FAX : (360)753-8659**

TO: Joan Miniken, Angelika Hagen-Breaux
FROM: Marianna Alexandersdottir

DATE: November 21, 2003

SUBJECT: Nisqually chinook sport estimates for 2003 – preliminary.

Here are the sport effort and chinook estimates for the Nisqually creel for 2003. A SAS program will be available at a later date with documentation for future years. Please check my descriptions etc. for any errors.

Description of survey and methods.

The survey was carried out in the area of the Highway 99 Bridge and railroad from August 1st to September 30, 2003. The survey was stratified into statistical weeks and then further into weekend and weekday periods. All weekend days were sampled and 3 out of 5 weekday days, with the exception of Labor Day weekend, when the weekend had 3 days and the following week a weekday period of 4 days. The estimate here is a minimum estimate for the Nisqually sport fishery, fish caught at other sites would not be included. The method is the same as that used last year, and equations are in the Appendix.

Results

The fishery was sampled from August 1 to September 30 (Table 1). A total of 2,829 interviews were made with 215 chinook total observed, 90 adipose fin-clipped and 154 reported as released. An average number of 43.55 cars per hour were counted. The average number of angler-hours per interview was 3.96 overall, ranging from 2.0 to 5.41 per day.

Effort

Effort is estimated as the total number of angler-hours expended (Table 2). The daily estimates of effort showed the pattern expected, with weekend days being higher than the weekdays surrounding them (Figure 1). A total of 46,947 angler-hours (95% CI: 44,885-48,917) were expended (Table 2), ranging from 525 to 10,000 per week (Figure 2) and averaging 645 angler-hours per day during the week and 1,044 on weekends. The coefficient of variation for the estimate of the total is 2.2%, ranging from 5.5 to 10% for the weekly estimates (Table 2).

Harvest and Release of Chinook Salmon

An estimated 1,384.45 chinook salmon (95% CI: 1,151.5-1,617.4) were harvested in the sport fishery (Table 3), of which 568.79 (95% CI: 461.2-676.4) were adipose fin clipped. In addition an estimated 885.58 (95% CI: 681.7-1,089.4) chinook salmon were released. The fishery peaked during statistical week 37 (September 8-14, Figure 2).

The percent of the chinook salmon harvested that were adipose fin-clipped ranged from 37-100% (Figure 2), with a weighted average for the total fishery of 41%. Except for the first and last days of the fishery (stat weeks 32 and 40 were not full weeks), the percent was stable, ranging from 37 to 47% (Figure 2).

Harvest of pink and coho salmon

An estimated 238.37 (95% CI: 220.0-256.7) coho salmon and 196.97 (95% CI: 184.3-209.7) were harvested in the sport fishery during statistical weeks 36 to 41 (Table 4).

Table 1. Sample statistics for the 2003 Nisqually creel survey .

Stat Week	Sample Date	Stratum	Average number of cars	Number of Interviews	Anglers	Chinook Salmon			Average of Angler-hours	Coho Salmon Harvest	Pink Salmon Harvest
						Total Harvest	Adipose fin clipped Harvest	Released			
31	08/01/03	wd	10.00	23	15	0	0	0	3.87	0	0
	08/02/03	we	16.25	57	43	0	0	0	4.29	0	0
	08/03/03	we	18.75	59	38	0	0	0	3.97	0	0
32	08/04/03	wd	15.50	50	48	0	0	0	4.21	0	0
	08/06/03	wd	18.75	50	50	0	0	0	3.29	0	0
	08/08/03	wd	16.50	51	63	1	1	0	4.20	0	0
	08/09/03	we	32.25	24	25	0	0	0	4.05	0	0
	08/10/03	we	32.25	80	84	2	2	0	3.87	0	0
33	08/12/03	wd	26.25	60	44	0	0	0	2.89	0	0
	08/14/03	wd	23.00	54	38	0	0	0	2.80	0	0
	08/15/03	wd	25.25	49	43	0	0	0	4.40	0	0
	08/16/03	we	38.00	87	93	1	1	0	4.06	0	0
	08/17/03	we	47.00	88	67	1	0	3	5.14	0	0
34	08/20/03	wd	29.50	65	73	3	2	0	3.19	0	0
	08/21/03	wd	27.75	47	25	2	0	2	3.51	0	0
	08/22/03	wd	34.25	72	83	7	1	0	3.52	0	0
	08/23/03	we	37.50	36	54	1	1	0	4.04	0	0
	08/24/03	we	52.67	38	54	0	0	0	3.61	0	0
35	08/25/03	wd	29.25	52	32	0	0	0	3.34	0	0
	08/26/03	wd	27.25	34	47	0	0	0	4.66	0	0
	08/27/03	wd	26.25	8	5	0	0	0	2.00	0	0
	08/30/03	we	48.00	81	91	9	4	10	4.49	0	0
	08/31/03	we	55.00	104	119	4	2	5	4.01	0	1
36	09/03/03	wd	27.75	76	73	7	6	26	3.61	0	0
	09/04/03	wd	37.00	59	48	0	0	0	3.30	0	0
	09/06/03	we	63.50	111	127	26	8	24	4.93	1	1
	09/07/03	we	59.75	67	62	3	1	1	4.77	0	0

Table 1. Sample statistics for the 2003 Nisqually creel survey .

Stat Week	Sample Date	Stratum	Average number of cars	Number of Interviews	Anglers	Chinook Salmon			Average of Angler-hours	Coho Salmon Harvest	Pink Salmon Harvest
						Total Harvest	Adipose fin clipped Harvest	Released			
37	09/09/03	wd	57.00	28	29	9	3	5	2.76	0	0
	09/10/03	wd	59.75	99	97	16	5	10	2.99	0	2
	09/12/03	wd	74.50	40	54	11	4	8	4.16	0	4
	09/13/03	we	89.00	140	173	21	13	7	4.67	1	3
	09/14/03	we	96.25	110	105	15	7	1	4.08	1	6
38	09/15/03	wd	57.75	49	53	0	0	0	3.32	0	0
	09/16/03	wd	60.25	37	48	6	3	2	3.86	3	0
	09/18/03	wd	72.25	131	151	16	10	12	3.74	15	9
	09/20/03	we	82.75	132	166	24	6	11	4.44	12	5
	09/21/03	we	60.67	50	70	1	1	1	4.20	1	0
39	09/23/03	wd	42.50	80	83	5	2	2	3.22	2	0
	09/24/03	wd	45.00	50	46	2	1	1	3.98	0	0
	09/25/03	wd	45.75	52	46	1	1	0	3.28	3	0
	09/27/03	we	67.25	89	117	6	0	12	5.41	7	1
	09/28/03	we	58.75	87	93	9	0	9	4.04	8	0
40	09/29/03	wd	37.00	52	54	2	2	1	2.97	3	1
	09/30/03	wd	34.75	21	23	4	3	1	2.32	0	0
Total			43.55	2,829	2,952	215	90	154	3.96	57	33

Table 2. Estimates of angler-hours expended in Nisqually sport fishery 2003 by stratum, statistical week and total.

Stat Week	Stratum	Total Days	Days Sampled	Angler Hours	Standard Error	CV
31	wd	1	1	111	33	30.1%
	we	2	2	414	70	16.8%
31 Total		3	3	525	70	13.4%
32	wd	5	3	1,530	131	8.6%
	we	2	2	1,147	115	10.0%
32 Total		7	5	2,677	147	5.5%
33	wd	5	3	1,632	225	13.8%
	we	2	2	1,299	159	12.2%
33 Total		7	5	2,931	238	8.1%
34	wd	5	3	2,476	459	18.5%
	we	2	2	2,229	189	8.5%
34 Total		7	5	4,704	462	9.8%
35	wd	5	3	2,042	466	22.8%
	we	3	2	2,997	288	9.6%
35 Total		8	5	5,039	482	9.6%
36	wd	4	2	1,954	296	15.2%
	we	2	2	2,175	286	13.1%
36 Total		6	4	4,129	346	8.4%
37	wd	5	3	6,181	926	15.0%
	we	2	2	3,764	323	8.6%
37 Total		7	5	9,945	929	9.3%
38	wd	5	3	6,344	566	8.9%
	we	2	2	3,213	432	13.5%
38 Total		7	5	9,557	609	6.4%
39	wd	5	3	3,569	393	11.0%
	we	2	2	2,571	600	23.4%
39 Total		7	5	6,140	626	10.2%
40	wd	2	2	1,300	133	10.2%
40 Total		2	2	1,300	133	10.2%
Grand Total		**122**	**44**	**46,947**	**1,037**	**2.2%**

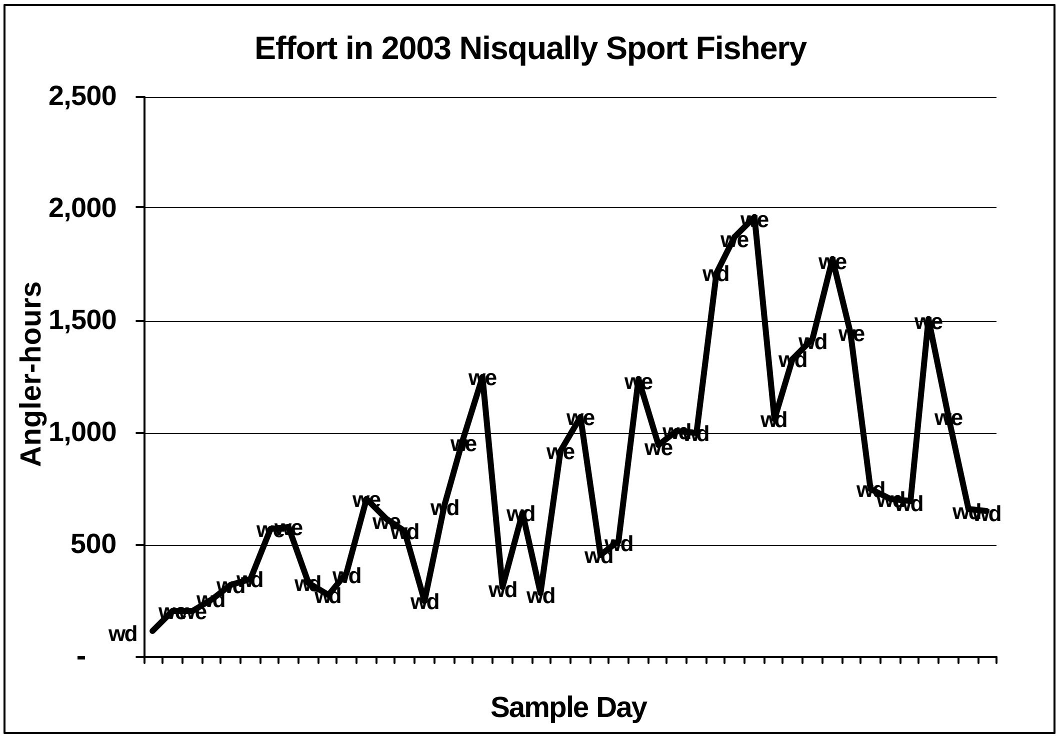
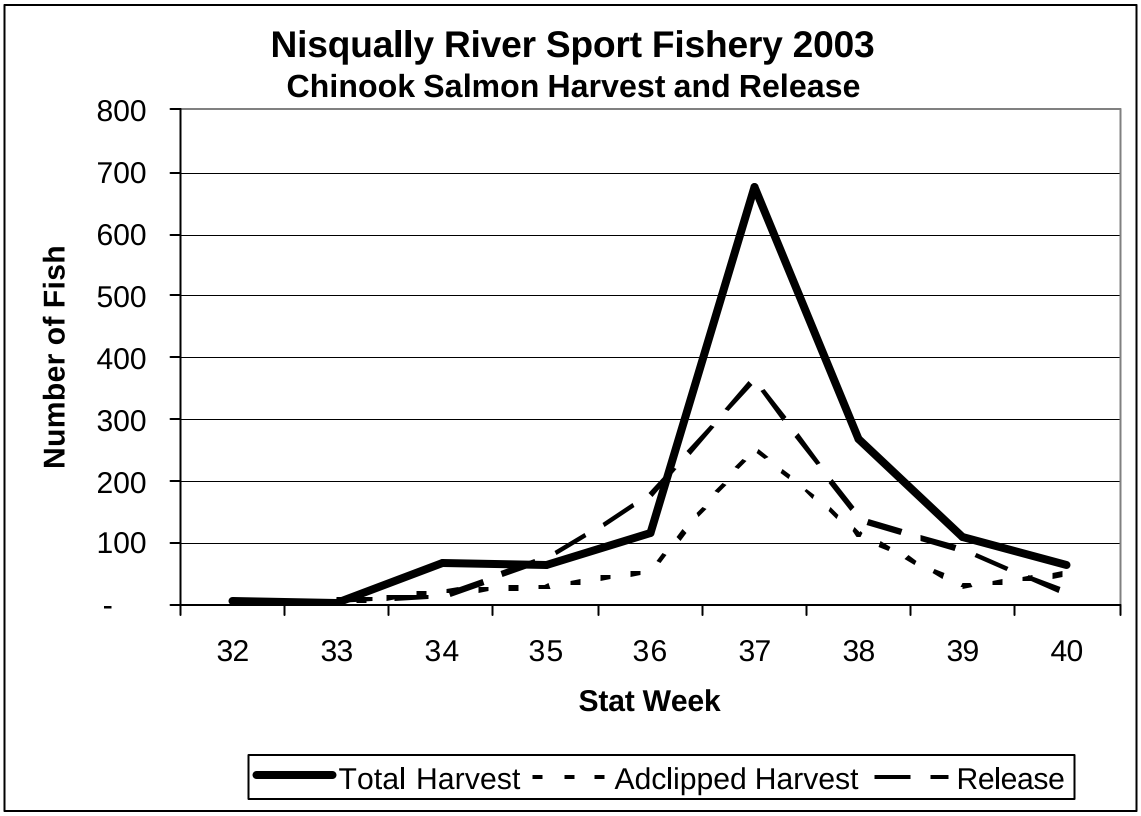


Figure 1. Estimated effort by sample day labeled to indicate weekday (wd) and weekend (we) sample days for Nisqually creel survey, 2003.

Table 3. Estimates of chinook salmon caught and released in Nisqually sport fishery 2003 by stratum, statistical week and for the total period.

Stat Week	Day Type	Total Harvest	SE	CV	Adipose Fin clipped Harvest	SE	CV	Released	SE	CV
32	wd	3.12	3.13	100%	3.12	3.13	100%			
	we	5.22	3.52	67%	5.22	3.52	67%			
32 Total		8.34	4.70	56%	8.34	4.70	56%			
33	wd									
	we	5.65	4.02	71%	2.58	2.61	101%	9.20	9.32	101%
33 Total		5.65	4.02	71%	2.58	2.61	101%	9.20	9.32	101%
34	wd	60.66	21.61	36%	16.23	9.36	58%	13.25	13.97	105%
	we	6.76	6.73	100%	6.76	6.73	100%			
34 Total		67.42	22.63	34%	22.99	11.53	50%	13.25	13.97	105%
35	wd									
	we	65.01	23.15	36%	30.05	11.46	38%	75.12	31.79	42%
35 Total		65.01	23.15	36%	30.05	11.46	38%	75.12	31.79	42%
36	wd	26.53	22.02	83%	26.53	22.02	83%	101.70	80.13	79%
	we	90.07	21.98	24%	28.12	9.59	34%	73.72	28.38	38%
36 Total		116.60	31.12	27%	54.65	24.02	44%	175.41	85.01	48%
37	wd	520.35	114.43	22%	177.20	50.46	28%	330.17	91.34	28%
	we	155.59	31.44	20%	76.13	22.17	29%	36.18	13.25	37%
37 Total		675.94	118.67	18%	253.32	55.12	22%	366.34	92.30	25%
38	wd	180.30	70.50	39%	83.71	36.12	43%	93.82	44.74	48%
	we	88.53	25.00	28%	31.11	13.08	42%	44.62	18.14	41%
38 Total		268.83	74.80	28%	114.82	38.41	33%	138.45	48.28	35%
39	wd	57.22	23.67	41%	30.90	13.71	44%	20.62	11.01	53%
	we	54.35	18.45	34%				68.59	23.03	34%
39 Total		111.58	30.01	27%	30.90	13.71	44%	89.22	25.53	29%
40	wd	65.09	27.02	42%	51.14	23.91	47%	18.59	14.75	79%
40 Total		65.09	27.02	42%	51.14	23.91	47%	18.59	14.75	79%
Grand Total		**1,384.45**	**118.84**	**9%**	**568.79**	**54.91**	**10%**	**885.58**	**104.01**	**12%**



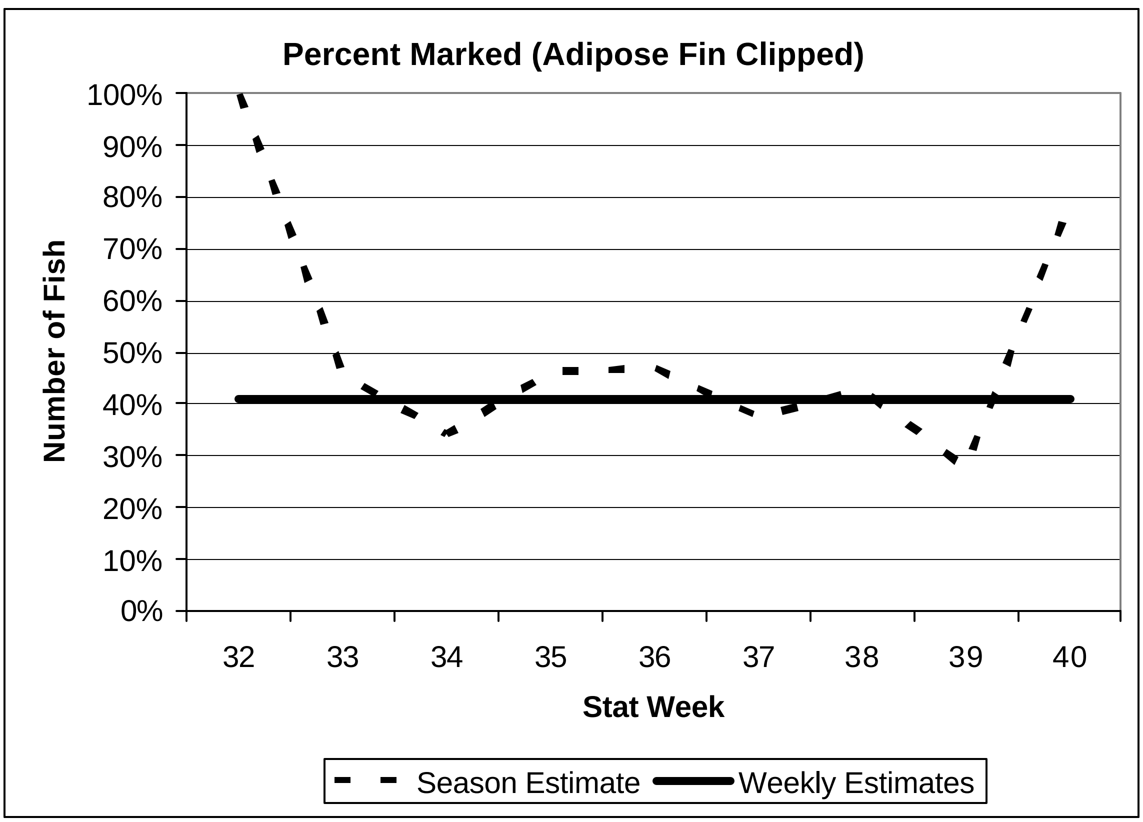


Figure 2. Estimate harvest and release of chinook salmon in the 2003 Nisqually River sport fishery and percent marked by statistical week.

Table 4. Estimated harvest of coho and pink salmon during sport fishery in Nisqually River 2003.

Statistical Week	Day Type	Coho Salmon	SE	CV	Pink Salmon	SE	CV
36	wd	0.00	0.00		0.00	0.00	
	we	2.85	2.86	100.4%	2.85	2.87	100.5%
36 Total		2.85	2.86	100.4%	2.85	2.87	100.5%
37	wd	0.00	0.00		84.67	53.75	63.5%
	we	9.44	6.88	72.9%	40.53	20.10	49.6%
37 Total		9.44	6.88	72.9%	125.20	57.39	45.8%
38	wd	75.88	51.86	68.3%	50.59	35.80	70.8%
	we	48.00	16.97	35.3%	10.13	5.94	58.6%
38 Total		123.88	54.56	44.0%	60.72	36.28	59.8%
39	wd	42.22	25.31	59.9%	0.00	0.00	
	we	50.69	19.47	38.4%			
39 Total		92.91	31.93	34.4%	3.56	3.59	100.8%
40	wd	9.29	6.61	71.2%	4.64	4.58	98.6%
40 Total		9.29	6.61	71.2%	4.64	4.58	98.6%
Grand Total		**238.37**	**9.35**	**3.9%**	**196.97**	**6.48**	**3.3%**

Appendix . Equations for estimation of total effort, harvest and release and variances.

Estimation of daily effort and catch and release

Effort

The fishing day lasts from approximately 5 AM to 10 PM, or 17 hours. The day will be divided into two periods; the first from 6 AM until 2 PM and the second from 2 PM until 10 PM. We will sample to 9 or 10 PM (depending on sunset and effort). During each period 2 counts will be made, or 4 counts for the whole day. The counts are made of parked cars at access sites. The first count will be randomly placed at six, seven, eight or nine AM and the remaining counts will each occur at four-hour intervals. The estimate of the average number of “anglers fishing” during any hour is then an average of the car counts times the average angler per car. The total number of angler-hours (E) expended over a fishing day is then;

$$E_{total} = \overline{Anglers}_S * H_S$$

$$Var(E_{total}) = Var(\overline{Anglers}_S) * H_S^2$$

$$\overline{Anglers}_S = \overline{Cars}_S * \overline{anglerpercar}_S$$

$$Var(\overline{Anglers})_S = Var(\overline{Cars}_S) * \overline{anglerpercar}_S^{\,2} + \overline{Cars}_S^{\,2} * Var(\overline{anglerpercar}_S) - Var(\overline{Cars}_S) * Var(\overline{anglerpercar}_S)$$

The average cars per hour, $\overline{Cars}$, is estimated from the counts for that day and the variance is the variance of the mean.

Catch

The estimate will be stratified into weekend and weekday periods. Estimates for the Upper River (above hatchery) are conducted separate from Lower River estimates.
The majority of the effort and catch (>90%) is expected to occur in the Lower River.
Sampling will be conducted at one site (see site map), each day chosen for sampling. Each day a total of two samplers will conduct interviews (am and pm shifts). Sampling sites will be selected based on effort. The chance for any site to be selected is directly related to the estimated proportion of effort coming from this site. The catch per angler-hour is estimated form the interviews by;

$$C\hat{PU}E = \frac{\sum_i C_i}{\sum_i e_i}$$

where $\sum_i C_i$ and $\sum_i e_i$ are the sum of catch and angler-hours from interviews for the period or stratum. The variance of the estimate of CPUE is estimated as the variance of the ratio of means or by,

$$V(C\hat{P}UE) = \frac{1}{n\bar{e}^2}\left[s_c^2 + CPUE^2 * s_e^2 - 2CPUE * s_{c,e}\right]$$

where $\bar{c}$ and $\bar{e}$ are the mean catch and mean hours fished for car interviewed and s_c^2 and s_e^2 are the variances $s_{c,e}$ is the covariance of catch and effort.

The total catch is then estimated by;

$$\hat{C}_{total} = \hat{E}_{total} * C\hat{P}UE$$

and the variance is estimated by,

$$V(\hat{C}_{total}) = V(\hat{E}_{total}) * C\hat{P}UE^2 + \hat{E}_{total}^2 * V(C\hat{P}UE) - V(\hat{E}_{total}) * V(C\hat{P}UE)$$

Estimation of totals by stratum (stat week and period).

For each stratum, i.e., stat week and weekend or weekday period, the total is estimated either by summing when all days have been sampled or by expanding an estimated daily average.

The total effort and harvest or release is estimated by;

$$\boldsymbol{\hat{Y}s = D \bullet \bar{y}_s}$$

where $\boldsymbol{\hat{Y}_s}$ is the total effort, harvest or release estimated for stratum s, $\boldsymbol{\bar{y}_s}$ is the average per day estimated for the stratum and $\boldsymbol{D}$ is the number of days in the stratum. The variance is estimated by:

$$\boldsymbol{Var(\hat{Y}s) = (1 - \frac{d}{D})D^2 Var(\bar{y}_s) + \frac{D}{d}\sum_{i=1}^{d} Var(\hat{y}_i)}$$

where $\boldsymbol{\hat{y}_i}$ is the estimate for sample i and d is the number of days sampled.

The season totals are derived by summing all the strata totals and their variances.

STATE OF WASHINGTON
DEPARTMENT OF FISH AND WILDLIFE
ENFORCEMENT PROGRAM
STATEWIDE MARINE PATROL DIVISION

2003 WASHINGTON SELECTIVE SALMON FISHERY

The following report is a synopsis of enforcement activities by Washington Department of Fish and Wildlife (WDFW) Officers, for the 2003 marine salmon fishery. Originally, compliance reporting was designed to measure and monitor adherence to wild Coho salmon release rules . With the expansion of selective fishing to other species, along with concerns raised during the North of Falcon Season setting process, Officers are tracking thirteen Salmon Management Catch Areas (SMCA). Enforcement presence in the various marine areas was accomplished by vessel, dock patrols, and joint operations with other enforcement agencies.

Developing compliance rate estimations for fish and wildlife violations are difficult. Uniformed presence on the water or at the dock provides visible deterrence to violations, thereby altering the behavior of those who may violate natural resource laws. In some instances, the contact to violation ratio may be merely a reflection of the effectiveness of the individual officer at discovering a violation. Therefore, estimated compliance rates compiled from uniformed enforcement activity may not be an accurate measure of actual compliance, but rather, serves best as an index when comparing one area to another, or one season to the next.

Once again, with this fishery being elevated to a high priority within WDFW, officers from Marine Stations, along with officers from other parts of the State, were utilized to meet enforcement commitments. An early and aggressive patrol presence to address compliance issues had a bearing on our successes in ensuring an orderly fishery. Support by District Court Judges and widely advertised violation penalties also added deterrence from circumventing regulations.

The average for estimated compliance with the wild Coho release rule in the eight applicable Salmon Management Catch Areas (SMCA) was 99.2%. The average for compliance with overall salmon rules was 88.6%, compared to 87% in 2002, for these same areas. The estimated rate of compliance with overall salmon rules for all thirteen monitored SMCA's was 84.6%.

SMCA AREA ONE AND TWO SUMMARY

The Columbia River / South Coast Marine Detachment is directly responsible for planning patrols for these SMCA's. The season started slowly, with catch rates low enough to allow for the expansion of a five day per week fishery to seven days per week. This put more demand on enforcement to cover the extra days. The presence of pink salmon complicated fish identification for some people, and undersized Chinook and unmarked Coho Salmon were sometimes mistaken for this species. Also, Buoy 10, a terminal fishery that exists at the mouth of the Columbia River, had a more liberal limit for Coho Salmon at the same time that the SMCA One fishery was underway. This resulted in some anglers exceeding ocean limits with the intent of claiming the extra fish as Columbia River caught. This fish laundering is difficult to detect and is believed to be extensive.

AREA **ONE**

(Ilwaco, WA):

Enforcement Hours:

Docks - 390
Vessel - 89
Total - **479 hours**

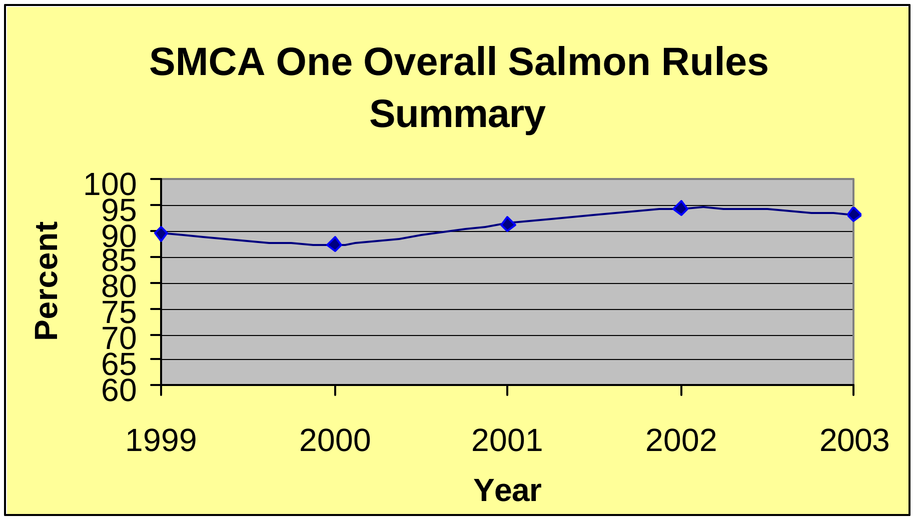
Contacts: **1801 total**

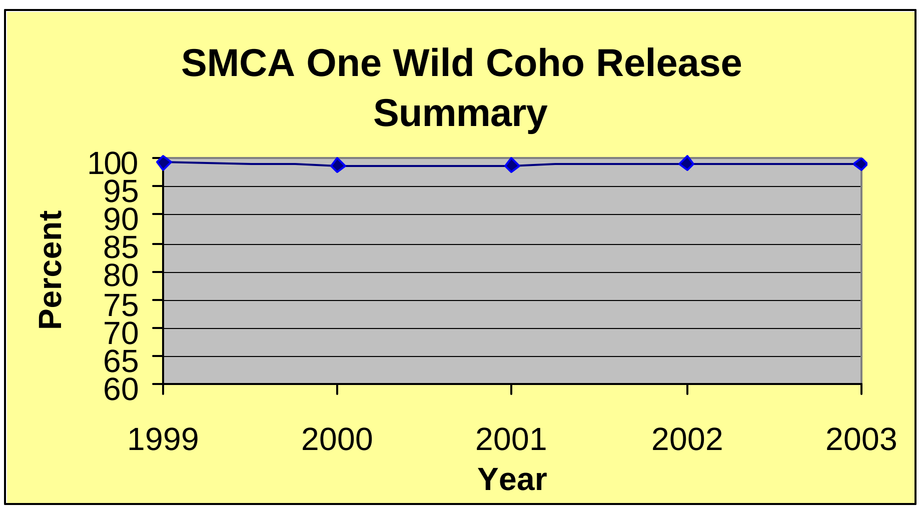
LIC VIO	Arrest	**19**	Warnings	**43**	Total	**62**
GEAR VIO	A	**2**	W	**4**	T	**6**
OVERLIMIT	A	**10**	W	**4**	T	**14**
WILD COHO	A	**18**	W	**0**	T	**18**
CHINOOK	A	**6**	W	**1**	T	**7**
AREA /SEASON	A	**9**	W	**7**	T	**16**
GRND FISH	A	**0**	W	**0**	T	**0**
BOAT SAFE	A	**4**	W	**4**	T	**8**
OTHER	A	**13**	W	**4**	T	**17**

Total Citations: 81
Total Warnings: 67

Estimated compliance regarding overall salmon rules was 93.2 %.*
Estimated compliance regarding the possession of wild Coho was 99 %.**

SMCA One Summaries





AREA **TWO**
(Westport, WA.):

<u>Enforcement Hours:</u>

Docks - 233
Vessel - 201
Investigative - <u>24</u>
Total - **438 hours**

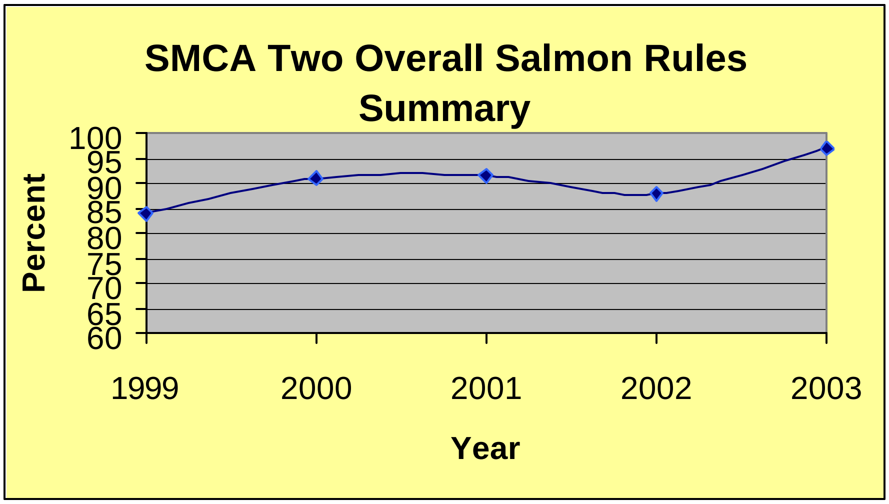
<u>Contacts:</u> **2164 total**

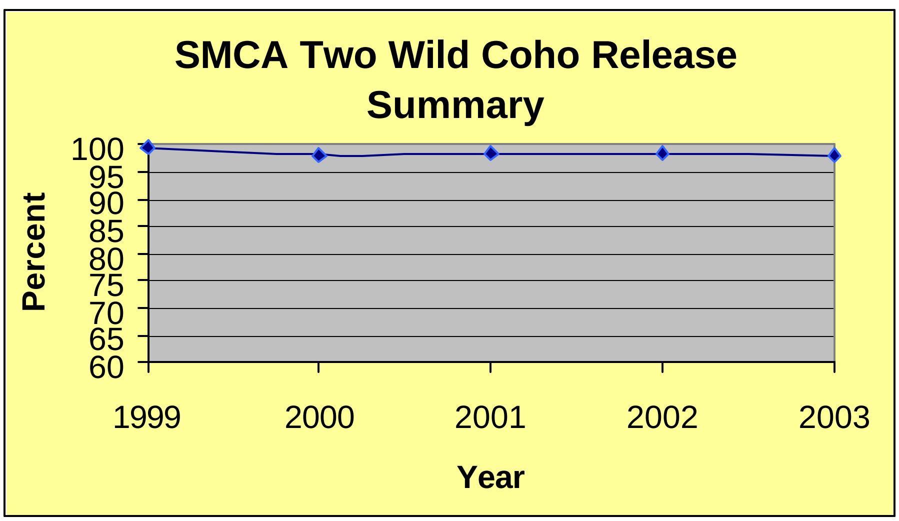
LIC VIO	Arrest	**14**	Warnings	**90**	Total	**104**
GEAR VIO	A	**6**	W	**12**	T	**18**
OVERLIMIT	A	**5**	W	**3**	T	**8**
WILD COHO	A	**27**	W	**0**	T	**27**
CHINOOK	A	**18**	W	**2**	T	**20**
AREA /SEASON	A	**5**	W	**5**	T	**10**
GRND FISH	A	**2**	W	**2**	T	**4**
BOAT SAFE	A	**2**	W	**3**	T	**5**
WARRANT	A	**0**	W	**1**	T	**1**
OTHER	A	**30**	W	**33**	T	**66**

Total Citations: 109
Total Warnings: 151

Estimated compliance regarding overall salmon rules was 97%.*
Estimated compliance regarding the possession of wild Coho was 98.7%**

SMCA Two Summaries





SMCA AREA THREE, FOUR, FIVE AND SIX SUMMARY

The North Coast / Strait Marine Detachment has primary responsibility for patrolling these SMCA's. The North Sound Detachment assisted in patrolling part of SMCA Six. A selective Chinook fishery was implemented this season in SMCA's Five and Six. Concern over compliance in this new fishery translated to more hours patrolling those fisheries versus SMCA 3 and 4. The presence of Pink Salmon resulted in some identification mistakes and thus the illegal possession of some unmarked Chinook Salmon. Those and intentional Chinook possession violations were captured under "area / season".

AREA **THREE**
(LaPush, WA.):

Enforcement Hours:

Docks - 18
Vessel 4
Total - **22 hours**

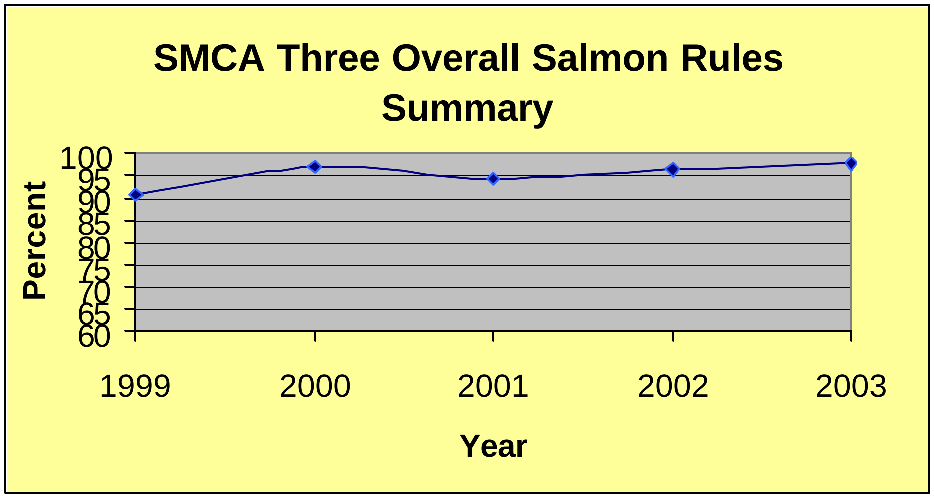
Contacts: **129total**

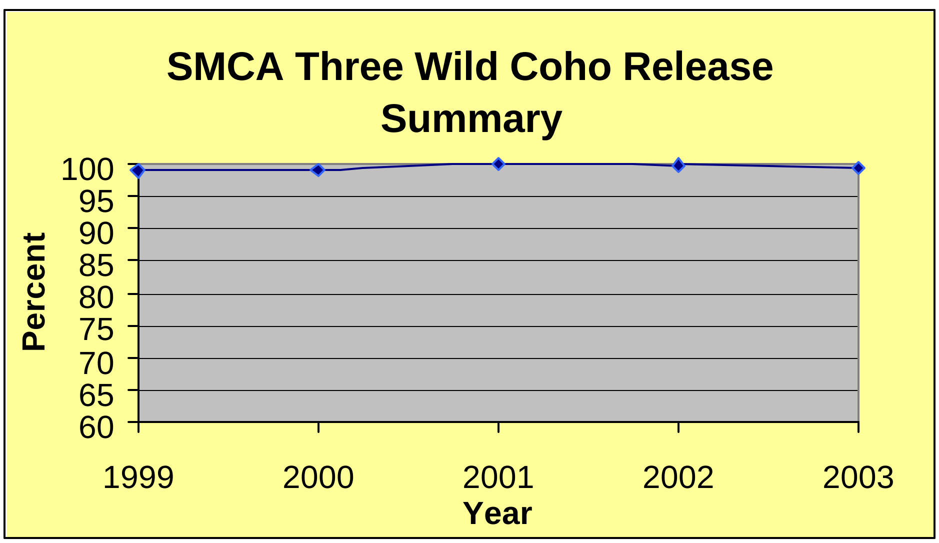
LIC VIO	Arrest	**1**	Warnings	**0**	Total	**1**
GEAR VIO	A	**0**	W	**0**	T	**0**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO	A	**1**	W	**0**	T	**1**
CHINOOK	A	**2**	W	**0**	T	**2**
AREA /SEASON	A	**0**	W	**1**	T	**1**
BOAT SAFE	A	**1**	W	**0**	T	**1**

Total Citations: 5
Total Warnings: 1

Estimated compliance regarding overall salmon rules was 96.2%.*
The estimated compliance regarding the possession of wild Coho was 99.3. **

SMCA Three Summaries





AREA **FOUR**

(Neah Bay, WA.):

Enforcement Hours:

Docks - 31
Vessel - 122
Interagency - 8

Total - **161 hours**

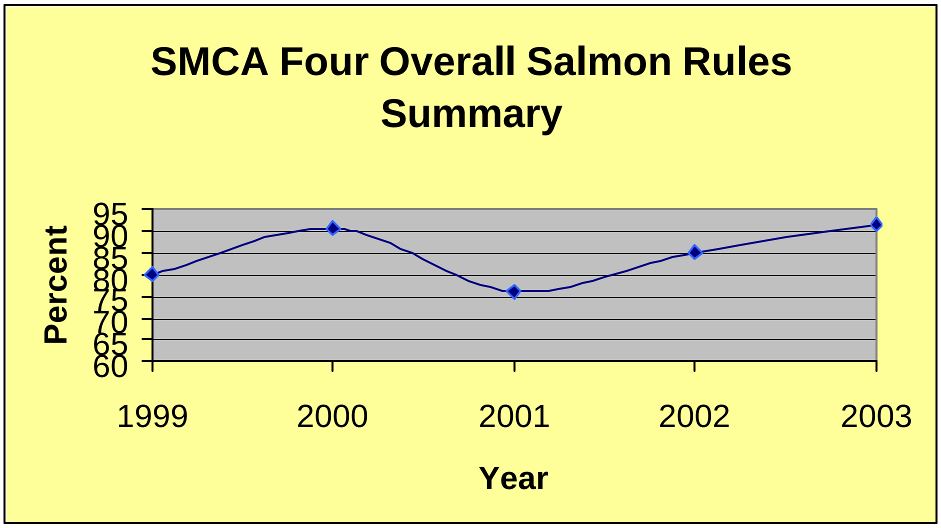
Contacts: **518 total**

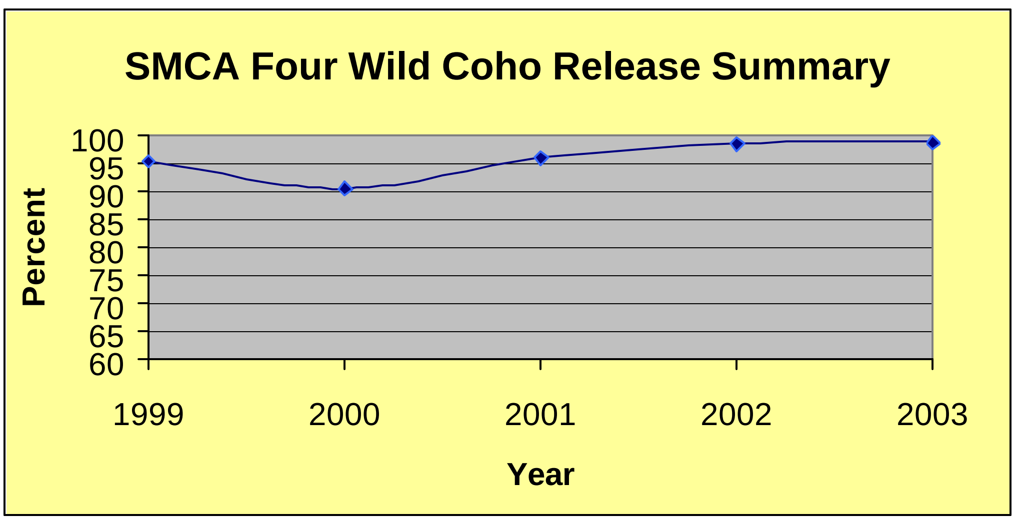
LIC VIO	Arrest	**11**	Warnings	**9**	Total	**20**
GEAR VIO	A	**15**	W	**1**	T	**16**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO	A	**6**	W	**0**	T	**6**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**2**	W	**0**	T	**2**
BOAT SAFE	A	**2**	W	**3**	T	**5**
OTHER	A	**1**	W	**0**	T	**1**

Total Citations: 37
Total Warnings: 13

Estimated compliance regarding overall salmon rules was 91.5%*
The estimated compliance regarding the possession of wild Coho was 98.8%**

SMCA Four Summaries





AREA FIVE

(Sekiu, WA.)

Enforcement Hours:

Docks- 73
Vessel- 261
Total- **334 hours**

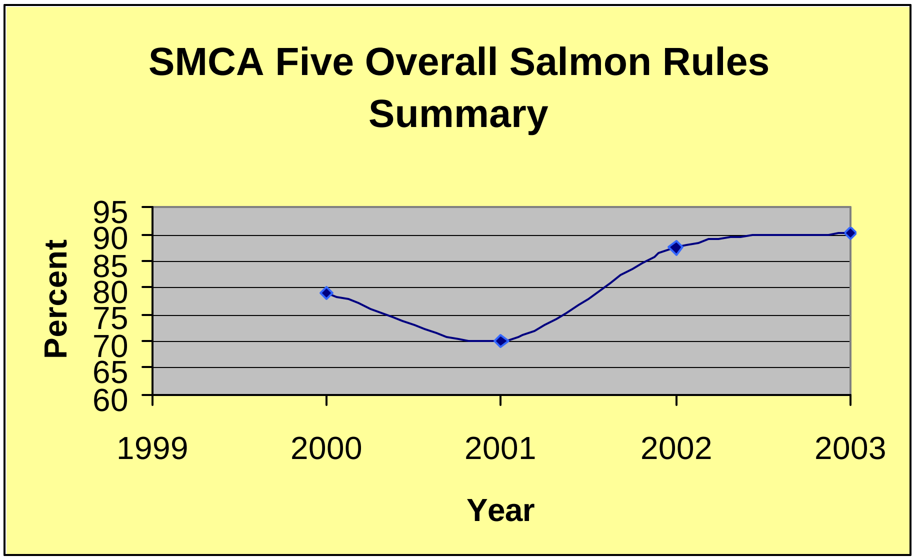
Contacts: **1662 total**

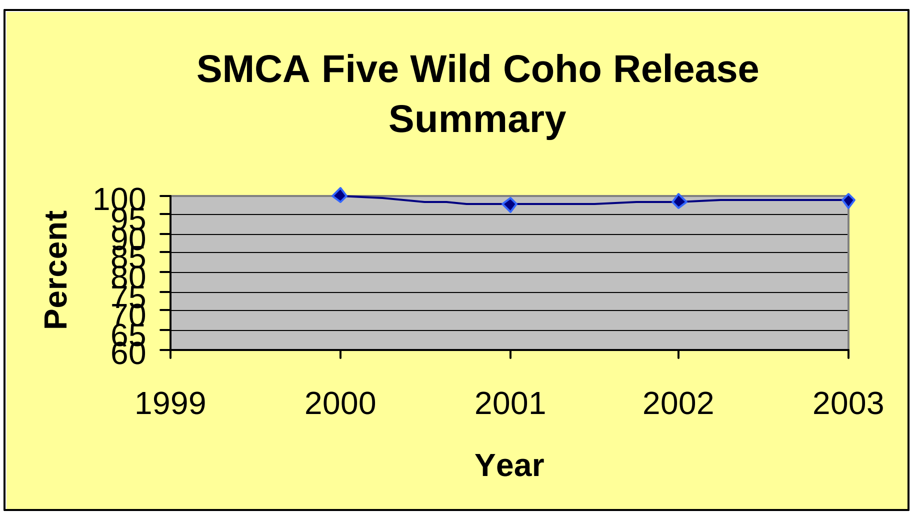
LIC VIO	Arrest	**39**	Warnings	**20**	Total	**59**
GEAR VIO	A	**50**	W	**6**	T	**56**
OVERLIMIT	A	**5**	W	**1**	T	**6**
WILD COHO	A	**21**	W	**1**	T	**22**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**5**	W	**9**	T	**14**
BOAT SAFE	A	**4**	W	**0**	T	**4**
HIDE FISH	A	**6**	W	**1**	T	**7**

Total Citations: 130
Total Warnings: 38

Estimated compliance rate for overall salmon rules was 90.2%.*
Estimated compliance for wild Coho possession was 98.7%**
Estimated compliance for closed season Chinook was 99.2%***

SMCA Five Summaries





AREA **SIX**

(Port Angeles, WA.)

Enforcement Hours:

Dock-	107
Vessel-	321
Investigative-	4
Inter-agency-	8
Total-	**440 hours**

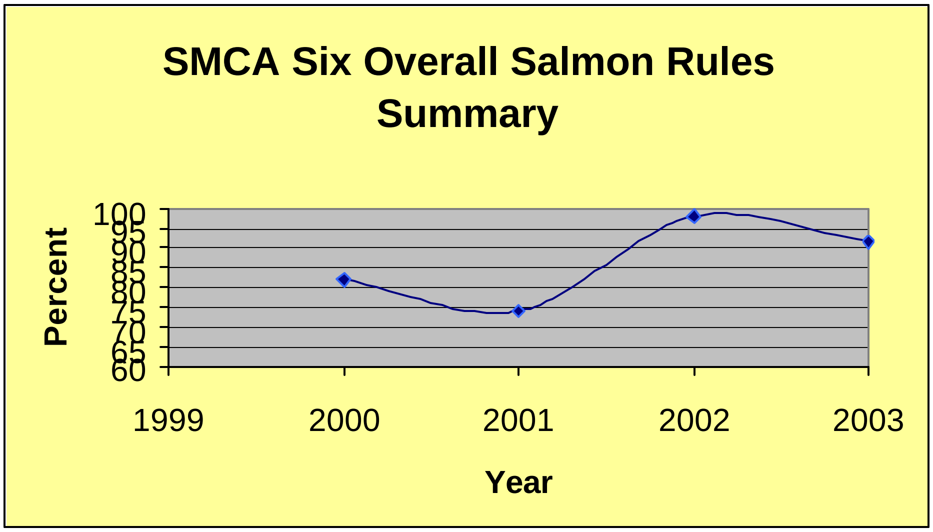
Contacts: **1013 total**

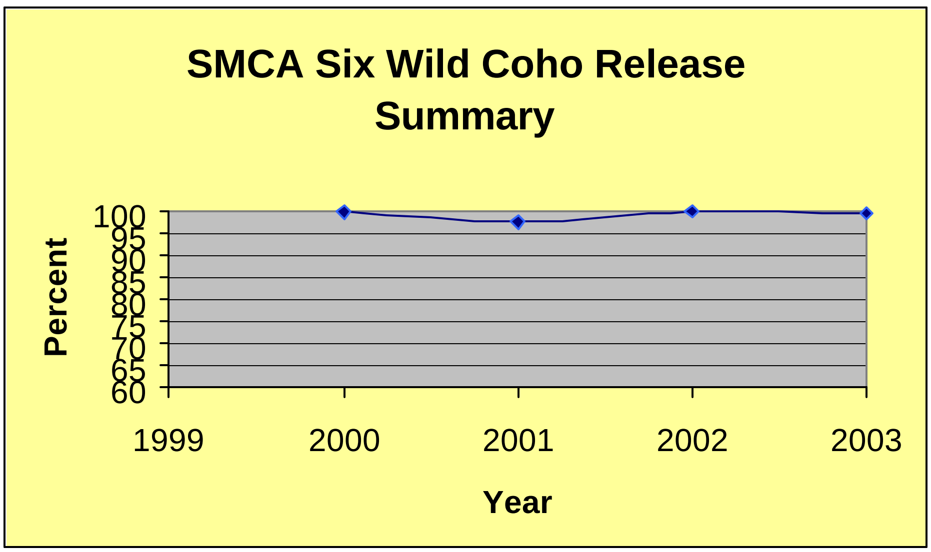
LIC VIO	Arrest	**7**	Warnings	**7**	Total	**14**
GEAR VIO	A	**49**	W	**10**	T	**59**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO	A	**4**	W	**0**	T	**4**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**5**	W	**3**	T	**8**
BOAT SAFE	A	**11**	W	**3**	T	**14**
CRAB	A	**17**	W	**11**	T	**28**

Total Citations: 93
Total Warnings: 34

Estimated compliance rate regarding overall salmon rules was 91.6%.*
Estimated compliance regarding possession of wild Coho: 99.6% .**
Estimated compliance regarding possessing Chinook closed season: 99.3%

SMCO Six Summaries





SMCA AREA NINE, TEN, TWELVE AND THIRTEEN SUMMARY

The South Sound / Hood Canal Marine Detachment is responsible for patrol effort in these SMCA's. Wild Coho release is only required in SMCA 13 and compliance was high this season. Patrol effort was also committed to Area 9 and 12 for the protection of Summer Chum. Additional commitments were made for Area 10 due to bubble fisheries in Elliot Bay and Sinclair Inlet, which allowed access to surplus hatchery stocks of Chinook, while the remainder of the area was closed to Chinook retention.

AREA **NINE**

(Point No Point AND Admiralty Inlet, WA):

Enforcement Hours:

Docks - 15
Vessel - 188
Total - **203 hours**

Contacts: **590 total**

LIC VIO	Arrest	**15**	Warnings	**13**	Total	**28**
GEAR VIO	A	**55**	W	**57**	V	**112**
OVERLIMIT	A	**2**	W	**2**	V	**4**
WILD COHO N/A	A	**0**	W	**0**	V	**0**
CHINOOK	A	**0**	W	**0**	V	**0**
AREA /SEASON	A	**2**	W	**1**	V	**3**
BOAT SAFE	A	**8**	W	**4**	V	**12**
OTHER	A	**8**	W	**1**	V	**9**

Total Citations: 90
Total Warnings: 78

Estimated compliance regarding overall salmon rules was 75.1 %.*

AREA **TEN**

(Bremerton, WA.):

Enforcement Hours:

Docks -	77
Vessel -	524
Interagency -	32
Total -	**633 hours**

Contacts: **678 total**

LIC VIO	Arrest	**46**	Warnings	**24**	Total	**70**
GEAR VIO	A	**90**	W	**24**	T	**114**
OVERLIMIT	A	**12**	W	**1**	T	**4**
WILD COHO N/A	A	**0**	W	**0**	T	**0**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**9**	W	**2**	T	**11**
BOAT SAFE	A	**9**	W	**4**	T	**13**
OTHER	A	**10**	W	**6**	T	**16**

Total Citations: 176
Total Warnings: 61

Estimated compliance regarding overall salmon rules was 69.3 %.*

AREA **TWELVE**
(Hood Canal, WA.):

Enforcement Hours:

Docks - 97
Vessel - 154
Total - **251 hours**

Contacts: **331 total**

LIC VIO	Arrest	**3**	Warnings	**8**	Total	**11**
GEAR VIO	A	**18**	W	**13**	T	**31**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO - N/A	A	**0**	W	**0**	T	**0**
CHINOOK	A	**0**	W	**0**	T	**0**
CHUM CLOSED SEASON	A	**4**	W	**0**	T	**4**
BOAT SAFE	A	**7**	W	**0**	T	**7**
OTHER	A	**24**	W	**14**	T	**38**

Total Citations: 56
Total Warnings: 35

Estimated compliance regarding overall salmon rules was 86.1%.*

AREA **THIRTEEN**
(Olympia, WA.):

Enforcement Hours:

Docks - 19
Vessel - 305
Total - **324 hours**

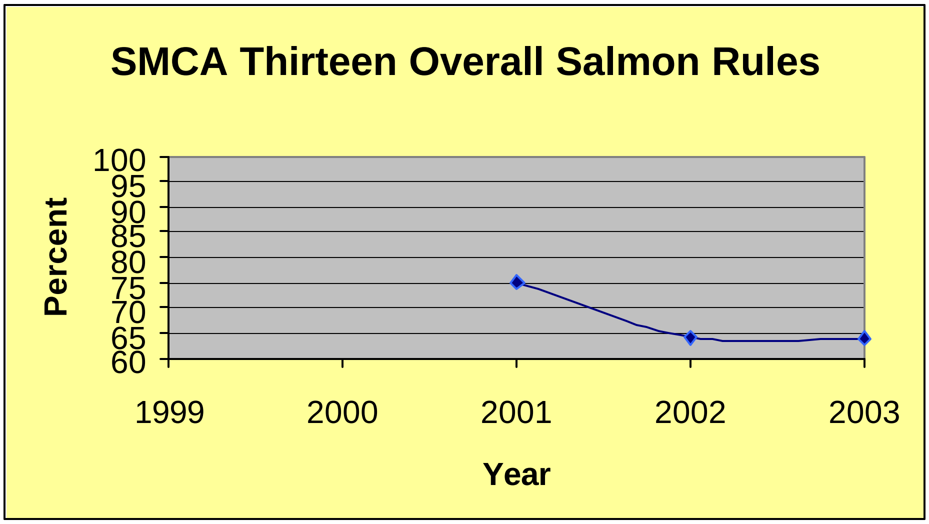
Contacts: **522 total**

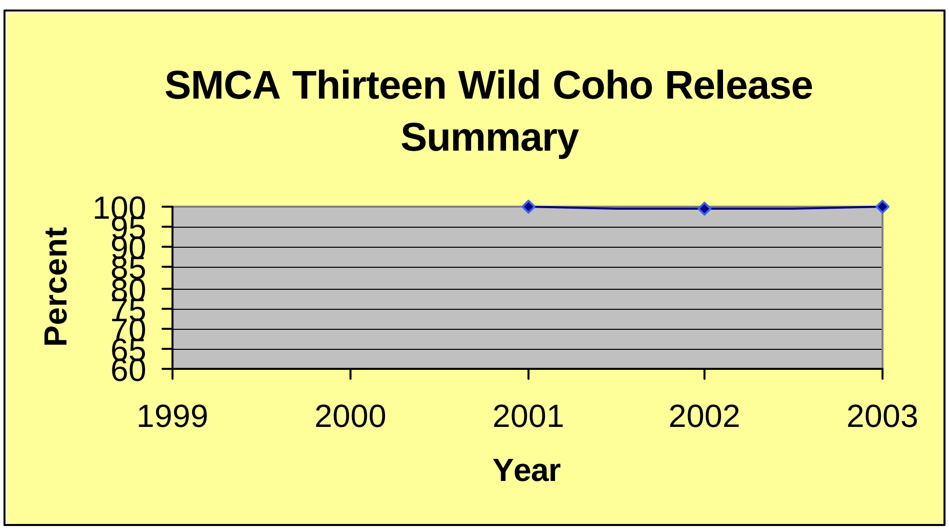
LIC VIO	Arrest	**25**	Warnings	**15**	Total **40**
GEAR VIO	A	**108**	W	**32**	T **140**
OVERLIMIT	A	**3**	W	**0**	T **3**
WILD COHO	A	**1**	W	**0**	T **1**
CHINOOK	A	**0**	W	**0**	T **0**
AREA /SEASON	A	**0**	W	**0**	T **0**
BOAT SAFE	A	**6**	W	**9**	T **15**
OTHER	A	**8**	W	**3**	T **11**

Total Citations: 151
Total Warnings: 59

Estimated compliance regarding overall salmon rules was 64.9%.*
The estimated compliance regarding the possession of wild coho was 99.9%**

SMCO Thirteen Summaries





SMCA AREA SEVEN, EIGHT-ONE, EIGHT- TWO, AND NINE SUMMARY

These SMCA's are the responsibility of the North Sound Marine Detachment. The only selective coho fishery in this marine region is SMCA Seven, which had high compliance with Coho Salmon release rules. Officers also patrolled SMCA's 8-1 and 8-2 to enforce Chinook Salmon closures in effect. Enforcement efforts included the Tulalip Terminal fishery in Area 8-2.

AREA **SEVEN**
(San Juan Islands):

Enforcement Hours:

Docks- 0
Vessel- 669
Total- 669 **hours**

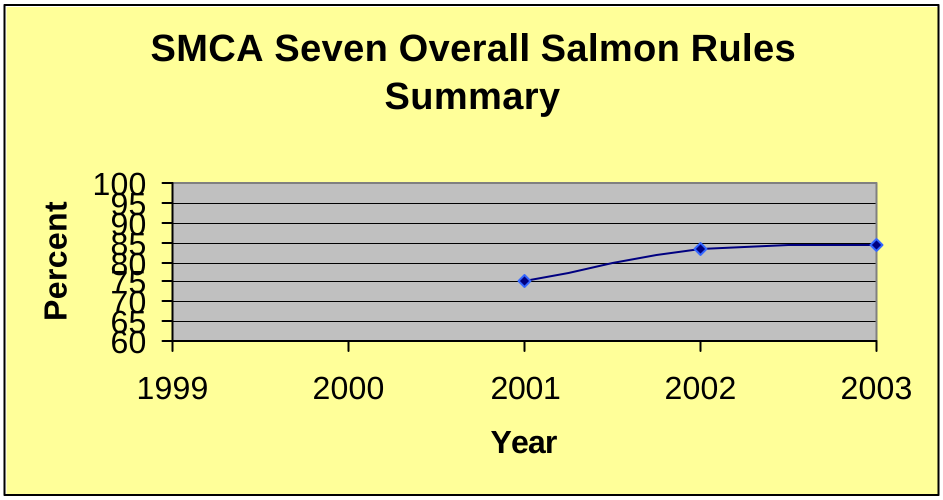
Contacts: **1,331 total**

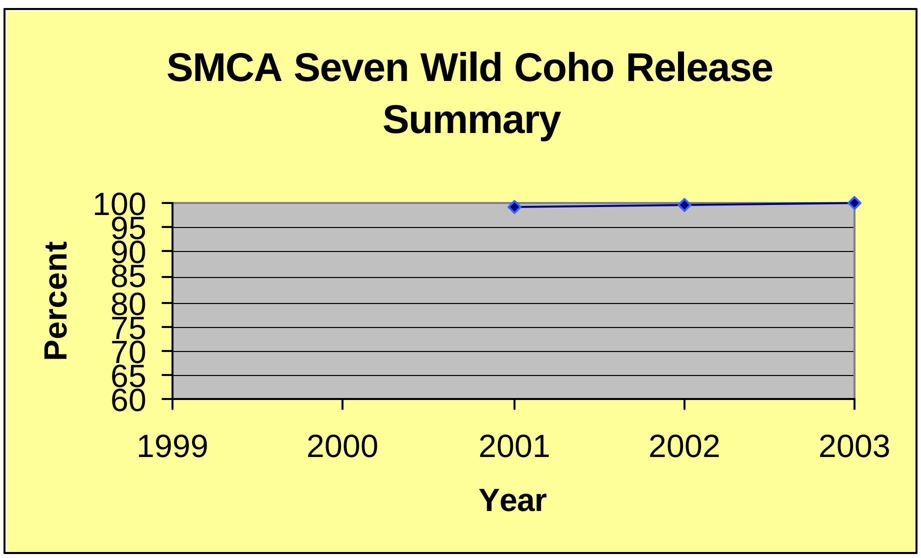
LIC VIO	Arrest	**36**	Warnings	**1**	Total	**37**
GEAR VIO	A	**147**	W	**14**	T	**161**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO	A	**1**	W	**2**	T	**3**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**4**	W	**6**	T	**10**
BOAT SAFE	A	**0**	W	**0**	T	**0**
OTHER	A	**0**	W	**0**	T	**0**

Total Citations: 188
Total Warnings: 23

Estimated compliance regarding overall salmon rules was 84.2%.*
Estimated compliance regarding the possession of wild Coho was 99.8%.**

SMCO Seven Summaries





AREA **EIGHT-ONE**

(Saratoga Passage/Skagit Bay):

<u>Enforcement Hours:</u>

Docks - 16
Vessel - 58
Total - 74 **hours**

Contacts: 132 total

LIC VIO	Arrest	**0**	Warnings	**0**	Total	**0**
GEAR VIO	A	**5**	W	**1**	T	**6**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO –N/A	A	**0**	W	**0**	T	**0**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**0**	W	**0**	T	**0**
BOAT SAFE	A	**0**	W	**0**	V	**0**

Total Citations: 5
Total Warnings: 1

Estimated compliance regarding overall salmon rules was 95.5%.

AREA **EIGHT-TWO**

(Port Gardner/Port Susan):

Enforcement Hours:

Docks - 16
Vessel - 167
Total - 183 **hours**

Contacts: **430 total**

LIC VIO	Arrest	**22**	Warnings	**24**	Total	**46**
GEAR VIO	A	**45**	W	**38**	T	**83**
OVERLIMIT	A	**0**	W	**0**	T	**0**
WILD COHO N/A	A	**0**	W	**0**	T	**0**
CHINOOK	A	**0**	W	**0**	T	**0**
AREA /SEASON	A	**4**	W	**5**	T	**9**
BOAT SAFE	A	**0**	W	**0**	T	**0**

Total Citations: 71
Total Warnings: 67

Estimated compliance regarding overall salmon rules was 67.7%*.

* % compliance with overall salmon regulations = total rule violations associated with **salmon only** (license, gear, possession, season and area) / total contacts.

** % compliance for possession of unmarked Coho = total unmarked fish violations / total contacts.

*** % compliance for possession of unmarked Chinook = total unmarked fish violations / total contacts.