Endangered Species Act - Reinitiated Section 7 Consultation

BIOLOGICAL OPINION

Take of Listed Salmon in Groundfish Fisheries Conducted under the Bering Sea and Aleutian Islands and Gulf of Alaska Fishery Management Plans

Agency: North Pacific Fishery Management Council and
National Marine Fisheries Service

Consultation Conducted By: National Marine Fisheries Service
Protected Resources Division

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1.0 PURPOSE AND CONSULTATION HISTORY

The National Marine Fisheries Service (NMFS) is required under section 7 of the Endangered Species Act (ESA) to conduct consultations which consider the impacts of groundfish fisheries on salmon species listed under the ESA. The objective of this biological opinion is to determine if fisheries conducted in conformance with the Fishery Management Plans (FMP) for the groundfish fisheries of the Bering Sea and Aleutian Islands area and Gulf of Alaska in the Exclusive Economic Zone (EEZ) off Alaska are likely to jeopardize the continued existence of listed salmon ESUs likely to be found in the action area (Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River Basin steelhead) or result in the destruction or adverse modification of their critical habitat.

No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. The ESA listed species or evolutionarily significant units (ESUs) that migrate into marine waters off Alaska, originate in freshwater habitat in Washington, Oregon, Idaho, and California. In the marine waters off Alaska, the ESA listed salmon stocks are mixed with hundreds to thousands of other stocks originating from the Columbia River, British Columbia, Alaska, and Asia. The ESA listed fish are not visually distinguishable from the other, unlisted, stocks. Mortal take of them in the salmon bycatch portion of the fisheries is assumed based on limited abundance, timing, and migration pattern information gleaned from recovery locations of coded-wire-tagged surrogate stocks (closely related hatchery stocks that are tagged with coded wire tags) .

On June 30, 1999, NMFS issued a biological opinion on management of the 1999 summer and 1999/2000 winter salmon fisheries subject to the Fishery Management Plan for salmon off the coast of Alaska as managed under the terms of the 1999 Pacific Salmon Treaty Chinook Annex (NMFS 1999a). The biological opinion concluded that the proposed salmon fisheries are not likely to jeopardize the continued existence of the Upper Willamette River chinook salmon, Lower Columbia River chinook salmon, or Puget Sound chinook salmon or destroy or adversely modify designated critical habitat. Subsequently, NMFS has conducted a biological opinion on the Pacific Salmon Treaty (PST) signed recently by the United States and Canada (NMFS 1999b).

After a protracted period of negotiations, the United States and Canada recently reached agreement under the PST on a long-term and comprehensive management plan that would govern salmon fisheries in Southeast Alaska (SEAK), British Columbia (BC), and the Pacific Northwest. A major component of this agreement is a management regime for chinook salmon that specifies an aggregate abundance-based approach for three major ocean fisheries in Alaska and Canada, coupled with an individual stock-based approach for all other fisheries in Canada and the Pacific Northwest. This chinook management regime, designed to meet the rebuilding and conservation needs of natural-origin stocks, establishes rules for determining allowable catches in the various fisheries.

The United States and Canada approved the agreement by an exchange of diplomatic notes in Washington, D.C. on June 30, 1999. The exchange of notes included contingencies on the U.S. implementation of its obligations under the agreement. Specifically, U.S. implementation of its obligations under the agreement is contingent upon 1) a determination that the agreement complies with the legal requirements of the ESA; and, 2) congressional appropriations to fund key elements of the agreement. On November 18, 1999, NMFS issued a biological opinion covering those salmon fisheries defined within the Pacific Salmon Treaty. The biological opinion concluded that the Pacific Salmon

Treaty and the decision by the NPFMC to defer its management authority to the State of Alaska is not likely to jeopardize any of the threatened or endangered ESUs of Pacific salmon, steelhead, or cutthroat trout or destroy or adversely modify any of the critical habitat that has been designated for these species (NMFS 1999b).

The effects of the Bering Sea and Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish fisheries on listed salmon were considered through informal consultations with NMFS, Northwest Region for fishing years 1992 and 1993 (February 20, 1992, April 21, 1993 respectively). Subsequent informal consultation occurred for BSAI Amendment 28 (June 7, 1993), and for GOA Amendment 31 (September 22, 1993). NMFS stated in the latter two memoranda associated with the informal consultation that it was essential that monitoring efforts be continued and that NMFS continue to seek additional information regarding potential impacts to listed fish. In a biological opinion issued the following year, NMFS stated that it believed that the potential effects of the GOA and BSAI groundfish fisheries on listed salmon warranted formal ESA Section 7 consultation (NMFS 1994).

The 1994 biological opinion was written to determine if continuation of the groundfish fisheries in the BSAI and GOA, in 1994 and beyond, was likely to jeopardize the continued existence of Snake River sockeye salmon, Snake River spring/summer chinook salmon or Snake River fall chinook salmon or destroy or adversely modify critical habitat designated for these species. The biological opinion established specific approaches that were used to assess the effects of the proposed action on listed species. Effects are expressed in terms of numerical catch assessment, base period analysis (that is, for the years 1986-1990), cumulative effects analysis, and combined effects analysis. For the analysis, NMFS assumed that annual bycatch of chinook salmon in 1994 and beyond would be 40,000 or fewer fish in each of the BSAI and GOA fisheries. Relative to the base period analysis question, NMFS assumed a maximum bycatch of 40,000 chinook salmon per region per year was substantially less than that which occurred in the foreign and joint venture fisheries in earlier years. The biological opinion did not evaluate cumulative effects, because none were thought to exist (NMFS 1994).

In its 1994 biological opinion, NMFS concluded that it was highly unlikely that any Snake River Sockeye salmon are taken in the groundfish fisheries. Based on that, NMFS concluded that the groundfish fisheries are not likely to adversely affect Snake River sockeye salmon and thus were not likely jeopardize their continued existence. For listed chinook salmon, NMFS concluded that the catch of Snake river spring/summer chinook salmon is unlikely to average more than one fish per year in each region, and that it is highly unlikely than any Snake River fall chinook salmon are taken in the BSAI groundfish fisheries. NMFS concluded that the catch of Snake River fall chinook in the GOA groundfish fisheries was unlikely to average more than five fish per year and may be substantially less. Based on available information, NMFS concluded that the groundfish fisheries are not likely to jeopardize the continued existence of any of the ESA listed salmon (NMFS 1994).

The incidental take statement of the 1994 biological opinion estimated that five Snake River fall chinook in the GOA, zero in the BSAI, one take of Snake River spring/summer chinook in the BSAI and GOA fisheries, and zero take of Snake River sockeye would be taken in either fishery in a particular year. As explained previously, it was not technically possible to know if any of these salmon have been taken so compliance with the incidental take statement was determined by limiting bycatch of salmon to under 40,000 fish per year for chinook salmon, and 200 and 100 sockeye salmon in the BSAI and GOA fisheries, respectively (NMFS 1994).

On December 7, 1995, NMFS issued a second biological opinion on these fisheries because the amount of incidental take authorized in the 1994 biological opinion had been exceeded (NMFS 1995a). The results of monitoring associated with the fisheries indicated that the estimated bycatch of chinook in the BSAI area was 44,487 in 1994, and revised estimates for the number of chinook salmon taken in the years 1991-1993 were greater than 40,000 fish per year (1993 = 46,014; 1992 = 41,955; and 1991 = 48,880), thus exceeding the terms of the 1994 incidental take statement. The purpose of the reinitiated consultation was to consider whether these higher take estimates affected the conclusion of the 1994 biological opinion (that the BSAI groundfish fisheries were not likely to jeopardize the continued existence of Snake River spring/summer or fall chinook salmon). The 1995 biological opinion concluded that these revised take estimates did not change the previous "no jeopardy" conclusion. Based on the available information, NMFS also concluded that the NPFMC groundfish fisheries are not likely to jeopardize the continued existence of Snake River spring/summer chinook salmon or Snake River fall chinook salmon (NMFS 1995a).

On December 1, 1998, NMFS concluded informal consultation on the effects of the BSAI and GOA groundfish fisheries on newly listed and proposed species (see Table 4 for ESU listings by date and *Federal Register* notice). At that time, 11 new species were listed (since the date of the previous biological opinion) and two were proposed (P = proposed, T = threatened, E = endangered):

- Southern California Steelhead (E)
- S-Central California Coast Steelhead (T)
- California Central Valley Steelhead (T)
- Upper Columbia River Steelhead (E)
- Snake River Basin Steelhead (T)
- Lower Columbia River Steelhead (T)
- Central California Coho (T)
- Southern Oregon Coho (T)
- Oregon Coastal Coho (T)
- Upper Willamette Steelhead (PT)
- Middle Columbia River Steelhead (PT)
- Umpqua River Sea-run Cutthroat (E)

Additional listing determinations were made on March 24, 1999 (64 FR 14308):

- Puget Sound Chinook (T)
- Lower Columbia River Chinook (T)
- Upper Willamette River Chinook (T)
- Upper Columbia River Spring Chinook (E)
- Central Valley Spring Chinook (PE)
- California Coastal Chinook (PT)
- Hood Canal Summer-Run Chum (T)
- Columbia River Chum (T)
- Ozette Lake Sockeye (T), (March 25, 1999; 64 FR 14528)
- Upper Willamette Steelhead (Changed from proposed to final: T)
- Middle Columbia River Steelhead (Changed from proposed to final: T)

On April 5, 1999 (64 FR 16397), the Southwest Washington/Columbia River Coastal Cutthroat Trout ESU was proposed as threatened.

On September 16, 1999 (64 FR 50394), 2 chinook salmon ESUs were listed as threatened (Table 4).

- Central Valley Spring Chinook (T)
- California Coastal Chinook (T)

The effects of BSAI and GOA groundfish fisheries on these additional ESUs have not been considered in other biological opinions. This biological opinion therefore considers the effects of the groundfish fisheries as managed by the NPFMC and NMFS on the following ESUs: Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River Basin steelhead.

2.0 DESCRIPTION OF THE PROPOSED ACTION

NMFS manages the groundfish fisheries in the exclusive economic zone off Alaska under the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area and the Fishery Management Plan for Groundfish of the Gulf of Alaska (FMPs). The North Pacific Fishery Management Council (Council) prepared the FMPs under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson Act), 16 U.S.C. 1801, *et seq*., implemented by regulations appearing at 50 CFR part 679. Regulations governing U.S. fisheries and implementing the FMPs appear at 50 CFR parts 600 and 679.

The proposed action evaluated in this biological opinion is implementation of fishery regulations for BSAI and GOA groundfish fisheries developed in accordance with the FMPs for fisheries in the EEZ off the coast of Alaska. The objective of this biological opinion is to determine whether fisheries conducted in conformance with these regulations are likely to jeopardize the continued existence of newly listed salmon ESUs (Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Puget Sound chinook, Central Valley Spring chinook, California Coastal chinook, Hood Canal summer-run chum, Lower Columbia River chum, Ozette Lake sockeye, Middle Columbia River steelhead and Upper Willamette River steelhead) or result in the destruction or adverse modification of their critical habitat.

The present groundfish fisheries are managed as two complexes -- one for the BSAI and the other for the GOA. The fisheries are promulgated each year with total allowable catch (TAC) specifications. The new TAC specifications are determined annually based on scientific appraisals of the biological status of the stocks and appropriate applications of fishery management principles. The TACs of individual species or groups may be set anywhere from zero up to, but not equal to, the amount determined to be the overfishing limit (OFL) of the species or group.

A description of the scientific foundations used to set TAC and related groundfish fishing regulations is contained in section 2.0 of the groundfish SEIS (NMFS 1998a). In general, the annual documentation in the stock assessment process starts with the "stock assessment and fishery evaluation" (SAFE) reports. These SAFE reports are produced annually by the Council's BSAI and GOA Groundfish Plan Teams and the NMFS. The Guidelines for Fishery Management Plans (602 Guidelines) published by the National Marine Fisheries Service require that a SAFE report be prepared and reviewed annually for each FMP. The SAFE reports are intended to summarize the best available scientific information concerning the past, present, and projected future condition of the stocks and fisheries under federal management. The FMPs for the groundfish fisheries managed by the Council require that drafts of the SAFE reports be produced each year in time for the Council meetings. The SAFE reports for the GOA and BSAI groundfish fisheries managed by the Council are compiled by the GOA and BSAI Groundfish Plan

Teams respectively, from chapters contributed by scientists at the NMFS Alaska Fisheries Science Center, ADF&G and the USFWS.

The TAC specifications for target groundfish categories are based on Acceptable Biological Catch (ABC) specifications as modified by ecological, social and economic factors and, in some cases, to accommodate uncertainty in the stock assessments. The ABC specifications, in turn, are developed under a precautionary approach which provides a risk-averse means of specifying ABC and OFL based on the best available scientific information as summarized in the annual SAFE reports. The ABC specifications are based on definitions that were developed to safeguard against overly aggressive harvest rates, particularly under conditions of high uncertainty or low stock size. The guidelines are robust enough to provide adequate protection to stocks even when recruitment is highly variable or when instances of low recruitment tend to occur in a series. The guidelines are based on the precautionary principle wherein the ABC/OFL guidelines maintain an appropriate buffer between the fishing mortality rates associated with ABC and OFL.

2.1 Bycatch of Salmon

2.1.2 Chinook Salmon

Chinook salmon are caught incidentally in trawl fisheries in the BSAI and GOA, particularly in the BSAI midwater pollock fishery. Salmon are a prohibited species in the BSAI groundfish fisheries. They cannot be retained, and must be returned to the sea as soon as possible with a minimum of injury after they have been counted by a NMFS certified observer. However, the mortality rate for salmon caught in trawl fisheries is 100 percent as salmon cannot survive interception by trawl gear and, therefore, cannot be released alive. Final regulations published on November 29, 1995 (60 FR 61215), and effective January 1996, established annual prohibited species catch (PSC) limits for chinook salmon and specific seasonal no trawling zones in the Chinook Salmon Savings Area (CHSSA) which are triggered when the limits are reached. These existing regulations prohibit trawling in the CHSSA through April 15 of each year once the bycatch limit of 48,000 chinook salmon is reached. Historically, the majority of the chinook salmon bycatch was accounted for before April 15 (in the winter/spring pollock trawl fisheries). Recently, chinook salmon bycatch has also been high in the fall/winter period.

Because of these changing bycatch patterns, NMFS intends to promulgate regulations to further reduce the bycatch of chinook salmon in the BSAI fisheries. In 1999, the Council adopted an FMP amendment that would incrementally reduce the bycatch limit of chinook salmon in trawl fisheries from 48,000 chinook salmon to 29,000 chinook salmon over a four-year period. Because the pollock trawl fishery accounts for the majority of the bycatch (about 90 percent) and has had the most variable bycatch, the limit and closure of the CHSSA would apply only to vessels fishing for pollock. The limit would also be accounted for annually with closures occurring in either the winter/spring or fall/winter periods (during the two seasons of high bycatch of chinook salmon by vessels fishing for pollock with trawl gear).

Chinook salmon bycatch in trawl fisheries reached a high in 1980, when foreign trawl vessels intercepted approximately 115,000 chinook salmon. Following Federal action to reduce bycatch in the trawl fisheries, the foreign fleet was constrained by a bycatch reduction schedule that reduced the allowable level each year from 65,000 chinook salmon in 1981, to 16,500 chinook salmon by 1986. Domestic vessels began fishing in the mid-1980s and bycatch numbers remained below 40,000 fish until 1993. From 1994-1998, most of the chinook salmon bycatch in the BSAI was within the area designated as the CHSSA (Table 1). During this same period, the bycatch limit of 48,000 chinook salmon was exceeded four times, with a high of about 63,000 chinook salmon intercepted in 1998. Since 1996, a PSC limit of

48,000 chinook salmon has been in place during the period from January 1 until April 15 for vessels using trawl gear, with no restrictions on the amount of chinook salmon bycatch in the subsequent months. Historically, most of the chinook salmon taken as bycatch has been by pelagic trawl gear for pollock.

In the GOA, while PSC limits have not been established for salmon, the timing of seasonal openings for pollock in the Central and Western GOA have been adjusted to avoid periods of high chinook bycatch. The number of salmon taken as bycatch has been much lower in the GOA than in the BSAI. The number of chinook salmon taken has ranged from about 14,000 in 1995 to just over 18,000 in 1999. Nearly all of the salmon taken have been by trawl gear in the GOA.

Table 1. Groundfish catch in the BSAI groundfish fisheries and associated bycatch of chinook salmon and "other" salmon (Source: NMFS, Alaska Region, Juneau, AK).

YEAR	GEAR TYPE	GROUNDFISH (MT)	Chinook (#'s)	Other Salmon (#'s)
1999*	Trawl	1,113,572	13,533	49,752
	Hook-and-line	91,141	3	31
	Pot Gear	15,788	9	0
	Jig	137	0	0
	Total	1,220,637	13,545	49,783
1998	Trawl	1,476,210	58,967	69,242
	Hook-and-line	130,359	4	62
	Pot Gear	14,155	0	0
	Jig	196	0	0
	Total	1,620,920	58,971	69,305
1997	Trawl	1,653,841	50,519	66,916
	Hook-and-line	153,853	11	79
	Pot Gear	22,658	0	0
	Jig	201	0	0
	Total	1,830,553	50,530	66,994
1996	Trawl	1,698,562	63,179	77,991
	Hook-and-line	116,169	26	69
	Pot Gear	33,639	0	0
	Jig	273	0	0
	Total	1,848,643	63,205	78,060
1995	Trawl	1,781,965	22,691	21,817
	Hook-and-line	126,069	745	57
	Pot Gear	21,101	0	1
	Jig	616	0	0
	Total	1,929,751	23,436	21,875

* Amounts as of October 1999.

Table 2. Groundfish catch in the GOA groundfish fisheries and associated bycatch of chinook salmon and other salmon (Source: NMFS, Alaska Region, Juneau, AK).

YEAR	GEAR TYPE	GROUNDFISH (MT)	Chinook (#'s)	Other Salmon (#'s)
1999*	Trawl	155,541	18,214	7,031
	Hook-and-line	25,686	0	0
	Pot Gear	18,125	0	0
	Jig	75	0	0
	Total	199,427	18,214	7,031
1998	Trawl	208,761	16,941	13,539
	Hook-and-line	25,467	0	0
	Pot Gear	10,806	0	0
	Jig	79	0	0
	Total	245,114	16,941	13,539
1997	Trawl	195,261	15,230	3,014
	Hook-and-line	25,937	0	0
	Pot Gear	9,417	0	0
	Jig	340	0	0
	Total	230,955	15,230	3,014
1996	Trawl	161,895	15,761	4,176
	Hook-and-line	27,261	0	0
	Pot Gear	12,296	0	0
	Jig	604	0	0
	Total	202,055	15,761	4,176
1995	Trawl	167,172	14,646	64,510
	Hook-and-line	31,863	6	179
	Pot Gear	16,251	0	0
	Jig	600	0	0
	Total	215,886	14,652	64,688

* Amounts as of October 1999.

2.1.3 "Other" Salmon

In the BSAI, bycatch of other salmon has ranged from about 22,000 in 1995 to 78,000 in 1996. Again, the vast majority of the salmon were caught in trawl fisheries. In Table 3, the "other" salmon category is broken out by percentages of the salmon that were identified within this category. No "other" salmon were caught in either the jig or pot gear fisheries. Chum salmon comprise the majority of the catch, 98 percent in trawl fisheries and about 92 percent in hook-and-line fisheries. Coho salmon are the next largest component, about 1.5 percent in trawl fisheries and 6.5 percent in hook-and-line. About 1.4 percent are pink salmon caught in hook-and-line fisheries, and very few sockeye are intercepted and no steelhead were reported.

In the GOA, "other" salmon bycatch, which is comprised mostly of chum salmon, between about 3,000 and 13,000 salmon have been taken since 1996. In 1995, a high of about 65,000 "other" salmon were taken, mostly in the trawl fisheries. Again, chum salmon represent the majority of the bycatch, with coho salmon second. Nearly all of the bycatch of salmon in the GOA (see Table 2) is intercepted in trawl fisheries, with very few salmon caught in the hook-and-line fisheries. From 1995 through 1999, about 88 percent of the trawl "other" salmon bycatch were chum, 10 percent coho, 1 percent sockeye, and 1.5 percent pink salmon (Table 3). Again, no steelhead salmon were reported.

Table 3. Breakdown of "other" salmon bycatch in BSAI and GOA groundfish fisheries (Source: NMFS, Alaska Fisheries Science Center; from the Observer Database).

			Percent of "Other" Salmon Category				
Area	Year	Gear Type	Chum Salmon	Coho	Sockeye	Pink	Steelhead
BSAI	1999 (ytd)	Trawl	96.891	2.912	0.004	0.193	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
	1998	Trawl	99.704	0.220	0.016	0.060	0.000
		Hook-and-line	81.061	18.939	0.000	0.000	0.000
	1997	Trawl	99.738	0.160	0.098	0.004	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
	1996	Trawl	99.707	0.289	0.002	0.002	0.000
		Hook-and-line	79.289	13.971	0.000	6.740	0.000
	1995	Trawl	95.917	3.985	0.000	0.098	0.000
		Hook-and-line	100.000	0.000	0.000	0.000	0.000
	Average	Trawl	98.391	1.513	0.024	0.071	0.000
		Hook-and-line	92.070	6.582	0.000	1.348	0.000
GOA	1999 (ytd)	Trawl	75.923	20.526	1.761	1.790	0.000
		Hook-and-line	15.686	84.314	0.000	0.000	0.000
	1998	Trawl	71.723	22.035	1.490	4.752	0.000
		Hook-and-line	12.800	53.600	25.600	8.000	0.000
	1997	Trawl	98.095	0.939	0.234	0.732	0.000
		Hook-and-line	60.561	39.439	0.000	0.000	0.000
	1996	Trawl	95.902	3.947	0.060	0.091	0.000
		Hook-and-line	38.327	50.348	0.000	11.325	0.000
	1995	Trawl	99.060	0.862	0.064	0.014	0.000
		Hook-and-line	20.109	75.043	0.000	4.848	0.000
	Average	Trawl	88.141	9.662	0.722	1.476	0.000
		Hook-and-line	29.497	60.549	5.120	4.835	0.000

2.2 Conservation Measures Included in the Proposed Action

Bycatch of salmon by groundfish fisheries in the Bering Sea and the GOA remains an issue in fisheries management. Although the groundfish fisheries are prohibited from retaining any salmon they catch, about 60,000 chinook salmon were taken incidentally in the BSAI each year between 1996 and 1998 in trawl fisheries. In that same period, about 60,000 to 80,000 other salmon (mostly chum salmon) were estimated as trawl bycatch annually. Most of the salmon bycatch has been taken by vessels using pelagic trawl gear targeting pollock. In the Bering Sea, a limit of 48,000 chinook salmon between January 1 and April 15 was established for trawl gear in the CHSSA (November 29, 1995; 60 FR 61215).

The Council, at its meeting in September 1997, initiated development of an analysis to investigate lowering the chinook salmon bycatch limit in the BSAI. This proposal, submitted by the Yukon River

Drainage Fisheries Association, identified the current bycatch trigger of 48,000 chinook salmon as too high to effectively reduce chinook salmon bycatch. At its meeting in February 1999, the Council considered this information and the analysis prepared by staffs from the Alaska Department of Fish and Game and the Council in support of this action, and adopted Amendment 58 to the BSAI FMP to reduce chinook salmon bycatch in the BSAI. Five alternatives were presented to the Council for consideration. The alternative adopted by the Council would: (1) reduce the chinook salmon bycatch limit from 48,000 to 29,000 chinook salmon over a 4-year period, (2) implement year-round accounting of chinook salmon bycatch for the pollock fishery, beginning on January 1 of each year, (3) revise the boundaries defined by the CHSSA, and (4) set new CHSSA closure dates. NMFS is presently promulgating rulemaking which would establish these annual chinook salmon limits for pollock fishing with trawl gear only. NMFS anticipates Amendment 58 to be effective early in 2000.

On July 5, 1995 (60 FR 34904) NMFS established the Chum Salmon Savings Area (CSSA) in the BSAI. A limit of 42,000 non-chinook salmon is established for vessels using trawl gear during August 15 through October 14 in the CVOA. If the limit is reached, trawling would be prohibited within the CSSA during the remainder of the period from September 1 through October 14.

In the GOA, while PSC limits have not been established for salmon, the timing of seasonal openings for pollock in the Central and Western GOA have been adjusted to avoid periods of high chinook and chum salmon bycatch.

Table 4. Summary of salmon species listed and proposed for listing under the Endangered Species Act. ESUs in italic represent those likely to range into Alaskan waters.

Species	Evolutionarily Significant Unit (ESU)	Present Status	Federal Register Notice	
Chinook Salmon (*O. tshawytscha*)	Sacramento River Winter-Run	Endangered	54 FR 32085	8/1/89
	Snake River Fall	Threatened	57 FR 14653	4/22/92
	Snake River Spring/Summer	Threatened	57 FR 14653	4/22/92
	Puget Sound	Threatened	64 FR 14308	3/24/99
	Lower Columbia River	Threatened	64 FR 14308	3/24/99
	Upper Willamette River	Threatened	64 FR 14308	3/24/99
	Upper Columbia River Spring	Endangered	64 FR 14308	3/24/99
	Central Valley Spring-Run	Threatened	64 FR 50393	9/16/99
	California Coast	Threatened	64 FR 50393	9/16/99
Chum Salmon (*O. keta*)	Hood Canal Summer-Run	Threatened	64 FR 14570	3/25/99
	Columbia River	Threatened	64 FR 14570	3/25/99
Coho Salmon (*O. kisutch*)	Central California Coast	Threatened	61 FR 56138	10/31/96
	S. Oregon/ N. California Coast	Threatened	62 FR 24588	5/6/97
	Oregon Coast	Threatened	63 FR 42587	8/10/98
Sockeye Salmon (*O. nerka*)	Snake River	Endangered	56 FR 58619	11/20/91
	Ozette Lake	Threatened	64 FR 14528	3/25/99
Steelhead (*O. mykiss*)	Southern California	Endangered	62 FR 43937	8/18/97
	South-Central California	Threatened	62 FR 43937	8/18/97
	Central California Coast	Threatened	62 FR 43937	8/18/97
	Upper Columbia River	Endangered	62 FR 43937	8/18/97
	Snake River Basin	Threatened	62 FR 43937	8/18/97
	Lower Columbia River	Threatened	63 FR 13347	3/19/98
	Central Valley California	Threatened	63 FR 13347	3/19/98
	Upper Willamette River	Threatened	64 FR 14517	3/25/99
	Middle Columbia River	Threatened	64 FR 14517	3/25/99
Cutthroat Trout Sea-Run (*O. clarki clarki*)	Umpqua River	Endangered	61 FR 41514	8/9/96
	Southwest Washington/Columbia River	Proposed Threatened	64 FR 16397	4/5/99

3.0 STATUS OF LISTED SPECIES AND CRITICAL HABITAT

Section 5.0 below discusses the effects of the proposed actions on the currently listed ESUs shown in Table 4. It is apparent from that discussion that the expected take in the proposed ocean salmon fisheries in BSAI and GOA fisheries of many of the ESUs is either zero or at most an occasional event. The following discussion regarding the Status of the Species and the Environmental Baseline therefore focuses on those ESUs that are subject to measurable harvest mortality in the proposed fisheries including Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River Basin steelhead. However, sufficient information regarding the other ESUs is provided in Section 5.0 to support the necessary conclusions.

3.1 Species and Critical Habitat Description

The SR fall chinook ESU includes all natural-origin populations of fall chinook in the mainstem Snake River and several tributaries including the Tucannon, Grande Ronde, Salmon, and Clearwater rivers. Fall chinook from the Lyons Ferry Hatchery are included in the ESU but are not listed.

Critical habitat was designated for SR fall chinook salmon on December 28, 1993 (58 FR 68543). The essential features of the critical habitat include four components: (1) spawning and juvenile rearing areas, (2) juvenile migration corridors, (3) areas of growth and development to adulthood, and (4) adult migration corridors. Marine areas including those within the action area, are not included as part of the designated critical habitat.

The UWR chinook ESU occupies the Willamette River and tributaries upstream of Willamette Falls. Historically, access above Willamette Falls was restricted to the spring when flows were high. In autumn low flows prevented fish from ascending past the falls. The Upper Willamette spring chinook are one of the most genetically distinct chinook groups in the Columbia River Basin. Fall chinook salmon spawn in the Upper Willamette but are not considered part of the ESU because they are not native. None of the hatchery populations in the Willamette River were listed although five spring-run hatchery stocks were included in the ESU.

The LCR ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. Celilo Falls, which corresponds to the edge of the drier Columbia Basin Ecosystem and historically may have presented a migrational barrier to chinook salmon at certain times of the year, is the eastern boundary for this ESU. Not included in this ESU are "stream-type" spring-run chinook salmon found in the Klickitat River (which are considered part of the Mid-Columbia River Spring-Run ESU) or the introduced Carson spring-chinook salmon strain. "Tule" fall chinook salmon in the Wind and Little White Salmon Rivers are included in this ESU, but not introduced "upriver bright" fall-chinook salmon populations in the Wind, White Salmon, and Klickitat Rivers. For this ESU, the Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river systems on the Washington side, and the lower Willamette and Sandy Rivers are foremost on the Oregon side. The majority of this ESU is represented by fall-run fish and includes both north migrating tule-type stocks and far-north migrating bright stocks. There is some question whether any natural-origin spring chinook salmon persist in this ESU. Fourteen hatchery stocks were included in the ESU; one was considered essential for recovery (Cowlitz River spring chinook) but was not listed.

The PS chinook ESU includes all runs of chinook salmon in the Puget Sound region from the North Fork

Nooksack River to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history although there are several populations with an adult spring run timing and ocean distribution. Although some spring-run chinook salmon populations in the PS ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Thirty-six hatchery populations were included as part of the ESU and five were considered essential for recovery and listed including spring chinook from Kendall Creek, the North Fork Stillaguamish River, White River, and Dungeness River, and fall run fish from the Elwha River.

The HCSR chum ESU includes summer-run chum salmon populations in Hood Canal in Puget Sound and in Discovery and Sequim Bays on the Strait of Juan de Fuca. It may also include summer-run fish in the Dungeness River, but the existence of that run is uncertain. Five hatchery populations are considered part of the ESU including those from the Quilcene National Fish Hatchery, Long Live the Kings Enhancement Project (Lilliwaup Creek), Hamma Hamma River Supplementation Project, Big Beef Creek reintroduction Project, and WDFW/Wild Olympic Salmon Cooperative (Dungeness River). Although included as part of the ESU, none of the hatchery populations were listed.

Critical habitat has not been designated for the UWR, LCR, or PS chinook ESUs or for HCSR chum.

3.2 Life History

3.2.1 Chinook Salmon

Chinook salmon is the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations.

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers, et al. (1998) and Healey (1991).

3.2.2 Chum Salmon

Historically, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey Bay, California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast.

Chum salmon (Oncorhynchus keta) are semelparous, spawn primarily in freshwater and, apparently, exhibit obligatory anadromy (there are no recorded landlocked or naturalized freshwater populations) (Randall et al. 1987). Chum salmon spend more of their life history in marine waters than other Pacific salmonids. Chum salmon, like pink salmon, usually spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. Juveniles outmigrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus Oncorhynchus (e.g., coastal cutthroat trout, steelhead, coho salmon, and most types of chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

3.3 Population Dynamics and Distribution

3.3.1 Chinook Salmon

Snake River Fall Chinook

The spawning grounds between Huntington (RM 328) and Auger Falls (RM 607) were historically the most important for this species. Only limited spawning activity was reported downstream from RM 273 (Waples, et al. 1991), about one mile upstream of Oxbow Dam. Since then, irrigation and hydropower projects on the mainstem Snake River have blocked access to or inundated much of this habitat—causing the fish to seek out less-preferable spawning grounds wherever they are available. Natural fall chinook salmon spawning now occurs primarily in the Snake River below Hells Canyon Dam and the lower reaches of the Clearwater, Grand Ronde, Salmon, and Tucannon Rivers.

Adult Snake River fall chinook salmon enter the Columbia River in July and migrate into the Snake River from August through October. Fall chinook salmon generally spawn from October through November and fry emerge from March through April. Downstream migration generally begins within several weeks of emergence (Becker 1970, Allen and Meekin 1973), and juveniles rear in backwaters and shallow water areas through mid-summer prior to smolting and migrating to the ocean—thus they exhibit an "ocean" type juvenile history. Once in the ocean, they spend one to four years (though usually, three) before beginning their spawning migration. Fall returns in the Snake River system are typically dominated by four-year-old fish. For detailed information on the Snake River fall chinook salmon, see NMFS (1991) and June 27, 1991, 56 FR 29542.

No reliable estimates of historical abundance are available, but because of their dependence on mainstem habitat for spawning, fall chinook have probably been impacted to a greater extent by the development of irrigation and hydroelectric projects than any other species of salmon. It has been estimated that the mean number of adult Snake River fall chinook salmon declined from 72,000 in the 1930s and 1940s to 29,000 during the 1950s. In spite of this, the Snake River remained the most important natural production area for fall chinook in the entire Columbia River basin through the 1950s. The number of adults counted at the uppermost Snake River mainstem dams averaged 12,720 total spawners from 1964 to 1968, 3,416 spawners from 1969 to 1974, and 610 spawners from 1975 to 1980 (Waples, et al. 1991).

Counts of adult fish of natural-origin continued to decline through the 1980s reaching a low of 78 individuals in 1990 (Table 5). Since then the return of natural-origin fish to Lower Granite Dam (LGD) has been variable, but generally increasing reaching a recent year high of 797 in 1997. The 1998 return declined to 306. This was not anticipated and is of particular concern because it is close to the low threshold escapement level of 300 that is indicative of increased risk (BRWG 1994). It has been suggested that the low return in 1998 was due to severe flooding in 1995 that affected the primary contributing brood year. The expected return of natural-origin adults to LGD in 1999 given the anticipated ocean and inriver fisheries is 518.

Unlike many of the listed salmonid ESUs, SR fall chinook is probably represented by only a single population that spawns in the parts of the mainstem that remain accessible and the lower reaches of the associated tributaries. The more complex population structure that likely existed historically was eliminated by the upstream dams.

The recovery standard identified in the 1995 Proposed Recovery Plan (NMFS 1995a) for Snake River fall chinook was a population of at least 2,500 naturally produced spawners (to be calculated as an eight year geometric mean) in the lower Snake River and its tributaries. The LGD counts can not be compared directly to the natural spawner escapement objective since it is also necessary to account for adults which may fall back below the dam after counting and prespawning mortality. A preliminary estimate suggested that a LGD count of 4,300 would be necessary to meet the 2,500 fish escapement goal (NMFS 1995a). For comparison, the geometric mean of the LGD counts of natural-origin fall chinook over the last eight years is 481.

A further consideration regarding the status of SR fall chinook is the existence of the Lyons Ferry Hatchery stock which is considered part of the ESU. There have been several hundred adults returning to the Lyons Ferry Hatchery in recent years (Table 5). More recently, supplementation efforts designed to accelerate rebuilding were initiated beginning with smolt outplants from the 1995 brood year. The existence of the Lyons Ferry program has been an important consideration in evaluating the status of the ESU since it reduces the short-term risk of extinction by providing a reserve of fish from the ESU. Without the hatchery program the risk of extinction would have to be considered high since the ESU would otherwise be comprised of a few hundred individuals from a single population, in marginal habitat, with a demonstrated record of low productivity. Although the supplementation program likely contributes future natural origin spawners, it does little to change the productivity of the system upon which a naturally spawning population must rely. Supplementation is, therefore, not a long-term substitute for recovery. [See NMFS (1999f) for further discussion on the supplementation program.]

Recent analyses conducted through the PATH process (Plan for Analyzing and Testing Hypotheses) considered the prospects for survival and recovery given several future management options for the hydro system and other mortality sectors (Marmorek, et al. 1998, Peters, et al. 1999). That analysis indicated that the prospects of survival for Snake River fall chinook were good, but that full recovery was relatively unlikely except under a very limited range of assumptions, or unless draw down was implemented for at least the four lower Snake River dams operated by the U.S. Army Corps of Engineers. Consideration of the draw down options led to a high likelihood that both survival and recovery objectives could be achieved.

The Northwest Fisheries Science Center (NFSC) has recently considered the extinction risk for SR fall chinook as part of their Cumulative Risk Initiative (CRI). The results indicate that the probability of extinction for SR fall chinook over the next ten years is near zero while the risk of extinction over 100 years is between 6-17% (depending on whether 1980 is included in the baseline analysis).

Table 5. Escapement and Stock Composition of Fall Chinook at Lower Granite Dam[1]

Year	L. Granite Count	Marked Fish to Lyons Ferry Hatch.	L. Granite Dam Escapement	Stock Comp. of L. Granite Escapement		
					Hatchery Origin	
				Wild	Snake R.	Non-Snake R.
1975	1000		1000	1000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1067	430	637	350	1	286
1996	1308	389	919	639	74	206
1997	1451	444	1007	797	20	190
1998	1909	947	962	306	479	177

[1] Information taken from *Revised Tables for the Biological Assessment of Impacts of Anticipated 1996-1998 Fall Season Columbia River Mainstem and Tributary Fisheries on Snake River Salmon Species Listed Under the Endangered Species Act*, prepared by the U.S. v. Oregon Technical Advisory Committee.

Upper Willamette River Chinook

Upper Willamette River chinook are one of the most genetically distinct groups or chinook in the Columbia River Basin. This may be related in part to the narrow time window available for passage above Willamette Falls. Chinook populations in this ESU have a life history pattern that includes traits from both ocean- and stream-type life histories. Smolt emigrations occur as young of the year and as age-1 fish. Ocean distribution of chinook in this ESU is consistent with an ocean-type life history with the majority of chinook being caught off the coasts of British Columbia and Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook stocks in the Columbia Basin with freshwater entry beginning in February. Historically, spawning occurred between mid-July and late October. However, the current spawn timing of hatchery and wild chinook in September and early October likely is due to hatchery fish introgression.

The abundance of naturally-produced spring chinook in the ESU has declined substantially from historic levels. Historic escapement levels may have been as high as 200,000 fish per year. The production capacity of the system has been reduced substantially by extensive dam construction and habitat degradation. From 1946-50, the geometric mean of Willamette Falls counts for spring chinook was 31,000 fish (Myers *et al.* 1998), which represented primarily naturally-produced fish. The most recent 5 year (1995-1999) geometric mean escapement above the falls was 27,800 fish, comprised predominantly of hatchery-produced fish (Table 6). Nicholas (1995) estimated 3,900 natural spawners in 1994 for the ESU, with approximately 1,300 of these spawners being naturally produced. There has been a gradual increase in naturally spawning fish in recent years, but it is believed that many of these are first generation hatchery fish. The long-term trend for total spring chinook abundance within the ESU has been approximately stable although there was a series of higher returns in the late-80s and early-90s that are associated with years of higher ocean survival. The great majority of fish returning to the Willamette River in recent years have been of hatchery-origin.

Historically, there were five major basins that produced spring chinook including the Clackamas, North and South Santiam Rivers, McKenzie, and the Middle Fork Willamette. However, between 1952-1968 dams were built on all of the major tributaries occupied by spring chinook, blocking over half the most important spawning and rearing habitat. Dam operations have also reduced habitat quality in downstream areas due to thermal and flow effects. Dams on the South Fork Santiam and Middle Fork Willamette eliminated wild spring chinook in those systems (ODFW 1997). Although there is still some natural spawning in these systems below the dams, habitat quality is such that there is probably little resulting production and the spawners are likely of hatchery origin. Populations in several smaller tributaries that also used to support spring chinook are believed to be extinct (Nicholas 1995).

The available habitat in the North Fork Santiam and McKenzie rivers was reduced to 1/4 and 2/3, respectively, of its original capacity. Spring chinook on the Clackamas were extirpated from the upper watershed after the fish ladder at Faraday Dam washed out in 1917, but recolonized the system after 1939 when the ladder was repaired. NMFS was unable to determine, based on available information whether this represents a historical affinity or a recent, human-mediated expansion into the Clackamas River. Regardless, NMFS included natural-origin spring chinook as part of the listed populations and considers Clackamas spring chinook as a potentially important genetic resource for recovery.

The McKenzie, Clackamas, and North Santiam are therefore the primarily basins that continue to support natural production. Of these the McKenzie is considered the most important. Prior to construction of major dams on Willamette tributaries, the McKenzie produced 40% of the spring chinook above Willamette Falls and it may now account for half the production potential in the Basin. Despite dam construction and other habitat degradations, the McKenzie still supports substantial production with most of the better quality habitat locate above Leaburg Dam. The interim escapement objective for the area above the Dam is 3,000-5,000 spawners (ODFW 1998a). Pristine production in that area may have been as high as 10,000, although substantial habitat improvements would be required to again achieve pristine production levels. Estimates of the number of natural-origin spring chinook returning to Leaburg Dam are available since 1994 when adults from releases of hatchery reared smolts above the dam were no longer present. The number of natural-origin fish at the Dam has increased steadily from 786 in 1994 to 1,458 in 1999 (Table 6). Additional spawning in areas below the Dam accounts for about 20% of the McKenzie return.

The Clackamas River currently accounts for about 20% of the production in the Willamette Basin. The production comes from one hatchery and natural production areas located primarily above the North Fork Dam. The interim escapement goal for the area above the Dam is 2,900 adults (ODFW 1998a). This system is heavily influenced by hatchery production so it is difficult to distinguish natural from hatchery-origin spawners. Most of the natural spawning occurs above the North Fork Dam with 1,000- 1,500 adults crossing the Dam in recent years. There were 380 redds counted above the dam in 1998 and similar counts in 1997 (Lindsay et. al. 1998). There is some spawning in the area below the Dam as well although the origin and productivity of these fish is again uncertain. There were 48 spring chinook redds counted below the North Fork Dam in 1998.

Over 70% of the production capacity of the North Santiam system was blocked by the Detroit Dam. There are no passage facilities at the Dam so all of the current natural production potential remains downstream. The remaining habitat is adversely affected by warm water and flow regulation. The system is again influenced substantially by hatchery production, although the original genetic resources have been maintained since Marion Forks Hatchery stock has been derived almost exclusively from North Santiam brood sources (ODFW 1998a). Despite these limitations there continues to be natural spawning in the lower river. There were 194 redds counted in the area below Minto Dam (the lower-most dam) in 1998, which was marginally higher than during the prior two years (Lindsay et. al. 1998). The origin of the spawning adults or their reproductive success has not been determined.

Mitigation hatcheries were built to offset the substantial habitat losses resulting from dam construction and, as a result, 85%-95% of the production in the basin is now hatchery origin fish. On the one hand these hatchery populations represent a risk to the ESU. The genetic diversity of the ESU has been largely homogenized due to the past practice of broodstock transfers within the basin. Domestication is also a risk given the predominance of hatchery fish. Nevertheless, the hatchery populations also represent a genetic resource. All five of the hatchery stocks were included in the ESU and therefore are available to support recovery efforts. Given the extensive network of dams in the basin and other pervasive habitat degradations, it is clear that most, if not all, of the remaining populations would have been eliminated had it not been for the hatchery programs.

NMFS is currently engaged in a consultation to consider the future operation of the hatchery facilities in the Willamette Basin. This will reduce future risks associated with hatchery operations. Substantial efforts have already been taken to remedy some of the past hatchery practices including limiting the proportion of hatchery spawners in some natural production areas and reincorporating local-origin wild fish into the hatchery broodstock (ODFW 1998a). All hatchery produced fish in the Basin are now externally marked. Once these fish are fully recruited, the mass marking will allow implementation of selective fisheries in terminal areas and thus provide harvest opportunity with limited impacts to natural origin fish. The marking program will also greatly improve the managers' ability to monitor and control hatchery straying and production. The fall chinook hatchery production program was also noted as a risk to the species since fall chinook were not historically present above Willamette Falls. The fall production program at Stayton Ponds has now been closed with the last release made in 1995. It is reasonable to expect that the return of fall chinook will diminish rapidly as a result.

Table 6. Run size of spring chinook at the mouth of the Willamette River and counts at Willamette Falls and Leaburg Dam on the McKenzie River (Nicholas 1995; ODFW and WDFW 1998). The Leaburg counts show wild and hatchery combined and wild only since 1994.

Return Year	Estimated number entering Willamette River	Willamette Falls Count	Leaburg Dam Count	
			Combined	Wild Only
1985	57,100	34,533	825	
1986	62,500	39,155	2,061	
1987	82,900	54,832	3,455	
1988	103,900	70,451	6,753	
1989	102,000	69,180	3,976	
1990	106,300	71,273	7,115	
1991	95,200	52,516	4,359	
1992	68,000	42,004	3,816	
1993	63,900	31,966	3,617	
1994	47,200	26,102	1,526	786
1995	42,600	20,592	1,622	894
1996	34,600	21,605	1,445	1,086
1997	35,000	26,885	1,176	981
1998	45,100	34,461	1,874	1,364
1999	58,000*	40,410	1,458	1,416

*preliminary

Lower Columbia River Chinook

The LCR ESU includes spring stocks and fall tule and bright components. Spring-run chinook salmon on the lower Columbia River, like those from coastal stocks, enter freshwater in March and April well in advance of spawning in August and September. Historically, fish migrations were synchronized with periods of high rainfall or snowmelt to provide access to upper reaches of most tributaries where spring stocks would hold until spawning (Fulton 1968, Olsen *et al.* 1992, WDF *et al.* 1993).

Fall chinook predominate the Lower Columbia River salmon runs. Fall chinook return to the river in mid-August and spawn within a few weeks (WDF et al. 1993, Kostow 1995). The majority of fall-run chinook salmon emigrate to the marine environment as subyearlings (Reimers and Loeffel 1967, Howell et al. 1985, WDF et al. 1993). A portion of returning adults whose scales indicate a yearling smolt migration may be the result of extended hatchery-rearing programs rather than of natural, volitional yearling emigration. It is also possible that modifications in the river environment may have altered the duration of freshwater residence. Adults return to tributaries in the Lower Columbia River at 3 and 4 years of age for fall-run fish and 4 to 5 years of age for spring-run fish. This may be related to the predominance of yearling smolts among spring-run stocks. Marine coded-wire-tag recoveries for lower Columbia River stocks tend to occur off the British Columbia and Washington coasts, though a small proportion of the tags are recovered in Alaskan waters.

There are no reliable estimates of historic abundance for this ESU, but it is generally agreed that there have been vast reductions in natural production over the last century. Recent abundance of spawners includes a 5-year geometric mean natural spawning escapement of 29,000 natural spawners and 37,000 hatchery spawners (1991-95), but according to the accounting of PFMC (1996), approximately 68% of the natural spawners are first-generation hatchery strays.

All basins in the region are affected to varying degrees by habitat degradation. Major habitat problems are related primarily to blockages, forest practices, urbanization in the Portland and Vancouver areas, and agriculture in flood plains and low-gradient tributaries. Substantial chinook salmon spawning habitat has been blocked (or passage substantially impaired) in the Cowlitz (Mayfield Dam 1963, RKm 84), Lewis (Merwin Dam 1931, RKm 31), Clackamas (North Fork Dam 1958, RKm 50), Hood (Powerdale Dam 1929, RKm 7), and Sandy (Marmot Dam 1912, RKm 48; Bull Run River dams in the early 1900s) rivers (WDF et.al. 1993, Kostow 1995).

Hatchery programs to enhance chinook salmon fisheries in the lower Columbia River began in the 1870s, expanded rapidly, and have continued throughout this century. Although the majority of the stocks have come from within this ESU, over 200 million fish from outside the ESU have been released since 1930. A particular concern noted at the time of listing related to the straying by Rogue River fall-run chinook salmon, which are released into the lower Columbia River to augment harvest opportunities. The release strategy has since been modified to minimize straying, but it is too early to assess the effect of the change. Available evidence indicates a pervasive influence of hatchery fish on most natural populations throughout this ESU, including both spring- and fall-run populations (Howell et al. 1985, Marshall et al. 1995). In addition, the exchange of eggs between hatcheries in this ESU has led to the extensive genetic homogenization of hatchery stocks (Utter et al. 1989).

The remaining spring chinook stocks in the LCR ESU are found in the Sandy on the Oregon side and Lewis, Cowlitz, and Kalama on the Washington side. Spring chinook in the Clackamas River are considered part of the UWR ESU. Naturally spawning spring chinook in the Sandy River are included in the LCR ESU despite substantial influence of Willamette hatchery fish from past years since they likely contain all that remains of the original genetic legacy for that system. Recent escapements above Marmot Dam on the Sandy River average 2,800 and have been increasing (ODFW 1998b). Hatchery-origin spring chinook are no longer released above Marmot Dam; the proportion of first generation hatchery fish in the escapement is relatively low, on the order of 10-20% in recent years.

On the Washington side spring chinook were present historically in the Cowlitz, Kalama, and Lewis rivers. Spawning areas were blocked by dam construction in the Cowlitz and Lewis. The native Lewis run became extinct soon after completion of Merwin Dam in 1932. Production in the Kalama was limited by the dams and by 1950 only a remnant population remained. Spring chinook in the Cowlitz, Kalama, and Lewis are currently all hatchery fish. There is some natural spawning in the three rivers, but these are believed to be primarily from hatchery strays (ODFW 1998b). The recent averages (1994-1998) for naturally spawning spring chinook in the Cowlitz, Kalama, and Lewis are 235, 224, and 372, respectively. The amount of natural production resulting from these escapements is unknown, but is presumably small since the remaining habitat in the lower rivers is not the preferred habitat for spring chinook. The Lewis and Kalama hatchery stocks have been mixed with out of basin stocks, but are nonetheless included in the ESU. The Cowlitz stock is largely free of introductions and is considered essential for recovery although not listed. The number of spring chinook returning to the Cowlitz, Kalama, and Lewis rivers have declined in recent years, but still number several hundred to a few thousand in each system (Table 7). Hatchery escapement goals have been consistently met in the Cowlitz and Lewis Rivers. The goal has not been met in all years in the Kalama, but WDFW continues to use brood stock from the Lewis to meet production goals in the Kalama. Although the status of hatchery stocks are not always a concern or priority from an ESA perspective, in situations where the historic spawning habitat is no longer accessible, the status of the hatchery stocks is pertinent.

Table 7. Estimated Lower Columbia River spring chinook tributary returns, 1992-1999. (Source: Pettit 1998, ODFW/WDFW 1998.)

Year	Sandy R.	Cowlitz R.	Lewis R.	Kalama R.	Total Returns Excluding the Willamette System
1992	8,600	10,400	5,600	2,400	27,200
1993	6,400	9,500	6,600	3,000	25,500
1994	3,500	3,100	3,000	1,300	10,900
1995	2,500	2,200	3,700	700	9,100
1996	4,100	1,800	1,700	600	8,200
1997	5,200	1,900	2,200	600	9,900
1998	4,300	1,100	1,600	400	7,400
1999		1,600	1,900	600	

There are apparently three self-sustaining natural populations of tule chinook in the Lower Columbia River (Coweeman, East Fork Lewis, and Clackamas) that are not substantially influenced by hatchery strays. Returns to the East Fork and Coweeman have been stable and near interim escapement goals in recent years. Recent 5 and 10 year average escapements to the East Fork Lewis have been about 300 compared to an interim escapement goal of 300. Recent 5 and 10 year average escapements to the Coweeman are 900 and 700, respectively compared to an interim natural escapement goal of 1000 (pers. comm., from G. Norman, WDFW to P. Dygert NMFS, February 22, 1999). Natural escapement on the Clackamas has averaged about 350 in recent years. There have been no releases of hatchery fall chinook in the Clackamas since 1981 and there are apparently few hatchery strays. The population is considered depressed, but stable and self-sustaining (ODFW 1998b). There is some natural spawning of tule fall chinook in the Wind and Little White Salmon Rivers, tributaries above Bonneville Dam (the only component of the ESU that is affected by tribal fisheries). Although there may be some natural production in these systems, the spawning results primarily from hatchery-origin strays.

The LCR bright stocks are among the few healthy natural chinook stocks in the Columbia River Basin. Escapement to the North Fork Lewis River has exceed its escapement goal of 5,700 by a substantial margin every year since 1980 with a recent five year average escapement of 10,000. The forecast in 1999 is for an exceptionally low return of about 2,500 and if correct would obviously be under the escapement goal. The low return in 1999 has been attributed to severe flooding that occurred in 1995 and 1996.

Despite this apparent aberration, this population is considered healthy.

There are two smaller populations of LCR brights in the Sandy and East Fork Lewis River. Run sizes in the Sandy have averaged about 1000 and been stable for the last 10-12 years. The fall chinook hatchery program in the Sandy was discontinued in 1977, which has certainly reduced the number of hatchery strays in the system. There is also a late spawning component in the East Fork Lewis that is comparable in timing to the other bright stocks. The escapement of these fish is less well documented, but it appears to be stable and largely unaffected by hatchery fish (ODFW 1998b).

Puget Sound Chinook

This ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River in the east to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns.

The peak recorded harvest landed in Puget Sound occurred in 1908, when 95,210 cases of canned chinook salmon were packed. This corresponds to a run-size of approximately 690,000 chinook salmon at a time when both ocean harvest and hatchery production were negligible. (This estimate, as with other historical estimates, needs to be viewed cautiously; Puget Sound cannery pack probably included a portion of fish landed at Puget Sound ports but originating in adjacent areas, and the estimates of exploitation rates (ER) used in run-size expansions are not based on precise data.) Recent mean spawning escapements totaling 71,000 correspond to a run entering Puget Sound of approximately 160,000 fish. Based on an exploitation rate of one-third in intercepting ocean fisheries, the recent average potential run-size would be 240,000 chinook salmon.

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1992-96 is approximately 13,000. Both long- and short-term trends for these runs were negative, with few exceptions. In South Puget Sound, spawning escapement of the natural runs has averaged 11,000 spawners. In this area, both long- and short-term trends are predominantly positive.

Puget Sound chinook are the largest and most complex ESU that is considered in detail in this opinion. WDF et al. (1993) identified 28 stocks that were distributed among five geographic regions and 12 management units or basins (Table 8). (The Hoko River stock was included in WDF's initial inventory, but was subsequently assigned to the neighboring ESU.) NMFS is currently engaged in delineating the population structure of PS chinook and other ESUs as an initial step in a formal recovery planning effort that is now underway. These determinations have not been finalized at this time, but it is clear that these 28 stocks represent the greatest level of potential stratification and that some further aggregation of these stocks is likely (Myers, J. NWFSC/NMFS, pers. com. P. Dygert, NMFS, Sept. 2, 1999). By considering at this time the status of the stocks as described by WDF NMFS can be reasonably certain that we are not overlooking population structures that may be important to the ESU.

Table 8. Distribution of stocks identified in WDF (1993) by recovery category. Stock timing designations are spring (SP), summer (S), fall (F), and summer/fall (SF).

Region of Origin	Management Unit	Stock/Timing	Recovery Category
Strait of Juan de Fuca	Strait of Juan de Fuca	Elwha/Morse Cr./SF	1
		Dungeness/SP	1
Hood Canal	Hood Canal	Hood Canal/SF	2 & 3
North Sound	Nooksack/Samish	NF Nooksack/SP	1
		SF Nooksack/SP	1
		Nooksack/F	2
	Skagit Spring	Upper Sauk/SP	1
		Suiattle/SP	1
		Cascade/SP	1
	Skagit Summer/Fall	Upper Skagit/S	1
		Lower Skagit/F	1
		Lower Sauk/S	1
	Stillaguamish	Stillaguamish/S	1
		Stillaguamish/F	1
	Snohomish	Snohomish/S	1
		Wallace/SF	1
		Snohomish/F	1
		Bridal Veil Cr/F	1
Mid-Sound	Lake Washington	Issaquah/SF	2
		N Lake WA Tribs/SF	2
		Cedar/SF	1
	Duwamish/Green	Duwamish/Green/SF	1
		Newaukum Cr/SF	1
South Sound	Puyallup	White River/SP	1
		White River/SF	2
		Puyallup River /SF	2
	Nisqually	Nisqually River/SF	2
	South Sound Tribs	South Sound Tribs/SF	3

Puget Sound includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In addition, the Puget Sound contains areas where indigenous local stocks persist and areas where local stocks are a composite of indigenous stocks and introduced hatchery fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production. In response to these varied circumstances, the state and tribal co-managers have developed a proposal to stratify stocks to provide a context for analyzing actions and considering recovery efforts. This stratification was initially proposed in conjunction with a now ongoing consultation regarding hatchery activities in Puget Sound. However, the proposal is broadly applicable and used in this consultation as well, thus providing a common framework for analyzing both harvest and hatchery activities. Although this stratification scheme has not been formally adopted by the co-managers, it nonetheless provides a useful construct for analysis.

The stratification assigns stocks to one of three categories:

Category 1 stocks are core stocks that are genetically unique and indigenous to watersheds of Puget Sound. Maintaining genetic diversity and integrity of these stocks and achieving abundance levels for long-term sustainability is the highest priority for these stocks. Twenty stocks have been identified in this category (Table 8).

The status of these stocks varies. Some stocks (Dungeness and Nooksack) have fallen to such low levels that our ability to maintain their genetic diversity may be at risk. Other stocks are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield harvest rates. All of these stocks have specific maximum sustained yield (MSY) escapement goals, which are actively managed for, but have not generally been achieved in recent years. In some cases (Elwha, Dungeness, Nooksack, Stillaguamish, and White River) hatchery operations are essential for recovery, and without them, the stocks would likely further decline and go extinct. In one case at least (Green River) the number of hatchery fish spawning naturally is a concern, in part because it masks our ability to evaluate the actual productivity of wild fish. The objective for category 1 stocks is to protect and recover these indigenous stocks.

Category 2 stocks are located in watersheds where indigenous stocks no longer exist, but where sustainable stocks existed in the past and where the habitat could still support such stocks. These are primarily areas in Hood Canal and South Sound that have been managed for hatchery production and harvest for many years. Natural spawning in these systems continues, but is primarily the result of hatchery-origin strays. Stocks have been preliminarily assigned to category 2 based on current information, but further investigations will seek to identify remnant indigenous stocks which, if found, would cause them to be reassigned to category 1. The objective for category 2 stocks is to use the most locally adaptable stock towards reestablishment of naturally sustainable populations.

Category 3 stocks are generally found in small independent tributaries that may now have some spawning, but never had independent, self-sustaining stocks of chinook salmon. Many of these watersheds do not have the morphological characteristics needed for chinook and may be better suited for coho and chum salmon, cutthroat trout or resident species. Chinook salmon that are observed occasionally in these watersheds are primarily the result of hatchery strays. The objective for these systems is directed at habitat protection to ensure the production of other species, but no specific actions are proposed to promote the natural production of chinook salmon.

Based on this framework, category 1 stocks are therefore the core stocks that provide the focus for the analysis of proposed harvest actions in this biological opinion. Category 2 stocks may require additional consideration and possibly more targeted protections in the future. However, category 2 stocks, by definition, occur in watersheds where the indigenous stocks no longer exist. Future decisions regarding the form and timing of recovery efforts in these watersheds will dictate the kinds of harvest actions that may be necessary and appropriate in the future. In the meantime, harvest constraints designed to protect category 1 stocks will benefit category 2 stocks as well.

Circumstances pertinent to the status of each of the category 1 stocks varies considerably. Their status ranges from healthy to critical; some stocks are severely limited by the available habitat. The range of hatchery influence varies from completely dependant to stocks that are largely unaffected by hatchery strays. These circumstances are pertinent to the consideration of the kinds of harvest management constraints that are necessary and appropriate. Following is therefore a brief review of factors relevant to the status of each of the category 1 stocks.

Elwha River Summer/Fall Chinook

Elwha chinook is one of the most genetically distinct stocks in Puget Sound. The Elwha River originates in the Olympic Mountains. Much of the drainage is still pristine and protected in the Olympic National Forest. Two dams at river miles 4.9 and 13.4 block passage to over 70 miles of potential habitat. The remaining habitat below the first dam is degraded by the loss of natural gravel, large woody debris, and the adverse effects of high water temperatures. The high temperatures exacerbate problems with the parasite Dermocystidium; resulting prespawning mortality is sometimes as high as 70%. Because of the limitations on natural production, the hatchery and naturally spawning stocks are fully integrated. Hatchery-origin fish commonly spawn in the river and broodstock is routinely supplemented by collecting adults from the river. No hatchery fish have been brought into the basin in recent years and the stock is considered unaffected by the few transfers that were made in earlier years. The escapement to the system has averaged about 1,900 over the last five years (range 1,546-2,527) compared to an escapement goal of 2,900. However, the goal is largely a hatchery production goal and does not represent the natural production capacity of the current degraded habitat.

Dungeness River Spring/Summer Chinook

Although there is no genetic data for Dungeness chinook, they are considered distinct based on their spawn timing and geographic distribution. The Dungeness River is located in a rain shadow and as a result receives relatively little rainfall (less than 20 inches per year). The Dungeness is therefore particularly dependent on annual precipitation and snow pack and is susceptible to habitat degradations that exacerbate low flow conditions. Agricultural water withdrawals remove as much as 60% of the natural flow during the critical low flow period which coincides with spawning. Other land use practices have also substantially degraded the system. The escapement has averaged 114 over the last five years (range 50-183) compared to an escapement goal of 925. Dungeness River chinook are considered critically depressed. As a result, a captive brood stock program was initiated in 1992 to maintain an egg bank to reduce the risk of extinction and help rebuild the native run. In the last couple of years juvenile releases from the program have been on the order of two million; a variety of release strategies are being tested to evaluate which approach is most effective.

Nooksack River Spring Chinook

The Nooksack River has two distinct natural spawning stocks in the North Fork and South Fork. These stocks are genetically distinct from each other and all other Washington stocks as well. The stocks have differentiated because of the unique characteristics of the two watersheds. The North Fork is a higher elevation glacier fed stream; the South Fork is a lower elevation stream that receives no glacier melt. The South Fork is therefore generally low and clear during spawning. Adaptation to these diverse water flow patterns reinforces the biological isolation of these stocks despite their proximity. There is apparently little straying between the two as indicated by the very few out-of-basin coded-wire tag (CWT) recoveries. Because of the unique characteristics of these stocks, both are considered important to the overall health and recovery of the PS chinook.

Both stocks are depressed due to low spawning in recent years and the South Fork in particular is likely critical. Over the last five years the escapements to the North Fork and South Fork have averaged 354 (range 45-621) and 190 (range 118-290), respectively compared to interim escapement goals of 1,000 each. The North Fork and South Fork have been substantially degraded due largely to timber harvest and associated road building activities. Improvements in habitat quality are considered essential to recovery.

A hatchery program on the North Fork has operated since 1988; the North Fork hatchery stock is considered essential to recovery. There is both an on-station program to maintain broodstock and a system of off-station acclimated release sites to supplement the natural production. Returns from the supplementation program have contributed to escapements in recent years thus helping to reduce the immediate risks associated with very low returns. Early supplementation efforts on the South Fork proved unsuccessful and were discontinued. There is currently no supplementation program and South Fork.

Skagit River Spring Chinook

The Skagit watershed is the largest in Puget Sound, contributing over 20% of the freshwater flowing into Puget Sound. The Skagit has several major stream systems that differ substantially in terms of geomorphology and hydrography. Because of this diversity, six different stock groups are recognized including three spring stocks on the upper Cascade, Sauk, and Suittle Rivers. The spring stocks occupy the upper portions of the watersheds where the gradients are moderate to high and water temperatures are generally cooler. The aggregate escapement goal for the spring stocks is 3,000. The combined escapements in recent years have been about 1,000, but returns have been reasonably well distributed and stable in each system. The average escapements to the Cascade, Sauk, and Suittle Rivers over the last five years have been 247 (range 173-323), 265 (range 130-408), and 389 (range 167-473). Critical threshold escapement levels have not been identified for these stocks in particular, but these stocks are depressed and are at least close to what could be considered critical levels.

The Skagit spring stocks are relatively unaffected by hatchery production. There is a spring chinook hatchery stock on the Cascade River that is used as an indicator stock for harvest and marine survival estimates. As a result, all fish released have a CWT. The program is not designed to supplement natural production.

Skagit River Summer/Fall Chinook

The Skagit also supports summer stocks on the lower Sauk and upper Skagit and a fall stock on the lower Skagit. The status of these stocks varies although all have declined in abundance over the last 20-25 years. The aggregate escapement goal for the Skagit summer/fall management unit is currently 14,900. However, more recent analysis, including that associated with this opinion suggests that the an MSY goal of about 9,000 is more consistent with the available information. The stock specific escapements for the lower Sauk, upper Skagit, and lower Skagit have averaged 444 (range 100-1,103), 4,886 (range 1,761-7,989), and 1,154 (range 409-2,388), respectively over the last five years. Escapements to the lower Sauk have been less than 300 in four of the last six years and so are likely at least approaching critical levels. The lower Skagit stock is depressed although the abundance in recent years is likely above threshold levels. The upper Skagit stock is the most abundant and productive component although still depressed relative to its production related escapement goal. The Skagit summer/fall stocks are also largely unaffected by hatchery production. There is again a harvest and survival rate indicator stock program for Skagit fall chinook that involves the collection of 40 spawning pairs per year and the release of about 200,000 marked juveniles.

Stillaguamish Summer/Fall Chinook

Two stocks are distinguished in the Stillaguamish River. There is a summer chinook stock in the North Fork Stillaguamish and a fall chinook stock in the South Fork. The average aggregate escapement to the system over the last five years is 1,080 (range 822-1,540) compared to an combined escapement goal of 2,000. However, the distribution of escapement has been uneven with most fish returning to the North Fork. Escapements to the South Fork have averaged just 200 over the last five years (range 96-251) and have been less than 251 since 1985. Although still low, the escapements of the last three years are the highest since 1985. Escapements in the North Fork showed a similar upward trend.

There is a supplementation program in place for Stillaguamish summer chinook which is considered essential for recovery. The program was initiated in 1980. There is no on-station release program; rather brood stock is collected annually from the river (the collection goal is 65 pairs) to provide for a release of 200,000 juveniles. The hatchery-origin fish are all marked and also serve as a harvest and survival indicator stock. The marking also means that returning hatchery fish can be distinguished from natural-origin spawners for assessment purposes. Juveniles are acclimated and released volitionally from a large, spring-fed rearing pond. The program contributes a significant proportion of the annual escapement and is at least partly the reason why escapements to the North Fork Stillaquamish have been higher than those in the South Fork. The fall chinook stock in the South Fork Stillaguamish is largely unaffected by artificial production either from supplementation or fishery enhancement programs.

Production in both systems is limited substantially by poor habitat conditions.

Snohomish Chinook

There are three natural-origin stocks in the Snohomish watershed, including Snohomish summer chinook that spawn in the Skykomish and Snohomish mainstems, Bridal Veil chinook which spawn in Bridal Veil Creek and in the North and South Fork Skykomish Rivers, and Snohomish fall chinook that spawn in the Sultan and Snoqualmie rivers and associated tributaries. There is a fourth population that spawns in the Wallace River that is associated with the Skykomish hatchery. The natural spawners in the Wallace River are primarily hatchery origin. This is the only chinook production facility in the Snohomish Basin. Hatchery strays apparently do not contribute substantially to other parts of the Basin.

The Snohomish system has a combined natural escapement goal of 5,250. The average escapement over the last five years is 4,450 (range 3,176-6,300). The escapement of 6,300 in 1998 is the first time the goal has been met since 1980. The distribution of spawners has also been relatively even across the four stocks with none that suggest critical stock concerns. Returns have been relatively stable, falling below 3,000 only twice since 1968.

Lake Washington Chinook

The Cedar River is the only category 1 stock in the Lake Washington system. Natural spawning occurs in Issaquah Creek, but this is supported primarily by releases from the Issaquah Hatchery which is a harvest-oriented production facility. Additional spawning occurs in several small tributaries that enter north Lake Washington including Big Bear Creek and Cottage Lake Creek. These are considered category 2 populations.

Production in the Cedar River is limited by a water diversion dam at river mile 21 which blocks passage to the upper watershed. Natural production is further limited by stream flows, physical barriers, poor water quality and limited spawning and rearing habitat related to watershed development. The escapement goal for the Cedar River is 1,200 natural spawners and 350 for the combined north Lake Washington tributaries. Escapement over the last five years has averaged 630 (range 294-930) primarily in the Cedar River. It is not known how much may be the result of hatchery straying.

Duwamish/Green Chinook

There is one category 1 stock identified in the Green River system. (The lower 10 miles of this drainage are referred to as the Duwamish; the upper portion of the drainage is known as the Green River.) The Green River population has two components; summer/fall chinook spawn from river mile 25-61 in the Green River, and an aggregation of summer/fall chinook that spawn in Neuwakum Creek. There is a large hatchery program at the Green River Hatchery on Soos Creek. The Green River Hatchery stock was founded using Green River origin fish and was the primary production stock that was distributed throughout Puget Sound in past years. (This practice of cross-basin transfers has now been largely eliminated.) There is considerable straying of the hatchery-origin fish into the Green River, but because there have been no out of basin stock transfer, this integrated Green River natural/hatchery-origin stock presumably retains most of is genetic characteristics.

The natural escapement goal for the Green River system is 5,800 chinook. Escapements to Newaukum Creek and the Green River have averaged 849 and 5,219 over the last five years ending in 1997. (The 1998 data was not immediately available.) However, this includes an unknown, but presumably substantial number of hatchery strays.

White River Spring Chinook

The only category 1 population in south Puget Sound is White River spring chinook. The White River is a tributary of the Puyallup River. White River spring chinook are the last remaining spring chinook population in south Puget Sound. The stock is genetically distinct from neighboring summer/fall stocks and is also distinguished by its life history characteristics.

The abundance of White River spring chinook reached critically low levels in the late 70s and early 80s; returns averaged just 60 fish over a period of 10 years and were below 30 for five years running. As a result, White River spring chinook have been the subject of an intensive rebuilding program since the 1970's. A hatchery program was developed that included both juvenile releases and a full life-cycle captive broodstock program. The hatchery population is considered essential for recovery. The current natural escapement goal is for 1,000 spawners per year. The supplementation program has been successful at substantially increasing the annual returns over the years. Escapements have averaged 469 over the last five years (range 316-628) although much of this is obviously still supported by the supplementation efforts. A number of significant habitat related problems will have to be addressed before the population can be weaned of its dependence on the supplementation program.

3.3.2 Chum Salmon

Hood Canal Summer-run Chum

The HCSR chum ESU encompasses those streams with summer chum from the Dungeness River in the eastern Strait of Juan de Fuca throughout Hood Canal in Puget Sound. This group of chum populations is distinguishable from other Puget Sound chum by an early return and spawning timing that creates a temporal separation from fall chum stocks spawning in the same rivers. This allows reproductive isolation between summer and fall stocks (WDF et al. 1993).

Hood Canal summer-run chum use the estuarine and marine areas in Hood Canal and the Strait of Juan de Fuca for rearing and seaward migration as juveniles. The fish spend two to five years in the northeast Pacific Ocean feeding areas prior to migrating southward during the summer months as maturing adults along the coasts of Alaska and British Columbia in returning to their natal streams (PNPTC/WDFW 1999). In general, maturing chum salmon in the North Pacific begin to enter coastal waters from June to November. Stock composition data from Canadian fisheries in the Strait of Juan de Fuca indicate significant Hood Canal summer chum presence in August, trailing off rapidly in early September (data from G. Graves, NWIFC). Little is known about the details of the ocean migration and distribution of salmon from the HCSR chum ESU. In fact, some data suggests that Puget Sound chum, including HCSR chum, may not make an extended migration into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Hartt and Dell 1986).

Summer chum mature primarily at three and four years of age, with low numbers returning at ages two and five. Adults delay migration in extreme terminal marine areas for up to several weeks before entering the streams to spawn. Hood Canal summer chum enter freshwater from early August through mid-October and spawn from late August through mid-October (WDF *et al.* 1993). Spawning occurs in the lower one to two miles of each summer chum stream. This characteristic may reflect an adaptation to low flows present during their late summer/early fall spawning ground migration timing, which confines spawning to areas with sufficient water volume. However, this spawning pattern also makes the incubating eggs more vulnerable to scour during periods of high flows (PNPTC/WDFW 1999).

The causes of decline for HCSR chum have been attributed to a combination of high fishery exploitation rates, shifts in climatic conditions that have changed patterns and intensity of precipitation, and the cumulative effects of habitat degradation, especially for those systems in the Strait of Juan de Fuca region of the ESU. Total fishery exploitation rates on the Hood Canal summer chum ESU averaged 44.5% from 1974-1994 (range = 12.2%-81.2%). Total exploitation rates dropped dramatically in 1995, to an average of 3.8% (range = 2.7-5.1%) since that time (Table 9) as a result of fishery actions taken to protect summer chum and other salmonid species.

A habitat assessment conducted by the Point No Point Treaty Tribes and Washington Department of Fish and Wildlife (1999) concluded that channel, riparian forest and subestuarine conditions were moderately to severely degraded in all the watersheds due to a history of logging, road building, rural development, agriculture, water withdrawal, and channel manipulations throughout the ESU. Within Hood Canal, the Big and Little Quilcene, and Skokomish were considered the most degraded watersheds, with the Big Beef, Union and Hamma Hamma River watersheds only marginally better. The Union stock, the only stock considered "healthy" in the HCSR chum ESU, is of particular concern because of the rapid urbanization occurring in the watershed. The Tahuya and Dewatto watersheds are considered to be recovering and in good condition which should increase the chances of success for recovery efforts. The other systems in the region are moderately degraded, with areas of good habitat.

Of the sixteen populations of summer chum identified in this ESU, seven are considered to be "functionally extinct" (Skokomish, Finch Cr., Anderson Cr., Dewatto, Tahuya, Big Beef Cr., and Chimicum). The remaining nine populations are well distributed throughout the ESU except for the eastern side of Hood Canal; those populations were among the least productive in the ESU (PNPTC/WDFW 1999).

This ESU has two geographically distinct regions: the Strait of Juan de Fuca (SJF) and Hood Canal (HC).

Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends.

In the Hood Canal region, summer chum are still found in the Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Big and Little Quilcene, and Union Rivers. A few chum have been observed in other systems during the summer chum migration period, but these observations are sporadic and are thought to be strays from other areas. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum populations declined rapidly beginning in 1979, and has remained at depressed levels (Table 9). The terminal run size for the Hood Canal summer chum stocks averaged 28,971 during the 1974-1978 period, declining to an average of 4,132 during 1979-1993. Abundance during the 1995-1998 period has improved, averaging 10,844. However, much of the increase in abundance can be attributed to a supplementation program for the Big/Little Quilcene River summer chum stock begun in 1992. Escapements in the Union have been above threshold levels of concern and stable for many years. Escapements to the Dosewallip and Duckabush rivers have been generally above threshold levels of concern, but are highly variable. Escapements in the Hamma Hamma and particularly the Lilliwaup have been below threshold escapement levels that represent an increased risk to the population too often in recent years (Table 9).

Supplementation programs were instituted in 1992 for the Big/Little Quilcene, the Hamma Hamma and Lilliwaup stocks due to the assessment of high risk of extinction for these stocks (PNPTC/WDFW 1999). The Quilcene program has been quite successful at increasing the number of returning adults. The Hamma Hamma and Lilliwaup programs have been hampered by an inability to collect sufficient broodstock. A re-introduction program was also started in Big Beef Creek using the Quilcene stock. It is too early to assess the success of that program. Other re-introduction programs may be initiated in the future, but will depend on the development of additional broodstock sources so as not to become dependent on Quilcene as the sole donor stock.

In the Strait of Juan de Fuca, summer chum stocks are found in Snow, Salmon, and Jimmycomelately Creeks and the Dungeness River. (The Snow and Salmon are treated as a single stock complex.) The terminal abundance of summer chum in the Strait of Juan de Fuca region began to decline in 1989, a decade after the decline observed for summer chum in Hood Canal. Terminal abundance declined from an average of 1,923 for the 1974-1988 period to a average of 477 during 1989-1994 period. During the most recent period (1995-1998) the average for the region has increased to 1,039, however, much of the increase may be due to the supplementation program in the Snow/Salmon system that was initiated in 1992. Escapements in Jimmycomelately have continued to be poor, i.e., less than 100 spawners in the last three years. There are no systematic surveys for summer chum in the Dungeness. However, their presence is routinely noted in surveys for other species. The status of the summer chum population in the Dungeness is therefore unknown.

An assessment of the habitat in the Strait of Juan de Fuca chum watersheds concluded that these were among the most degraded watersheds in the ESU (PNPTC/WDFW 1999). Winter peak and summer low flows, and sediment aggradation are considered problems in the Dungeness, Jimmycomelately and Snow Creeks. Improvement in habitat conditions will be essential for successful recovery of summer chum in this region of the ESU.

Table 9. Hood Canal summer chum terminal abundance by population and year

Return Year	HC Summer Chum ESU	Hood Canal Region: Skokomish	Tahuya	Union	B.Quilcene/L. Quilcene	Big Beef	Anderson	Dosewallips	Duckabush	Hamma Hamma	Lilliwaup	Dewatto	Strait of Juan de Fuca: Snow/ Salmon	Jimmy comelately
1974	14,548	475	882	68	841	75	-	3,600	3,588	2,453	617	181	1,330	438
1975	29,176	2,601	3,352	203	3,061	1,333	226	2,604	2,598	8,495	1,643	1,427	1,287	348
1976	66,803	4,865	18,661	583	9,861	1,368	250	3,492	6,507	8,165	7,918	3,640	1,129	365
1977	16,790	921	2,129	220	1,742	325	28	3,461	2,641	1,803	1,221	654	1,239	405
1978	27,158	261	548	132	5,279	749	18	2,093	2,090	9,045	2,743	1,121	2,293	787
1979	8,798	100	377	313	620	200	6	1,246	1,247	3,244	526	158	591	170
1980	17,036	78	904	1,051	1,770	310	5	3,061	2,082	828	1,248	591	3,783	1,326
1981	5,416	219	286	84	589	147	2	103	909	1,512	598	84	681	203
1982	9,198	253	267	476	1,161	-	-	1,006	1,369	1,589	261	65	2,152	599
1983	4,411	45	188	372	2,157	-	-	84	105	249	39	33	885	254
1984	4,686	91	196	268	1,372	27	1	260	366	208	258	61	1,212	367
1985	2,715	111	214	585	577	-	-	380	48	372	161	33	171	61
1986	8,085	68	243	4,217	1,325	-	-	124	385	376	216	45	795	292
1987	5,610	61	145	794	2,482	9	-	13	18	38	51	8	1,527	464
1988	8,776	45	153	664	2,269	-	-	679	511	452	290	24	2,638	1,052
1989	2,569	38	21	1,042	781	-	-	34	127	34	100	5	215	173
1990	1,344	75	8	364	389	-	-	9	49	106	3	-	278	63
1991	1,906	3	5	228	853	-	-	262	107	72	33	34	184	125
1992	3,660	7	-	140	952	-	-	657	619	123	90	-	454	616
1993	1,344	2	-	252	163	-	-	105	105	69	72	1	463	110
1994	2,633	1	-	742	744	-	-	226	264	372	106	-	163	15
1995	10,332	-	-	723	4,589	-	-	2,796	828	478	79	-	616	223
1996	21,762	35	5	496	9,597	-	-	7,005	2,661	777	100	-	1,054	30
1997	10,113	-	-	482	8,006	-	-	47	475	104	31	7	901	61
1998	5326	5	-	244	3,066	-	-	336	226	143	24	12	1,172	98
1974-78 Avg.	30,895	1,825	5,114	241	4,157	770	104	3,050	3,485	5,992	2,829	1,405		
1979-94 Avg.	5,512	75	188	724	1,138	43	1	516	519	603	253	71		
1974-88 Avg.	5,608												1,306	439
1989-94 Avg.	5,903												293	184
1995-98 Avg.	11,883	10	1	486	6,314	-	-	2,546	1,048	375	59	5	936	103

4.0 Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

4.1 Status of the Species and Critical Habitat within the Action Areas

The assessments of the size, variability and stability of salmon populations, described in the previous sections, are made in fresh water spawning and migratory environments and closely reflect the status of the ESUs of concern in the marine environment.

Critical habitat has not been designated for any of the newly listed chinook ESUs considered in this opinion. Critical habitat has been designated for SRF chinook. Marine habitats (i.e., oceanic or near shore areas seaward of the mouth of coastal rivers) are clearly vital to the species, and ocean conditions are believed to have a major influence on chinook salmon survival and productivity (see review in Pearcy, 1992). To date NMFS has not included marine areas when designating critical habitat for other salmon ESUs because there has been no apparent need for special management action to protect offshore areas. NMFS has not included marine areas when designating critical habitat for SRF chinook, or other salmon ESUs. Inshore marine areas, such as those in Puget Sound, may be more critical to the species survival. In the event that marine areas are designated for newly listed chinook salmon, the effect of ocean fisheries on critical habitat will be reconsidered.

There are no state, federal or private actions in the action area that are likely to impact the listed species considered in this opinion.

4.2 Natural Factors Causing Variability in Population Abundance

Changes in the abundance of salmon populations are affected substantially by variations in freshwater and marine environments. For example, large scale changes in climatic regimes, such as El Niño, likely affect changes in ocean productivity; much of the Pacific coast was subject to a series of very dry years during the first part of the decade which adversely affected some the populations. In more recent years, severe flooding has adversely affected other stocks. For example, the anticipated low return of Lewis River bright fall chinook in 1999 is attributed to flood events during both 1995 and 1996.

Chinook salmon are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation likely also contributes to significant natural mortality, although the levels of predation are largely unknown. In general, chinook are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebounding of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook at Willamette Falls and have gone so far as to climb into the fish ladder where they can easily pick-off migrating spring chinook.

A key factor that has substantially affected many west coast salmon stocks has been the general pattern of long-term decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed between stocks, presumably due to differences in their timing and distribution. It is presumed that ocean survival is driven largely by events between ocean entry and recruitment to a sub-adult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries at age 2 relative to the number of CWTs released from that brood year. The time series of survival rate information for Upper Willamette River spring chinook, Lewis River fall chinook, and Skagit fall chinook are shown as examples. (The Skagit survival rates are shown as an index.) Skagit fall chinook is an indicator of fall-type stocks from Puget Sound. The patterns differ between stocks, but each shows a highly variable or declining trend in early ocean survival with very low survivals in recent years.

Recent evidence suggests that marine survival of salmon species fluctuates in response to 20-30 year long periods of either above or below average survival that is driven by long-term cycles of climatic conditions and ocean productivity (Cramer 1999) . This has been referred to as the Pacific Decadal Oscillation (PDO). It is apparent that ocean conditions and resulting productivity affecting many of northwest salmon populations have been in a low phase of the cycle for some time. Smolt-to-adult return rates provide another measure of survival and the effect of ocean conditions on salmon stocks. The smolt-to-adult survival rates for Puget Sound chinook stocks, for example, dropped sharply beginning with the 1979 broods to less than half of what they were during the 1974-1977 brood years (Cramer 1999). The variation in ocean conditions has been an important contributor to the decline of many stocks. However, the survival and recovery of these species depends on the ability of these species to persist through periods of low ocean survival when stocks may depend on better quality freshwater habitat and lower relative harvest rates.

4.3 Impacts Within the Action Area

There are no state, federal or private actions in the action area that are likely to impact the listed species considered in this opinion.

4.4 Impacts Outside the Action Area

4.4.1 Washington, Oregon, California Coast Groundfish Fisheries

Salmon are also taken incidentally in the groundfish fishery off Washington, Oregon, and California. NMFS has conducted section 7 consultations on the impacts of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan (PCGFMP) on ESA listed species and concluded that impacts on species listed at that time were low and not likely to jeopardize the listed species (NMFS 1996a). NMFS has reinitiated consultation on the PCGFMP regarding impacts to recently listed species. Most salmon caught incidental to the whiting fishery are chinook. (For example, the 1991-97 average annual catch of pink, coho, chum, sockeye, and steelhead in the whiting fishery are approximately 800, 300, 100, 20, and 0 fish, respectively, out of an annual catch of 143 metric tons of whiting)

Although the reinitiated consultation is not yet complete, the incidental total catch of all chinook in the groundfish fisheries is generally low. The estimated catch of chinook in the whiting fishery for example has averaged 6,300 annually from 1991 to 1997. The incidental catch of chinook in other components of the groundfish fishery are comparable in magnitude to those in the whiting fishery (NMFS 1996a). Since the incidental catch of all chinook off the Washington coast is unlikely to exceed more than a few thousand fish per year, the catch of listed fish is likely to be no more than a few tens of listed fish per year spread across the six listed chinook ESUs. A more definitive analysis of the incidental catch of listed chinook will be made in the reinitiated groundfish opinion.

4.4.2 Alaska State Fisheries

The Alaska Department of Fish and Game (ADF&G) manages fisheries out to three miles, oversees crab fisheries in federal waters (EEZ) under the FMP adopted by the NPFMC. With the exception of the Alaska state sablefish fishery, ADF&G coordinates their fishery openings and in-season adjustments with federal fisheries.

Herring

Herring have been fished in Alaska since 1878. At present, the state fishery is located in the following areas: Prince William Sound, Cook Inlet, Kodiak, Alaska Peninsula, Bristol Bay, Kuskokwim, Norton Sound, Southeast, and Port Clarence. Fisheries in the Southeast and Port Clarence regions are not likely to affect the western population of Steller sea lions and are not considered further. Harvest methods are by gillnet, purse seine, and handpicking of roe from kelp. Herring are primarily caught for their roe during the sac roe harvest in the spring. Harvest levels for 1998 are expected to be about 36,000 mt, similar to the last few years. Bristol Bay is the primary producer with recent catches of about 23,000 mt annually. Effort over the last two decades has decreased in Prince William Sound and Cook Inlet, but increased in Kuskokwim, Kodiak, and Bristol Bay. Since the early 1980s, the total state catch of herring has been relatively constant, with some variability in the late 1980s and early 1990s, but then constant again through 1997.

Miscellaneous Shellfish (Invertebrates)

Clam, abalone, octopus, squid, snail, scallop, geoduck clams, sea urchins, and sea cucumbers have been harvested throughout the state. Of these, octopus and squid are the most likely prey of sea lions. Most of the catch of shellfish is taken from April to September, and they are taken by hand-picking, shovel, trawl, pot, and dredge gear. Harvest levels were relatively consistent through the 1980s, but have increased dramatically in amount and annual variation in the 1990s. The variability has been due, in large part, to recent but sporadic catches in Bristol Bay and the Bering Sea, areas not usually fished for shellfish. With the exception of the recent large catches in these areas, most of the shellfish fisheries have traditionally taken place in the Kodiak and Cook Inlet areas.

Crab

The state manages all crab fisheries in the BSAI and GOA. King (brown, red, blue), Dungeness, and Tanner crabs are taken by hand-picking, shovel, trawl, pot, and dredge gear. Crab fisheries began in the early 1960s when the stocks were abundant, then declined due to the King Crab recession in the early 1980s. State crab fisheries occur in Bristol Bay, Dutch Harbor, Alaska Peninsula, Kodiak, Cook Inlet, Adak and W. Aleutian Islands, and Prince William Sound. This fishery primarily occurs during the winter season. In the past ten years, the industry has focused on Alaska snow crab *(C. opilio)*, and the catch exceeded historical levels of king crab in the early 1990s. The Bering Sea fishery produces the vast majority of crab that is harvested in Alaska but has also been declining since 1993. Catch per landing has been greatest in the Bering Sea, and worst in the Kodiak and Cook Inlet areas. In the 1970s, the crab fleet purportedly killed sea lions for bait; the numbers killed is not known.

Shrimp

The shrimp fishery occurs primarily in the southeast and Yakutat areas, and to a lesser extent in Prince

William Sound, Kodiak, Dutch Harbor, Cook Inlet, and the Alaska Peninsula. Shrimp are harvested by pot gear and often sold to floating processors. In_1995, over 45,000 mt of shrimp were harvested by 351 vessels. In the last ten years, effort has increased in the southeast due, in part, to the availability of floating processors, which allow fishing vessels to devote more of their time to fishing. Effort was highest during the late 1970s and 1980s, but has since ceased in most areas.

Groundfish

The state manages groundfish within the 3-mile limit for lingcod, Pacific Ocean perch, flathead sole, rex sole, arrowtooth flounder, sablefish, black rockfish, and pollock. Fisheries occur in the Alaska Peninsula, Kodiak, Bering Sea, Dutch Harbor, Adak and W. Aleutian Islands, Cook Inlet, Prince William Sound, and Southeast areas.

Pacific Cod

The Pacific cod fishery is undergoing a change in management from federal to state authorities. A total TAC is set for Pacific cod, and that TAC is divided into federal and state shares. In 1997 and 1998, the state assumed management responsibility of 15% of the total TAC for cod, and is expected to manage 20% in 1999. Under current regulations, the state portion of the total TAC can not exceed 25%. The state fishery is limited to pot and jig gear only. The Pacific Cod fishing season is primarily in the winter.

Salmon

On June 30, 1999, NMFS issued a biological opinion on management of the 1999 summer and 1999/2000 winter salmon fisheries subject to the Fishery Management Plan for salmon off the coast of Alaska as managed under the terms of the 1999 Pacific Salmon Treaty Chinook Annex. The biological opinion concluded that the proposed salmon fisheries are not likely to jeopardize the continued existence of the Upper Willamette River chinook salmon, Lower Columbia River chinook salmon, or Puget Sound chinook salmon or destroy or adversely modify designated critical habitat. Subsequently, NMFS has conducted a biological opinion on the Pacific Salmon Treaty signed recently by the United States and Canada (see section 4.4.3 below).

4.4.3 Salmon Fisheries

After a protracted period of negotiations, the United States and Canada recently reached agreement under the Pacific Salmon Treaty on a long-term and comprehensive management plan that would govern SEAK salmon fisheries, British Columbia, and the Pacific Northwest. A major component of this agreement is a management regime for chinook salmon that specifies an aggregate abundance-based approach for three major ocean fisheries in Alaska and Canada, coupled with an individual stock-based approach for all other fisheries in Canada and the Pacific Northwest. This chinook management regime, designed to meet the rebuilding and conservation needs of natural-origin stocks, establishes rules for determining allowable catches in the various fisheries.

The United States and Canada approved the agreement by an exchange of diplomatic notes in Washington, D.C. on June 30, 1999. The exchange of notes included contingencies on the U.S. implementation of its obligations under the agreement. Specifically, U.S. implementation of its obligations under the agreement is contingent upon 1) a determination that the agreement complies with the legal requirements of the ESA; and, 2) congressional appropriations to fund key elements of the agreement. On November 18, 1999, NMFS issued a biological opinion covering those salmon fisheries defined within the Pacific Salmon Treaty. The biological opinion considers whether fisheries off Southeast Alaska and in British Columbia, if managed pursuant to the 1999 agreement, are likely to jeopardize the continued existence of listed salmon, steelhead, and cutthroat trout (Table 3) or result in the destruction or adverse modification of their critical habitat.

The biological opinion concluded that the Pacific Salmon Treaty and the decision by the NPFMC to defer its management authority to the State of Alaska is not likely to jeopardize any of the threatened or endangered ESUs of Pacific salmon, steelhead, or cutthroat trout or destroy or adversely modify any of the critical habitat that has been designated for these species.

4.4.4 Other Human Activities

All of the listed species are affected, often substantially, by mortality factors related to other human activities that are commonly referred to as the "Hs". In addition to the harvest H that is considered in detail in this opinion, the species of concern are affected by impacts related to habitat degradation, hatchery programs, and hydro-development. The relative effect of each H to the ESUs, and to each stock within an ESU, differs. However, in general, human development associated with forestry, farming, grazing, road construction, mining, and urbanization have all contributed to the decline of the species. The combined effect of multitude of habitat degradations often poses the greatest risk and greatest challenge to species recovery because they are often the result of multiple dispersed actions, each of which must be addressed. Additionally, habitat degradations by their nature can only be remedied over time as the affected systems slowly recover their properly functioning condition.

Hatcheries have both positive and negative effects. Hatcheries are playing an increasingly important role in conserving natural populations in areas where the habitat can no longer support natural production or where the numbers of returning adults are now so low that intervention is required to reduce the immediate risk of extinction. However, there are also negative consequences associated with hatchery programs, particularly as they were developed and managed in the past. There are genetic interactions associated with the interbreeding of hatchery and wild fish. There are a number of ecological interactions such as predation of wild fish by larger hatchery fish, competition for food and space, and disease transmission. In addition, fisheries that target hatchery fish may over harvest less productive wild populations. Hatchery activities in Puget Sound and the Columbia Basin are currently the subject of ongoing section 7 consultation that are designed to address the adverse effects of ongoing hatchery programs.

Hydro development also has substantially affected or eliminated some populations or even whole ESUs. In some cases, the effects are direct as the dams block access to spawning and rearing habitat. In other cases, the effects are less direct, but nonetheless significant as they increase downstream and upstream passage mortality, change natural flow regimes, dewater or reduce flow to downstream areas, block the recruitment of spawning gravel, or result in elevated temperatures.

Although it is not possible to review here the relative importance of each of these factors on each ESU or stock within the ESUs, it is clear that it is the combined effect of all of the H's that has lead to the decline and resulting current status of the species of concern. In this opinion, NMFS focuses on harvest, in the context of the environmental baseline and the current status of the species. Although harvest can be reduce in response to the species depressed status and the reduced productivity that results from the degradations related to other human activities, the recovery of the listed species depends on improving the productivity of the natural populations in the wild. These improvements can only be made by addressing the factors of decline related to all of the H's that will be the subject of future opinions and recovery planning efforts.

5.0 EFFECTS OF THE ACTION

The standards for determining jeopardy are set forth in Section 7(a)(2) of the ESA as defined at 50 CFR §402.02. This section of the biological opinion applies those standards in determining whether the proposed fisheries are likely to jeopardize the continued existence of one or more of the listed ESUs that may be adversely affected by the fisheries. This analysis considers the direct, indirect, interrelated, and interdependent effects of the proposed fisheries and compares them against the environmental baseline to determine if the proposed fisheries will appreciably reduce the likelihood of survival and recovery of these listed salmon in the wild. The jeopardy determinations are also based on a consideration of the magnitude of salmon bycatch by species, the geographic distribution of the bycatch, and the available information indicating the relative magnitude of impacts to each ESU. Consideration is also given to the proposed management actions taken to reduce the catch of listed fish. The jeopardy determinations are largely qualitative at this time. The ESUs considered here have just recently been listed. Impacts to these ESUs in the groundfish fisheries have not been previously analyzed and are not tied to more quantitative analysis that are typically part of salmon fishery management models or more holistic life cycle or risk assessment analysis. Such analyses will necessarily be developed over time. In the meantime, NMFS must rely on the best available information in making its judgement about the risk of the proposed action to the newly listed ESUs.

For many of the ESUs considered in the opinion critical habitat has not been designated. As a result, this section will not determine, for those species, if the proposed fisheries are likely to destroy or adversely modify critical habitat. For those ESUs with designated or proposed critical habitat, the action area is outside the range of the designated habitat. As a result, the proposed fisheries are not likely to destroy or adversely modify the critical habitat of any ESU.

There are two general patterns of ocean distribution for the listed chinook ESUs. The chinook ESUs originating in CA are generally distributed off the California and southern Oregon coast. The other chinook ESUs from Puget Sound and the Columbia River basin are either north or far-north migrating stocks. It is therefore useful to first consider both the magnitude and geographic distribution of the anticipated bycatch of chinook in order to characterize the likely impact on each ESU of concern.

There is insufficient information to characterize the stocks composition of the chinook bycatch in the groundfish fisheries. It is therefore not possible to estimate directly the catch mortality by ESU. More qualitative impact estimates can be derived based on our general understanding of the distribution and timing of stocks that are derived from analysis of salmon fisheries. For some of the ESUs or stocks within an ESU the salmon management models can be used to generally characterize the relative abundance of listed fish in terms of catch per thousand. In other cases, it is more appropriate to use estimates of the exploitation rates in the salmon fisheries along with the associated catch to get a general sense of the level of impact associated with the groundfish fisheries occurring in similar areas and times. However, these estimates are best considered as approximations, as the salmon and groundfish fisheries do not occur in the same time and place, and therefore catch different stock mixes.

Information from the salmon fishery models is supplemented in the opinion by an analysis of the CWT recoveries that are available from the groundfish fisheries. Reported recoveries for hatchery or wild salmon stocks from each ESU that are used to represent the distribution of listed fish contribute to our understanding of the presence or absence and distribution of listed fish in the groundfish fisheries. For the SRF chinook ESU only sub-yearling release groups were used to represent the ocean distribution.

There were additional releases of yearling smolts from the Lyons Ferry Hatchery. However, because the yearling releases have a different age at maturity and different ocean distribution, they are not considered representative of the listed natural origin fish.

The total annual bycatch of other listed species (coho, chum, sockeye, steelhead, and cutthroat) are reviewed briefly, but are not analyzed in detail because of the consistently low level of catch.

5.1 Chinook Salmon

Chinook salmon have a complex life cycle that involves a freshwater rearing period followed by 2-4 years of ocean feeding prior to their spawning migration. Chinook from individual brood years can return over a 2-6 year period, although most adult chinook return to spawn as 4 and 5 year old fish. As a result, a single year class can be vulnerable to fisheries for several years. Chinook salmon migrate and feed over great distances during their marine life stage; some stocks range from the Columbia River and coastal Oregon rivers to as far north as the ocean waters off North/Central B.C. and Alaska. Most chinook stocks are vulnerable to harvest by numerous commercial troll, sport and commercial net fisheries in marine areas. Many are also taken in rivers and streams during their spawning migration by sport, commercial net and subsistence fishermen.

Their extended migrations and the extreme mixed stock nature of most chinook fisheries greatly complicates the management of chinook salmon. Prior to the mid-1970s, the extent of chinook migration and the impacts of ocean fisheries on particular chinook stocks was poorly understood. This changed with the advent of the CWT and extensive tagging programs; large scale tagging of chinook made it possible for fishery managers to determine chinook migration routes, the timing of their migrations, and stock-specific impacts in distant fisheries. This kind of information, though sparse by today's standards, was used to establish the original harvest ceilings for ocean fisheries.

5.1.1 Snake River Fall Chinook Salmon

There is only one population within the SR fall chinook ESU. Fall chinook are primarily mainstem spawners. Hells Canyon Dam blocked off most of the original spawning habitat. The current population is now confined primarily to the mainstem and lower tributaries in the area between Lower Granite and Hells Canyon Dams.

There is little direct information regarding the impact of NPFMC groundfish fisheries on Snake River fall chinook. There have been no recoveries of tagged fall chinook from the Snake River in either the BSAI or GOA groundfish fisheries. CWT recoveries of the Snake River hatchery indicator stock in the ocean salmon fisheries indicate that the greatest concentration of recoveries occurs off the southern British Columbia and Washington coasts. Tags have been recovered from southern California to southeast Alaska, but the concentration of Snake River fall chinook expressed in terms of listed fish caught per thousand chinook is much lower in these more distant areas suggesting that they are being sampled from the margins of their distribution.

Although there have been no recoveries of Snake River fall chinook in the NPFMC groundfish fisheries, there have been several observed recoveries of upper Columbia River fall chinook (known as upriver brights, URB) in the GOA fishery. URB are known to have a more northerly distribution than Snake River fall chinook (Morishima 1993) based on a longer and much more extensive tagging history. The presence of URB in the GOA fishery suggests that the occasional occurrence of Snake River fall chinook in NPFMC groundfish fisheries is at least plausible.

Healey (1991) concluded that virtually all chinook caught in the Bering Sea were stream-type fish. Myers and Rogers (1988) used scale samples to determine general life history characteristics and major region of origin for chinook taken as bycatch in the eastern Bering Sea. They estimated that only about four percent of the bycatch were ocean-type fish comparable to Snake River fall chinook or other fall chinook stocks. If we assume an annual chinook bycatch in the BSAI of 55,000 (from the most recent biological opinion, NMFS 1995b), then only a small portion, about 2,200, (55,000 * 0.04) are ocean-type fish that could be Snake River fall chinook. However, existing information continues to suggest that it is unlikely that Snake River fall chinook will be caught in the BSAI fisheries.

The southeast Alaska salmon fisheries represent the closest geographic region where estimates of the relative abundance of Snake River fall chinook are available. Lestelle and Gilbertson (1993) estimated that the concentration of Snake River fall chinook in the fishery was about 0.3 per thousand for the 1987 - 1991 time period. A similar analysis for the 1985 - 1991 time period resulted in an estimate of 0.2 per thousand (PSC 1992). (These estimates were derived using the PSC chinook model.) Other estimates developed using the PFMC chinook model have ranged from 0.5 to 1.1 Snake River fall chinook per thousand depending on the time period and assumptions used in the analysis (NMFS 1993). Higher concentrations were generally observed when analyzing 1993 than when averaging estimated concentrations over a longer time period.

Snake River fall chinook are observed in the southeast Alaska fisheries, but in concentrations that are substantially lower than in southern fisheries. It is reasonable to assume that the concentration of listed fish will continue to decrease to the north. Given the great additional distance to the BSAI area, the low abundance of ocean-type fish in the BSAI area, and the relatively few Snake River fall chinook compared to the more populous ocean-type stocks from the British Columbia and Washington and Oregon production areas, NMFS concludes that it is highly unlikely that any Snake River fall chinook are taken in BSAI groundfish fisheries.

It is more difficult to judge what the impacts to Snake River fall chinook may be from GOA groundfish fisheries because of the absence of applicable information regarding region of origin or life history type. It is reasonable to assume that the concentration of Snake River fall chinook in the GOA groundfish fisheries will be lower than that observed in the southeast Alaska salmon fisheries because of the greater distance from the apparent center of their distribution. Similarly, it is reasonable to assume that there will be more stream-type fish in the GOA groundfish fishing areas than in the southeast Alaska fishery based on their observed dominance in the BSAI area. A very conservative range of estimates can be derived by multiplying the available concentration factors for the southeast Alaska salmon fishery by the assumed maximum chinook bycatch of 40,000. This analysis suggests that the catch of Snake River fall chinook could be as high as 8 to 44 fish per year (i.e., 40,000 * 1.1 Snake River fall chinook per thousand (from previous discussion) = 44). However, this analysis does not account for expected decreases in the concentration of listed fish in the more northerly GOA groundfish fisheries. Based on the available information, NMFS concludes that the catch of Snake River fall chinook in the GOA groundfish fishery is unlikely to average more than five per year and may be substantially less.

5.1.2 Upper Willamette River Chinook Salmon

There are three spring chinook stocks in the Willamette River that are still supported to varying degrees by natural origin production. These are found in the McKenzie, North Santiam, and Clackamas Rivers. There has been no determination to date regarding the population structure of the ESU. All of these systems have been substantially influenced by hatchery production and in past years there was substantial exchange of brood stock among the hatcheries with the possible exception of the North Santiam system.

The McKenzie River stock is the harvest indicator stock for Willamette spring chinook and, absent other information, it is assumed that the other components have similar distributions and are subject to the same rates of harvest. UWR chinook are a far north migrating stock and so are caught primarily in Alaska and Canada salmon fisheries.

Until recently UWR chinook were subjected to relatively intense commercial and recreation fisheries in the lower Columbia and Willamette rivers that were directed primarily at the hatchery origin fish. Terminal area ERs have been on the order of 40-50% in past years. Spring stocks from the Upper Columbia, Lower Columbia, Snake, and Willamette rivers are now listed, and as a result, it is safe to assume that ESA constraints, if nothing else, will all but eliminate mixed stock fisheries targeting spring chinook in the Lower Columbia River for the foreseeable future. Fishery objectives in the Willamette River have also changed to emphasize the protection of natural-origin fish. A revised management plan for the Willamette River spring chinook is being developed by the State of Oregon although it is still subject to review and approval by NMFS. However, Oregon has already implemented a mass marking program and intends to manage terminal area recreational fisheries while requiring the release of all unmarked fish. (Commercial fisheries in the Willamette have long since been disallowed.) The marked fish will fully recruit to the terminal fishery in the year 2002. Once the marked fish are fully recruited to the fishery Oregon expects that it can manage the lower Willamette River recreational fishery using selective harvest to limit mortality of natural-origin fish to 5% or less until the abundance of natural-origin fish allows for an increase in harvest. The only other potential sources of harvest mortality would be what little may occur in the Upper Willamette recreational fishery or the limited fisheries in the lower Columbia that may target sturgeon for example.

About 33 UWR CWTs, have been recovered from GOA groundfish fisheries and one in BSAI groundfish fisheries since 1986. However, the number of UWR chinook intercepted in relation to the amount caught in directed salmon fisheries in southeast Alaska and British Columbia is very low. Although it is impossible to extrapolate these observed recoveries into exploitation rates, NMFS believes that the take of UWR chinook is a relatively rare event. CWT recoveries have been about 2 - 3 per year, with none recorded in the last 3 years. In 1993, 11 UWR CWTs were recovered in GOA fisheries, the highest amount in any year since 1986.

5.1.3 Lower Columbia River Chinook Salmon

The LCR chinook ESU is composed of spring run, and fall run tule and bright stocks. There are three spring stocks, three self-sustaining natural tule stocks, and likewise, three identified bright stocks that rely primarily on natural production. The population structure of the ESU has not been determined, but it is intuitively obvious that the spring, tule, and bright life history types warrant independent review with respect to their status and the effect of the proposed action. The effects analysis therefore treats each life history type independently and, where possible, also considers the status of and presumed effect on each stock.

The three remaining spring stocks within the ESU include those on the Cowlitz, Kalama, and Lewis rivers. Although some spring chinook spawn naturally in each of these rivers, the historic habitat for spring chinook is now largely inaccessible. The remaining spring stocks are therefore dependent, for the time being, on the associated hatchery production programs. The hatcheries have met their escapement objectives in recent years thus insuring that what remains of the genetic legacy is preserved. Harvest constraints for other stocks, including those provided specifically as a result of the agreement, will provide additional protection for the hatchery programs until such time that a more comprehensive recovery plan is implemented.

These spring stocks have a wider ocean distribution than most stocks originating in the lower Columbia River, and are impacted by ocean fisheries off Alaska, Canada, and the southern U.S. They were also subject, in past years, to significant sport and commercial fisheries inside the Columbia. Since 1984, there have only been 9 LCR CWT recoveries in GOA groundfish fisheries, indicating that it is a relatively rare event.

The three tule stocks in the ESU include those on the Coweeman, East Fork Lewis, and Clackamas rivers. These are apparently self-sustaining natural populations without substantial influence from hatchery-origin fish. These stocks are all relatively small. Since 1984, there have no reported CWT recoveries in BSAI or GOA groundfish fisheries for this ESU component. The interim escapement goals on the Coweeman and East Fork Lewis are 1,000 and 300, respectively. Escapements have been below these goals 8 of the past 10 years for the Coweeman, and 5 of the past 10 years for the East Fork Lewis. The 10 year average escapement for the Coweeman is 700 , compared to a recent 5 year average of 995 (range 146-2,100). In the East Fork Lewis, the 10 year average escapement is 300, compared to a recent 5 year average of 279. There is currently no escapement goal for the Clackamas where escapements have averaged about 350 per year.

Until recently tule hatchery production has been prioritized to support ocean and Lower Columbia River fisheries thus providing the potential for very high ERs. The tule stocks are north migrating, but are most vulnerable to catch in fisheries off the Washington coast and in the lower river. In recent years, ESA and other unrelated conservation constraints have substantially limited these fisheries in particular even though there have been no specific limits set for natural-origin tule stocks.

Three natural-origin bright stocks have also been identified. There is a relatively large and healthy stock on the North Fork Lewis River. Since 1984, there have no reported CWT recoveries in BSAI or GOA groundfish fisheries for this ESU component. The escapement goal for this system is 5,700. That goal has been met, and often exceeded by a substantial margin every year since 1980 with the exception of 1999. This year the return is expected to be substantially below goal because of severe flooding during the 1995 and 1996 brood years. Nonetheless, the stock is considered healthy. The Sandy and East Fork Lewis stocks are smaller. Escapements to the Sandy have been stable and on the order of 1,000 fish per year for the last 10-12 years. Less is known about the East Fork stock, but it too appears to be stable in abundance.

However, the retrospective analysis for the North Fork Lewis stock compares the actual ERs with that which would be expected under the agreement and what further reductions might be expected in the southern U.S. fisheries. The North Fork Lewis stock is similar to the UWR spring chinook in that the agreement will do relatively little to reduce harvest, in part because the reductions in SEAK and NCBC are small and because the stocks' distribution is such that less than a quarter of all harvest occurs in SEAK and BC fisheries. As a result, there is substantial latitude in southern fisheries to meet necessary conservation objectives.

5.1.4 Puget Sound Chinook Salmon

There are both spring and fall-run stocks in the PS ESU. As a group, the spring stocks from the Dungeness, Nooksack, and White rivers are considered in critical health status while the Skagit springs and later timed stocks are generally less depressed. Harvest on the Puget Sound spring stocks occurs primarily in Canadian and Puget Sound fisheries. Exploitation rate reductions are reflected to a degree in the most recent reported brood years. However, management planning in Puget Sound has focused more attention on spring stocks over the last couple of years. The effects of these actions should become apparent once the 1994 and 1995 brood year exploitation rates are available. These stocks have also benefitted from Canadian fishery reductions. The resulting reductions in exploitation rates over the last two years have been substantial. There have been no reported CWT recoveries from the PS ESU in BSAI or GOA groundfish fisheries.

Exploitation rates in the near-bye SEAK fisheries (NMFS 199a) on the PS spring chinook aggregate have averaged less than 1%. Data suggests that the SEAK fisheries impact the Nooksack spring stocks more so than the other stocks within the aggregate. SEAK fisheries are projected to account for 11% of the harvest mortality of these stocks, compared with less than 1% for other stocks within the aggregate. Estimates for the 1999 SEAK fisheries indicate an ER of about 0.52% on the aggregate and 1.4% and 0.9% ERs on the North Fork Nooksack and South Fork Nooksack stocks, respectively.

The ocean distribution of fall stocks are similar to the PS spring stocks in that they are harvested primarily in Canadian and Puget Sound fisheries with little catch occurring in Alaska. There are particular stocks within the ESU that have a somewhat more northerly distribution and higher ERs in Alaskan fisheries. The long-term brood year average ER through 1990 is 0% and has slightly increased to 1% over the last three brood years. Estimates for the 1999 fisheries are for an ER of less than 1% in SEAK fisheries compared with 14.3% in all ocean fisheries. Further reductions in harvest across all fisheries have been made in 1998 and 1999. The exploitation rate in 1999 is expected to be reduced by 24% relative to the 1989-93 average. Unlike the spring stocks which are severely depressed, the status of fall stocks within the Puget Sound chinook ESU varies from healthy to depressed. Many have significant portions of hatchery strays, but most of the historically large chinook producers remain dominated by natural production. Although these stocks have declined since the mid-1970s, they appear to have stabilized at low levels since 1991. Returns in 1998 exceeded the Snohomish River escapement goal, were very close to the goal for the Skagit and were the largest Stillaguamish escapement in seven years (Sands and Gaudet 1999).

5.1.5 Snake River Spring/Summer and Upper Columbia River Spring Chinook Salmon

The PFMC Salmon Technical Team previously reviewed the record of coded-wire tag recoveries of spring and summer chinook from the Snake River and other relevant information regarding distribution and harvest related mortality. The were no CWT recoveries or other information to suggest that SR spring/summer chinook are caught in the Alaskan fisheries (PFMC 1992, Clark et. al. 1995). There were four Snake River spring chinook tags recovered, all in Canadian fisheries, from over 2.8 million tags released from the 1976-1987 brood years. Snake River summer chinook tag groups from the same brood years were recovered in Washington (12), Oregon (8), and Canadian fisheries (7). No recoveries from summer chinook releases were reported from Alaskan fisheries. It is evident that SR spring/summer may be caught occasionally in Canadian fisheries, but that the impact is too low to specifically quantify and of little significance. The recent multi-agency PATH report and NMFS' subsequent review of similar information lead to the conclusion that the ocean harvest of SR spring/summer chinook (and steelhead) is "effectively non-existent" (Marmorek et. al. 1998, NMFS 1999e). In the related life-cycle modeling and risk analysis, the ocean harvest rate on SR spring/summer chinook was assumed to be zero.

The life history of UCRS chinook including the timing and ocean distribution is similar to that of SR spring/summer chinook. The state agencies concluded that there is almost no harvest of UCRS chinook in ocean fisheries (ODFW/WDFW 1998). In an earlier review Chapman et al. (1995) estimated an average ocean harvest for UCRS chinook of 0.6%. Recent life cycle modeling and risk assessment efforts have again assumed that UCRS chinook are subject to no ocean harvest mortality (Cooney, T. NMFS, pers. com. P. Dygert NMFS, August 1999). The available information suggests that UCRS chinook are rarely caught in the proposed BSAI and GOA groundfish fisheries.

5.1.6 California Chinook Salmon ESUs

California chinook stocks are presumed to reside primarily off California and not migrate to British Columbia or Alaska waters (Healy 1991). Myers et al. (1998) summarized a review of CWT recoveries from ocean fisheries and reported no recoveries in Alaska and Canada for stocks originating from the Rogue River in southern Oregon south. The CWT record for Sacramento River winter chinook (SRW) is relatively limited, but all recoveries except one have been taken off of California and none have been as far north as British Columbia (D. Viele NMFS, pers. com. P. Dygert, NMFS August 25, 1999). The current harvest management model for SRW chinook assumes that all harvest impacts are limited to California.

Spring chinook released from the Feather River Hatchery are considered most representative of Central Valley spring chinook. The distribution of the expanded CWT recoveries out of a total of almost 13,000 over a twenty year period showed 0.6% in Canadian fisheries, 1.1%, in Washington fisheries, 10.4% in Oregon fisheries, and 87.9% in California fisheries. There was a much more limited CWT program on the Mad River Hatchery that serves to indicate the distribution of California Coastal chinook. The distribution of expanded recoveries from north to south again were 0.9% (Canadian), 7.0%, 29.3%, and 62.9% in California fisheries.

5.2 Chum Salmon

In general, maturing chum salmon in the North Pacific begin to enter coastal waters from June to November. Columbia River chum enter fresh water from mid-October through mid-December and spawn from early November through mid-January (WDF et al. 1993). Although no information is available for the presence of Columbia River chum ESU in Alaskan fisheries, stock composition data from chum caught in June in the Aleutian Islands area indicate very small contributions of Washington chum stocks (0-2%)(Seeb and Crane, 1999). The Northern Boundary Technical Committee (NBTC 1991) concluded that, based on chum tagging studies, chum caught in the Northern Boundary fisheries between Alaska and Canada were from Alaska and Canada (in 1996-1998, 14 out of 2,221 recoveries were Canadian, none were from WA or OR, and the rest were from Alaska). There has been some speculation based on past catch patterns (Henry 1953) that Columbia River chum ocean distribution may be more southerly, similar to the present distribution of Columbia River coho salmon (Sandercock 1991). Only an estimated 25 coded-wire tagged Columbia River coho were caught in near-bye Alaskan salmon fisheries between 1979 and 1993 (Weitkamp et al. 1995). In addition, the large numbers of chum from regions outside the listed ESUs migrating through the same area, relative to the much smaller abundances of the listed ESUs, make it extremely unlikely that listed chum salmon would be caught.

5.3 Coho salmon

Coho from the Southern Oregon/Northern California Coast (SONCC) coho ESU are not caught in Alaskan or Canadian fisheries as indicated by the Rogue/Klamath indicator stock (PFMC 1999). Central California Coast coho have a similar, but somewhat more southerly distribution suggesting that they are also not caught in northern fisheries. Oregon Coast coho are occasionally caught in Alaska and Canadian salmon fisheries although the incidence is quite low. In 1999 the estimated exploitation rates (ERs) on SONCC coho in Alaskan and Canadian fisheries were 0.03% and 0.22%, respectively (PFMC 1999). The estimates for 1998 were similar (PFMC 1998). We can therefore assume, since these exploitation rates in the directed fisheries are so low, that the impact of bycatch by the BSAI and GOA groundfish fisheries would be much lower. Also, because there have been no recorded CWT recoveries of any surrogate stocks, we can further assume that the impact on listed coho salmon is unlikely. Coho salmon represent about 1.5 percent of the trawl bycatch of "other" salmon in the BSAI and about 9.5 percent in the GOA, and is the second most abundant species in the "other" salmon bycatch category after chum salmon. However, given the low relative amount of catch in the BSAI and the lower catch rates of "other" salmon in the GOA, and the lack of recoveries of any CWTs for SONCC coho salmon, NMFS concludes that it is unlikely that any SONCC coho salmon would be taken in BSAI or GOA groundfish fisheries.

5.4 Sockeye Salmon

Although the ocean distribution and migration patterns of Snake River sockeye and Ozette Lake sockeye are not well understood, catch information suggest that they are unlikely to be caught in proposed groundfish fisheries of the BSAI and GOA.

The NMFS found no information to suggest that there is any significant harvest of Snake River sockeye salmon in ocean fisheries (November 20, 1991, 56 FR 58619). NMFS previously concluded that Snake River sockeye are not likely to be caught in BSAI and GOA groundfish fisheries because few sockeye salmon are caught in trawl or hook-and-line fisheries that rarely intercept sockeye salmon (Table 3). Given the low total abundance of Snake River and Ozette Lake sockeye salmon, NMFS concludes that it is highly unlikely that any of these ESUs would be taken in BSAI or GOA groundfish fisheries.

5.5 Steelhead

5.5.1 California Steelhead ESUs

Very little is known about the marine distribution patterns of California steelhead. However, the likelihood of their being present as far north as Alaska can be inferred from the distribution of available mark recovery data by general life history type and from the commonalities in distribution with other salmonids from the region.

The California Central Valley, Central California Coast, South-Central California and Southern California steelhead ESUs are coastal winter-run steelhead stocks (Busby *et al.* 1996). Available fin-mark and CWT data suggests that winter-run stocks tend to migrate further offshore but not as far north into the GOA as summer-run steelhead stocks (Burgner *et al.* 1992). Some limited mark data (CWTs and disc tags) is available. No CWT or disc tags from mature California steelhead were recovered in the North Pacific Ocean. A few immature California steelhead were recovered during the 1956-1995 time period in the open ocean, consistent with the winter-run life history (Myers *et al.* 1996), but no recoveries have been reported in Alaskan or Canadian waters. Coded-wire tags from California coho and chinook are recovered almost exclusively in California and Oregon fisheries, with very few recoveries reported in British Columbia or Alaska. Since California coho and chinook stocks share similar patterns of ocean distribution, it is reasonable to assume that listed California steelhead ESUs would also have a southerly distribution and would not be present in Alaskan waters. Based on these data, NMFS believes it is reasonable not to expect that California steelhead would be caught in BSAI and GOA groundfish fisheries in numbers that could reasonably reduce their likelihood of survival and recovery in the wild (ODFW/WDFW 1998, PSMFC 1999).

5.5.2 Columbia River Steelhead ESUs

Lower Columbia River and Upper Willamette River steelhead ESUs are coastal steelhead stocks. The

Upper Willamette River stocks are winter run stocks; the Lower Columbia River steelhead stocks are primarily winter run although there are a few summer run stocks in the upriver portion of the ESU. Upper Columbia River, Snake River, and Middle Columbia River steelhead ESUs include inland stocks generally comprised of summer-run fish (Busby *et al* 1996).

The summer-run steelhead generally enter freshwater from May through October (Busby *et al* 1996) with peak entry occurring in July based on timing at Bonneville dam (US/O TAC 1997). Mark recoveries indicate that immature Columbia River steelhead are out in the mid North Pacific Ocean at this time. Data from high seas tagging studies found maturing summer-run Columbia River steelhead distributed off the coast of Northern British Columbia and west into the North Pacific Ocean (Myers *et al* 1996). Coded-wire tag data indicates summer-run steelhead are also present off the West Coast of Vancouver Island, with occasional recoveries in near shore Canadian fisheries.

The Lower Columbia River and Upper Willamette steelhead winter-run stocks enter freshwater from November through April (Busby et al. 1996). As mentioned above, the ocean distribution of winter-run steelhead is far offshore as compared with their summer counterparts, although coded-wire tag data indicates they are found as far east as the west coast of Vancouver Island. Adults move rapidly back to the Columbia River once the migration begins, averaging 50 km/day mean straight-line-distance (range = 15-85 km/day) (USO TAC 1997).

The ocean distributions of listed steelhead are not known in detail, but steelhead are rarely caught in ocean salmon fisheries. For the salmon fishery in Alaska, during 1982-1993, when the southeast Alaska seine landings were sampled for CWT steelhead, only one tag was recovered, although tag releases of southern U.S. steelhead were quite high. Since then, only one other steelhead CWT has been recovered while sampling for other species. From 1995 through 1999, no steelhead were reported as bycatch in the "other" salmon bycatch category in the BSAI or GOA (Table 3). Based on these data, NMFS believes it is reasonable not to expect that Columbia River steelhead would be caught in BSAI and GOA groundfish fisheries in numbers that could reasonably reduce their likelihood of survival and recovery in the wild (ODFW/WDFW 1998, PSMFC 1999).

5.6 Cutthroat Trout

Cutthroat trout are rarely caught in ocean fisheries and are unlikely to be found in the action area due to their relatively limited ocean migration (Sands and Gaudet 1999). Cutthroat trout are therefore unlikely to be caught in the proposed BSAI and GOA groundfish fisheries and are not likely to be adversely affected by the proposed action.

6.0 CUMULATIVE EFFECTS

Cumulative effects are defined as the "effects of future state or private activities, not involving federal activities, which are reasonably certain to occur within the action area of the federal action subject to consultation" (50 CFR 402.02). The action area is limited to the marine areas off Alaska, in which any activities that are likely to affect listed salmon are not regulated by the State of Alaska, so no future state activities listed species are anticipated. NMFS has no information on private activities that are unregulated by the Federal government, that may be occurring in the action area.

7.0 CONCLUSION

After reviewing the current status of Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River Basin steelhead, the environmental baseline for the action area, the effects of the proposed fishery and the cumulative effects, it is NMFS biological opinion that the BSAI and GOA groundfish fisheries subject to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area and the Fishery Management Plan for Groundfish of the GOA, as proposed is not likely to jeopardize their continued existence. No critical habitat has been designated for these species; therefore, none will be affected by the proposed fisheries.

8.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by NMFS. NMFS has a continuing duty to regulate the activity covered by this incidental take statement. If NMFS fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NMFS must document the progress of the action and its impact on the species as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

Amount or Extent of the Take

While it is not possible to identify individual listed fish that may be taken in a fishery, impacts to listed fish can be limited by specifying limits in terms of either an exploitation rate or total catch. The catch of listed fish will be limited specifically by the measures proposed to limit the total bycatch of chinook salmon. Bycatch should be minimized to the extent possible and in any case should not exceed 55,000 chinook per year in the BSAI fisheries or 40,000 chinook salmon per year in the GOA fisheries. No take of HCSR chum or LCR chum is expected in BSAI or GOA groundfish fisheries. NMFS does not anticipate that the proposed fisheries will take any coho from the Southern Oregon/Northern California Coast or Central California ESUs, any Snake River or Lake Ozette sockeye salmon, or any steelhead ESUs.

Effect of the Take

In the accompanying biological opinion, NMFS determined that the level of anticipated take of Snake River fall chinook, Snake River spring/summer chinook, Puget Sound chinook, Upper Columbia River spring chinook, Upper Willamette River chinook, Lower Columbia River chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia

River steelhead, and Snake River Basin steelhead in the BSAI and GOA groundfish fisheries is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

The following reasonable and prudent measures are provided to minimize and reduce the anticipated level of incidental take associated with NPFMC groundfish fisheries:

1. The NPFMC and NMFS, Alaska Region shall ensure there is sufficient NMFS-certified observer coverage such that the bycatch of chinook salmon and "other" salmon in the BSAI and GOA groundfish fisheries can be monitored on an inseason basis.

2. The NPFMC and NMFS, Alaska Region shall monitor bycatch reports inseason to ensure that the bycatch of chinook salmon does not exceed 55,000 fish per year in the BSAI fisheries and 40,000 fish per year in the GOA fisheries.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the specified agencies must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. NMFS' Division of Sustainable Fisheries (Alaska Region) shall provide an annual report to the NMFS Division of Protected Resources (Alaska Region) that details the results of its monitoring of bycatch reports during each fishing season. These reports shall be submitted in writing within one month of the new fishing year (February 1), and will summarize all statistical information based on a January 1 through December 31 fishing year.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might result from the proposed action. If, during the course of the groundfish fishery, this level of incidental take is exceeded, the additional level of take would represent new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided above.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to develop additional information, or to assist the Federal agencies in complying with their obligations under section 7(a)(1) of the ESA. NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by the NPFMC and NMFS:

1. The NPFMC and NMFS, Alaska Region should improve estimates of the region-of-origin and stock composition of the chinook salmon bycatch by increasing CWT sampling rates as part of the mandatory salmon retention program, collecting and analyzing scale samples, and employing additional stock identification techniques applicable to the problem.

2. The NPFMC and NMFS, Alaska Region should use information collected during the observer monitoring program to identify times and areas of high salmon abundance that could be used to reduce salmon bycatch through regulatory action.

3. The NPFMC and NMFS, Alaska Region should encourage development of incentive programs designed to reduce the bycatch of salmon in the NPFMC groundfish fisheries.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

Reinitiation of Consultation

This concludes formal consultation on the proposed actions. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, the action agency must immediately reinitiate formal consultation.

9.0 REFERENCES

Allen, R.L., and T.K. Meekin. 1973. An evaluation of the Priest Rapids chinook salmon spawning channel, 1963-1971. Wash. Dept. Fisheries, Technical Report 11:1-52 p.

Andrews, T.R., and H.M. McSheffrey. 1976. Commercial interceptions of steelhead trout stocks in British Columbia: a preliminary review. Fisheries Management Report No. 1, British Columbia Marine Resources Branch. 31 p.

Becker, D.C. 1970. Temperature, timing, and seaward migration of juvenile chinook salmon from the central Columbia River. AEC Research and Development Report, Battelle Northwest Laboratories. Richland, WA. 21 p.

Biological Requirements Work Group (BRWG). 1994. Analytical methods for determining requirements of listed Snake River salmon relative to survival and recovery. Progress Report, October 13, 1994. 129 p w/ Appendices.

Bison, R.G. 1990. Steelhead trout harvest by the commercial gill net fisheries of the Johnstone Strait, Strait of Juan de Fuca, and Nitinat areas, 1989. British Columbia Ministry of Environment, Fisheries Branch, Kamloops, B.C. 14 p.

Bison, R.G. 1992. The interception of steelhead, chinook, and coho salmon during three commercial gill net openings at Nitinat, 1991. B.C. Environment, Lands and Parks, Fisheries Branch, Kamloops, B.C. 17 p.

Burgner, R.L. 1991. The life history of sockeye salmon (*Oncorhynchus nerka*). *In* C. Groot and L. Margolis (eds.), Life history of Pacific salmon. Univ. British Columbia Press; Vancouver, B.C.

Burgner, R. L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51, 92 p.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWIFSC-27, 261 p.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, F. Utter. 1994. Status of summer steelhead in the mid-Columbia River. Don Chapman Consultants, Inc., Boise, Idaho. 186 p. w/ appendices.

Chapman, D., C. Peven, A. Giorgi, T. Hillman, and F. Utter. 1995. Status of spring chinook salmon in the Mid-Columbia Region. Don Chapman Consultants Inc. 477 p.

Clark, J.H., J.E. Clark, D. Gaudet, and J. Carlile. 1995. Biological assessment of potential incidental impacts of 1995-1998 Southeast Alaska salmon fisheries on ESA listed Snake River salmon. ADFG Regional Information Report No. 1J95-15. April 28, 1995. 79 pp.

Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. Status of chinook salmon and their habitat in Puget Sound. Volume 2, Final Report. June 1999.

Dlugokenski, C.E., W.H. Bradshow, and S.R. Hager. 1981. An investigation of the limiting factors to Lake Ozette sockeye salmon production and a plan for their restoration. U.S. Fish. Wildl. Serv. Fisheries Assistance Office, Olympia, WA, 52 p.

Fulton, L.A. 1968. Spawning areas and abundance of chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River Basin — past and present. U.S. Fish. Wildl. Serv. Spec. Sci. Rep. Fish. 571:26.

Gilbert, C.H. 1912. Age at maturity of Pacific coast salmon of the genus *Oncorhynchus*. Bull. U.S. Fish Comm. 32:57-70.

Hartt, A.C. and M.B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. International North Pacific Fisheries Commission Bulletin 46:1-105. *In* Nickelson *et al.* (1992a).

Healey, M.C. 1983. Coastwide distribution and ocean migration patterns of stream- and ocean-type chinook salmon, *Oncorhynchus tshawytscha*. Can. Field-Nat. 97:427-433.

Healey, M.C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. Can. Spec. Publ. Fish. Aquat. Sci. 89:39-52.

Healey, M.C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). *In* C. Groot and L. Margolis (eds.), Life history of Pacific Salmon. Univ. of British Columbia Press. Vancouver, B.C.

Henry, K.A. 1953. Analysis of factors affecting the production of chum salmon (Oncorhynchus keta) in Tillamook Bay. Oreg. Fish Comm. Contrib. 18, 37 p.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Knedra, and D. Orrmann. 1985. Stock assessment of Columbia River anadromous salmonids. Vol. I. U.S. Dept. of Energy, Bonneville Power Administration. Project No. 83-335. 558p.

Kareiva, P., Marvier, M., McClure, M., McElhany, P., Ruckelshaus, M., Sanderson, B., Waples, R. 1999. Evaluating viability of salmonid populations and ESUs - upcoming approaches and analyses In [italics] An introduction to NMFS decision-support science for ESA decision making,- with examples. White paper prepared for workshop entitled Putting the 4-H's together in the real world and using the analytical framework to evaluate specific management scenarios. August 31, 1999, NMFS NW Regional office, Seattle, Washington. http://research.nwfsc.noaa.gov/cri/pdf_files/notes.htm.

Kostow, K. 1995. Biennial report on the status of wild fish in Oregon. Oreg. Dep. Fish Wildl. Rep., 217p. + app.

Lestelle, L. C. and L. G. Gilbertson. 1993. Harvest management and recovery of Snake River salmon stocks. Draft technical report number 5. U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, OR. 97 p.

Lindsay, R.B., R.K. Schroeder, and K.R. Kenaston. 1998. Spring chinook salmon in the Willamette and Sandy rivers. ODFW Annual Progress Report. F-163-R-03. 29 p.

Marmorek, D.R., C.N. Peters, and I. Parnell. 1998. Plan for analyzing and testing hypotheses (PATH) - Final report for fiscal year 1998. December 16, 1998. 263 p.

Marshall, A.R., C. Smith, R. Brix, W. Dammers, J. Hymer, and L. LaVoy. 1995. Genetic diversity units and major ancestral lineages for chinook salmon in Washington. In C. Busack and J. B. Shaklee (eds.), Genetic diversity units and major ancestral lineages of salmonid fishes in Washington, p. 111-173. Wash. Dep. Fish Wildl. Tech. Rep. RAD95-02. (Available from Washington Department of Fish and Wildlife, 600 Capital Way N., Olympia WA 98501-1091).

Marshall, S. 1999. Letter to P. Dygert, NMFS. June 24, 1999. 1 p.

McPhail, J.D., and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Bull. Fish. Res. Board Canada 173: 381.

Miller, R.J., and E.L. Brannon. 1982. The origin and development of life-history patterns in Pacific salmon. *In* E.L. Brannon and E.O. Salo (eds.), Proceedings of the Salmon and Trout Migratory Behavior Symposium. Univ. Washington Press; Seattle, Washington.

Ministry of Environment, Lands and Parks and Canada Department of Fisheries and Oceans. 1998. Review of Fraser River steelhead trout (*Oncorhynchus mykiss*). Draft report. 46 p w/ appendices.

Myers, K.W., K.Y. Aydiu, R.V. Walker, S. Fowler and M.L. Dahlberg. 1996. Known ocean ranges of stocks of Pacific salmon and steelhead as shown by tagging experiments, 1956-1995. (NPAFC Doc. 192) Fish Res. Inst., Univ. Wash., Seattle (FRI-UW-9614). 4p w/ figs. and append.

Myers and 10 co-authors. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443p.

Nicholas, J. 1995. Status of Willamette spring-run chinook salmon relative to Federal Endangered Species Act considerations. Unpublished Report. November 30, 1995. 44 p.

National Marine Fisheries Service (NMFS). 1991. Factors for decline. A supplement to the notice of determination for Snake River fall chinook salmon under the Endangered Species Act. June 1991. 55 p.

NMFS. 1992. Endangered Species Act - Section 7 Consultation Biological Opinion: Fishing conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. August 28, 1992. 53 pp.

NMFS. 1993. Section 7 Consultation - Biological Opinion: 1992/1993 and 1993/1994 Winter Season Regulations Under the Fishery Management Plan for Salmon Fisheries off the Coast of Alaska and other activities. May 28, 1993. Northwest Region, 7600 Sand Point Way N.E. BIN C15700, Building 1, Seattle, Washington. 74 pp.

NMFS. 1994. Section 7 Consultation - Biological Opinion: Groundfish fisheries conducted under the Bering Sea and Aleutian Island and Gulf of Alaska Fishery Management Plans of the North Pacific Fishery Management Council. January 19, 1994. 74 pp.

Paula Johnson

NMFS. 1995a. Proposed recovery plan for Snake River salmon. March 1995.

NMFS. 1995b. Endangered Species Act - Section 7 Reinitiation of Consultation Biological Opinion: Groundfish fisheries conducted under the Bering Sea and Aleutian Island and Gulf of Alaska Fishery Management Plans of the North Pacific Fishery Management Council. December 7, 1995. 8 pp.

NMFS. 1996a. Endangered Species Act Reinitiation of Section 7 Consultation - Biological Opinion: Fishing Conducted under the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery, May 14, 1996.

NMFS. 1996b. Endangered Species Act Section 7 Consultation - Biological Opinion. The Fishery Management Plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California of the Pacific Fishery Management Council. March 8, 1996.

NMFS. 1998a. Final Supplemental Environmental Impact Statement: Groundfish Total Allowable Catch Specifications and Prohibited Species Catch Limits Under the Authority of the Fishery Management Plans for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area and Groundfish of the Gulf of Alaska. December 1998. National Marine Fisheries Service, P.O. Box 21668, Juneau, Alaska 99802. 692 pp + Appendices and Comments.

NMFS. 1998b. Endangered Species Act - Section 7 Consultation - Managing the Southeast Alaska salmon fisheries subject to the Fishery Management Plan for Salmon Fisheries off the Coast of Alaska and the U.S. Letter of Agreement Regarding Chinook Salmon Fisheries in Alaska. NMFS, Protected Resources Division. June 29, 1998. 22 pp.

NMFS. 1999a. Endangered Species Act - Section 7 Consultation - Managing the Southeast Alaska salmon fisheries subject to the Fishery Management Plan for Salmon Fisheries off the Coast of Alaska and the U.S. Letter of Agreement Regarding Chinook Salmon Fisheries in Alaska. NMFS, Protected Resources Division. June 30, 1999. 48 pp.

NMFS. 1999b. Endangered Species Act - Section 7 Consultation - Approval of the Pacific Salmon Treaty and Management of the Southeast Alaska Salmon Fisheries Subject to the Pacific Salmon Treaty. NMFS, Protected Resources Division. November 18, 1999. 48 pp.

NMFS. 1999c. Endangered Species Act - Section 7 Consultation. Supplemental Biological Opinion and Incidental Take Statement on the Pacific Coast Salmon Plan and Amendment 13 to the Plan. April 28, 1999. 39 pp. (with appendices).

NMFS. 1999d. Groundfish fisheries bycatch statistics. Alaska Region/Sustainable Fisheries Division Website. http://www.fakr.noaa.gov/sustainablefisheries/default.htm#groundfish November, 1999.

NMFS. 1999e. An assessment of Lower Snake River hydrosystem alternatives on survival and recovery of Snake River salmonids. April 14, 1999. 163 pp.

NMFS. 1999f. Endangered Species Act - Section 7 Consultation. Biological Opinion and Incidental Take Statement. 1999 Treaty Indian and non-Indian fall season fisheries in the Columbia River

Basin. July 30, 1999. 68 p.

ODFW. 1997. Backgrounder - Willamette spring chinook. February 21, 1997. 6 p.

ODFW. 1998a. Spring chinook chapters - Willamette basin fish management plan. Oregon Department of Fish and Wildlife. March 1998. 39 p.

ODFW. 1998b. Briefing paper - Lower Columbia River chinook ESU. October 13, 1998. 7 p.

ODFW/WDFW. 1998. Status Report: Columbia River fish runs and fisheries, 1938-1997. Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife. June 1998.

Oguss, E. and L.K. Evans. 1978. Incidental catches of steelhead trout in the commercial salmon fisheries of Barkley Sound, Johnstone Strait, and the Skeena and Fraser Rivers. Fisheries Management Report No. 14, British Columbia Marine Resources Branch. 84 p.

Olsen, E., P. Pierce, M. McLean, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids Volume 1: Oregon. U.S. Dep. Energy, Bonneville Power Administration. Project No. 88-108.

Pacific Fishery Management Council (PFMC). 1992. Preseason report III: Analysis of Council-adopted management measures for 1992 ocean salmon fisheries. April 1992. 27 pp. (with appendices).

PFMC. 1996. Review of the 1995 ocean salmon fisheries. Pacific Fishery Management Council, 115 p. + app. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201.)

PFMC. 1998. Preseason report III: Analysis of Council-adopted management measures for 1998 ocean salmon fisheries. April 1998. 27 pp. (with appendices).

PFMC. 1999. Preseason report III: Analysis of Council-adopted management measures for 1999 ocean salmon fisheries. April 1999. 30 pp. (with appendices).

Pacific States Marine Fisheries Commission (PSMFC). 1999. Coded wire tag recovery data. Regional Mark Information Systems Database, http://www.psmfc.org/rmpc/index.html. June 16, 1999.

Parkinson, E.A. 1984. Identification of steelhead stocks in the commercial net fishery of the southern British Columbia coast. Fisheries Management Report No. 81.16 p.

Pearcy, W.G., 1992. Ocean ecology of North Pacific salmonids. Univ. Washington Press, Seattle, 179 p.

Peterman, R.M. 1977. A simple mechanism that causes collapsing stability regions in exploited salmonid populations. J. Fish. Res. Board Can. 34: 1130-1142.

Peters, C.N., D.R. Marmorek, and I. Parnell (eds.). 1999. PATH decision analysis report for Snake River fall chinook. Prepared by ESSA Technologies Ltd., Vancouver, BC. 332 pp.

Pettit, R. 1998. Escapement estimates for spring chinook in Washington tributaries below Bonneville

Dam, 1980-1998. WDFW Columbia River Progress Report 98-13. 3 p. (with Tables).

Pitcher, T.J. 1986. Functions of shoaling in teleosts. In Fisher, T.J. (ed.), The behavior of teleost fishes, p. 294-337. Johns Hopkins Univ. Press, Baltimore, MD.

Point No Point Treaty Tribes and Washington Department of Fish and Wildlife (PNPTC/WDFW). 1999. Summer Chum Salmon Conservation Initiative - Hood Canal and Strait of Juan de Fuca Region. *In preparation.*

Randall, R.G., M.C. Healey, and J.B. Dempson. 1987. Variability in length of freshwater residence of salmon, trout, and char. In Dodswell, M.J., et al. (eds.), Common strategies of anadromous and catadromous fishes. Am. Fish. Soc. Symp. 1:27-41.

Reimers, G.H., F.H. Everest, and J.D. Hall. 1987. Interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. Can. J. Fish. Aquat. Sci. 44:1603-1613.

Ricker, W.E. 1972. Hereditary and environmental factors affecting certain salmonid populations. *In* R.C. Simon and P.A. Larkin (eds.), The stock concept in Pacific salmon. MacMillan Lectures in Fisheries. Univ. British Columbia; Vancouver, B.C.

Rue, F. 1999. Letter to R. B. Lauber, NPFMC and S. Pennoyer, NMFS, August 31, 1999. 1 p.

Salo, E.O. 1991. Life history of chum salmon, Oncorhynchus keta. In Groot, C., and L. Margolis (eds.), Pacific salmon life histories, p. 231-309. Univ. B.C. Press, Vancouver, B.C., Canada.

Sands, N.J. and D. Gaudet. 1999. The biological assessment for the Southeast Alaska salmon fishery for 1999-2003 under section 7 of the Federal Endangered Species Act. ADFG Regional Information Report No. 5J99-07. June 1999. 28 pp.

Seeb, L.W. and P.A. Crane. 1999. Allozymes and Mitochondrial DNA Discriminate Asian and North American Populations of chum salmon in mixed-stock fisheries along the South coast of the Alaska Peninsula. Trans. Amer. Fish Soc. 128: 88-103.

Stelle, W. 1999. Letter to Bill Frank, Jr., Northwest Indian Fisheries Commission. September 3, 1999. 1 p w/ enclosure.

Stelle, W.W., and W.T. Hogarth. 1999. Letter to J. Mallet, Chairman, Pacific Fisheries Management Council. March 1, 1999. p 5.

Taylor, E.B. 1991. A review of local adaptation in Salmonidae, with particular reference to Pacific and Atlantic salmon. Aquaculture 98:185-207.

U.S. v Oregon Technical Advisory Committee. 1997. 1996 All Species Review - Columbia River Fish Management Plan.

Utter, R., G. Milner, G. Stahl, and D. Teel. 1989. Genetic population structure of chinook salmon (Oncorhynchus tshawytsha), in the Pacific Northwest. Fish. Bull. 87:239-264.

Waples, R.S., R.P Jones, Jr., B.R. Beckman, and G.A. Swan. 1991. Status Review for Snake River fall chinook salmon. NOAA Technical Memorandum. NMFS F/NWC-201. June 1991. 73 p.

Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212p. + 5 regional volumes.

Figure 1. Early ocean survival rate index for Lewis River fall chinook.

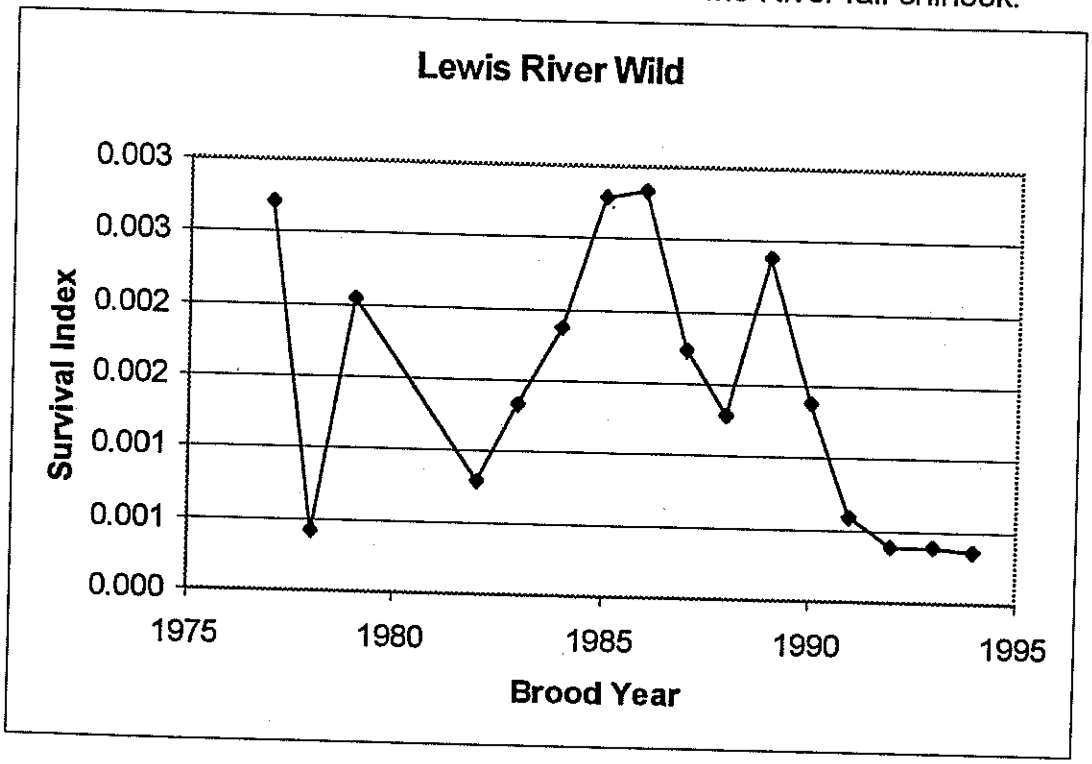

Figure 2. Early ocean survival rate index for Nooksack spring chinook from Puget Sound.

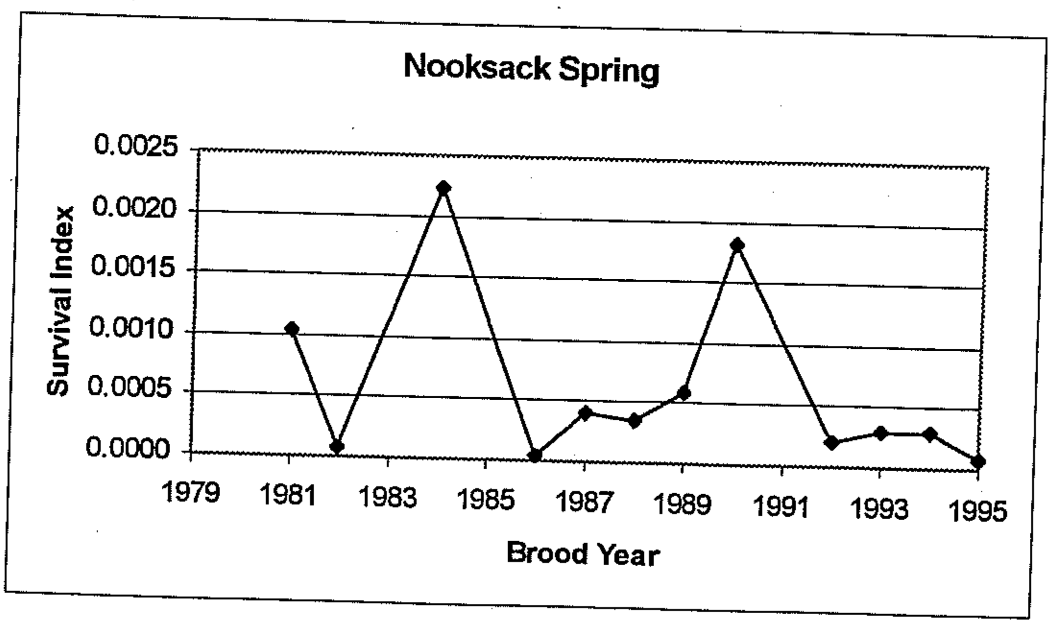

Figure 3. Early ocean survival rate index for Upper Willamette River chinook.