Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Consultation on the Approval of Revised Regimes under the Pacific Salmon Treaty and the Deferral of Management to Alaska of Certain Fisheries Included in those Regimes

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Table of Contents

Table of Tables

Table 7.4.3.3-1. Rebuilding exploitation rates for the Coweeman, East Fork Lewis, and Grays river populations.. 7 · 39

Table 7.4.3.3-2. Results for the SPAZ analysis results indicating the probability of persistence associated with exploitation rates of 0%, 25%, and 50% for QETs of 50 and 150. Persistence is defined as the probability of not falling below the specified QET value, based on a four year average, any time in a 100 year projection... 7 · 40

Table of Figures

Acronyms and Abbreviations

AABM	aggregate abundance based management
ACOE	Army Corps of Engineers
AI	abundance index
ADFG	Alaska Department of Fish and Game
BC	British Columbia
BFR	brominated flame retardants
BRT	Biological Review Team
BSAI	Bearing Sea/Aleutian Islands
CET	critical escapement thresholds
CTC	Chinook Technical Committee
CWT	coded wire tag
DPS	distinct population segment
EEZ	exclusive economic zone
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
FMEP	Fishery Management Evaluation and Plan
FMP	Fishery Management Plan
FRAM	Fishery Regulation Assessment Model
GOA	Gulf of Alaska
GSI	genetic stock identification
HPA	Hydraulic Project Approval
HRI	Harvest Rate Index
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Technical Recovery Team
ISAB	Independent Scientific Advisory Board
ISBM	individual stock based management
LCFRB	Lower Columbia Fish Recovery Board
LWD	large woody debris
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MPG	major population group
MMPA	Marine Mammal Protection Act
NBC	Northern British Columbia
NCBC	North/Central British Columbia
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish and Wildlife
PAH	polycyclic aromatic hydrocarbons
PFMC	Pacific Fishery Management Council
PNNL	Pacific Northwest National Laboratory
POP	persistent organic pollutants
PSC	Pacific Salmon Commission
PSMFC	Pacific States Marine Fisheries Commission

PST	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PVA	population viability analysis
QCI	Queen Charlotte Islands
QET	quasi-extinction threshold
RER	recovery exploitation rate
RET	recovery escapement threshold
RPA	Reasonable and Prudent Alternative
SASSI	salmon and steelhead stock inventory
SCA	Supplemental Comprehensive Analysis
SEAK	Southeast Alaska
SOI	Southern Oscillation Index
SPAZ	Salmon Population AnalyZer
SRFCI	Snake River Fall Chinook Index
TAC	total allowable catch
TRT	Technical Recovery Team
WCVI	West Coast Vancouver Island
WDOE	Washington Department of Ecology
WDFW	Washington Department of Fish and Wildlife
WLCTRT	Willamette/Lower Columbia Technical Recovery Team
VRAP	viable risk assessment procedure
VSP	viable salmonid population

1 ▪ Introduction and Background

NOAA's National Marine Fisheries Service (NOAA Fisheries) consults on the impacts of salmon fisheries on listed species under the Endangered Species Act (ESA). The Pacific Salmon Commission (Commission, or PSC) recently reached agreement on new fishing regimes under the Pacific Salmon Treaty (PST, or Treaty) and, pursuant to the procedural terms of the Treaty, has recommended that the Parties (Canada and the United States) adopt and implement these new regimes through their respective domestic management authorities (Koenings and Sprout 2008). The new fishing regimes apply to and/or affect nearly all salmon fisheries in Southeast Alaska (SEAK), British Columbia (BC), and the Pacific Northwest for ten years. The regimes will commence in 2009 and extend through 2018 (January 1, 2009 through December 31, 2018). The recommended agreement (generally referred to as the 2008 Agreement) is now being considered by the two Parties pursuant to their respective domestic legal requirements. The goal of the Parties is to conclude their respective domestic consideration processes before the current regimes expire at the end of 2008. Because the regimes will affect species listed under the ESA, approval of the 2008 Agreement by the United States is contingent on the analyses of these impacts. Thus, the purpose of this biological opinion is to consider the effects that implementation of the fishing regimes recommended by the Commission will have on ESA listed species, including listed salmon and steelhead species, Southern Resident killer whales, green sturgeon, and steller sea lions.

1.1 Background

The United States and Canada ratified the Pacific Salmon Treaty in 1985 following many years of intermittent negotiations. The Treaty provides a framework for the management of salmon fisheries in those waters of the United States and Canada that fall within the Treaty's geographical scope. In addition to institutional and procedural provisions (e.g., establishment of the Commission and its panels; meeting schedules and protocols, etc.), the Treaty established fishing regimes that set upper limits on intercepting fisheries, defined as fisheries in one country that harvest salmon originating in another country, and sometimes include provisions that apply to the management of the Parties' non-intercepting fisheries as well. The Treaty also established procedural mechanisms for revising the regimes when necessary. The overall purpose of the regimes, which are found in Chapters 1-6 of Annex IV, is to accomplish the conservation, production, and harvest allocation objectives set forth in the Treaty. It is important to note that these fishing regimes are not self-executing; they must be implemented by the Parties with conforming regulations issued under the authority of their respective management agencies.

The fishing regimes contained in Annex IV of the Treaty (Koenings and Sprout 2008) are expected to be amended periodically upon recommendation of the Commission as new information becomes available to better accomplish the Treaty's conservation, production, and allocation objectives. The original (1985) regimes varied in duration and some were modified and extended for several years, but by the end of 1992, all had expired. Despite several years of negotiations, both within the Commission and a variety of other processes and forums, the United States and Canada were unable to reach a comprehensive new agreement until 1999. During the interim period (1993 through 1998), fisheries subject to the Treaty generally were managed pursuant to short term (annual) agreements that governed only some of the fisheries. When even short term agreements were not reached, the fisheries were managed independently by the Parties' respective domestic management agencies, but generally in approximate conformity with the most recently applicable bilateral agreement.

The agreement finally reached in 1999 (the 1999 Agreement) came to fruition through a government-to-government process rather than within the normal PSC process established under the Treaty. The 1999 Agreement was comprehensive, and included amended versions of Chapters 1-6 of Annex IV, as well as a variety of other provisions designed to improve implementation of the Treaty and the operations of the Commission. The fishing regimes in Chapters 1-6 would apply for a duration of ten years, expiring at the end of 2008, except for Chapter 4 (Fraser River Sockeye and Pink Salmon), which would apply for twelve years, through 2010. The Treaty provides mechanisms whereby the Commission may recommend amendments to any fishing regime at any time, including prior to their scheduled expiration date; this in fact has occurred for some of the fishing regimes contained in the 1999 Agreement, but in each case the expiration dates set in 1999 were left unchanged. Approval of Commission recommendations to amend fishing regimes is formalized by the two countries in an exchange of diplomatic notes between the U.S. Secretary of State and Canada's Minister of Foreign Affairs.

Anticipating the expiration of the fishing regimes established in the 1999 Agreement and the time required to negotiate new regimes, the Commission began negotiations for new regimes in January of 2007. After nearly 18 months of negotiations, the Commission reached agreement in May of 2008 on amended versions of each of the five expiring Chapters of Annex IV. By letter dated May 21, 2008, the Commission transmitted the amended Chapters to the governments of Canada and the United States and recommended their approval (Koenings and Sprout 2008).

A major component of the 2008 Agreement, and the one that proved most difficult and time-consuming to negotiate, is the management regime set forth in Chapter 3 of Annex IV for Chinook salmon. It continues the basic aggregate abundance-based management (AABM) approach established in the 1999 Agreement for three major ocean Chinook salmon fisheries in southeast Alaska and Canada, coupled with an individual stock-based management (ISBM) approach for all other Treaty-area fisheries in Canada and the Pacific Northwest. The new Chinook regime incorporates several revisions, including reductions in two major fisheries relative to those allowed under the 1999 Agreement.

Other components of the agreement include amended versions of the transboundary rivers regime (Chapter 1), the northern boundary fisheries regime in southeast Alaska and northern British Columbia (Chapter 2), and the regimes applicable to southern area coho salmon (Chapter 5) and chum salmon (Chapter 6). As noted above, because the existing Fraser River sockeye and pink salmon regime (Chapter 4) does not expire until the end of 2010, the Commission has not recommended amendments to that regime at this time.

Pursuant to the Pacific Salmon Treaty Act of 1985 (16 USC 3631), the U.S. Federal law governing implementation of the Treaty, the Secretary of State, in consultation with the Secretaries of Commerce and Interior, is authorized to approve, on behalf of the United States, fishing regimes recommended by the Commission. Throughout the negotiations that occurred within the Commission to develop new regimes, the U.S. Federal representatives involved in the negotiations indicated to all participants, Canadian and U.S. alike, that approval of the new regimes by the United States would be considered a Federal action that would require consultation under section 7 of the ESA, and thus the approval of a new agreement by the U.S. government would be contingent on a determination by NOAA Fisheries that implementation of the agreement would meet the requirements of the ESA. Thus, the purpose of this biological opinion is to determine whether salmon fisheries in southeast Alaska (SEAK), British Columbia, and the Pacific Northwest, if managed consistent with the Commission's proposed Agreement, are likely to jeopardize the continued existence of ESA listed species including in particular salmon, steelhead, the Southern Distinct Population Segment (DPS) green sturgeon, Southern Resident killer whales and steller sea lions, or result in the destruction or adverse modification of their critical habitat. This determination will necessarily take into account other applicable fishing plans implemented per U.S. domestic regulatory process that affect the same listed species, as will be explained below.

Finally, NOAA Fisheries recognizes the importance of consulting with the tribes regarding actions taken on behalf of the federal government that may affect trust resources. Because of the need to complete this biological opinion prior to the end of the year, NOAA Fisheries was unable to conduct an adequate consultation with the tribes regarding our approval of this opinion on the PST Agreement. As a consequence, the tribes will review the biological opinion after its completion and then consult with NOAA Fisheries. If the tribes raise issues as a result of that review, NOAA Fisheries will take the appropriate steps to address their concerns.

1.2 Application of ESA Section 7(a)(2) Standards—Jeopardy Analysis Framework

Section 7 of the ESA requires that all Federal agencies consult with NOAA Fisheries (or the U.S. Fish and Wildlife Service regarding species listed under their jurisdiction) concerning the effects of their proposed actions on any species listed as threatened or endangered. Through this consultation process, section 7 may authorize Federal agency actions that may involve some “take” of listed species provided that such take is incidental to, and not the primary purpose of, the proposed action, and provided that the effects of the proposed action do not jeopardize the continued existence of the species or destroy or adversely modify designated critical habitat (“Take” means to harass, harm, pursue, hunt, shoot, wound, kill, trap capture, or collect, or to attempt to engage in any such conduct (section 3(18) ESA)). The consultation process includes the documentation of a cause and effect analysis using best available scientific information in a biological opinion.

NOAA Fisheries has previously described in some detail its approach to making determinations pursuant to section 7 regarding the effects of harvest actions on ESA listed salmon and steelhead species (NMFS 2004a). The following section summarizes that information and describes the approach used in this opinion to apply the standards for determining the likelihood of jeopardy to listed species and adverse modification of critical habitat as set forth in Section 7(a)(2) of the ESA and as defined in 50 CFR Part 402. The analysis in this opinion proceeds using the following outline:

- Describe the proposed action and action area. This includes identifying the Federal action agency, the statutory authority for the action, the purpose and timing, and duration and location of the action, and any interrelated and interdependent actions. The action area defines the boundaries that include the direct and indirect effects of the action. The proposed actions and action area considered in this opinion are described in Chapters 3 and 4.

- Identify the species and critical habitat likely to be adversely affected by the proposed action. Describe the status of the affected species with respect to biological requirements that are indicative of survival and recovery and the essential features of any designated critical habitat. In the Northwest Region, NOAA Fisheries has developed guidance for analyzing the status of the component populations of each ESU or DPS in a “Viable Salmonid Populations” paper (VSP) (See McElhany et al. 2000). The VSP approach relies on consideration of abundance, productivity, spatial structure, and diversity of each population as part of the overall review of the species’ status. Technical Recovery Team recommendations and recovery plans where available describe how VSP criteria are applied to specific populations, major population groups, and species and these are relied upon in determining biological requirements relative to status in this opinion. The status of species affected by the proposed actions in this opinion is discussed in Chapter 5.

- Summarize the environmental baseline in the action area. The environmental baseline includes past and present impacts of Federal, state, local and private actions on the affected species and their habitat, any recovery activities, whether the environmental baseline is meeting the species' biological requirements, or whether further improvement is needed. The environmental baseline is discussed in Chapter 6 of this opinion.

- Analyze the effects of the proposed actions. In this step NOAA Fisheries considers whether the proposed action reduces the abundance, productivity, or distribution of the species or alters any physical or biological features of designated critical habitat. Any cumulative effects (future non-federal actions that are reasonably certain to occur) are considered in a separate section. The effects of the proposed actions and cumulative effects are considered in Chapters 7 and 8.

- Determine whether the effects of the proposed action, taken together with any cumulative effects and added to the environmental baseline, can be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the affected species, or is likely to destroy or adversely modify their designated critical habitat. In Chapter 9 of this opinion we summarize information from the above described parts of the analysis and make the necessary determinations with respect to jeopardy and adverse modification.

If, in completing the last step in the analysis, NOAA Fisheries determines that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or adversely modify designated critical habitat, NOAA Fisheries must identify a reasonable and prudent alternative (RPA) for the action that is not likely to jeopardize the continued existence of ESA-listed species or adversely modify their designated critical habitat and meets the other regulatory requirements for an RPA. For further information regarding the process for making section 7 determinations on harvest related activities, refer to the previously cited report on the subject (NMFS 2004a).

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2 ▪ Consultation History

The first ESA listings of salmon species in the Pacific Northwest occurred in 1992. NOAA Fisheries conducted its first ESA review of salmon fisheries in SEAK in 1993, and continued their consideration of the SEAK fisheries by means of annual consultations through 1998 (NMFS 1993a; NMFS 1998). The United States and Canada tentatively concluded the 1999 Agreement in June of 1999. Final approval of the 1999 Agreement by the United States also was subject to contingencies related to ESA review, as well as to certain funding provisions. It was understood that the ESA review would take several months. The proposed agreement was concluded just a few days before the start of the summer fishery in SEAK. Nonetheless, Alaska modified its fishing plan to comply with the tentative agreement. There was little time between the announcement of the agreement and the pending start of the 1999 fishery in SEAK on July 1. This time constraint combined with NOAA Fisheries' obligation to provide a more comprehensive review of the entire PST agreement prior to December 31, 1999, resulted in a biological opinion issued on June 30, 1999 (NMFS 1999a). In this opinion, NOAA Fisheries considered the effects on listed species resulting from SEAK fisheries managed under the new regime for the 1999 summer and 1999/2000 winter seasons. NOAA Fisheries subsequently completed consultation on the full scope of the 1999 Agreement on November 18, 1999 (NMFS 1999b). Once the ESA and funding contingencies were satisfied, the 1999 Agreement was finalized by the governments and has since provided the basis for managing the affected fisheries in the United States and Canada.

Section 7 consultations covering southern U.S. fisheries also began in 1992 as a consequence of the initial ESA listings. These consultations have focused, in particular, on fisheries off the coast of Washington, Oregon, and California managed by the Pacific Fishery Management Council, as well as fisheries in the Columbia River Basin and Puget Sound. During these consultations and those on the SEAK fishery prior to the 1999 Agreement, NOAA Fisheries generally tried to anticipate the effect of Canadian fisheries on the species status. But absent an agreement with Canada that set forth specific fishing provisions, Canadian fisheries were not in the baseline or part of a proposed action. The consultation on the 1999 Agreement was therefore the first time that NOAA Fisheries was able to consult directly on a proposed fishery management regime that involved specific harvest provisions for both U.S. and Canadian fisheries. The proposed actions considered in the opinion included a Federal action related to the implementation of the SEAK fishery (i.e., decision by NOAA Fisheries to approve the NPFMC's deferral to ADFG management of the SEAK fisheries in the U.S. EEZ consistent with the PST) and approval by the U.S. Secretary of State, on behalf of the United States, of the fishing regimes in the 1999 Agreement (NMFS 1999b).

The biological opinion on the 1999 Agreement focused primarily on the effects of fisheries in SEAK and Canada ("northern fisheries") on four Chinook evolutionarily significant units (ESUs) and Hood Canal summer chum that were subject to the highest levels of take. The four Chinook ESUs included Snake River fall Chinook, Lower Columbia River Chinook, Upper Willamette Chinook, and Puget Sound Chinook. Other listed salmon and steelhead were subject to relatively little take in the northern fisheries. However, impacts to these other species were considered in the opinion in sufficient detail to make the necessary conclusions. NOAA Fisheries concluded in the biological opinion that the proposed actions were not likely to jeopardize the continued existence of any of the listed species. Critical habitat for the listed species either had not been designated at the time, or was designated but did not include marine fishing areas that were the subject of the 1999 Agreement. As a result, NOAA Fisheries also concluded that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species (NMFS 1999b).

The Southern Resident killer whale distinct population segment (DPS) was listed as endangered under the ESA in 2006. Critical habitat was also designated in 2006. Following the listing, NOAA Fisheries conducted annual consultations to evaluate effects of southern U.S. fisheries off the coast of Washington, Oregon, and California managed by the Pacific Fishery Management Council (2006-2007, 2007-2008 and 2008-2009) and the U.S. Fraser Panel fisheries (2007 and 2008) on the Southern Resident killer whale DPS. NOAA Fisheries also consulted on the effects of Columbia River fisheries on Southern Residents as part of the 2008 *U.S. v. Oregon* Agreement (2008-2017). Effects of Puget Sound fisheries on Southern Residents will be evaluated by NOAA Fisheries when consultation is re-initiated on the Puget Sound Harvest Management Plan in 2010 (current ESA Section 4(d) approval for salmon extends through April 30, 2010). Effects of northern U.S. and Canadian fisheries, and general obligations of southern U.S. fisheries under the PST agreement on Southern Residents, will be evaluated by NOAA Fisheries as part of the current consultation on the PST agreement. Because the proposed 2008 Agreement affects fisheries in SEAK, British Columbia, and the Pacific Northwest, this consultation provides the first opportunity to consider, through section 7 consultation, the effects of harvest on Southern Resident killer whales over a broad geographic range and for a period of ten years.

We note here that the scope of the consultation in this opinion differs somewhat from that of the biological opinion on the 1999 Agreement (NMFS 1999b). In the 1999 opinion the action area was limited to the SEAK and Canadian fisheries - the so called northern fisheries. In this opinion on the 2008 Agreement the action area includes the northern fisheries, as well as all marine and freshwater areas in the southern U.S. subject to provisions of the PST. (See section 4 for a more detailed description of the action area.) Reasons for defining the action area in 1999 as we did are discussed in the 1999 opinion. The PST Agreement both then and now defines upper limits of impact on specified stock groups for the southern fisheries, but does not specify how those impacts will be distributed each year across fisheries in the south, or take account of the numerous other conservation and allocation constraints that generally apply to these fisheries. In 1999 more specific management plans for the fisheries in the south were still being developed with the understanding that they would be subject to subsequent consultation at the appropriate time. Now ten years later fishery plans and associated consultations in the south are largely complete and are thus part of the baseline, at least with respect to their effect on salmon. In this consultation on the 2008 Agreement we are also consulting on the effects of the actions on Southern Resident killer whales which were not listed in 1999. As discussed above, this provides the first opportunity to consider the effects of fishing on killer whales over the broad geographic area that is subject to provisions of the PST. Because of these changed circumstances this consultation on the 2008 Agreement is more comprehensive and inclusive than the 1999 biological opinion.

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3 ▪ Proposed Actions

Two proposed Federal actions are considered in this opinion. The first involves the formal approval by the Secretary of State, on behalf of the United States, of the new fishing regimes (i.e., amended Chapters 1, 2, 3, 5, and 6 of Annex IV of the Treaty[1]) that have been recommended by the PSC (Koenings and Sprout 2008). The Pacific Salmon Treaty Act of 1985 (PSTA; 16 USC 3631, et seq.), the U.S. Federal law governing implementation of the Treaty, assigns this authority to the Secretary of State in consultation with the Secretaries of Commerce and Interior. Approval of the 2008 Agreement will obligate U.S. domestic management entities to manage fisheries under their respective jurisdictions in a manner consistent with the provisions of the new regimes for their duration unless otherwise modified by a new agreement between the United States and Canada. Consistency with the new regimes means that both countries will regulate their domestic fisheries so as not to exceed the catch or mortality levels specified in the regimes. Note that the State Department's approval of the agreement does not by itself result in the issuance of any regulations nor directly authorize any fishing. The State Department's approval nonetheless provides a framework for analyzing the effects on ESA listed species of west coast salmon fisheries that are subject to the Agreement. It is also important to note that there is no provision in the Pacific Salmon Treaty, including the proposed agreement that *requires* harvest to occur at a particular level; either Party may harvest at levels less than the upper limits allowed in the regimes. This point is particularly relevant because some U.S. fisheries, particularly the southern area fisheries, are routinely constrained by U.S. domestic regulations and plans to a greater degree than required by the bilateral agreement due, for example, to more stringent ESU-specific constraints necessitated by the ESA.

The proposed regimes will apply from 2009 through 2018, subject only to certain "off-ramp" provisions in the first few years relating to funding contingencies (explained below). Because the fishing regimes also set the terms applicable to Canadian fisheries in Canadian waters that affect salmon originating in the United States, approval of the new regimes by the United States amounts essentially to approval of Canadian fishing impacts up to the levels allowed in the regimes for the duration of the agreement. Unlike U.S. fisheries, Canadian fisheries are beyond the scope of the ESA and cannot be subjected to re-initiation of consultations under the ESA (50 CFR §402.16) should future circumstances so warrant. Thus, approval of the Canadian fishery levels in the new regimes cannot be revisited except as may otherwise be voluntarily agreed to by Canada. For these reasons, U.S. Federal participants in the PSC negotiations disclosed to all participants in the Commission negotiations that the United States would not approve the agreement until NOAA Fisheries had made a determination that the proposed agreement

[1] Chapter 4 of Annex IV covers the Fraser River Sockeye and Pink Salmon fishery. Because the current provisions of Chapter 4 do not expire until the end of 2010, the PSC has not recommended changes to Chapter 4 at this time.

satisfies the legal requirements of the ESA, i.e., its implementation is not likely to jeopardize the continued existence of ESA-listed species or adversely modify designated critical habitat. The Department of State, on behalf of the Secretary, subsequently confirmed their understanding and intention that NOAA Fisheries would conduct the necessary ESA consultation with the intention that the biological opinion be completed prior to the end of 2008 (Balton 2008). Because the United States does not have legal jurisdiction over Canadian fisheries, the analysis of the proposed agreement necessarily would assume that Canadian fisheries would fully harvest the amounts allowed by the agreement for the duration of the agreement.

The second proposed Federal action considered in this biological opinion is the decision by NOAA Fisheries to approve the North Pacific Fishery Management Council (NPFMC) decision to continue to defer its management authority over salmon fisheries in southeast Alaska to the State of Alaska. With NOAA Fisheries' approval, the NPFMC has conditionally deferred regulation and management of Alaska salmon fisheries in the Exclusive Economic Zone (EEZ) off the coast of Alaska to the State of Alaska under the April 1990 Fishery Management Plan For The Salmon Fisheries In The EEZ Off The Coast Of Alaska (FMP) (NPFMC 1990). NOAA Fisheries Alaska Regional Administrator oversees state management to ensure consistency with the Salmon FMP, the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the PST, ESA, and other applicable laws. Thus, state management regulations, limited entry licensing programs, reporting requirements, and other management-related actions, are applied to the EEZ unless the NOAA Fisheries Alaska Regional Administrator determines that he must issue a specific regulation for the salmon fisheries in the EEZ to ensure compliance with applicable Federal laws. In addition, NOAA Fisheries reserves the right to specify management measures applicable to the EEZ that differ from those of the state if it is deemed that state actions are inconsistent with the FMP or other applicable laws.

Because state regulations governing salmon management do not differentiate between EEZ and state waters, the NPFMC review will apply to salmon fisheries in the EEZ and in state waters within three miles of jurisdictional boundaries. Under its obligation to coordinate management, NOAA Fisheries approval of the NPFMC decision to continue to defer management will necessarily evaluate the EEZ and state water fisheries. It is this decision to approve deferral that triggers consultation with NOAA Fisheries to ensure that the NPFMC's action does not jeopardize the continued existence of species listed under the ESA. The State of Alaska has committed to manage the SEAK fisheries in conformity with the PST, particularly including the proposed new Chinook agreement, for the duration of the agreement (Bedford 2008). Based on this commitment, NOAA Fisheries affirmed their intent to approve the continuing deferral of their management authority to the State of Alaska (Mecum 2008).

It is important to appreciate the jurisdictional context within which the proposed Chinook regime considered in this opinion was negotiated, because this context helps explain the complex mosaic of ESA consultations that result. On one level, the PSC negotiations must consider and resolve the allocation of the allowable harvest of healthier stocks between two sovereigns – the United States and Canada – who are the formal Parties to the Treaty. Accordingly, the PSC negotiations focus on provisions governing intercepting fisheries, defined as the fisheries of one country that harvest fish originating in the other country. At this level, Canada directs most of its attention relating to Chinook salmon at Alaska's AABM fishery, which harvests a complex mixture of healthy and depressed Canadian as well as southern U.S.-origin Chinook stocks. The southern U.S. parties focus on both Alaskan and Canadian AABM fisheries, which together harvest a substantial portion of many southern-origin Chinook stocks, some of which are healthy and some that are depressed and/or ESA-listed. The Alaskan fishery has relatively little direct impact on most ESA-listed Chinook ESUs compared to the Canadian fisheries, but does exert a substantial impact on Canadian stocks, some of which Canada asserts to be in a depressed status. The Alaskan fishery also has a substantial impact on several healthy, unlisted southern U.S.-origin Chinook stocks, and thus sharing of the available harvest between Alaska on the one hand, and the southern states and tribes on the other, is the relevant but problematic issue. Pursuant to a Federal court order and stipulation entered into by the treaty Indian tribes, the United States and the States of Washington, Oregon and Alaska, the U.S. north-south allocation of Chinook harvest must be resolved (negotiated) within the PSC process (*Confederated Tribes and Bands of the Yakima Indian Nation v. Baldridge*, 605 F. Supp 833 (W.D. Wash. 1985).

In general, then, the negotiating dynamics are as follows: the southern states and tribes seek to limit Alaska's fishery primarily to meet north-south allocation objectives, and to limit Canada's fisheries to meet conservation objectives and U.S.-Canadian sharing objectives. Canada seeks to limit Alaska's fishery to meet Canadian allocation and conservation objectives, and to mitigate for limits on Canadian fisheries sought by the southern U.S. parties. Alaska seeks to receive a fair share of the harvest of healthy stocks present in its fisheries and to ensure that other jurisdictions do their part to maintain the stocks at healthy levels and/or to rebuild depressed stocks.

Because of the above considerations and circumstances, the PSC negotiations focus intensely on what the appropriate limits are for Alaska's AABM fishery. At the same time, the negotiations consider the relative distribution of the conservation burden and allocation of allowable harvest between the U.S. (Alaskan) and Canadian AABM fisheries and the multitude of relatively-more-terminal ISBM fisheries in Canada and the southern U.S. waters. This is the classic mixed-stock versus terminal area tension that typifies and always complicates management of Pacific salmon, especially Chinook salmon. Resolving these tensions is a primary objective of the PSC negotiations; their resolution is manifest in the proposed PSC-negotiated Chinook regime. What is particularly pertinent here is the understanding by all that Alaska will manage its AABM fishery pursuant to the applicable provisions of the Chinook regime, i.e., it is clear to all participants the Alaska intends to fully harvest the number of Chinook salmon provided each year by the abundance-based regime in the agreement. Thus, for the purpose of this biological opinion, it is assumed that Alaska will manage its fishery consistent with the agreement and will annually harvest its full amount as provided therein.

Just as it is important to understand what the negotiations seek to accomplish, it is important to understand what they do *not* seek to accomplish. The PSC focuses on resolving the tensions between U.S. and Canadian fisheries, between U.S. (Alaskan) and Canadian AABM fisheries, and between AABM and ISBM fisheries, as described above. The PSC does not attempt to develop or negotiate ESA standards, or to define fishery or stock-specific limits to meet such standards. The U.S. Federal representatives involved in the PSC negotiations routinely reminded all U.S. participants that additional stock and/or ESU specific ESA constraints will continue to be required and will be applied to U.S. ISBM fisheries through U.S. domestic management forums.

For the purpose of analyzing and contrasting the relative effects of various levels of fishery constraints, this biological opinion defines and analyzes several different fishery scenarios. One scenario will consider the effects on listed species under the assumption that southern U.S. fisheries would be managed subject only to the constraints contained in the agreement; another scenario will incorporate the more realistic assumption that southern fisheries will continue to be subject to additional ESA constraints established by NOAA Fisheries and/ or developed by southern state and tribal managers and approved by NOAA Fisheries, as has occurred for several years.

Both proposed Federal actions considered in this opinion – the approval of the 2008 Agreement by the Secretary of State and the deferral of management authority over fisheries in the EEZ in Southeast Alaska – lead to the same place: the need to analyze the substantive effects on listed species of the provisions contained in the new fishing regimes recommended by the Commission. This opinion, therefore, considers the combined impacts on listed species of the Canadian and United States fisheries when managed in accordance with the terms of the agreement recommended by the Commission and other applicable U.S. regulations, with particular emphasis on Annex IV, Chapter 3, the Chinook salmon regime.

Another notable premise of this analysis is as follows: the 2008 Agreement will be analyzed based on the assumption that the funding contingencies affecting the Chinook chapter will be satisfied and the regime fully implemented, i.e., that the reductions in allowable catch that are central to the new regime will in fact occur beginning in 2009 and continue for the duration of the new Chinook regime. Although a degree of uncertainty exists as to whether Congress or the Canadian government will provide the funding called for in the new Chinook chapter in a timely manner, the agreement itself addresses this uncertainty with “off-ramps” from the agreement. In the event the required funding is not forthcoming, the agreement would be suspended unless otherwise agreed by the Parties; an eventuality that presumably would require the Parties and/or the Commission to develop an alternative agreement.

As noted previously, this opinion will focus mostly on the Chinook provisions contained in Chapter 3 of the proposed agreement because that chapter encompasses fisheries with the greatest impact on the largest number of listed species. However, the other four chapters of the proposed agreement will be described here and a perspective provided on their relevance to listed species.

Chapter 1 of Annex IV covers fisheries in the Transboundary Rivers, those rivers that flow from Canada to the ocean passing through the Alaskan panhandle, and associated terminal areas. The substantive provisions of this chapter focus entirely on the management of sockeye, coho and Chinook salmon originating in those rivers, none of which are ESA listed. There is no evidence that any listed salmon from the Pacific Northwest are caught in those fisheries; to the extent it may occur, it likely would be a rare event. Additionally, the rivers and stocks addressed in this chapter are outside the range of Southern Resident Killer whales and are unlikely to affect the prey supply available to those whales. Thus, fisheries covered by the Transboundary Rivers Chapter are not further discussed in this opinion.

Chapter 2 of Annex IV covers certain sockeye, pink, coho and chum salmon fisheries near the marine border areas of Northern British Columbia and Southeastern Alaska. These fisheries are directed at stocks originating in nearby rivers such as the Nass and Skeena, and many smaller streams tributary to these marine areas. None of the fisheries managed pursuant to this chapter are directed at stocks listed under the ESA. While it is conceivable that listed Chinook or chum salmon from the Pacific Northwest are occasionally caught incidental to these fisheries, there is no direct evidence that they are caught and it is likely that such incidental catches to the degree that they do occur would be a rare event and/or of insignificant magnitude. Furthermore, any out-of-area Chinook caught in such fisheries, including listed Chinook would be accounted for and covered under the provisions of Chapter 3 covering Chinook salmon. The marine waters and stocks addressed in this chapter are largely to the north of the range of Southern Resident Killer whales and are unlikely to affect the prey supply available to those whales. Thus, fisheries covered by Chapter 2, the Northern British Columbia and Southeastern Alaska Chapter, are not further discussed in this opinion.

As noted above, Chapter 3, the Chinook chapter, will be considered in detail in this opinion due to its impact on listed Chinook salmon and its effect on prey availability for Southern Resident killer whales.

Chapter 4, relating to Fraser Sockeye and Pink Salmon, is not a part of the new agreement because the existing regime does not expire until after 2010. Nevertheless, the harvest of listed species taken incidentally in the fisheries directed at Fraser sockeye and pink salmon, particularly listed Chinook salmon are accounted for and will be considered in the analysis of the Chinook provisions of Chapter 3.

Chapter 5, the Coho Salmon chapter, contains a Southern Coho Management Plan with provisions that limit the impact of Canadian and U.S. fisheries on natural coho stocks originating in southern British Columbia, Puget Sound, and along the northern and central Washington coast (Chapter 5 also contains a reference to northern coho stocks, but no substantive fishery provisions; those are found in Chapter 2). The substantive provisions of the Southern Coho Management Plan limit the impact of U.S. and Canadian fisheries on the subject coho stocks – none of which are listed under the ESA – to specified exploitation rate limits that vary as a function of the annual status forecast of those runs. The Canadian fisheries covered by the provisions in Chapter 5 do affect some of the listed coho ESUs (evolutionary significant unit), although the exploitation rates range from zero to fractions of one percent. The potential effects of Canadian coho fisheries are considered in the appropriate sections below. The potential effects on listed species of the U.S. fisheries covered by the provisions of Chapter 5 also will be considered further in the appropriate sections, below, but also will be addressed in subsequent biological opinions that consider other Federal actions, such as approval of U.S. ocean fisheries managed by the Pacific Fishery Management Council, or fisheries managed by the state and tribal co-managers in Puget Sound pursuant to section 4(d) of the ESA.

Chapter 6 covers Southern British Columbia and Washington State Chum Salmon. Most of the fishery provisions focus on the U.S. chum fishery in northern Puget Sound and the Canadian chum fisheries in Georgia Strait and the Fraser River terminal areas, all of which are directed primarily at the sustainable harvest of chum salmon returning to the Fraser River. There are, however, provisions that require the live release of chum salmon in certain Canadian and U.S. fisheries at times when listed Hood Canal summer chum are likely to be present. Other provisions are designed to prevent the growth in interceptions of chum salmon, and to improve the scientific basis of chum salmon management. The potential effects of Canadian chum fisheries on other listed species, including Southern Resident killer whales, which are known to prey on chum salmon at certain times of the year, will be considered further in the appropriate sections below. The potential effects on listed species of the U.S. fisheries covered by the provisions of Chapter 6 also will be considered further in the appropriate sections, below, as well as in subsequent biological opinions that consider other Federal actions, such as approval of fisheries managed by the state and tribal co-managers in Puget Sound pursuant to section 4(d) of the ESA.

Chapter 3 of the agreement is by far the most complex of the several regimes included in the proposed new agreement. It is also the regime with the greatest impact on the largest number of listed salmon species. Additionally, Chinook salmon are the preferred prey of listed Southern Resident killer whales. Thus, much of the focus of this opinion will be on the effects of the Chinook regime.

Some background information related to the biology of Chinook salmon, management of Chinook fisheries under the PST, and a description of the proposed 2009-2018 management regime proposed in the new agreement follows:

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. (NCBC) and SEAK. Other stocks migrate in a less distant but still significantly northerly direction, while still others remain in local waters or range to the south of their natal streams. While there is great diversity in the range and migratory habits among different stock groups of Chinook salmon, there also is a remarkable consistency in the migratory habits within stock groups, which greatly facilitates stock-specific fishery planning. 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.

Chinook salmon are taken in directed commercial fisheries using both troll and net gear. The majority of the harvest in SEAK, NCBC, and off the West Coast of Vancouver Island (WCVI) is taken with commercial troll gear. Net gear is the primary gear in terminal areas, i.e., near enhancement facilities, river mouths, and in rivers. Most of the Chinook harvested by net fisheries in marine areas and outside terminal harvest areas are taken incidentally, i.e., in fisheries directed at other salmon species. Sport fisheries operate in most marine areas and in many freshwater areas. Subsistence and ceremonial harvests with nets occur mainly in larger rivers.

Their extended migrations, vulnerability to fisheries at multiple age classes, and the extreme mixed stock nature of many Chinook fisheries greatly complicate 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 were poorly understood. This changed with the advent of the coded wire tag (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 contained in the 1985 Pacific Salmon Treaty. Those ceilings comprised the cornerstone of the Chinook rebuilding program established in the original Chinook chapter of the Treaty.

The 1985 Chinook rebuilding program relied on the establishment of harvest ceilings for major ocean Chinook fisheries for the SEAK, NCBC, WCVI and Strait of Georgia fisheries. These ceilings were fixed, i.e., they were not varied from year to year to reflect changes in abundance. Besides immediately reducing the catch, the ceilings were intended to reduce Chinook exploitation rates over time. The bulk of fish saved in the ocean fisheries was to be passed through subsequent fisheries to the spawning escapement. The production increases expected to result from the increased escapements, in combination with the fixed ceilings, would further reduce harvest rates over time, resulting in the completion of the rebuilding program by 1998. During the initial years of the Treaty, survival conditions for Chinook salmon were favorable and improved returns for many stocks made it appear that the ceiling approach was working. However, during the 1990s, several years of drought in the Pacific Northwest and poor survival conditions in the ocean, in combination with the accumulating effects of chronic habitat degradation reversed the initial rebuilding progress. Chinook survival was so poor and some stocks declined so precipitously, that the ocean harvest ceilings no longer served as an effective constraint on harvest rates, and in some cases the ceilings could not be fully harvested. Additionally, the ceiling levels became viewed by some as catch entitlements; management plans adopted by affected jurisdictions were designed to fully harvest up to the ceiling levels, and thus actually resulted in increased harvest rates just when survival conditions were least favorable for many stocks. After 1992, the PST Chinook ceilings expired. Despite several attempts, the Commission failed to reach agreement on a new Chinook management regime, so each country managed its annual Chinook harvest unilaterally. This continued through the 1998 fishing season.

Finally, in the late spring of 1999, government-to-government negotiations successfully produced a comprehensive new agreement, one that included amended versions to all six of the fishing regime chapters of Annex IV. The 1999 Agreement replaced the previous fixed ceiling-based Chinook regime with a new approach based on the annual abundance of Chinook salmon available to those fisheries. Dependent as it is on estimates of the annual abundance of a large number of stocks of varying status and taking into account the effects of many different fisheries over a large geographical area, the abundance-based approach is considerably more complex than the original ceiling-based Chinook management regime. It included much greater specificity as to how all fisheries – ocean, terminal, direct and indirect – affecting Chinook would be managed, and contained specific provisions designed to address the conservation requirements of a much larger number of depressed stocks, including some that had been listed under the ESA.

Since the original treaty was signed in 1985, there has been a vast improvement in the quantity and quality of technical and scientific information available to inform management of the fisheries. For Chinook salmon, an extensive data base of coded wire tagging information has been accumulated, which in turn has allowed the development of increasingly complex and sophisticated computer models for planning and managing fisheries affecting a large number of stocks. New models that employ data made possible by advances in Genetic Stock Identification (GSI) methods have become increasingly available and important for management of mixed stock fisheries. Both CWT and GSI based models were used extensively to facilitate the negotiation of the fishing regimes included in the new PSC agreement; they will also be key to its implementation.

As noted above, the new proposed Chinook chapter continues the abundance based Chinook management approach developed in the 1999 Agreement, but modifies several provisions. It also reduces the allowable catch in two of the major ocean fisheries. The proposed Chinook regime would be in effect from 2009 through 2018. As before, the fisheries are classified into two categories, aggregate abundance-based management (AABM) fisheries and individual stock-based management (ISBM) fisheries. An AABM fishery is an abundance-based regime that constrains catch or total adult equivalent mortality to a numerical limit computed from either a pre-season forecast or an in-season estimate of abundance, from which a harvest rate index can be calculated, expressed as a proportion of the 1979-1982 base period. This particular base period is commonly used as a reference period in the context of Chinook management under the Treaty; it represents a period of time prior to the Treaty when ocean fisheries directed at Chinook salmon in both Canadian and U.S. waters were far more extensive and had relatively fewer constraints compared to recent years. Thus, the resulting pattern of CWT recoveries during that period provide a good snapshot representation of the migratory patterns of Chinook stocks and the distribution of exploitation rates among the ocean fisheries at a time when the ocean fisheries were relatively unfettered by regulations that typify more contemporary active management. The Chinook model that is used by the CTC and relied upon to plan, implement and analyze Chinook fisheries typically expresses fishery metrics such as exploitation rates and abundances in the form of indices relative to that time period. For example, an abundance index of 1.5 for a particular AABM fishery means that the abundance of Chinook present in that fishery is 1.5 times the average of what it was during the 1979-1982 base period. Similarly, a harvest rate index of 0.85 means that the harvest rate of that fishery is 85% of that which occurred during the base period.

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK sport, net and troll fisheries; 2) the Northern British Columbia (NBC) troll (Canada's Pacific Fishery Management Areas 1-2, 101-105 and 142) and the Queen Charlotte Islands (QCI) sport (Canada's Pacific Fishery Management Areas 1-2, 101, 102 and 142) and 3) the WCVI troll and outside sport (Canada's Pacific Fishery Management Areas 21, 23-27, 121, 123-127 but with additional time and area specifications which distinguish WCVI outside sport from inside sport). The abundance index is calculated each year by the PSC's Chinook Technical Committee (CTC) for each AABM fishery, using the CTC's Chinook model. Table 1 of the Chinook chapter specifies the allowable maximum catch for each AABM fishery associated with the abundance index estimated for any given year (Koenings and Sprout 2008). All Chinook fisheries subject to the Treaty that are not AABM fisheries are classified as ISBM fisheries, including freshwater

Chinook fisheries.[2] An ISBM fishery is a regime that constrains to a numerical limit the total catch or total adult equivalent mortality rate within the fisheries of a jurisdiction for a naturally spawning Chinook stock or stock group. Because all fisheries that are not AABM fisheries are ISBM fisheries, this provision essentially results in accounting for all Chinook impacts, whether they are the result of directed fisheries or are only incidental to fisheries directed at other stocks. The 2008 Agreement specifies that Canada and the U.S. must limit the total adult equivalent mortality rate in the aggregate of their respective ISBM fisheries to no greater than 63.5% and 60% of that which occurred during the 1979-1982 base period for a specified list of escapement indicator stocks identified in Attachments IV and V to the agreement (Koenings and Sprout 2008). If such limits do not result in achieving PSC-agreed biologically-based escapement objectives for the specified natural-origin stocks, the Party in whose waters the stock originates must further constrain its fisheries to the extent necessary to achieve those agreed escapement objectives. However, the agreement establishes a limit to a Party's obligation to further constrain its fisheries; for the purpose of complying with the agreement, a Party need not limit its fisheries to an extent greater than the average of that which occurred in the years 1991-1996.

There are several points to be made that help clarify the rationale underlying the obligation as it is stated in the agreement. First, the ISBM limits are expressed in a mortality rate metric that is indexed to the 1979-1982 base period as opposed, for example, to expressing the limit as an absolute exploitation rate. Expressing the limits in this form requires some translation to determine the total absolute exploitation rate on particular stocks, but facilitates the negotiation of limits within the PSC process and facilitates implementation, evaluation and monitoring with the CTC's Chinook model. Second, the limits for the ISBM fisheries are established and monitored relative to a specific list of natural stock groups identified in Attachments IV-V of the agreement. The stock groups appearing on these lists are those that are significantly affected by the particular ISBM fisheries, are thought to be broadly representative of natural stocks of similar life histories from a particular region, and have a sufficiently long time series of data to facilitate management and the monitoring of compliance with the commitments in the agreement. It is important to note that the purpose of those lists and the criteria used to place a stock group on the lists are different than what might be used, for example, by U.S. domestic managers for assessing the status of populations in a listed ESU.

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[2] ISBM fisheries include, but are not necessarily limited to: northern British Columbia marine net and coastal sport (excluding Queen Charlotte Islands), and freshwater sport and net; central British Columbia marine net, sport and troll and freshwater sport and net; southern British Columbia marine net, troll and sport and freshwater sport and net; West Coast of Vancouver Island inside marine sport and net and freshwater sport and net; south Puget Sound marine net and sport and freshwater sport and net; north Puget Sound marine net and sport and freshwater sport and net; Juan de Fuca marine net, troll and sport and freshwater sport and net; Washington Coastal marine net, troll and sport and freshwater sport and net; Washington Ocean marine troll and sport; Columbia River net and sport; Oregon marine net, sport and troll, and freshwater sport; Idaho (Snake River Basin) freshwater sport and net.

It is also important to note again that a Party may choose voluntarily to apply more constraints to its fisheries than are specifically mandated by the agreement. In fact, it was clearly understood throughout the negotiations that U.S. ISBM fisheries have been and would continue to be managed to meet the requirements of the ESA, and that these domestically-imposed limits apply to a much larger number of stocks and are more constraining than the limits in the proposed PSC agreement. As explained previously, the PSC negotiations seek to assign conservation obligations and harvest sharing among AABM fisheries versus ISBM fisheries, Canadian fisheries versus U.S. fisheries, and Alaskan fisheries versus southern U.S. fisheries; the bilateral negotiations do not attempt to develop the stock and fishery-specific constraints that are required by the ESA. Just as it was expected that the United States would further constrain its ISBM fisheries to meet ESA requirements, it was understood that Canada might choose to further constrain its AABM or ISBM fisheries, for example, to meet Canadian domestic allocation and/or conservation objectives for Canadian stocks. Those additional Canadian constraints, if applied to intercepting fisheries, might well benefit U.S. stocks, but because any additional Canadian constraints are voluntary, cannot be predicted, and thus cannot be counted on, the analysis contained in this opinion assumes that Canada will manage its AABM fisheries to harvest up to the limits specified in the agreement. We have assumed that Canadian ISBM fisheries will be constrained beyond the ISBM limits to levels observed in recent years in one scenario in the retrospective analysis. Although this involves some speculation, it is based on past practice, our understanding of Canadian management constraints, and what we can reasonably expect to occur in the future.

The proposed new Chinook chapter contains a number of changes relative to the regime it replaces. The most notable and immediate change is that it reduces the allowable annual catch in the SEAK and WCVI AABM fisheries by 15% and 30%, respectively, compared to the previous agreement.

In addition, the new agreement strengthens the commitment to transition from the current catch-based AABM limits to limits based on total mortality (catch + incidental mortalities), a modification that better and more comprehensively accounts for non-landed mortalities due to “drop-offs” and minimum size limits, a particularly consequential modification as mark selective and other forms of catch-and-release fisheries increase. The agreement specifies a specific schedule for the transition to total mortality management and assigns high priority to the specific technical tasks that must be completed to enable the transition.

Paragraph 13 of the proposed agreement specifies conditions under which additional harvest constraints will be applied to AABM and ISBM fisheries in the event that the standard regimes have not resulted in achieving the specified escapement objectives or, under certain conditions, if the standard regimes are projected to not meet specified escapement objectives based on forecasts of abundance. Another part of this paragraph provides that either Party may recommend, for conservation purposes, that the

Commission consider developing additional management actions in the event "extraordinary circumstances" so warrant. The intent of the various provisions of Paragraph 13 is to ensure that the basic conservation objectives of the regime are met even if unforeseen circumstances should emerge. While important, the efficacy of these safety net provisions will be difficult to gauge in advance, as they each depend on the outcome of procedural steps that remain untested. Changes to Annex provisions that may occur as a result of a review through Paragraph 13 would require agreement of the U.S. and Canada through the PSC.

4 ▪ Action Area

The action area includes all marine and freshwater fishing areas in SEAK, BC, and the Pacific Northwest subject to provisions of Annex IV of the PST (Figure 4.1). Fishing area in this context refers to all areas where stocks or stock groups designated in Attachments I through V of Chapter 3 Annex IV of the PST may be caught. For BC this includes in particular all marine and freshwater Chinook fishing areas located between the International Boundary in Dixon Entrance and the International Boundary separating BC from the State of Washington. For SEAK this includes in particular all marine and freshwater Chinook fishing areas, including waters of the EEZ, between the longitude of Cape Suckling (143 53' 36" W.) and the International Boundary in Dixon Entrance. In the southern United States the action area includes marine and freshwater fishing areas in the Strait of Juan de Fuca, Puget Sound, and the Washington and Oregon coast, and fishing areas in the Columbia River and Snake River basin in Idaho. Figure 4.2 shows management areas for PSC and PFMC ocean fisheries and various geographic subdivisions of each that are referenced throughout this opinion. Figure 4.2 reflects that fact that provisions of the PST affect areas to the south of the border with Canada. Figure 4.3 shows the fishing zones used for managing fisheries in the Columbia and Snake Rivers.

Figure 4-1. Marine and freshwater fishing areas in southeast Alaska, British Columbia, and the Pacific Northwest, subject to the provisions of Annex IV of the Pacific Salmon Treaty.

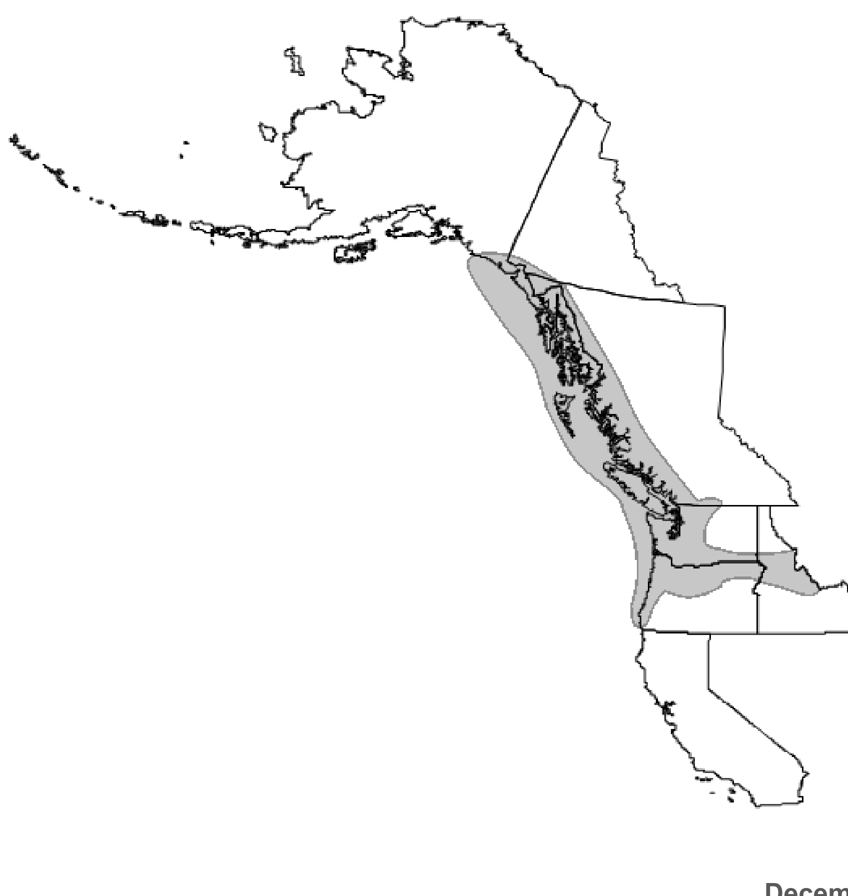


Figure 4-2. Areas managed subject to the jurisdiction of the PSC and PFMC and various geographic subdivisions of each that are referenced throughout this opinion.

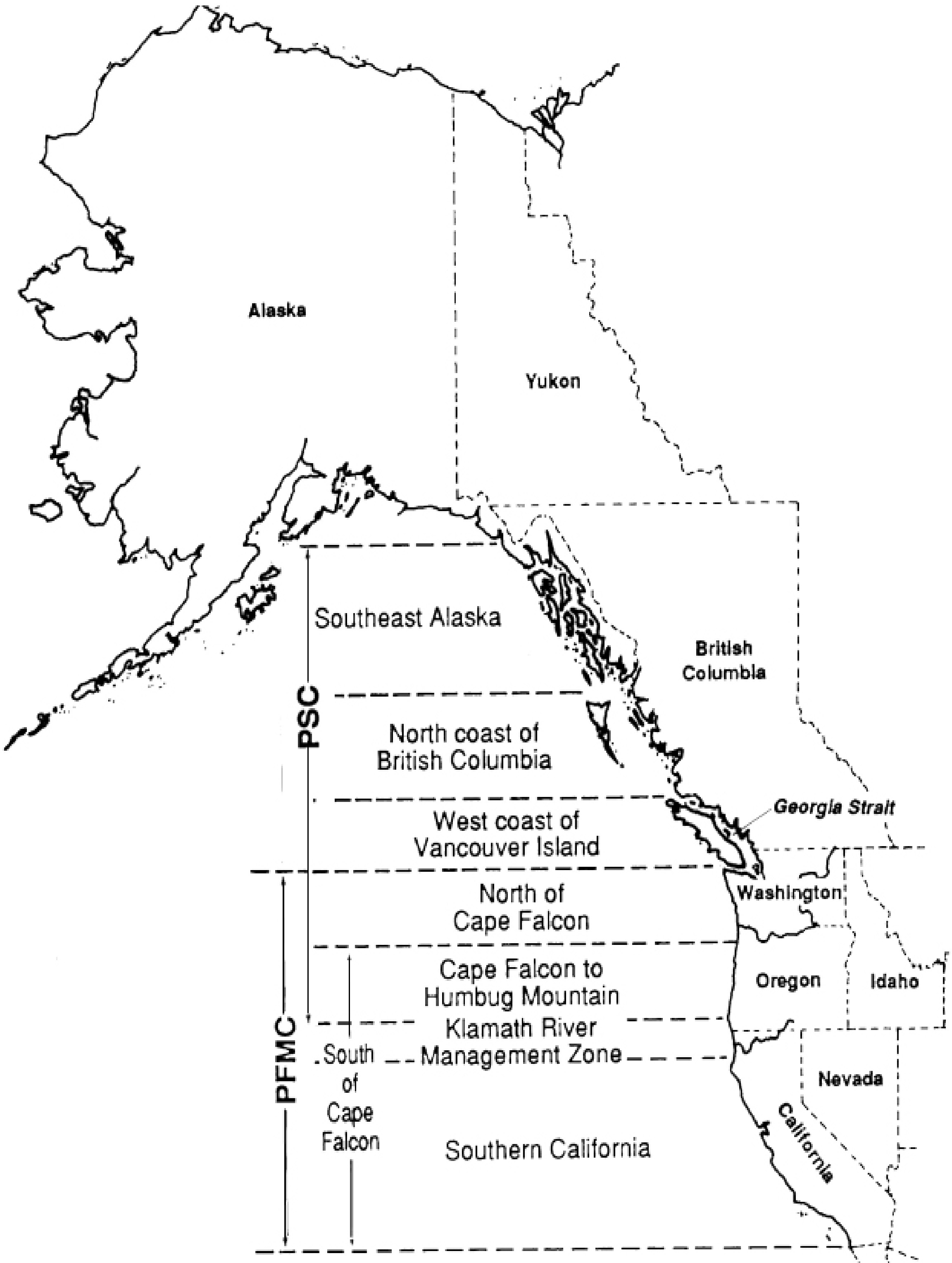
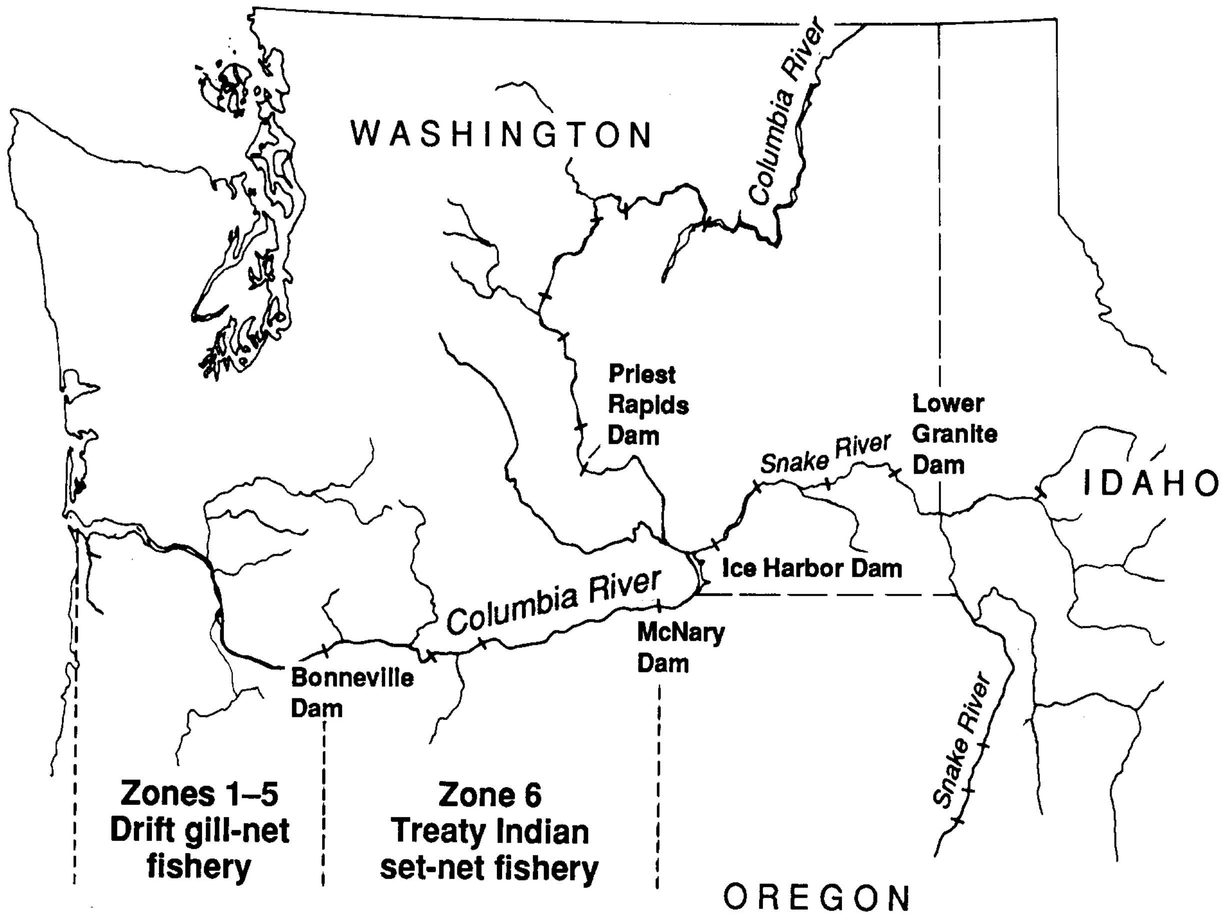


Figure 4-3. Fishing zones of the Columbia and Snake Rivers, subject to the *U.S. v. Oregon* Management Agreement.



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5 ▪ Status of the Species & Critical Habitat

There are 28 salmon and steelhead species that are listed currently as threatened or endangered under the ESA and that potentially are affected by the proposed actions. In this biological opinion we also consider the effects on Southern Resident killer whales, green sturgeon, and steller sea lions. Critical habitat has been designated for all of the species listed above except Lower Columbia River coho and Puget Sound steelhead. Critical habitat for green sturgeon was recently proposed for designation (Table 5-1).

In Chapter 7 below we discuss the effects of the proposed actions on the currently listed species shown in Table 5-1. It is apparent from that discussion that the expected take in the proposed ocean salmon fisheries in SEAK and BC of many of the species is either zero or at most an occasional event. The expected take of listed salmon in southern U.S. fisheries has been considered through prior consultation and is thus part of the environmental baseline. It is also apparent that the effects of the proposed actions on Southern DPS green sturgeon and steller sea lions are limited. The following discussion regarding the status of the species and the environmental baseline therefore focuses on those salmon species that are subject to significant harvest mortality in the proposed fisheries and Southern Resident killer whales. The discussion for salmon focuses on four Chinook species (Snake River fall Chinook, Puget Sound Chinook, Lower Columbia River Chinook, and Upper Willamette River Chinook) and Hood Canal Summer-Run chum. However, sufficient information regarding the other salmon Evolutionarily Significant Units (ESU) and Distinct Population Segments (DPS) [3] is provided in Chapter 7 of this opinion to support the necessary conclusions. In the case of Southern Resident killer whales, the discussion focuses on the effects of fisheries on available prey, as well as the effect of vessel operations within their range and critical habitat.

[3] The ESA defines a *species* to include any species, sub-species, or distinct population segment (ESA section (3)(15)). NOAA Fisheries defines distinct population segments as Evolutionarily Significant Units (ESUs) for listing Pacific salmon (and previously used the term ESU for West Coast steelhead as well) (Waples 1991). An ESU is a group of Pacific salmon that is (1) substantially reproductively isolated from other groups and (2) represents an important component of the evolutionary legacy of the species. Recently, NMFS revised its species determinations for West Coast steelhead under the ESA, delineating anadromous, steelhead-only "distinct population segments" (DPS). Rainbow trout, the resident form of *O. mykiss*, are under the jurisdiction of the U.S. Fish and Wildlife Service. The Federal Register notice (71 FR 834) contains a more complete explanation of the listing decision and of previous ESA actions related to steelhead. Each ESU or DPS is composed of a number of demographically independent populations. Independent populations are grouped into strata, or major population groups (MPGs), based on ecoregions and life history types. MPGs are thus groups of populations that share similar environments, life history characteristics, and geographic proximity (WLCTRT and ODFW 2006).

Table 5-1. Listing status and critical habitat designations for species considered in this opinion (Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered).

SPECIES	LISTING STATUS	CRITICAL HABITAT
Chinook salmon (*Oncorhynchus tshawytscha*)		
Puget Sound	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Upper Columbia River spring-run	E: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Snake River spring/summer run	T: 6/28/05 (NMFS 2005a)	10/25/99 (NMFS 1999c)
Snake River fall-run	T: 6/28/05 (NMFS 2005a)	12/28/93 (NMFS 1993b)
Upper Willamette River	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Lower Columbia River	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
California Coastal	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Central Valley spring-run	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Sacramento River winter-run	E: 6/28/05 (NMFS 2005a)	06/16/93 (NMFS 1993c)
Chum salmon (*O. keta*)		
Hood Canal Summer-Run	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Columbia River	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Coho salmon (*O. kisutch*)		
Lower Columbia River	T: 6/28/05 (NMFS 2005a)	Not yet designated
Oregon Coast	T: 2/11/08 (NMFS 2008a)	2/11/08 (NMFS 2008a)
S. Oregon/ N. California Coast	T: 6/28/05 (NMFS 2005a)	05/5/99 (NMFS 1999d)
Central California Coast	E: 6/28/05 (NMFS 2005a)	05/5/99 (NMFS 1999d)
Sockeye salmon (*O. nerka*)		
Ozette Lake	T: 6/28/05 (NMFS 2005a)	09/02/05 (NMFS 2005b)
Snake River	E: 6/28/05 (NMFS 2005a)	12/28/93 (NMFS 1993b)
Steelhead *(O. mykiss)*		
Puget Sound Steelhead	T: 5/11/07 (NMFS 2007a)	Not yet designated
Upper Columbia River	E: 6/18/2007 (NMFS 1997a)	09/02/05 (NMFS 2005b)
Snake River Basin	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Middle Columbia River	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Upper Willamette River	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Lower Columbia River	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Northern California	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
California Central Valley	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Central California Coast	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)

South-Central California Coast	T: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Southern California	E: 1/5/06 (NMFS 2006a)	09/02/05 (NMFS 2005b)
Green Sturgeon *(Acipenser medirostris)*		
Southern DPS of Green Sturgeon	T: 4/7/06 (NMFS 2006b)	09/08/08 (NMFS 2008b) Proposed
Killer Whales *(Orcinus orca)*		
Southern Resident DPS Killer Whales	E: 11/18/05 (NMFS 2005c)	11/29/06 (NMFS 2006c)
Steller Sea Lions (*Eumetopias jubatus)*		
Eastern DPS Steller Sea Lions	T: 11/26/90 (NMFS 1990)	09/27/93 (NMFS 1993d)

In the first step of its section 7 analyses, NOAA Fisheries defines the biological requirements and current status of each affected listed species and the conservation role and current function of any designated critical habitat. For salmon and steelhead species, this involves comparing the status of each ESU and its component populations and MPGs, or strata, to available viability criteria. Viability at the population scale is evaluated based on the viable salmonid population parameters of abundance, productivity, spatial structure, and diversity, which are used to assess population extinction risk (McElhany et al. 2000). At the MPG scale, viability is evaluated based on guidelines regarding how many and which populations should be at low risk for the MPG to be considered low risk. ESU or DPS viability is similarly evaluated based on guidelines that each MPG should be at low risk (WLCTRT and ODFW 2006.

In assessing status, NOAA Fisheries starts with the information used in its most recent decision to list for ESA protection the salmon and steelhead species considered in this opinion, and also considers more recent data, where applicable, that are relevant to the species' rangewide status. This step of the analysis tells NOAA Fisheries how well the species is doing over its entire range in terms of trends in abundance and productivity, spatial distribution, and diversity. It also identifies the potential causes of the species' decline.

The following sections describe the current status of the species (listing status, general life history, and population dynamics) in a manner relevant to each species' biological requirements. The nature and type of information available for each species is generally consistent, but does vary in detail. For each species we provide information on the current range wide status of the species, and range wide status of the critical habitat. Under species status, we first describe the population structure of the ESU and the strata or major population groups (MPG) where they occur. We discuss the limiting factors and threats, and then review available information on the VSP criteria including abundance, productivity and trends (information on trends supplements the assessment of abundance and productivity parameters), and spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of the populations and ESUs. Methods used to characterize risk vary between ESUs, and the information is often integrated with the overall assessment of VSP parameters.

5.1 Chinook Salmon

5.1.1 Snake River Fall Chinook

Because a recovery plan for Snake River fall Chinook has not been adopted yet, we are relying for the time being on viability goals recommended by the Interior Columbia Technical Review Team (ICTRT) for describing the current status of the ESU and their biological requirements.[4] Recommendations of the ICTRT regarding the current status of Snake River fall Chinook was recently summarized in biological opinions on the FCRPS (NMFS 2008c) and *U.S. v. Oregon* Management Agreement (NMFS 2008d), and the associated Supplemental Comprehensive Analysis (SCA) (NMFS 2008e). Information from the SCA is summarized here and updated with new information where appropriate.

NOAA Fisheries analyzed the status of species, and the effect of *Prospective Actions* on the listed species, in the SCA using a standard set of quantitative methods when the data were available, and more qualitative considerations when necessary (Prospective Actions is a term used in the SCA, and FCRPS and *U.S. v Oregon* biological opinions to refer to the collective set of actions considered in those opinions). The quantitative methods in particular are complex, but are explained in detail in Chapter 7 of the SCA (NMFS 2008e).

5.1.1.1 Current Rangewide Status of the Species

Snake River fall Chinook is a threatened species composed of one extant population in one MPG. Two historical populations have been extirpated. This population must be highly viable to achieve the ICTRT's suggested viability scenario (ICTRT 2007a, Attachment 2). Key statistics associated with the current status of Snake River fall Chinook salmon are summarized in Tables 5.1-1 through 5.1-4. These initially were developed for use in the SCA (NMFS 2008e).

Limiting Factors and Threats

The key limiting factors and threats for Snake River fall Chinook include hydropower projects, predation, harvest, degraded estuary habitat, and degraded mainstem and tributary habitat. Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of Snake River fall Chinook were generally poor during the early part of the last 20 years.

[4] ICTRT products were developed as primary sources of information for the development of delisting or long-term recovery goals. There were not intended as the basis for setting goals for "no jeopardy" determinations.

Abundance, Productivity, and Trend

The return of natural origin Snake River fall Chinook over Lower Granite Dam averaged 2,358 over the last ten years (through 2007). The average over the last five years is 2,788 reflecting the greater increase in abundance observed in recent years (Figure 5.1-1). This compares to an average abundance threshold of 3,000 natural spawners that the ICTRT identifies as a minimum for low risk. The ICTRT recommends that no fewer than 2,500 of the 3,000 natural-origin fish be mainstem Snake River spawners. There has also been a substantial and increasing number of returning hatchery fish. The total return of Snake River fall Chinook past Lower Granite Dam averaged 7,905 over the last ten years and 10,758 over the last five (Figure 5.1-2). The return of Snake River fall Chinook in 2008 is not yet complete, but it is already apparent that it will be the highest return on record. Current projections are for a return of at least 20,000 fish (IDFG 2008).

The return of fall Chinook over Lower Granite Dam increased steadily from the mid-1990s to the present. Natural-origin returns increased at roughly the same rate as hatchery origin returns (through run year 2000). Since then hatchery returns have increased disproportionately to natural-origin returns (Figure 5.1-2). The median proportion of natural-origin has been approximately 32% over the past two brood cycles (Cooney and Ford 2007).

Figure 5.1-1. The return of natural-origin Snake River fall Chinook salmon past Lower Granite Dam.

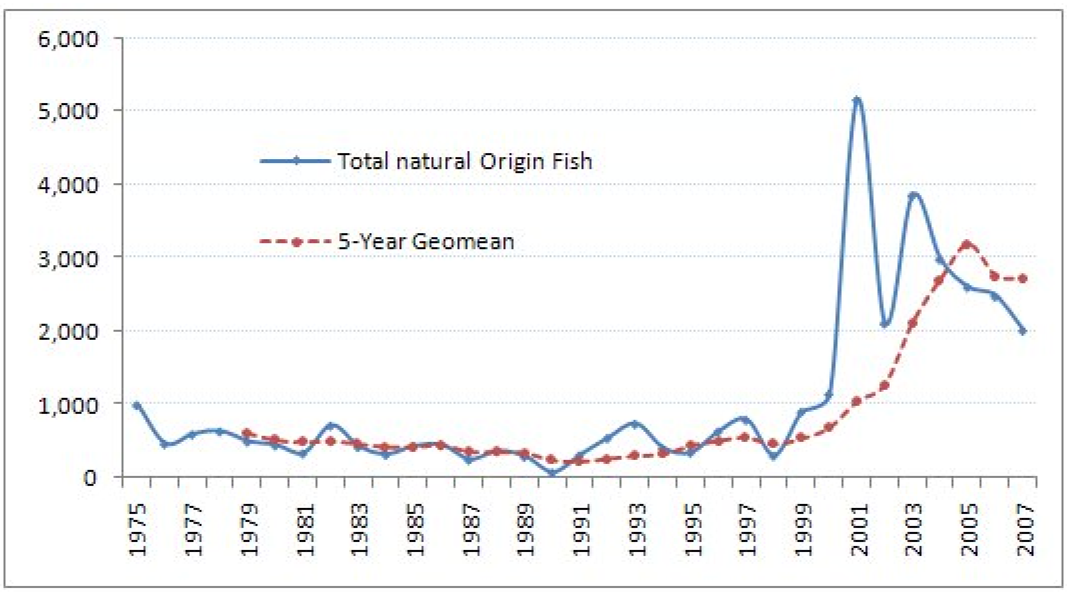
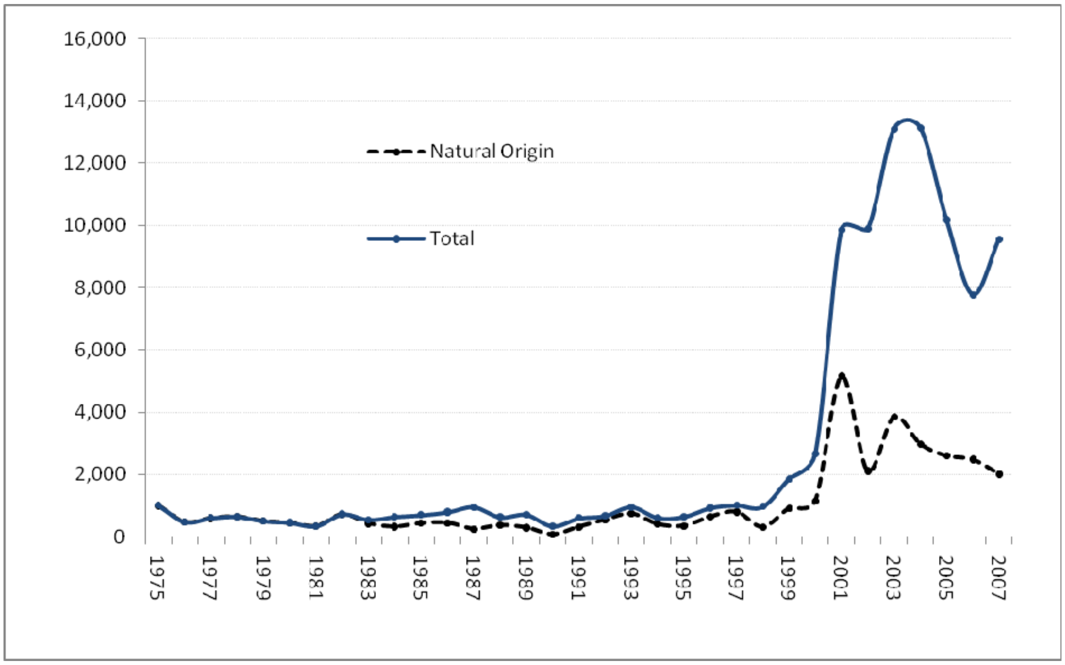


Figure 5.1-2. The return of natural-origin and hatchery-origin Snake River fall Chinook salmon past Lower Granite Dam.



The driving factors for the recent increase in abundance may include reduced harvest rates, improved in-river rearing and migration conditions, the development of life history adaptations to current conditions, improved ocean conditions benefiting the relatively northern migration pattern, the supplementation program, or other factors. At this time, there is insufficient information to estimate the relative contributions of these factors (Cooney and Ford 2007).

On average over the last 23 full brood year returns (1977-1999 brood years [BY], including adult returns through 2004), when only natural-origin production is considered, SR fall Chinook populations have not replaced themselves (i.e., average R/S has been less than 1.0; Table 5.1-1). R/S productivity was below 1.0 for all but three brood years prior to 1995, and it was above 1.0 between 1995 and 1999 (Cooney and Ford 2007). Additionally, Cooney and Ford (2007) make preliminary estimates for the 2000-2003 brood years, half of which also indicate R/S>1.0.

Intrinsic productivity, which is the average of adjusted R/S estimates for only those brood years with the lowest spawner abundance levels, has been lower than the intrinsic productivity R/S levels identified by the ICTRT as necessary for long-term population viability at <5% extinction risk (ICTRT 2007b).

The BRT trend in abundance was >1.0 during the 1980-2004 period (Table 5.1-1). Median population growth rate (lambda), when calculated with an assumption that hatchery-origin natural spawners do not reproduce effectively (HF=0), also was greater than 1.0 (increasing) for SR fall Chinook (Table 5.1-1). When calculated with the HF=1 assumption, lambda has been less than 1.0.

Spatial Structure and Diversity

The ICTRT does not yet characterize the spatial structure risk to Snake River fall Chinook, although generic spatial structure criteria have been described in ICTRT (2007c). However, the Biological Review Team (Good et al. 2005) characterizes the risk for the "distribution" VSP factor as "moderately high" (Table 5.1-2) because approximately 85% of historical habitat is inaccessible and the distribution of the extant population makes it relatively vulnerable to variable environmental conditions and large disturbances.

The ICTRT has not yet characterized the diversity risk to Snake River fall Chinook, although generic diversity criteria and the presence of five major spawning areas within currently occupied habitat are described in ICTRT (2007c). However, the Biological Review Team (Good et al. 2005) characterizes the risk for the diversity VSP factor as "moderately high" (Table 5.1-2) because of the loss of diversity associated with extinct populations and the significant hatchery influence on the extant population. The median proportion of hatchery-origin fish has been approximately 68% over the past two brood cycles.

Based on NOAA Fisheries' SHIEER document (NMFS 2004b), the hatchery and harvest workgroup (under the Policy Work Group), "Hatchery Effects Report," and Cooney and Ford (2007), there are four primary reasons why the current supplementation program contributes to a diversity risk for Snake River fall Chinook: 1) In order to meet the ICTRT's (2007a) diversity viability goals, the proportion of hatchery fish spawning naturally must be significantly reduced from current levels; 2) In the current configuration of the program, all components of the ESU are supplemented, limiting the options for evaluating the programs; 3) In the mainstem Snake River major spawning areas, the ESU may be at or near carrying capacity, suggesting the further supplementation is unlikely to be beneficial to the ESU; and 4) The proportion of natural origin fish in the broodstock has been low. These issues are discussed in more detail in Cooney and Ford (2007).

Extinction Risk

A draft ICTRT Current Status Summary (ICTRT 2007c) characterizes the long-term (100 year) extinction risk, calculated from productivity and natural origin abundance estimates of Snake River fall Chinook during the 1977-1999 Brood year "base period" described above for R/S productivity estimates, as "High" (>25% 100-year extinction risk). In these analyses, the ICTRT defines the quasi-extinction threshold (QET) for 100-year extinction risk as fewer than 50 spawners in four consecutive years (QET=50). The ICTRT also calculated the extinction risk based on the 1990-1999 time period and determined that it was "moderate" (6-25% 100-year extinction risk). The ICTRT indicates that extinction risk is likely between these estimates ("moderate" to "high").

The ICTRT assessments are framed in terms of long-term viability and do not directly incorporate short-term (24-year) extinction risk or specify a particular QET for use in analyzing short-term risk, as discussed in Section 7.1.1 of the Supplemental Comprehensive Analysis. Table 5.1-3 displays results of an analysis of short-term extinction risk at four different QET levels (50, 30, 10, and 1 fish) for Snake River fall Chinook. This short-term extinction risk analysis is also based on the assumption that productivity observed during the "base period" will be unchanged in the future. At QET=50, as well as at lower QET levels, there is less than 5% risk of short-term extinction. Confidence limits on this estimate are extremely wide, ranging from 0 to 100% risk of extinction.

The short-term and ICTRT long-term extinction risk analyses assume that all hatchery supplementation ceases immediately. As described in Section 7.1.1.1 of the SCA, this assumption is not representative of hatchery management under the Prospective Actions. A more realistic assessment of short-term extinction risk will take hatchery programs into consideration, either qualitatively or quantitatively. If hatchery supplementation is assumed to continue at current levels for Snake River fall Chinook, short-term extinction risk is 0% at all QETs (Hinrichsen 2008).

Quantitative Survival Gaps

The change in density-independent survival that is necessary for quantitative indicators of productivity to be greater than 1.0 and for extinction risk to be less than 5% are displayed in Table 5.1-4. Mean base period R/S survival gap for the 1977-1999 brood year base period is 34%, while the mean survival gap for lambda (HF=1) is 27%. No additional survival improvements are needed for the R/S gap calculated using the 1990-1999 period, for lambda (HF=0) or for BRT trend estimates. Because base short-term extinction risk is 0-1%, no additional improvements are needed to achieve less than 5% risk at QET=50.

Tables 5.1-5, 5.1-6, and 5.1-7 provide estimates of survival improvements that are expected to occur as a result of past and ongoing activities (Table 5-1-5), and those expect to occur as a result of the Prospective Actions (Table 5.1-6). Table 5.1-7 provides further information relevant to the recovery prong of the jeopardy standard for Snake River fall Chinook. Although it would be appropriate to review this information describing the anticipated survival improvements associated with the Prospective Actions under the environmental baseline, it is provided here for convenience and because it represents the expected future condition of the species status.

5.1.1.2 Rangewide Status of Critical Habitat

Designated critical habitat for Snake River fall Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake rivers; all Snake River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; and the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Critical habitat also includes river reaches presently or historically accessible (except those above impassable natural falls and Dworshak and Hells Canyon dams) in the following subbasins: Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse. The lower Columbia River corridor is among the areas of high conservation value to the ESU because it connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults. The Columbia River estuary is a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats. Designated areas consist of the water, waterway bottom, and the adjacent riparian zone (defined as an area 300 feet from the normal high water line on each side of the river channel) (NMFS 1993b).

Table 5.1-1. Status of SR fall Chinook salmon with respect to abundance and productivity VSP factors. Productivity is estimated using two base time periods.

			Abundance			R/S Productivity			Lambda			Lambda			BRT Trend		
ESU	MPG	Population	Most Recent 10-yr Geomean Abundance[1]	Years Included In Geomean	ICTRT Recovery Abundance Threshold[1]	Average R/S: non-SAR adj.; non-delimited[2]	Lower 95% CI	Upper 95% CI	Median Population Growth Rate (lambda; HF=0)[3]	Lower 95% CI	Upper 95% CI	Median Population Growth Rate (lambda; HF=1)[3]	Lower 95% CI	Upper 95% CI	Ln+1 Regression Slope[4]	Lower 95% CI	Upper 95% CI
Snake River Fall Chinook Salmon	**Main Stem and Lower Tributaries**	Lower Mainstem Fall Chinook 1977-	1273	1995-2004	3000	0.81	0.46	1.21	1.09	0.91	1.30	0.95	0.80	1.12	1.09	1.06	1.13
		Lower Mainstem Fall Chinook 1990-	1273	1995-2004	3000	1.24	0.93	1.66	1.18	0.89	1.56	1.01	0.79	1.27	1.23	1.16	1.31

1 Most recent year for 10-year geometric mean abundance is 2007. ICTRT abundance thresholds are average abundance levels that would be necessary to meet ICTRT viability goals at <5% risk of extinction. Estimates and thresholds are from draft ICTRT 2007c, as cited in the SCA.
2 Mean returns-per-spawner are estimated from the most recent periods of 1977-2004 (1977 through 1999 brood years) and 1990-2004 (1990 through 1999 brood years). Averages are calculated from information in Cooney and Ford 2007, as cited in the SCA and updated with information in Cooney 2007, as cited in the SCA.
3 Median population growth rate (lambda) are estimated from the most recent periods of 1977-2004 (1977 through 1999 brood years) and 1990-2004 (1990 through 1999 brood years) using estimates from Cooney 2008d, as cited in the SCA.
4 Biological Review Team (Good et al. 2005) as cited in the SCA trend estimates updated for recent years in Cooney 2008d, as cited in the SCA.

Table 5.1-2. Status of SR fall Chinook salmon with respect to spatial structure and diversity VSP factors.

ESU	MPG	Population	BRT Current Risk For Distribution[1]	BRT Current Risk For Diversity[1]	10-yr Average % Natural-Origin Spawners[2]
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook	"Moderately High" (Large portion of historical habitat is inaccessible and the distribution of the extant population makes it vulnerable to variable environmental conditions and large disturbances)	"Moderately High" (Loss of diversity associated with extinct populations and significant hatchery influence for the extant population)	0.46

1 The ICTRT has not assigned specific risk levels to this population at this time. Biological Review Team (BRT) assessments are from Good et al. 2005, as cited in the SCA.
2 Average fraction of natural-origin natural spawners from ICTRT 2007c, as cited in the SCA.

Table 5.1-3. Status of SR fall Chinook salmon with respect to extinction risk. Short-term (24-year) extinction risk is estimated from performance during the "base period" of the 20 most recent brood years (approximately 1980 BY – 1999 BY). It was not possible to estimate short-term extinction risk from the more recent 1990-1999 BY data set.

			24-Year Extinction Risk											
ESU	MPG	Population	Risk (QET=1)[1]	Risk (QET=1) Lower 95CI	Risk (QET=1) Upper 95CI	Risk (QET=10)[1]	Risk (QET=10) Lower 95CI	Risk (QET=10) Upper 95CI	Risk (QET=30)[1]	Risk (QET=30) Lower 95CI	Risk (QET=30) Upper 95CI	Risk (QET=50)[1]	Risk (QET=50) Lower 95CI	Risk (QET=50) Upper 95CI
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook 1977-	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.01	0.00	1.00
		Lower Mainstem Fall Chinook 1990-												

1 Short-term (24-year) extinction risk from Hinrichsen 2008, as cited in the Aggregate Analysis Appendix of the SCA. If populations fall to or below the quasi-extinction threshold (QET) four years in a row they are considered extinct in this analysis.

Table 5.1-4. Changes in density-independent survival ("gaps") necessary for indices of productivity to equal 1.0 and estimates of extinction risk no higher than 5% for SR fall Chinook salmon. Survival changes would need to be greater than these estimates for trend or productivity to be greater than 1.0. Estimated "gaps" are based on population performance during the "base period" of approximately the last 20 brood years or spawning years. Factors greater than 1.0 indicate a need for higher survival (e.g., 1.225 indicates that a 22.5% proportional increase in survival is necessary for productivity or trend to equal 1.0); 1.0 indicates no change; and numbers less than 1.0 indicate that additional changes in survival are not necessary for productivity or trend equal to 1.0 and extinction risk to be less than or equal to 5%.

ESU	MPG	Population	Survival Gap For Average R/S=1.0[1]	Upper 95% CI	Lower 95% CI	Survival Gap For 20-yr lambda = 1.0 @ HF=0[2]	Upper 95% CI	Lower 95% CI	Survival Gap For 20-yr lambda = 1.0@ HF=1[2]	Upper 95% CI	Lower 95% CI	Survival Gap For BRT trend = 1.0[3]	Upper 95% CI	Lower 95% CI	Survival Gap for 24-Yr Ext. Risk <5% (QET=1)[4]	Survival Gap for 24-Yr Ext. Risk <5% (QET=10)[4]	Survival Gap for 24-Yr Ext. Risk <5% (QET=30)[4]	Survival Gap for 24-Yr Ext. Risk <5% (QET=50)[4]
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook 1977-	1.34	2.17	0.83	0.68	1.52	0.31	1.27	2.73	0.59	0.67	0.78	0.58	<1.0	<1.0	<1.0	<1.0
		Lower Mainstem Fall Chinook 1990-	0.80	1.07	0.60	0.48	1.66	0.14	0.98	2.86	0.34	0.39	0.51	0.30				

1 R/S survival gap is calculated as 1.0 ÷ base R/S from Table 5.1-1.

2 Lambda survival gap is calculated as (1.0 ÷ base lambda from Table 5.1-1)^Mean Generation Time. Mean generation time was estimated at 4.5 years for these calculations.

3 BRT trend survival gap is calculated as (1.0 ÷ base BRT slope from Table 5.1-1)^Mean Generation Time. Mean generation time was estimated at 4.5 years for these calculations.

4 Extinction risk survival gap is calculated as the exponent of a Beverton-Holt "a" value from a production function that would result in 5% risk, divided by the exponent of the base period Beverton-Holt "a" value. Estimates are from Hinrichsen (2008), as cited in the Aggregate Analysis Appendix of the SCA.

Table 5.1-5. Proportional changes in average base period survival expected from completed actions and current human activities that are likely to continue into the future. Factors greater than one result in higher survival (e.g., 1.225 indicates a 22.5% increase in survival, compared to the base period average); 1.0 indicates no change; and numbers less than 1.0 result in lower survival (e.g., 0.996 indicates a 0.4% reduction in survival, compared to the base period average). The 1990-present estimate, which likely includes recent harvest and hydro survival, is not adjusted.

			Base-to-Current Adjustment (Survival Multiplier)						
ESU	MPG	Population	Hydro[1]	Tributary Habitat[2]	Estuary Habitat[3]	Bird Predation[4]	Harvest[5]	Hatcheries[6]	Total Base-to-Current Survival Multiplier[7]
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook 1977-	N/A	1.00	1.01	1.02	1.09	N/A	1.12
		Lower Mainstem Fall Chinook 1990-							1.00

1 Hydro survival cannot be quantified or compared between the base and current periods for this species.
2 No tributary habitat actions are relevant per CA Section 4.3.1.2 (Corps et al. 2007a), as cited in the SCA.
3 From Comprehensive Analysis Appendix D, Attachment D-1, Table 6 (Corps et al. 2007a), as cited in the SCA.
4 From Comprehensive Analysis Appendix F, Attachment F-2, Table 4 (Corps et al. 2007a), as cited in the SCA. Estimate is based on the "Current 2 S/Baseline 2 S" approach, as described in Attachment F-2.
5 From SCA Quantitative Analysis of Harvest Actions Appendix (NMFS 2008e), as cited in the SCA. Primary source: memorandum from *U.S. v. Oregon* ad hoc technical workgroup.
6 Hatchery survival is not quantified for comparison between the base and current period
7 Total survival improvement multiplier is the product of the survival improvement multipliers in each previous column.

Table 5.1-6. Proportional changes in survival expected from the Prospective Actions. Factors greater than 1.0 result in higher survival (e.g., 1.225 indicates a 22.5% increase in survival, compared to average current survival); 1.0 indicates no change; and numbers less than 1.0 result in lower survival (e.g., 0.996 indicates a 0.4% reduction in survival, compared to current average survival).

			Current-to-Future Adjustment (Survival Multiplier)											
ESU	MPG	Population	Hydro[1]	Tributary Habitat[2] (2007-2017)	Estuary Habitat[3]	Bird Predation[4]	Pike-minnow Predation[5]	Hatcheries[6]	Low Harvest[7]	High Harvest[7]	Non-Hydro Current-to-Future Survival Multiplier[8]	Total Current-to-Future Survival Multiplier[9]		Total Base-to-Future Survival Multiplier[10]
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook 1977-1999 with Allowable Future Harvest	1.00	1.00	1.09	1.01	1.01	1.00	1.00		1.11	1.11		1.24
		Lower Mainstem Fall Chinook 1977-1999 with Expected Future Harvest	1.00	1.00	1.09	1.01	1.01	1.00		1.06	1.18	1.18		1.32
		Lower Mainstem Fall Chinook 1990-1999 with Allowable Future Harvest	1.00	1.00	1.09	1.01	1.01	1.00	1.00		1.11	1.11		1.11
		Lower Mainstem Fall Chinook 1990-1999 with Expected Future Harvest	1.00	1.00	1.09	1.01	1.01	1.00		1.06	1.18	1.18		1.18

1 Hydro survival cannot be quantified or compared between the base and current periods for this species.
2 No tributary habitat actions are relevant per Comprehensive Analysis Section 4.3.3.2 (Corps et al. 2007a), as cited in the SCA.
3 From Comprehensive Analysis Appendix D, Attachment D-1, Table 6 (Corps et al. 2007a), as cited in the SCA.
4 From Comprehensive Analysis Appendix F, Attachment F-2, Table 4 (Corps et al. 2007a), as cited in the SCA. Estimate is based on the "Prospective 2 S/Current 2 S" approach, as described in Attachment F-2.
5 From Comprehensive Analysis Appendix F, Attachment F-1 (Corps et al. 2007a), as cited in the SCA.
6 Hatchery survival is not quantified for comparison between the current and future period.
7 Harvest estimates from SCA Quantitative Analysis of Hatchery Actions Appendix (NMFS 2008e), as cited in the SCA. Primary source: memorandum from *U.S. v. Oregon* ad hoc technical workgroup.
8 This multiplier represents the survival changes resulting from non-hydro Prospective Actions. It is calculated as the product of the survival improvement multipliers in each previous column, except for the hydro multipliers.
9 Same as Footnote 7, except it is calculated from all Prospective Actions. For SR fall Chinook, hydro survival changes cannot be quantified, so this number represents a minimum survival change.
10 Calculated as the product of the Total Current-to-Future multiplier and the Total Base-to-Current multiplier from Table 5.1-5. For SR fall Chinook, hydro survival changes cannot be quantified, so this number represents a minimum survival change.

Table 5.1-7. Summary of prospective estimates relevant to the recovery prong of the jeopardy standard for SR fall Chinook. The 1977-present time series was adjusted for base-to-current survival changes other than hydro, which could not be estimated quantitatively. The 1990-present time series was not adjusted for base-to-current changes. Estimates of productivity expected under the Prospective Actions do not include future hydro survival improvements, which could not be quantified for this species.

ESU	MPG	Population	R/S Recent Climate[1]	Lambda Recent Climate @ HF=0[2]	Lambda Recent Climate @ HF=1[3]	BRT Trend Recent Climate[3]	ICTRT MPG Viability Scenario[4]	Recovery Prong Notes for Abundance/Productivity	Recovery Prong Notes for Spatial Structure[5]	Recovery Prong Notes for Diversity[5]
Snake River Fall Chinook Salmon	Main Stem and Lower Tributaries	Lower Mainstem Fall Chinook 1977-1999 with Allowable Future Harvest	1.01	1.14	0.99	1.15	Must be HV	All three metrics >1, with both a base-to-current adjusted 1977-present time series or a 1990-present time series with no base-to-current adjustment, except for lambda = 0.99 with HF=1 for the 1977-1999 series. Note that hydro improvements have not been quantified for this species.	"Moderately High" (Large portion of historical habitat is inaccessible and the distribution of the extant population makes it vulnerable to variable environmental conditions and large disturbances)	"Moderately High" (Loss of diversity associated with extinct populations and significant hatchery influence for the extant population)
		Lower Mainstem Fall Chinook 1977-1999 with Expected Future Harvest	1.07	1.16	1.01	1.16				
		Lower Mainstem Fall Chinook 1990-1999 with Allowable Future Harvest	1.38	1.21	1.03	1.26				
		Lower Mainstem Fall Chinook 1990-1999 with Expected Future Harvest	1.47	1.22	1.04	1.28				

1 Calculated as the base period R/S productivity from Table 5.1-1, multiplied by the total base-to-future survival multiplier in Table 5.1-6.
2 Calculated as the base period mean population growth rate (lambda) from Table 5.1-1, multiplied by the total base-to-future survival multiplier in Table 5.1-6, raised to the power of (1/mean generation time). Mean generation time was estimated to be 4.5 years.
3 Calculated as the base mean BRT abundance trend from Table 5.1-1, multiplied by the total base-to-future survival multiplier in Table 5.1-6, raised to the power of (1/mean generation time). Mean generation time was estimated to be 4.5 years.
4 From ICTRT (2007a), as cited in Attachment 2 of the SCA.
5 From Table 5.1-2

5.1.2 Upper Willamette River Chinook

The current status of Upper Willamette River Chinook was recently summarized in biological opinions on the Willamette River Flood Control Project, and the FCRPS and the associated Supplemental Comprehensive Analysis (NMFS 2008e). Information from these opinions is summarized here and updated with new information where appropriate.

5.1.2.1 Current Rangewide Status of the Species

While adult Upper Willamette River Chinook salmon begin appearing in the lower Willamette River in January, the majority of the run ascends the falls from April through May (Myers et al. 2006). Mattson (1963) discusses the existence of a late spring-run Chinook salmon that ascended the falls in June. These fish are apparently much larger and older (presumably 6 year olds) than the earlier part of the run. Mattson (1963) speculated that this portion of the run intermingled with the earlier-run fish on the spawning grounds and did not represent a distinct run. The disappearance of the June run in the Willamette River in the 1920s and 1930s was associated with a dramatic decline in water quality in the lower Willamette River.

Ocean distribution of this ESU is consistent with an ocean-type life history, with the majority of spring Chinook being caught off the coasts of British Columbia and Alaska. Spring Chinook from the Willamette River have the earliest return timing of all Chinook stocks in the Columbia Basin, with freshwater entry beginning in February. At present, adults return to the Willamette River primarily at ages 3 through 5 (ODFW 2008c), with age 4 fish being most abundant. Historically, age 5 fish were most abundant, and spawning occurred between mid-July and late October. The current spawn timing of both hatchery and natural-origin Upper Willamette River Chinook is September and early October (Schroeder and Kenaston 2004). Table 5.1.2.1-1 shows generalized life history timing for Upper Willamette River Chinook salmon.

Table 5.1.2.1-1. Upper Willamette River Chinook salmon life history timing. Light shading represents low-level abundance and dark shading represents higher abundance (after Corps et al. 2007b, Table 4-2) (Upstream migration in this table refers to adult presence in the mainstem Willamette and tributaries).

Month:	J	F	M	A	M	J	J	A	S	O	N	D
Upstream Migration												
Spawning in Tributaries												
Intragravel Development												
Juvenile Rearing												
Juvenile Out-migration												

The Upper Willamette River Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon, as well as Upper Willamette River Chinook from seven artificial propagation programs (NMFS 2005c). The seven artificial propagation programs considered part of the ESU are the McKenzie River Hatchery (Oregon Department of Fish and Wildlife (ODFW) stock # 24), Marion Forks/North Fork Santiam River (ODFW stock # 21), South Santiam Hatchery (ODFW stock # 23) in the South Fork Santiam River, South Santiam Hatchery (ODFW stock # 23) in the Calapooia River, South Santiam Hatchery (ODFW stock # 23) in the Molalla River, Willamette Hatchery (ODFW stock # 22), and Clackamas hatchery (ODFW stock # 19) spring-run Chinook hatchery programs (NMFS 2005c).

The Willamette/Lower Columbia Technical Recovery Team (WLCTRT) identified seven independent populations within this ESU, as shown in Table 5.1.2.1-2 and Figure 5.1.2.1-2, below (Myers et al. 2006); all populations are part of the same stratum, or major population group (WLCTRT 2003). The McKenzie population is the only genetic legacy population. Oregon's recovery planners have tentatively prioritized all of the core populations including the McKenzie, Clackamas, North Fork Santiam, and Middle Fork Willamette for high viability, and indicated that the status of all populations needs to improve from current conditions.

Table 5.1.2.1-2. Historical populations in the Upper Willamette River Chinook salmon ESU (Myers et al. 2006).

Stratum	Population*
Upper Willamette	Clackamas (C)
	Molalla
	North Fork Santiam (C)
	South Fork Santiam
	Calapooia
	McKenzie (C)(G)
	Middle Fork Willamette (C)

*The designations "C" and "G" identify Core and Genetic Legacy populations, respectively. Core populations historically represented the centers of abundance and productivity for a major population group. Genetic legacy populations have had minimal influence from nonendemic fish due to artificial propagation activities or exhibit important life history characteristics no longer found throughout the ESU (WLCTRT 2003).

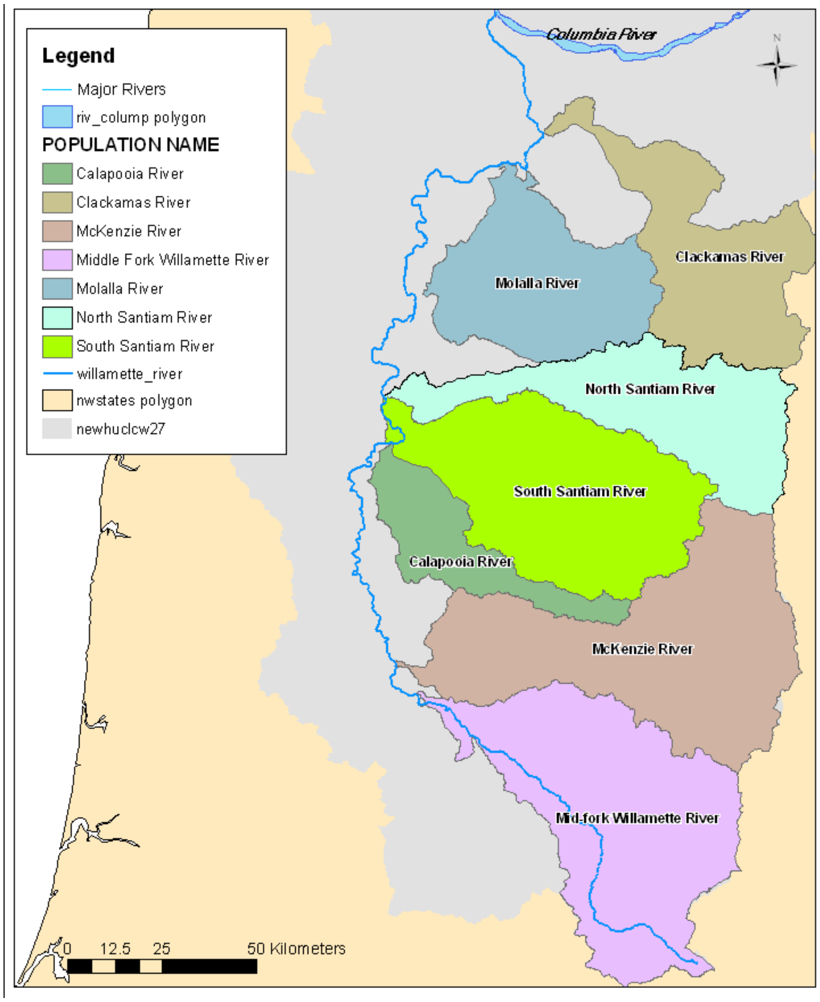


Figure 5.1.2.1-2. Map of historical populations in the UWR Chinook ESU (Myers et al. 2006).

Upper Willamette River Chinook salmon are one of the most genetically distinct groups of Chinook salmon in the Columbia River Basin. Historically (before the laddering of Willamette Falls), passage by returning adult salmonids over Willamette Falls (RKm 37) was possible only during the winter and spring high-flow periods. The early run timing of Willamette River spring-run Chinook salmon relative to other lower Columbia River spring-run populations is viewed as an adaptation to flow conditions at the falls. Since the Willamette Valley was not glaciated during the last epoch, the reproductive isolation provided by the falls was probably uninterrupted for a considerable time and provided the potential for significant local adaptation relative to other Columbia River populations (Myers et al. 2006). Upper Willamette River Chinook salmon still contain a unique set of genetic resources compared to other Chinook stocks in the Willamette/Lower Columbia Domain (Figure 5.1.2.1-3; also see Myers et al. 1998 and Myers et al. 2006).

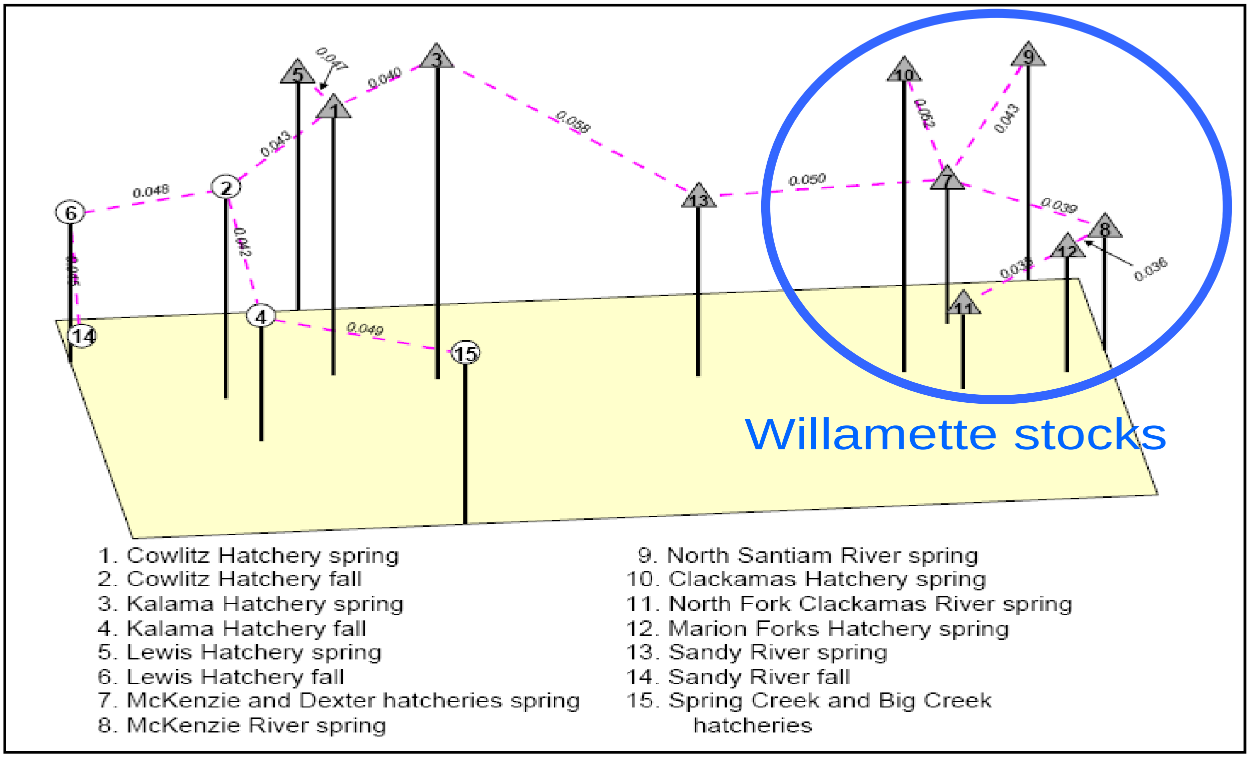


Figure 5.1.2.1-3. Three-dimensional representation of genetic difference, showing similarity of Upper Willamette River Chinook stocks (indicated by proximity in the diagram) and their distinctness from Lower Columbia Chinook stocks (indicated by distance in the diagram). Figure adapted from Myers et al. 2006.

Limiting Factors and Threats

The factors that have caused the decline of this ESU to its threatened status and that are limiting the ESU's ability to recover include multipurpose dams, hatcheries, harvest, habitat degradation (tributary, mainstem, and estuarine), predation, and ocean and climate conditions. These factors are reviewed in the biological opinion on the Willamette River Project (NMFS 2008g). Of these factors, harvest is believed to have been reduced to a point where it is no longer limiting recovery, based on assessments by the ODFW as part of its recovery planning process (ODFW 2007a). Additional information on limiting factors is described for individual populations in the environmental baseline section of the Willamette River Project Biological Opinion.

Abundance, Productivity, and Trends

Historically the Upper Willamette supported large numbers (perhaps exceeding 275,000 fish) of Chinook salmon (Myers et al. 2006). While counts of hatchery- and natural-origin adult spring Chinook salmon over Willamette Falls since 1946 have increased (Figure 5.1.2.1-4), approximately 90 percent of the return is now hatchery fish. Current abundance of natural-origin fish is estimated to be less than 10,000, with significant natural production occurring only in two populations – the Clackamas and McKenzie (McElhany et al. 2007). The Clackamas and McKenzie are the only two watersheds in the ESU where sufficient habitat is still accessible and of sufficient quality to produce significant numbers of natural-origin spring Chinook.

On the Clackamas most of the available habitat and natural spawning occurs above the North Fork Dam. Marked hatchery fish have been removed and not passed above the Dam since 2002. The number of unmarked fish passed above the Dam has averaged over 2,700 since then (ODFW 2008c). This compares to a minimum abundance threshold of 1,300 recommended for the viability of large Chinook populations (McElhany et al. 2007) and a broad sense recovery goal of 2,900 identified in ODFW's draft Recovery Plan (ODFW 2007a). The estimates of productivity and long-term trends noted above may be relatively flat because escapements are near habitat capacity.

Fish returning to the McKenzie are counted at Leaburg Dam. Like the Clackamas marked hatchery fish have not been passed above the Dam since 2002. The number of fish passed above Leaburg Dam has averaged over 3,700 since 2002 (ODFW 2008c) compared to the minimum abundance threshold of 1,300 and a broad sense recovery goal of 3,100 (ODFW 2007a).

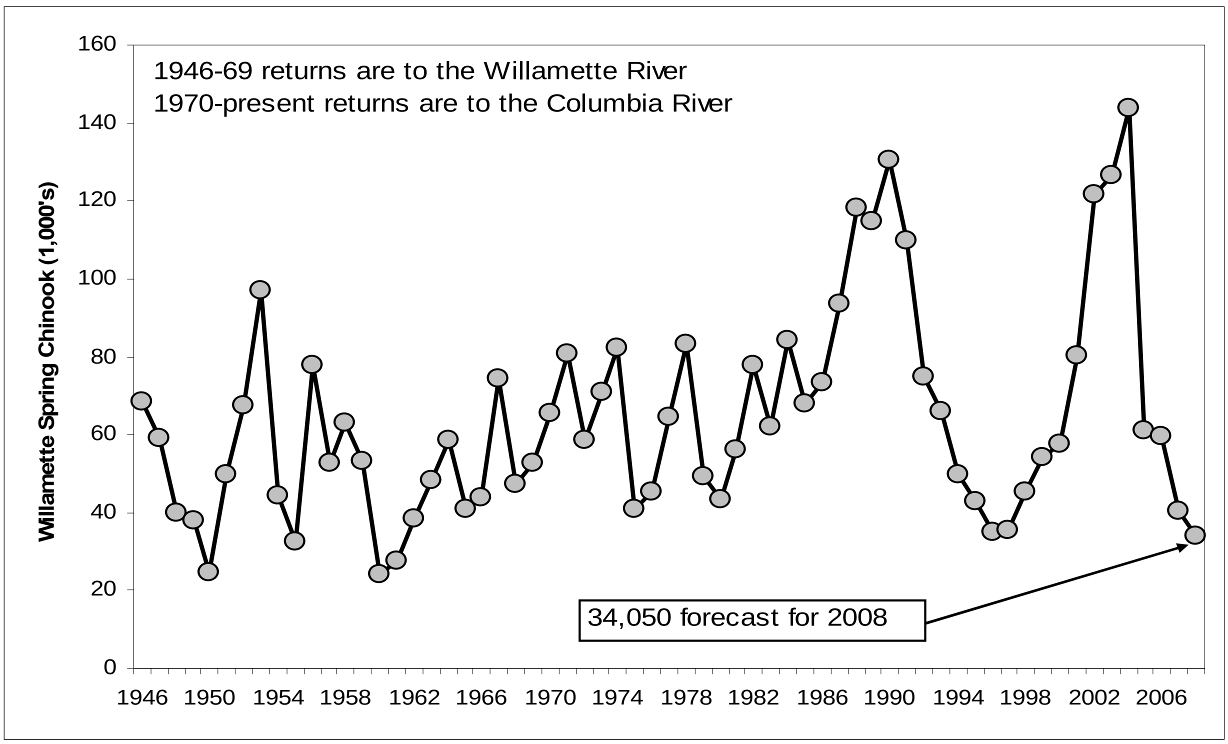


Figure 5.1.2.1-4. Total Willamette spring Chinook returns, (hatchery and wild fish combined) 1946-2007 and 2008 forecast[5] (ODFW 2008c).

[5] Figure uses 2 datasets. Prior to 1970, estimates are for fish returning to the Willamette (do not include fish harvested in ocean and Columbia). For 1970 – present, estimates are for Willamette fish entering the Columbia River (do not include fish harvested in ocean).

With the exception of the Clackamas and McKenzie, natural-origin populations in this ESU have very low current abundances (less than a few hundred fish), and high proportions of hatchery-origin spawners. Quantitative estimates of trends in abundance and adult returns per spawner are available only for the Clackamas and McKenzie Chinook populations. In both cases, while the long-term trend in abundance is slightly higher than 1.0, long-term median population growth rates (lambda) are negative, as are recruits per spawner (Table 5.1.2.1-3) (McElhany et al. 2007).

All three of these metrics evaluate whether a population is maintaining itself, declining, or growing. A long-term trend > 1.0 indicates that population abundance is increasing over time, while a trend of <1.0 indicates abundance is decreasing. A median population growth rate (lambda) of 1.0 indicates a stationary population. Similarly, recruits per spawner of 1.0 indicates that 100 parental spawners would produce 100 progeny that survive and spawn successfully, while values above and below 1.0 indicate that each parental spawner produces less than one successful spawner, or more than one successful spawner, respectively. The long-term trend calculation may be elevated by the way in which it includes the progeny of hatchery-origin spawners, whereas the lambda and recruits per spawner values assess how a population would perform in the absence of continued hatchery production (NMFS 2008c; McElhany et al. 2007).

Table 5.1.2.1-3. Abundance, productivity, and trends of Upper Willamette River Chinook populations (source: McElhany et al. 2007). 95% confidence intervals are shown in parentheses.

Population	Recent Natural Spawners			Long-Term Trend		Median Growth Rate		Recruits/spawner	
	Years[1]	No. [2]	pHOS[3]	Years	Value[4]	Years	λ[5]	Years	Value[6]
Clackamas	90-05	1656 (1122-2443)	47%	58-05	1.04 4 (1.033-1.055)	58-05	0.967 (0.849-1.102)	58-05	0.888 (0.667-1.182)
Molalla	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NF Santiam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SF Santiam	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calapooia	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
McKenzie	90-05	2104 (1484-2983)	33%	70-05	1.017 (0.994-1.04)	70-05	0.927 (0.761-1.129)	70-05	0.705 (0.485-1.024)
MF Willamette	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: Reported time series correspond to reported values in available information.
1 Years of data for recent means.
2 Geometric mean of natural-origin spawners.
3 Average recent proportion of hatchery-origin spawners
4 Long-term trend of natural-origin spawners (regression of log-transformed natural-origin spawner abundances against time).
5 Long-term median population growth rate after accounting for the relative reproductive success of hatchery-origin spawners compared to those of natural origin. The statistic is corrected for hatchery fish to model the growth rate of the natural population if there had been no hatchery supplementation (McElhany et al. 2007).
6 Geometric mean of recruits per spawner using all brood years in the analysis period.
N/A = not available

Table 5.1.2.1-4. Risk of extinction categories for populations of UWR Chinook (source: McElhany et al. 2007).

STRATUM	POPULATION	EXTINCTION RISK CATEGORY
Upper Willamette	Clackamas	Low
	Molalla	Very High
	NF Santiam	Very High
	SF Santiam	Very High
	Calapooia	Very High
	McKenzie	Moderate
	MF Willamette	Very High

Spatial Structure, Diversity, and Extinction Risk

Spatial structure, or geographic distribution, of the North Fork Santiam, South Fork Santiam, McKenzie, and Middle Fork Willamette populations has been substantially reduced by the loss of access to the upper portions of those tributary basins due to flood control and hydropower development, including dams owned and operated by the Corps. It is likely that genetic diversity has also been reduced by this habitat loss. The habitat conditions conducive to salmon survival in the Molalla and Calapooia subbasins have been reduced significantly by the effects of land use, including forestry, agriculture, and development. Spatial structure of the Clackamas population remains relatively intact (McElhany et al. 2007).

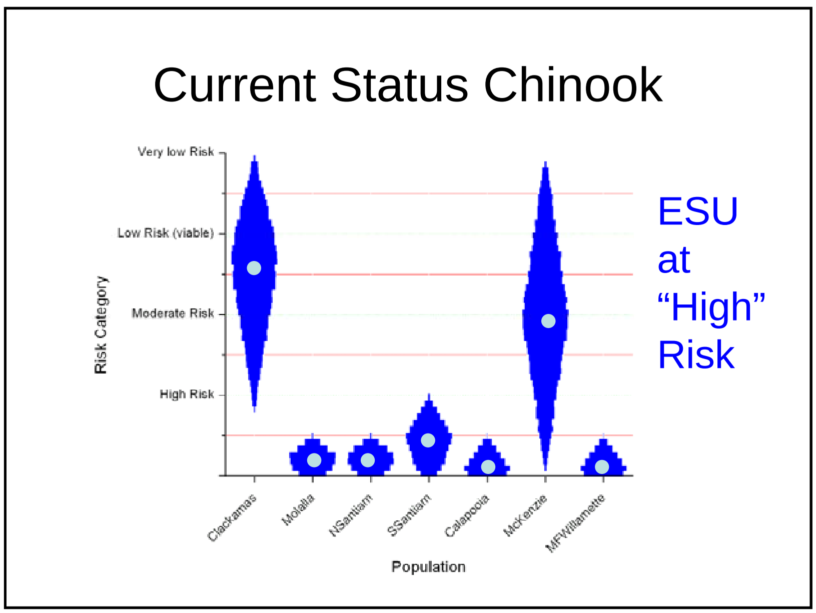


Figure 5.1.2.1-5. Current risk status of Upper Willamette River spring Chinook salmon populations. Width of diamond corresponds with likelihood that the population is at status shown (McElhany et al. 2007).

The diversity of some populations has been further eroded by hatchery and harvest influences and degraded habitat conditions in lower elevation reaches, all of which have contributed to low population sizes (McElhany et al. 2007). As described above, historically Upper Willamette River Chinook had diverse life history types, with greater variation in the age structure and timing of both returning adults and out-migrating juveniles. At present, the life history diversity of all Upper Willamette River Chinook populations has been significantly simplified because there is less variation in ages and run timing. The healthiest populations (Clackamas and McKenzie) still have life history characteristics representative of historical runs, although interbreeding with hatchery fish has likely resulted in genetic introgression over the last 50 years.

Extinction risk for each population was estimated qualitatively, based on criteria identified by the WLCTRT (Table 5.1.2.1-4 and Figure 5.1.2.1-5) (McElhany et al. 2007). The rating system categorized extinction risk as very low, low, moderate, high, and very high based on abundance, productivity, spatial structure, and diversity characteristics. Based on the results for each population, McElhany et al. (2007) determined that the risk of extinction for the ESU was "high."

5.1.2.2 Rangewide Status of Critical Habitat

Designated critical habitat for Upper Willamette River Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in the following subbasins: Middle Fork Willamette, Coast Fork Willamette, Upper Willamette, McKenzie, North Santiam, South Santiam, Middle Willamette, Molalla/Pudding, Clackamas, and Lower Willamette (NMFS 2005b). There are 60 watersheds within the range of this ESU. Nineteen watersheds received a low rating, 18 received a medium rating, and 23 received a high rating of conservation value to the ESU (for more information, see Chapter 4). The lower Willamette/Columbia River rearing/migration corridor is considered to have a high conservation value and is the only habitat area designated in one of the high value watersheds identified above. This corridor connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults. The Columbia River estuary is a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats. Of the 1,796 miles of habitat eligible for designation, 1,472 miles of stream are designated critical habitat.

In the lower Columbia and Willamette basins, major factors affecting the primary constituent elements (PCEs) essential for the conservation of the species are altered channel morphology and stability; lost/degraded floodplain connectivity; loss of habitat diversity; excessive sediment; degraded water quality; increased stream temperatures; reduced stream flow; and reduced access to spawning and rearing areas (LCFRB 2004; ODFW 2007a; PCSRF 2006). A wide variety of actions with the potential to improve PCEs and habitat function have been implemented in the upper Willamette River and its tributaries since 2000, involving non-Federal and Federal parties. Actions have included beneficial land management practices, restoration projects such as culvert replacement to improve access, and improved passage at FERC-licensed and other small dams. A summary of the recent actions that have benefitted critical habitat is provided in the SCA (NMFS 2008e). A more detailed discussion of critical habitat is provided in the Biological Opinion on the Willamette River Projects (NMFS 2008g).

5.1.3 Lower Columbia River Chinook

The current status of Lower Columbia River Chinook was recently summarized in a biological opinion regarding ocean fisheries managed by the Pacific Fishery Management Council (PFMC) (NMFS 2008h) and in biological opinions on the FCRPS and *U.S. v. Oregon* Management Agreement, and the associated Supplemental Comprehensive Analysis (NMFS 2008c, 2008d, 2008e). Information from these opinions is summarized here and updated with new information where appropriate.

5.1.3.1 Current Rangewide Status of the Species

Lower Columbia River Chinook display three life history types including spring-run, early fall run (“tules”), and late fall run (“brights”) (Table 5.1.3.1-1). Both spring and fall runs have been designated as part of a Lower Columbia River Chinook ESU that includes Oregon and Washington populations in tributaries from the ocean to and including the Big White Salmon River in Washington and the Hood River in Oregon. Fall Chinook salmon historically were found throughout the entire range, while spring Chinook salmon historically were only found in the upper portions of basins with snowmelt driven flow regimes (western Cascade Crest and Columbia Gorge tributaries). Late fall Chinook salmon were identified in only two basins in the western Cascade Crest tributaries. In general, late fall Chinook salmon also mature at an older average age than either lower Columbia River spring or fall Chinook salmon, and have a more northerly oceanic distribution. Currently, the abundance of fall Chinook greatly exceeds that of the spring component.

Table 5.1.3.1-1. Life history and population characteristics of Lower Columbia River Chinook salmon originating in Washington portions of the lower Columbia River.

Racial Features			
Characteristic	**Spring**	**Tule Fall**	**Late Fall Bright**
Number of extant populations	7 (including 4 that are possibly extinct)	13	1
Life history type	Stream	Ocean	Ocean
River entry timing	March-June	August-September	August-October
Spawn timing	August-September	September-November	November-January
Spawning habitat type	Headwater large tributaries	Mainstem large tributaries	Mainstem large tributaries
Emergence timing	December-January	January-April	March-May
Duration in freshwater	Usually 12-14 months	1-4 months, a few up to 12 months	1-4 months, a few up to 12 months
Rearing habitat	Tributaries and mainstem	Mainstem, tributaries, sloughs, estuary	Mainstem, tributaries, sloughs, estuary
Estuarine use	A few days to weeks	Several weeks up to several months	Several weeks up to several months
Ocean migration	As far North as Alaska	As far North as Alaska	As far North as Alaska
Age at return	4-5 Years	3-5 Years	3-5 Years
Estimated historical spawners	125,000	140,000	19,000
Recent natural Spawners	800	6,500	9,000
Recent hatchery adults	12,600 (1990-2000)	37,000 (1991-1995)	NA

The Lower Columbia River Chinook salmon ESU is composed of 32 historical populations. The populations are distributed through three ecological zones. The combination of life history types based on run timing, and ecological zones result in six major population groups (MPG, referred to as strata by the WLC TRT) (Table 5.1.3.1-2). There are 23 fall and late fall populations, and nine spring populations, some of which existed historically but are now extinct. Also included in the ESU are 17 hatchery programs. Excluded from the ESU are Carson spring Chinook, and introduced bright fall Chinook occurring in the Wind and (Big) White Salmon rivers, as well as spring Chinook released at terminal fishery areas in Youngs Bay, Blind Slough, and Deep River and in the mainstem Columbia. Populations of spring Chinook in the Willamette, including the Clackamas, are also in a separate ESU.

Consideration of the status of Lower Columbia River Chinook and the tule populations in particular is complicated and requires some understanding of the relationship between hatchery and natural-origin fish in addition to information on the VSP parameters and the other common risk metrics used to assess population status. The Lower Columbia River Chinook tule populations have been subject to high harvest rates, degraded habitat conditions, and extensive hatchery influence for decades. It is clear from the record that the hatchery fish have strayed into natural spawning areas and, in most cases, dominated the natural spawning that has occurred in these systems. In some cases, hatchery populations were derived from a single stock and have been maintained through time (e.g., Cowlitz River and Spring Creek Hatchery (which is derived from the White Salmon River population)). Although these hatchery stocks may have diverged from their source populations due to the effects of hatchery domestication, they are at least associated genetically to their source population. In other cases, hatchery brood stocks have been mixed over the years and are thus an amalgam of the contributing stocks (e.g., Washougal, Elochoman, Kalama, Toutle, and Big Creek.). Several populations have hatcheries located in basin, but most other populations are also subject to substantial straying from adjacent or nearby hatchery programs (e.g., Mill/Abernathy/Germany, Youngs Bay, Clatskine, and Scappoose).

It is therefore pertinent, when considering whether an action is likely to appreciably reduce the survival and recovery of a population, or jeopardize the ESU as a whole, to consider the extent of local adaptation to natural conditions in these populations and whether it has been compromised by past practice to the point where it is no longer distinct. Populations are defined by their relative isolation from each other which presumably allows for their adaptation to unique conditions that exist in specific habitats. If there are populations that still retain their historic genetic legacy, then the appropriate course to insure their survival and recovery is to preserve that genetic legacy and rebuild those populations. Preserving that legacy should be a high priority and, if threatened, requires a sense of urgency and implementation of actions necessary and appropriate to preserve the unique characteristics of those populations. However, if the genetic characteristics of the populations are significantly diminished and we are left with individuals that can no longer be associated with a distinct population, then the appropriate course to recover the population, consistent with the requirements of the ESA, is to use individuals that best approximate the genetic legacy of each population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions. These circumstances will require a deliberate response, but one that may be less urgent in the sense that coordinated progress can and should be made over time to address the limiting factors. For example, if the source of individuals for the rebuilding effort is a hatchery with thousands of returning fish, then recovery will have to occur through a coordinated and deliberate strategy that reduces the effects of hatchery straying and harvest, and improves the habitat to the degree necessary for the population to adapt and rebuild. Retaining some of the hatchery fish may be important for the near term to provide on ongoing source of brood stock during the transition and guard against catastrophic loss. The transition will most often involve allowing time for habitat improvements and for the population to readapt to exiting circumstances. Given the nature of these processes, it is reasonable to expect that rebuilding and recovery will take years and perhaps decades of consistent and steady progress.

The WLCTRT identified the Coweeman and the East Fork Lewis as the only genetic legacy tule populations in the Lower Columbia River ESU (Appendix B in WLCTRT 2003). Myers et al. (2006) indicate that there are no other remnant groups that remain isolated from the hatcheries, and what remains is a mix of hatchery and naturally spawning fish. As a consequence, the appropriate course is to scale harvest actions as appropriate to sustain and recover the legacy populations and, for the other runs, to use what remains and create the conditions that allow the populations to readapt to local conditions and once again become naturally self-sustaining populations. Our consideration of the effects of the proposed actions on the Lower Columbia River tule populations takes these circumstances into account.

Limiting Factors and Threats

Lower Columbia River Chinook salmon populations began to decline by the early 1900s because of habitat alterations and harvest rates that were unsustainable given these changing habitat conditions. Human impacts and limiting factors come from multiple sources: habitat degradation (including tributary hydropower development), hatchery effects, fishery management and harvest decisions, and ecological factors including predation. Tributary habitat has been degraded by extensive development and other types of land use. Fall Chinook spawning and rearing habitat in tributary mainstems has been adversely affected by sedimentation, increased temperatures, and reduced habitat diversity. Spring Chinook access to subbasin headwaters has been restricted or eliminated by the construction of non-Federal dams without fish passage. Five populations (Upper Gorge Fall Run, White Salmon Fall Run, Hood River Fall Run, White Salmon Spring Run, and Hood River Spring Run) are subject to FCRPS impacts involving passage at Bonneville Dam and all populations are affected by habitat alterations in the Columbia River mainstem and estuary. Many naturally-spawning populations have been subject to the effects of a high incidence of naturally-spawning hatchery fish. The species was subject to harvest rates of 50% or more until recent years. Preservation and recovery of this ESU will require significant efforts by many parties. For a more detailed summary of the key limiting factors for this ESU see the biological opinion for the *U.S v. Oregon* Management Agreement (NMFS 2008d), for Washington populations see the Lower Columbia Fish Recovery Board Recovery Plan (referred to here as the Interim Regional Recovery Plan) (LCFRB 2004; Lohn 2006), and for Oregon populations, Oregon’s draft Lower Columbia Recovery Plan (ODFW 2007b).

Table 5.1.3.1-2. Lower Columbia Chinook salmon ESU description and major population groups (MPGs) (Sources: NMFS 2005a; Myers et al. 2006). The designations "(C)" and "(G)" identify Core and Genetic Legacy populations, respectively (Appendix B in WLCTRT 2003).

ESU Description	
Threatened	Listed under ESA in 1999; reaffirmed in 2005
6 major population groups	32 historical populations
Major Population Group	**Population**
Cascade Spring	Upper Cowlitz (C,G), Cispus (C), Tilton, Toutle, Kalama, Lewis (C), Sandy (C,G)
Gorge Spring	White Salmon (C), Hood
Coastal Fall	Grays, Elochoman (C), Mill Creek, Youngs Bay, Big Creek (C), Clatskanie, Scappoose
Cascade Fall	Lower Cowlitz (C), Upper Cowlitz, Toutle (C), Coweeman (G), Kalama, Lewis (G), Salmon Creek, Washougal, Clackamas (C), Sandy
Cascade Late Fall	Lewis (C,G), Sandy (C,G)
Gorge Fall	Lower Gorge, Upper Gorge (C,G), White Salmon (C,G), Hood
Hatchery programs included in ESU (17)	Sea Resources Tule Chinook, Big Creek Tule Chinook, Astoria High School (STEP) Tule Chinook, Warrenton High School (STEP) Tule Chinook, Elochoman River Tule Chinook, Cowlitz Tule Chinook Program, North Fork Toutle Tule Chinook, Kalama Tule Chinook, Washougal River Tule Chinook, Spring Creek NFH Tule Chinook, Cowlitz spring Chinook (2 programs), Friends of Cowlitz spring Chinook, Kalama River spring Chinook, Lewis River spring Chinook, Fish First spring Chinook, Sandy River Hatchery (ODFW stock #11)

Abundance, Productivity and Trends

The Interim Regional Recovery Plan described a recovery scenario for Lower Columbia River Chinook (LCFRB 2004). They identified each population's role in recovery as a primary, contributing, or stabilizing populations which generally refer to a desired viability level. The Recovery Plan also suggested viable abundance goals for each population (Table 5.1.3.1-3). The Plan focused on Washington populations and made some assumptions or suggestions regarding Oregon populations. Washington has since reconsidered the recovery scenario and changed priority designations for some of the tule populations. Oregon has also now made some tentative priority designations for tule populations in Oregon. These revisions are discussed in more detail under effects in Section 7.4.3.3. The states' respective recommendations will eventually have to be finalized and reconciled to provide a final recovery scenario.

Table 5.1.3.1-3. The ecological zones and populations for the Lower Columbia River Chinook salmon ESU (LCFRB 2004). Primary populations identified for greater than high viability objectives are denoted with an '*'. Recent averages are compiled from Tables 5.1.3.1-5, 5.1.3.1-6, and 5.1.3.1-7. Percent wild indicated if available.

Population/Strata	Status/ Goal[1]	Abundance Range		Recent 5 Year Average	
		Viable	Potential	Spawners	% wild
GORGE SPRING					
White Salmon (WA)	C	1,400	2,800	5,237	19
Hood (OR)	P	1,400	2,800		
CASCADE SPRING					
Upper Cowlitz (WA)	P*	2,800	8,100	10,500	NA
Cispus (WA)	P*	1,400	2,300		
Tilton (WA)	S	1,400	2,800		
Toutle (WA)	C	1,400	3,400		
Kalama (WA)	P	1,400	1,400		
NF Lewis (WA)	P	2,200	3,900		
Sandy (OR)	P	2,600	5,200		
CASCADE LATE FALL					
NF Lewis (WA)	P*	6,500	16,600		
Sandy (OR)	P	5,100	10,200		
COAST FALL (Tule)					
Grays/Chinook (WA)	P	1,400	1,400	336	78
Eloch/Skam (WA)	P	1,400	4,500	4,751	31
Mill/Aber/Germ (WA)	C	2,000	3,200	4,063	23
Youngs Bay (OR)	S	1,400	2,800		
Big Creek (OR)	S	1,400	2,800		
Clatskanie (OR)	P	1,400	2,800	179	43
Scapoose (OR)	S	1,400	2,800		
CASCADE FALL (Tule)					
Lower Cowlitz (WA)	C	3,900	33,200		
Upper Cowlitz (WA)	S	1,400	10,800		
Toutle (WA)	S	1,400	14,100		
Coweeman (WA)	P*	3,000	4,100	1,128	82
Kalama (WA)	P	1,300	3,200	12,680	7
EF Lewis/Salmon (WA)	P*	1,900	3,900	597	75
Washougal (WA)	P	5,800	5,800	5,334	39
Clackamas (OR)	C	1,400	2,800		
Sandy (OR)	S	1,400	2,800		
GORGE FALL (Tule)					
Lower Gorge (WA)	C	1,400	2,800		
Upper Gorge (WA)	S	1,400	2,400		
White Salmon (WA)	C	1,600	3,200		

Hood (OR)	S	1,400	2,800		

[1] **Primary populations** are those that would be restored to high or "high+" viability. At least two populations per strata must be at high or better viability to meet recommended TRT criteria. Primary populations typically, but not always, include those of high significance and medium viability. In several instances, populations with low or very low current viability were designated as primary populations in order to achieve viable strata and ESU conditions. In addition, where factors suggest that a greater than high viability level can be achieved, populations have been designated as High+. High+ indicates that the population is targeted to reach a viability level between High and Very High levels as defined by the TRT. **Contributing populations** are those for which some restoration will be needed to achieve a stratum-wide average of medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.
Stabilizing populations are those that would be maintained at current levels (likely to be low viability). Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high.

The information in 5.1.3.1-4 was reported in NOAA Fisheries' most recent status review (Good et al. 2005). Draft status assessments were updated for Oregon populations in a more recent review (McElhany et al. 2007). Some of the natural runs (e.g., the Youngs Bay, Kalama River and Upper and Lower Gorge fall runs, and all of the spring run populations) have been replaced largely by hatchery production. Quantitative data is not available for about half of the populations.

The majority of populations for which data is available have a long-term trend of less than 1.0, indicating the population is in decline. In addition, for most populations there is a high probability that the true trend/growth rate is less than 1.0 (Table 16 in Good et al. 2005). Assuming that the reproductive success of hatchery-origin fish has been equal to that of natural-origin fish, the analysis indicates a negative long-term growth rate for all of the populations except the Coweeman River fall run, which has had very few hatchery-origin spawners. The North Fork Lewis River late fall population is considered the healthiest and is significantly larger than any other natural-origin population in the ESU.

The data used for the analysis shown in Table 5.1.3.1-4 is current only through 2001 for Washington populations and 2004 for Oregon populations. More recent estimates of escapement along with available data for the time series are provided in the following tables.

There are seven spring Chinook populations in the Cascade MPG. The Upper Cowlitz, Cispus, and Tilton populations (collectively referred to as Cowlitz) are all located above Mayfield Dam which has no juvenile or adult passage. Current production of spring Chinook above Mayfiled Dam is maintained from juvenile hatchery plants and an adult trap and haul program. Escapement estimates to the Cowlitz refers to fish returning to the area below Mayfield Dam (Table 5.1.3.1-5).

The return of spring Chinook to the Cowlitz, Kalama, Lewis, and Sandy river populations have all numbered in the thousands in recent years (Table 5.1.3.1-5). The Cowlitz and Lewis populations on the Washington side are managed for hatchery production since most of the historical spawning habitat is inaccessible due to hydro development in the upper basin. A supplementation program is now being implemented on the Cowlitz that involves trap and haul of adults and juveniles. A supplementation program is also being implemented on the Kalama with fish being passed above the ladder at Kalama Falls. Historically, the Kalama was a relatively small system compared to the other three rivers (Table 5.1.3.1-10). A supplementation program is also being developed for the Lewis River, but the population is still dependent on hatchery production. These systems have all met their respective hatchery escapement goals in recent years, and are expected to do so again in 2008 and for the foreseeable future. The existence of the hatchery programs mitigates the risk to these populations. The Cowlitz and Lewis populations would be extinct but for the hatchery programs. The Cowlitz and Lewis populations are designated as primary populations and are thus targeted in the Interim Regional Recovery Plan for high viability. Achieving high viability will require reintroducing the species and providing access to upstream habitat through by providing passage for juveniles and adults. The historical significance of the Kalama population was likely limited because access to the preferred upstream spawning areas was likely blocked by lower Kalama Falls. The recovery status for the Kalama spring Chinook population is designated as contributing by the Interim Plan.

The Sandy River is managed with an integrated hatchery supplementation program that incorporates natural-origin brood stock. There is some spawning in the lower river, but the area above Marmot Dam is preserved for natural-origin production. The Marmot Dam was used as a counting and sorting site in prior years, but the Dam was removed in October 2007. The return of natural-origin fish to Marmot Dam has averaged almost 1,700 since 2000. This does not account for the additional spawning of natural-origin fish below the dam. The tentative delisting and broad sense recovery goals for Sandy River spring Chinook are 1,400 and 1,900, respectively, although these goals are subject to further review through Oregon's ongoing recovery planning process. The total return of spring Chinook to the Sandy including hatchery fish has averaged more than 6,000 since 2000 (Table 5.1.3.1-5). The Sandy River spring Chinook population is also designated as a primary population that will be important to the overall recovery of the ESU.

Spring Chinook populations occur in both the Gorge and Cascade MPGs. The Hood River and White Salmon populations are the only populations in the Gorge MPG. The 2005 Biological Review Team report describe the Hood River spring run as "extirpated or nearly so" and the 2005 ODFW Native Fish Status report describes the population as extinct. Spring Chinook from the Deschutes River are being reintroduced into the Hood River. The Deschutes River is the nearest source for brood stock, but the population is from the Middle Columbia River ESU. Native fish are therefore not considered to be present. Most of the habitat that was historically available to spring Chinook in the Hood River is still accessible, but the basin was likely not highly productive for spring Chinook due to the character of the basin (ODFW 2007b).

The White River population is also considered extinct (LCFRB 2007). Recovery of this population will therefore also depend on a reintroduction effort. Condit Dam located at river mile 3.3 on the White Salmon River is scheduled for removal in 2008. Spring Chinook will eventually be reintroduced from an out of basin stock.

Table 5.1.3.1-4. Abundance, productivity, and trends of Lower Columbia River Chinook salmon populations (sources: Good et al. 2005 for Washington and McElhany et al. 2007 for Oregon populations).

	Strata	Population	State	Recent Abundance of Natural Spawners			Long-term Trend[b]		Median Growth Rate[c]	
				Years	Geo Mean	pHOS[a]	Years	Value	Years	λ
Spring	Cascade	Cowlitz	W	na	na	na	80-01	0.994	na	na
		Cispus	W	2001	1,787	na	na	na	na	na
		Tilton	W	na	na	na	na	na	na	na
		Toutle	W	na	na	na	na	na	na	na
		Kalama	W	97-01	98	na	80-01	0.945	na	na
		NF Lewis	W	97-01	347	na	80-01	0.935	na	na
		Sandy	O	90-04	959	52%	90-04	1.047	90-04	0.834
	Gorge	(Big) White Salmon	W	na	na	na	na	na	na	na
		Hood	O	94-98	51	na	na	na	na	na
Fall	Coastal	Grays	W	97-01	59	38%	64-01	0.965	80-01	0.844
		Elochoman	W	97-01	186	68%	64-01	1.019	80-01	0.800
		Mill	W	97-01	362	47%	80-01	0.965	80-01	0.829
		Youngs Bay	O	na	na	na	na	na	na	na
		Big Creek	O	na	na	na	na	na	na	na
		Clatskanie	O	90-04	41	15%	90-04	1.077	90-04	1.152
		Scappoose	O	na	na	na	na	na	na	na
	Cascade	Lower Cowlitz	W	96-01	463	62%	64-00	0.951	80-01	0.682
		Upper Cowlitz	W	na	na	na	na	na	na	na
		Toutle	W	na	na	na	na	na	na	na
		Coweeman	W	97-01	274	0%	64-01	1.046	80-01	1.091
		Kalama	W	97-01	655	67%	64-01	0.994	80-01	0.818
		Lewis	W	97-01	256	0%	80-01	0.981	80-01	0.979
		Salmon	W	na	na	na	na	na	na	Na
		Washougal	W	97-01	1,130	58%	64-01	1.088	80-01	0.815
		Clackamas	O	98-01	40	na	67-01	0.937	na	na
		Sandy	O	97-01	183	na	na	na	na	na
	Gorge	Lower Gorge	W/O	na	na	na	na	na	na	na
		Upper Gorge	W/O	97-01	109	13%	64-01	0.935	80-01	0.955
		(Big) White Salmon	W	97-01	218	21%	67-01	0.941	80-01	0.945
		Hood River	O	00-04	36	na	na	na	na	na
Late	Cascade	NF Lewis	W	97-01	6,818	13%	64-01	0.992	80-01	0.948
		Sandy	O	90-04	2,771	5%	81-04	0.983	81-04	0.997

[a] Average recent proportion of hatchery-origin spawners. Hatchery-origin fish are the offspring of fish that were spawned in a hatchery. Gomeans are calculated for total spawners where hatchery fractions are unavailable.
[b] Long-term trend of total (hatchery- and natural-origin) spawners (regression of log-transformed spawner indices against time).
[c] Long-term median population growth rate after accounting for hatchery spawners (equal spawning success assumption).
Note: time series represent available information and therefore may not correspond to reference periods identified in this biological opinion's evaluations for other species.

Table 5.1.3.1-5. Total annual escapement of Lower Columbia River spring Chinook populations (TAC 2008).

Year or Average	Cowlitz River [a]	Kalama River	Lewis River [a]	Sandy River (Total)	Sandy River (natural-origin fish at Marmot Dam)[b]
1971-1975	11,900	1,100	200	-	
1976-1980	19,680	2,020	2,980	975	
1981-1985	19,960	3,740	4,220	1,940	
1986-1990	10,691	1,877	11,340	2,425	
1991-1995	6,801	1,976	5,870	5,088	
1996	1,787	627	1,730	3,997	
1997	1,877	505	2,196	4,625	
1998	1,055	407	1,611	3,768	
1999	2,069	977	1,753	3,985	
2000	2,199	1,418	2,515	3,641	1,984
2001	1,649	1,784	3,777	5,329	2,445
2002	5,019	2,883	3,554	5,903	1,275
2003	15,890	4,528	5,104	5,600	1,151
2004	16,712	4,573	11,090	12,675	2,698
2005	9,200	3,100	3,400	7,475	1,808
2006	7,000	5,600	7,500	4,812	1,381
2007	3,700	7,300	6,700	3,400	790

[a] Includes hatchery escapements, tributary recreational catch, and natural spawning escapement for 1975 to present. The years 1971-73 are based on using the 1975-76 Cowlitz River recreational fishery adult harvest rate
[b] TAC (2008)

There are two bright Chinook populations in the Lower Columbia River Chinook ESU in the Sandy and North Fork Lewis rivers. Both populations are in the Cascade MPG. TAC provided estimates of the escapement of bright Chinook to the Sandy River (Table 5.1.3.1-6) (TAC 2008), but it is apparent that these are estimates for an index area that is surveyed directly. These estimates are expanded to account for spawners in areas that are not surveyed. The geometric mean of the estimate of total spawners is 2,771 (Table 5.1.3.1-4). These estimates have been used by Oregon's recovery planners to assess the status of the population (ODFW 2007b). Based on these estimates, Oregon concluded that the Sandy bright population is at low risk and further indicated that the population is viable under current harvest patterns (ODFW 2007b). The tentative delisting and broad sense recovery goals for Sandy River bright Chinook are 4,600 and 5,500, respectively. These goals are subject to further review through Oregon's ongoing recovery planning process.

The North Fork Lewis population is the principal indicator stock for management. It is a natural-origin population with little or no hatchery influence. The maximum sustained yield escapement goal is 5,700. The viable abundance goal is 6,500. The escapement in the North Fork Lewis was below the escapement goal in 2007. This is consistent with a pattern of low escapements for other far north migrating bright populations including Oregon coastal stocks and upriver brights that return to the Hanford Reach area. This pattern of low escapements for a diverse range of stocks suggests that they were all affected by poor ocean conditions. Escapement to the North Fork Lewis was expected to be below goal again in 2008 (PFMC 2008c). Inseason estimates of the return of upriver brights to the Columbia River are well above preseason expectations. We do not yet have any information that is specific to the North Fork Lewis or Sandy populations, but as indicated above the far north migrating stocks do generally show similar patterns of abundance.

Table 5.1.3.1-6. Annual escapement of Lower Columbia River bright fall Chinook populations (TAC 2008).

Year	Sandy River	North Fork Lewis
1993	1,314	6,429
1994	941	8,439
1995	1,036	9,718
1996	505	12,700
1997	2,001	8,168
1998	773	5,167
1999	447	2,639
2000	84	8,727
2001	824	11,272
2002	1,275	13,284
2003	619	13,433
2004	601	14,165
2005	770	10,197
2006	1,130	10,522
2007	171	3,130

There are twenty one populations of tule Chinook with some located in each of the MPGs (Table 5.1.3.1-3). The four populations in the Gorge MPG include the Lower Gorge, Upper Gorge, White Salmon, and Hood. There are ten populations in the Cascade MPG. Of these only the Coweeman and East Fork Lewis are considered genetic legacy populations. All of the remaining populations are substantially affect by hatchery strays or in basin hatchery production programs and, as discussed in the introduction to this section, are unlikely to retain the remnant characteristics of the original populations. There are seven populations in the Coastal MPG. None are considered genetic legacy populations, and like most other tule populations in the ESU are unlikely to be genetically distinct. The Grays River populations in used as an indicator and to calculate an RER (see section 7.4.3). The hatchery program on the Grays was closed in 1997 so it is currently subject to less hatchery straying, but the history of the population is such that the unique characteristics of the population are likely gone.

Table 5.1.3.1-7 provides escapement information for several of the tule populations including estimates of the proportion of spawners that are natural origin. The Coweeman, Grays, and East Fork Lewis populations are subject to less hatchery straying. The Cowlitz, Kalama, Washougal, Elochoman, and Mill/Abernathy/Germany populations are more strongly influenced by hatchery fish because of in-basin hatchery programs or their close proximity to such programs. The natural-origin populations are generally below their viability abundance goals. The populations that are more strongly influenced by hatchery origin fish are generally at or above their abundance goals, but presumably only because of the contribution of hatchery fish.

Spatial Structure, Diversity, and Extinction Risk

The Interim Regional Recovery Plan provides an overview of the status of populations in the ESU based on TRT recommendations for assessing viability. The risk of extinction category integrates abundance and other viability criteria (Table 5.1.3.1-8). The Recovery Plan also characterizes population status relative to persistence (which combines the abundance and productivity criteria), spatial structure, and diversity, and also habitat characteristics (Table 5.1.3.1-9). This overview for tule populations suggests that risk related to abundance and productivity are higher than those for spatial structure and diversity. Lower scores indicate higher risk. The scores for persistence for most populations range between 1.5 and 2.0. The scores for spatial structure generally range between 3 and 4, and for diversity between 2 and 3, respectively.

Table 5.1.3.1-7. Annual escapement of Lower Columbia River tule Chinook populations.

	Coweeman		Grays		Lewis		Cowlitz		Kalama		Washougal		Elochoman		Ge/Ab/Mi	
Year	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild	#	Proportion Wild
1977	337	1.00	1,009	0.65	1,086		5,837	0.26	6,549	0.50	1,652	0.46	568			
1978	243	1.00	1,806	0.65	1,448		3,192	0.26	3,711	0.50	593	0.46	1,846			
1979	344	1.00	344	0.65	1,304		8,253	0.26	2,731	0.50	2,388	0.46	1,478			
1980	180	1.00	125	0.65	899	1.00	1,793	0.26	5,850	0.50	3,437	0.46	64	0.42	516	0.49
1981	116	1.00	208	0.65	799	1.00	3,213	0.26	1,917	0.50	1,841	0.46	138	0.42	1,367	0.48
1982	149	1.00	272	0.65	646	1.00	2,100	0.26	4,595	0.50	330	0.46	340	0.42	2,750	0.50
1983	122	1.00	825	0.65	598	1.00	2,463	0.26	2,722	0.50	2,677	0.46	1,016	0.42	3,725	0.51
1984	683	1.00	252	0.65	340	1.00	1,737	0.26	3,043	0.50	1,217	0.46	294	0.42	614	0.52
1985	491	0.95	532	0.65	1,029	1.00	3,200	0.26	1,259	0.50	1,983	0.46	464	0.42	1,815	0.53
1986	396	1.00	370	0.65	696	1.00	2,474	0.26	2,601	0.50	1,589	0.46	918	0.42	980	0.49
1987	386	1.00	555	0.65	256	1.00	4,260	0.26	9,651	0.50	3,625	0.46	2,458	0.42	6,168	0.59
1988	1,890	1.00	680	0.65	744	1.00	5,327	0.26	24,549	0.50	3,328	0.46	1,370	0.42	3,133	0.69
1989	2,549	1.00	516	0.65	972	0.78	4,917	0.26	20,495	0.50	4,578	0.46	122	0.42	2,792	0.69
1990	812	1.00	166	0.65	563	1.00	1,833	0.26	2,157	0.50	2,205	0.46	174	0.42	650	0.63
1991	340	1.00	127	0.94	470	1.00	935	0.26	5,152	0.54	3,673	0.47	196	0.09	2,017	0.85
1992	1,247	1.00	109	1.00	335	1.00	1,022	0.26	3,683	0.48	2,399	0.76	190	1.00	839	0.47
1993	890	1.00	27	1.00	164	1.00	1,330	0.06	1,961	0.89	3,924	0.52	288	0.78	885	0.71
1994	1,695	1.00	30	1.00	610	1.00	1,225	0.19	2,190	0.73	3,888	0.70	706	0.98	3,854	0.40
1995	1,368	1.00	9	1.00	409	1.00	1,370	0.13	3,094	0.69	3,063	0.39	156	0.50	1,395	0.51
1996	2,305	1.00	280	0.48	403	1.00	1,325	0.58	10,676	0.44	2,921	0.17	533	0.66	593	0.54
1997	689	1.00	15	0.64	305	1.00	2,007	0.72	3,548	0.40	4,669	0.12	1,875	0.11	603	0.23
1998	491	1.00	96	0.41	127	1.00	1,665	0.37	4,355	0.69	2,971	0.24	228	0.25	368	0.60
1999	299	1.00	195	0.51	331	1.00	969	0.16	2,655	0.03	3,129	0.68	718	0.25	575	0.69
2000	290	1.00	169	0.96	515	1.00	2,165	0.10	1,420	0.19	2,155	0.70	196	0.62	416	0.58
2001	802	0.73	261	0.64	750	0.70	3,647	0.44	3,714	0.19	3,901	0.43	2,354	0.82	4,024	0.39
2002	877	0.97	107	1.00	1,032	0.77	9,671	0.76	18,952	0.01	6,050	0.47	7,581	0.00	3,343	0.05
2003	1,106	0.89	398	0.72	738	0.98	7,001	0.88	24,782	0.01	3,444	0.39	6,820	0.65	3,810	0.56
2004	1,503	0.91	766	0.90	1,388	0.29	4,621	0.70	6,680	0.10	10,597	0.25	4,796	0.01	6,804	0.02
2005	853	0.60	147	0.66	607	1.00	2,968	0.17	9,272	0.03	2,678	0.41	2,204	0.05	2,083	0.13
2006	561		383		427		2,944		10,386		2,600		317		322	

Table 5.1.3.1-8. Risk of extinction (in 100 years) categories for populations of Lower Columbia River Chinook salmon (sources: Washington's Lower Columbia Fish Recovery Board plan (LCFRB 2004) and McElhany et al. 2007 for Oregon populations).

Type	Strata	Population	State	Extinction Risk Category
Spring	Cascade	Cowlitz	W	H
		Cispus	W	H
		Tilton	W	VH
		Toutle	W	VH
		Kalama	W	VH
		NF Lewis	W	VH
		Sandy	O	M
	Gorge	(Big) White Salmon	W	VH
		Hood	O	VH
Fall	Coastal	Grays/Chinook	W	H
		Elochoman/Skamokawa	W	H
		Mill/Abernathy/Germany	W	H
		Youngs Bay	O	VH
		Big Creek	O	VH
		Clatskanie	O	H
		Scappoose	O	VH
	Cascade	Lower Cowlitz	W	H
		Upper Cowlitz	W	VH
		Toutle	W	H
		Coweeman	W	M
		Kalama	W	H
		Lewis	W	M
		Salmon	W	VH
		Washougal	W	H
		Clackamas	O	VH
		Sandy	O	VH
	Gorge	Lower Gorge	W/O	H/VH
		Upper Gorge	W/O	H/VH
		(Big) White Salmon	W	H
		Hood River	O	VH
Late Fall	Cascade	NF Lewis	W	M
		Sandy	O	L

Table 5.1.3.1-9. LCFRB status summaries for Lower Columbia River tule Chinook populations LCFRB, Appendix E).

Strata	State	Population	Persistence	Spatial Structure	Diversity	Habitat
Coast Fall	WA	Grays	1.5	4	2.5	1.5
	WA	Elochoman	1.5	3	2	2
	WA	Mill/Abern/Ger	1.8	4	2	2
	OR	Youngs Bay				
	OR	Big Creek				
	OR	Clatskanie				
	OR	Scappoose				
Cascade Fall	WA	Lower Cowlitz	1.7	4	2.5	1.5
	WA	Coweeman	2.2	4	3	2
	WA	Toutle	1.6	3	2	1.75
	WA	Upper Cowlitz	1.2	2	2	2
	WA	Kalama	1.8	4	2.5	2
	WA	Lewis Salmon	2.2	4	3	2
	WA	Washougal	1.7	4	2	2
	OR	Sandy	1.7	4	2	2
	OR	Clackamas				
Gorge Fall	WA	Lower Gorge	1.8	3	2.5	2.5
	WA	Upper Gorge	1.8	2	2.5	2
	OR	Big White Salmon	1.7	2	2.5	1.5
	OR	Hood				

Notes:
Summaries are taken directly from the Interim Regional Recovery Plan. All are on a 4 point scale, with 4 being lowest risk and 0 being highest risk.
Persistence: 0 = extinct or very high risk of extinction (0-40% probability of persistence in 100 years); 1 = Relatively high risk of extinction (40-75% probability of persistence in 100 years); 2 = Moderate risk of extinction (75-95% probability of persistence in 100 years); 3 = Low (negligible) risk of extinction (95-99% probability of persistence in 100 years); 4 = Very low risk of extinction (>99% probability of persistence in 100 years)
Spatial Structure: 0 = Inadequate to support a population at all (e.g., completely blocked); 1 = Adequate to support a population far below viable size (only small portion of historic range accessible); 2 = Adequate to support a moderate, but less than viable, population (majority of historical range accessible but fish are not using it); 3 = Adequate to support a viable population but subcriteria for dynamics or catastrophic risk are not met; 4 = Adequate to support a viable population (all historical areas accessible and used; key use areas broadly distributed among multiple reaches or tributaries)
Diversity: 0 = functionally extirpated or consist primarily of stray hatchery fish; 1 = large fractions of non-local hatchery stocks; substantial shifts in life-history; 2 = Significant hatchery influence or periods of critically low escapement; 3 = Limited hatchery influence with stable life history patterns. No extended intervals of critically low

escapements; rapid rebounds from periodic declines in numbers; 4 = Stable life history patterns, minimal hatchery influence, no extended intervals of critically low escapements, rapid rebounds from periodic declines in numbers. Habitat: 0 = Quality not suitable for salmon production; 1 = Highly impaired; significant natural production may occur only in favorable years; 2 = Moderately impaired; significant degradation in habitat quality associated with reduced population productivity; 3 = Intact habitat. Some degradation but habitat is sufficient to produce significant numbers of fish; 4 = Favorable habitat. Quality is near or at optimums for salmon.

Population status indicators are all affected by available habitat. Steel and Sheer (2003) analyzed the number of stream kilometers historically and currently available to salmon populations in the lower Columbia River (Table 5.1.3.1-10). Stream kilometers usable by salmon are determined based on simple gradient cutoffs and on the presence of impassable barriers. This approach overestimates the number of usable stream kilometers, because it does not account for aspects of habitat quality other than gradient. However, the analysis does indicate that the number of kilometers of stream habitat currently accessible is greatly reduced from the historical condition for some populations. Hydroelectric projects in the Cowlitz, North Fork Lewis, and White Salmon Rivers have greatly reduced or eliminated access to upstream production areas and therefore extirpated some of the affected populations. Spring populations on the Cowlitz and its tributaries (Cispus and Tilton) and the Lewis rivers that depend on headwater spawning and rearing areas are particularly affected by these barriers.

Table 5.1.3.1-10. Current and historically available habitat located below barriers in the Lower Columbia River Chinook salmon ESU.

Population/Strata	Potential Current Habitat (km)	Potential Historical Habitat (km)	Current/ Historical Habitat Ratio (%)
GORGE SPRING			
White Salmon (WA)	0	232	0
Hood (OR)	150	150	99
CASCADE SPRING			
Upper Cowlitz (WA)	4	276	1
Cispus (WA)	0	76	0
Tilton (WA)	0	93	0
Toutle (WA)	217	313	69
Kalama (WA)	78	83	94
Lewis (WA)	87	365	24
Sandy (OR)	167	218	77
CASCADE LATE FALL			
NF Lewis (WA)	87	166	52
Sandy (OR)	217	225	96
COAST FALL (Tule)			
Grays/Chinook (WA)	133	133	100
Eloch/Skam (WA)	85	116	74

Population/Strata	Potential Current Habitat (km)	Potential Historical Habitat (km)	Current/ Historical Habitat Ratio (%)
Mill/Aber/Germ (WA)	117	123	96
Youngs Bay (OR)	178	195	91
Big Creek (OR)	92	129	71
Clatskamie (OR)	159	159	100
Scapoose (OR)	122	157	78
CASCADE FALL (Tule)			
Lower Cowlitz (WA)	418	919	45
Upper Cowlitz (WA)	-	-	-
Toutle (WA)	217	313	69
Coweeman (WA)	61	71	86
Kalama (WA)	78	83	94
Lewis/Salmon (WA)	438	598	73
Washougal (WA)	84	164	51
Clackamas (OR)	568	613	93
Sandy (OR)	227	286	79
GORGE FALL (Tule)			
Lower Gorge (WA)	34	35	99
Upper Gorge (WA)	23	27	84
White Salmon (WA)	0	71	0
Hood (OR)	35	35	100

5.1.3.2 Current Rangewide Status of Critical Habitat

Designated critical habitat for Lower Columbia River Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood River as well as specific stream reaches in the following subbasins: Middle Columbia/Hood, Lower Columbia/Sandy, Lewis, Lower Columbia/Clatskanie, Upper Cowlitz, Cowlitz, Lower Columbia, Grays/Elochoman, Clackamas, and Lower Willamette (NMFS 2005b). There are 48 watersheds within the range of this ESU. Four watersheds received a low rating, 13 received a medium rating, and 31 received a high rating for their conservation value (i.e., for recovery). The lower Columbia River rearing/migration corridor is considered to have a high conservation value and is the only habitat area designated in one of the high value watersheds identified above. This corridor connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults. The Columbia River estuary is a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats. Of the 1,655 miles of habitat eligible for designation, 1,311 miles of stream are designated critical habitat. The lower Columbia River unit includes the estuary, where both juveniles and adults make the critical physiological transition between life in freshwater and marine habitats, but does not otherwise include offshore marine areas.

5.1.4 Puget Sound Chinook

5.1.4.1 Current Rangewide Status of the Species

The Puget Sound Chinook Salmon ESU was listed under the ESA as threatened in March of 1999 (64 FR 14308, NMFS 1999e). This 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 (Figure 5.1.4.1-1). Also included in the ESU are Chinook salmon originating from 26 artificial propagation programs. The majority of Chinook salmon in this area are fall run (also called late) fish that exhibit an ocean-type life history. Although some spring-run (also called early) Chinook salmon populations in the Puget Sound Chinook 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 (Myers et al. 1998). Puget Sound populations all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns (Table 5.1.4.1-1).

The Puget Sound Technical Recovery Team (TRT) identified 22 demographically independent populations within five geographic regions across the ESU, representing the primary historical spawning areas of Chinook salmon (Ruckelshaus et al. 2006) (Figure 5.1.4.1-1). NOAA Fisheries further classified the populations into two broad categories according to the population's life history and production characteristics (Table 5.1.4.1-2). Category 1 watersheds are areas where populations are genetically unique and indigenous to the watershed. Category 2 watersheds are areas where it is believed that indigenous populations no longer exist, but where sustainable wild populations existed at one time. Historically, Category 2 watersheds were intensively managed for hatchery production to mitigate for natural fish production lost to habitat loss and degradation. Consequently, in many of these systems, hatchery-origin fish contribute substantially to natural spawning, and hatchery and natural origin fish are currently indistinguishable on the spawning grounds.

NOAA Fisheries considers these distinctions in genetic legacy and watershed condition in assessing the risks to survival and recovery of proposed actions across populations within the Puget Sound Chinook ESU. It is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct. Populations are defined by their relative isolation from each other, and by the unique genetic characteristics that evolve as a result of that isolation to adapt to their specific habitats. If these are populations that still retain their historic genetic legacy, then the appropriate course to insure their survival and recovery is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires a both sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recovery the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production and provide the opportunity for them to readapt to the existing conditions. The relevance of these distinctions for specific populations is discussed in more detail in the Effects section of this document (Section 7).

Table 5.1.4.1-1. Life history and population characteristics of Puget Sound Chinook salmon (Myers et al. 1998).

Characteristic	Spring	Summer	Fall
Number of extant populations	7	3	12
Life history type	Primarily Ocean	Ocean	Ocean
River entry timing	March-July	June-July	July-August
Spawn timing	July-September	August-September	September-December
Duration in freshwater	1-4 months, a few up to 12 months	1-4 months	1-4 months
Rearing habitat	Tributaries and mainstem in upper river	Mainstem, tributaries in mid-lower river	Mainstem, tributaries in mid-lower river
Ocean migration[1]	WA Coast to West Coast Vancouver Isl.	WA Coast to West Coast Vancouver Isl.	WA Coast to West Coast Vancouver Isl.
Primary age at return	3-4 Years	3-4 Years	3-4 Years
Recovery Goals[2]	7,290+[3]	17,680	34,700+[3]
1999-2007 Average Natural Spawners	5,504	15,140	23,893

[1] Primary distribution – a small percentage are recovered as far north as Alaska (PSC 2008)
[2] Assumes high productivity target goals (NMFS 2006d)
[3] Recovery goals for Skokomish and Green fall and White River spring populations as yet undefined.

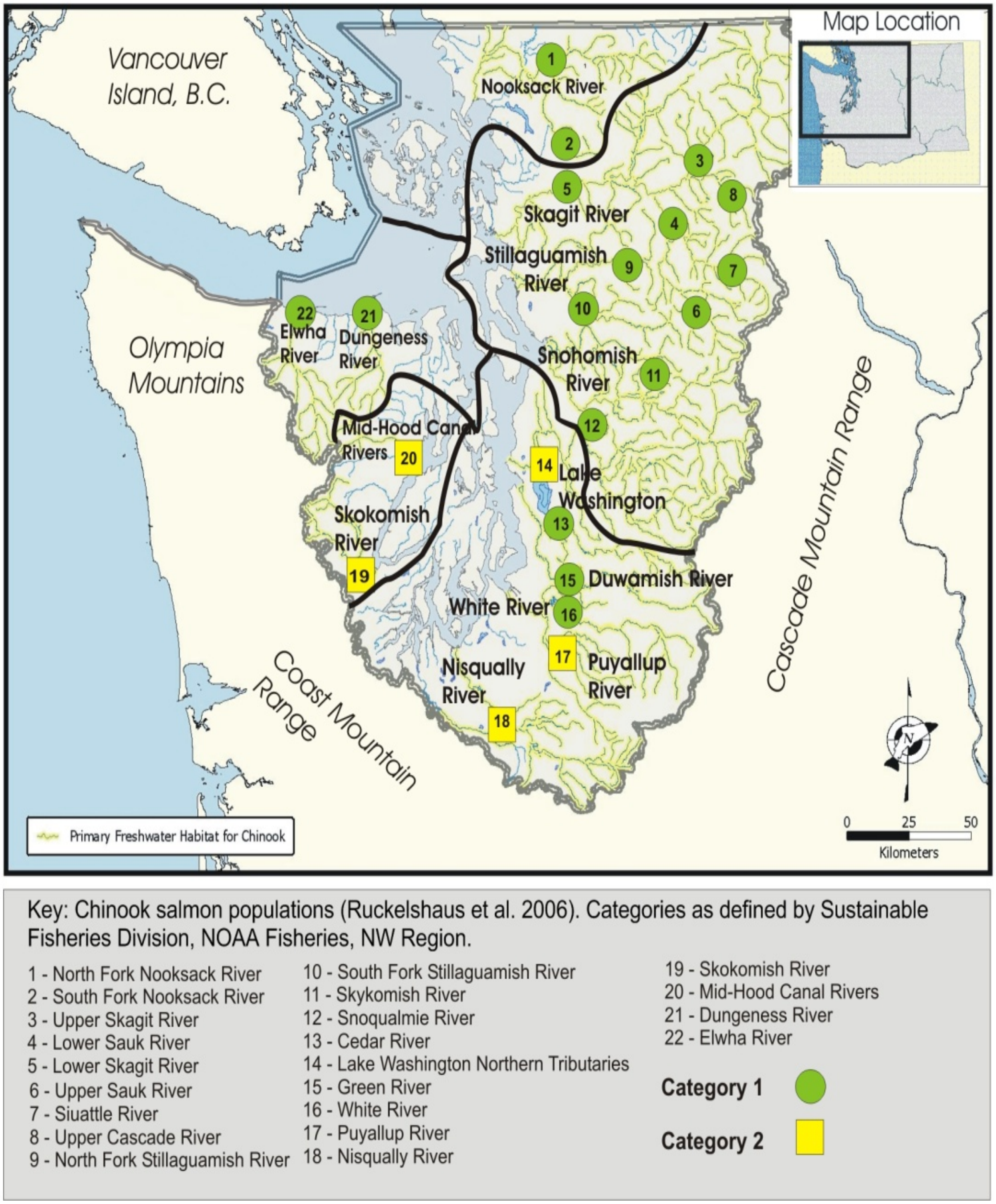


Figure 5.1.4.1-1. Populations of the Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU).

Table 5.1.4.1-2. Puget Sound Chinook populations stratified by geographic region, major life history type, and watershed category (NMFS 2005d; Ruckelshaus et al. 2006).

Geographic Region	Life History Type	Population Category	Population
(1) Strait of Georgia	spring	1	North Fork Nooksack
		1	South Fork Nooksack
(2) Whidbey/Main Basin	spring	1	Upper Cascade
		1	Upper Sauk
		1	Suiattle
	fall	1	Lower Skagit
	summer	1	Upper Skagit
	summer	1	Lower Sauk
	summer	1	North Fork Stillaguamish
	fall	1	South Fork Stillaguamish
	summer/fall	1	Skykomish
		1	Snoqualmie
(3) Southern Basin	fall	2	Sammamish
		1	Cedar
		1	Green
		2	Puyallup
		2	Nisqually
	spring	1	White
(4) Hood Canal	fall	2	Skokomish
		2	Mid-Hood Canal Rivers
(5) Strait of Juan de Fuca	fall	1	Elwha
	spring	1	Dungeness

Limiting Factors and Threats

In general, a wide variety of factors have contributed to the decline of Chinook salmon populations in the Puget Sound area. In some cases, activities identified at the time of listing as factors for decline have received increased attention, and their effects are being reduced. However, the most pervasive risks to improved status of listed salmon require long and difficult efforts to correct, and many actions geared toward reducing the likelihood of extinction still require relatively long periods of time for their positive effects to become noticeable. Bishop and Morgan (1996) identified a variety of habitat-related threats to salmon for streams in the range of this ESU resulting from urbanization, forest, and agricultural practices including (1) changes in flow regime (all basins), (2) sedimentation (all basins), (3) high temperatures (Dungeness, Elwha, Green/Duwamish, Skagit, Snohomish, and Stillaguamish Rivers), (4) streambed instability (most basins), (5) estuarine loss (most basins), (6) loss of large woody debris (Elwha, Snohomish, and White Rivers), (7) loss of pool habitat (Nooksack, Snohomish, and Stillaguamish Rivers), and (8) blockage or passage problems associated with dams or other structures (Cedar, Elwha, Green/Duwamish, Snohomish, and White Rivers). The above activities and habitat modifications have greatly degraded extensive areas of salmon spawning and rearing habitat in the Puget Sound. Chinook salmon stocks are artificially propagated through 42 programs in Puget Sound. Hatchery-origin fish may potentially pose risks to naturally-produced salmon and steelhead in four primary ways: (1) ecological effects, (2) genetic effects, (3) harvest effects, and (4) masking effects. There is currently a shift occurring in hatchery management from augmenting harvest to restoring, maintaining and conserving natural populations of anadromous salmonids. In the past, fisheries in Puget Sound generally were not managed in a manner appropriate for the conservation of naturally spawning Chinook salmon populations. Fisheries exploitation rates were in most cases too high considering the declining productivity of natural Chinook salmon stocks. The co-managers implemented several strategies to manage fisheries to reduce harvest impacts in recent years and to implement harvest objectives that are consistent with the underlying productivity of the affected natural populations (PSIT and WDFW 2004). The declines in fish populations in Puget Sound in the 1980s and into the 1990s may reflect broad-scale shifts in natural limiting conditions, such as increased predator abundances and decreased food resources in ocean rearing areas. Additional information on limiting factors is described for individual populations in the watershed chapters of the Puget Sound Salmon Recovery Plan (Shared Strategy 2007).

Abundance, Productivity and Trends

Overall abundance of Chinook salmon in this ESU has declined substantially from historical levels, and several populations are small enough that genetic and demographic risks are high. In its 1998 status review, NOAA Fisheries noted that the average run size (hatchery + natural) at that time was approximately 240,000 fish with natural spawning escapement averaging 25,000 fish (Myers et al. 1998). Since 1998, natural spawning escapement has increased to an annually average of approximately 46,000 with increases observed in all life history types (spring, summer, fall) (Figure 5.1.4.1-2).

Table 5.1.4.1-3 summarizes the available information on current abundance and productivity and their trends for the Puget Sound Chinook populations including recovery plan targets for abundance and productivity. The information is summarized from the most recent status review of West Coast salmon ESUs (Good et al. 2005), NOAA Fisheries' final supplement to the Puget Sound Salmon Recovery Plan (NMFS 2006) and recent escapement data provided by the co-managers.

Escapement trends for natural Chinook salmon runs in North Puget Sound (Georgia Strait and Whidbey Basin Regions) were predominately negative through the mid-1990s. Escapement trends are now predominantly positive (1990-2007. In South Puget Sound and Hood Canal, escapement trends have been predominantly positive. However, the contribution of hatchery fish to natural escapements in many of the populations, particularly in the latter regions, may be substantial, masking the trends in natural production.

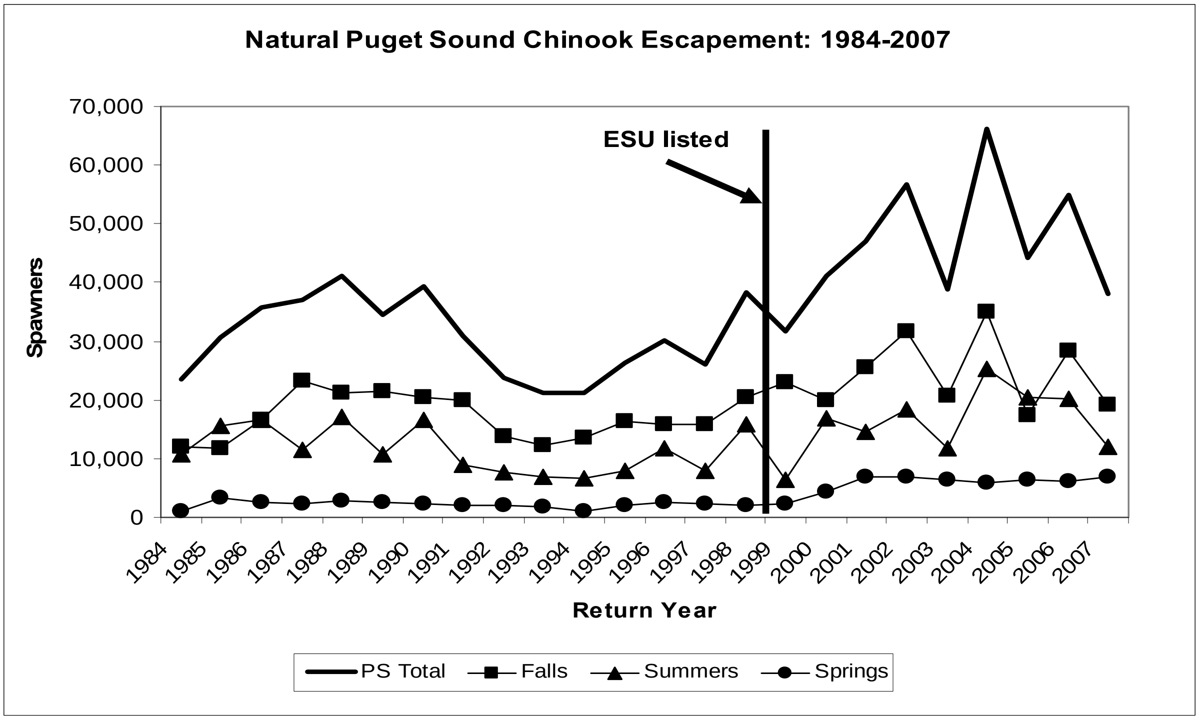


Figure 5.1.4.1-2. Changes in Puget Sound natural escapement over time by timing component.

Since listing, the geometric mean (1999–2007) of natural spawners in populations of Puget Sound Chinook salmon ranges from 143 (Mid-Hood Canal population) to over 11,000 fish (Upper Skagit River population). Just over half of the 22 populations contain natural spawners numbering over 1,000 fish (median recent natural escapement = 1,254 fish); however, only two of those are thought to have a consistently low fraction of hatchery fish (Table 5.1.4.1-3). Estimates of the fraction of natural spawners that are of hatchery origin are currently limited-data are available for 15 of the 22 populations in the ESU, and such information is available or only the most recent 5-10 years and varies greatly in quality (Table 5.1.4.1-3). Based on the available information, the six Skagit populations have very little hatchery contribution to natural spawning. The Cedar, Stillaguamish and Snohomish populations have moderate proportions of naturally spawning hatchery fish. The remainder of the populations have substantial numbers of naturally spawning hatchery fish. Better, more broad-scale information will be become available over the next several years because management agencies have increased marking and monitoring programs to more comprehensively track hatchery fish.

Table 5.1.4.1-3. Estimates of abundance and productivity (indicated by median growth rate) for Puget Sound Chinook populations. Recent natural origin escapement information is provided where available. As noted, for many of the populations, data on hatchery contribution to natural spawning is limited or unavailable.

Region	Population (run timing)	Geometric mean natural spawners 1999-2007 (NOR est.)	Recovery Abundance Target (high productivity)	Recovery Abundance Target (low productivity)	Abundance Trend[a] (1990-2007)	Median Growth Rate[b] (1990-2002)	Average % hatchery fish in escapement 1999-2006 (min-max)[c]
Strait of Georgia	NF Nooksack (early)	1,699 (216)	3,800 (3.4)	16,000 (1.0)	1.25	0.75	87 (77-94)
	SF Nooksack (early)	368 (56)	2,000(3.6)	9,100 (1.0)	1.06	0.94	81 (62-92)
Whidbey Basin	Lower Skagit (late)	2,312	3,900 (3.0)	16,000 (1.0)	1.04	1.05	2 (0-7)
	Upper Skagit (moderately early)	11,061	5,380 (3.8)	26,000 (1.0)	1.07	1.05	4 (2-7)
	Lower Sauk (moderately early)	702	1,400 (3.0)	5,600 (1.0)	1.04	1.01	2 (0-7)
	Upper Cascade (moderately early)	307	290 (3.0)	1,200 (1.0)	1.05	1.06	0 (0-1)
	Upper Sauk (early)	391	750(3.0)	3,030 (1.0)	1.00	0.96	0
	Suiattle (very early)	333	160 (2	610 (1.0)	0.99	0.99	0
	NF Stillaguamish (early)	1,003 (579)	4,000 (3.4)	18,000 (1.0)	1.02	0.92	40 (13-52)[h]
	SF Stillaguamish[d] (moderately early)	163	3,600 (3.3)	15,000 (1.0)	0.93	0.99	Under development
	Skykomish (late)	4,199	8,700 (3.4)	39,000 (1.0)	1.05	0.87	40 (11-66)[h]
	Snoqualmie (late)	2,005	5,500 (3.6)	25,000 (1.0)	1.06	1.00	16 (5-72)[h]
Central/South Sound	Sammamish[d] (late)	248	1,000 (3.0)	4,000 (1.0)	1.00	1.07	Under development
	Cedar[d] (late)	522	2,000 (3.1)	8,200 (1.0)	1.05	0.99	24 (10-34)
	Green (late)	8,647	Unknown	27,000 (1.0)	1.04	0.67	83 (35-100)[h]
	White [de] (early)	1,520	Unknown	Unknown	1.15	1.16	Under development
	Puyallup[d] (late)	1,445	5,300 (2.3)	18,000 (1.0)	0.96	0.95	NA
	Nisqually[d] (late)	1,514	3,400 (3.0)	13,000 (1.0)	1.07	1.04	NA
Hood Canal	Skokomish[d] (late)	1,325	Unknown	Unknown	1.02	1.04	60 (7-95)
	Mid-Hood Canal[df] (late)	143	1,300 (3,0)	5,200 (1.0)	1.01	1.17	Under

							development
Strait of Juan de Fuca	Dungeness[d] (early)	502	1,200 (3.0)	4,700 (1.0)	1.15	1.09	82 (72-96)
	Elwha[dg] (late)	2,015	6,900 (4.6)	17,000 (1.0)	1.00	0.95	NA

[a] Trends are calculated based on all spawners (i.e., including both hatchery and natural origin spawners).
[b] Median growth rate (λ)is calculated assuming the reproductive success of naturally spawning hatchery fish is equivalent to that of natural-origin fish (for those populations where information on the fraction of hatchery fish in natural spawning abundance is available).
[c] Estimates of the fraction of hatchery fish in natural spawning escapements are from the Puget Sound TRT database; Green River estimates are from Alexandersdottir (2001) and co-manager postseason reports on the Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2005); Cedar River estimates are from Paul Hage (pers. comm.. to S. Bishop 2008).
[d] Estimate of the fraction of hatchery fish in time series is not available for use in λ calculation, so trend represents that in hatchery-origin + natural-origin spawners.
[e] Captive broodstock program for early run Chinook salmon ended in 2000; estimates of natural spawning escapement include an unknown fraction of naturally spawning hatchery-origin fish from late- and early run hatchery programs in the White and Puyallup River basins.
[f] The Puget Sound TRT considers Chinook salmon spawning in the Dosewallips, Duckabush, and Hamma Hamma rivers to be subpopulations of the same historically independent population; annual counts in those three streams are variable due to inconsistent visibility during spawning ground surveys.
[g] Estimates of natural escapement do not include volitional returns to the hatchery or those fish gaffed or seined from spawning grounds for broodstock collection.
[h] Estimates of the fraction of hatchery fish in natural spawning escapement not yet available for recent years so taken from Good et al. 2005 (Puget Sound TRT database and co-manager postseason reports on the Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2005).

Nineteen of the 22 Puget Sound Chinook populations exhibit stable or increasing trends in abundance (Table 5.1.4.1-3). In particular, the North Fork Nooksack, White and Dungeness River populations show substantial increasing trends. Estimates of median population growth rate have not been updated for the most recent period, but the current information is probably still reflective of the general trends since escapements have remained at or above those seen in the early 2000s. Trends in growth rate are generally similar to or lower than those for abundance[6] with the number of populations exhibiting stable or increasing trends dropping from 19 to 11. In those cases where hatchery information is available and the fraction of hatchery-origin natural spawners is significant (e.g., North and South Forks Nooksack, Skokomish, Dungeness, and Green rivers), the trend in growth rate is negative, for three of the five populations, compared with an increasing abundance trend. Since the growth rate reflects the performance of the naturally produced fish, the differences likely reflect the influence of degraded habitat and potential negative effects of the intermingled hatchery fish. Growth rates show substantial declining trends for the Green and North Fork Nooksack populations. The populations with the most positive trends in population growth rates are the White River and Dungeness populations.[7] No clear patterns in trends in abundance or growth rate are evident among the five major regions of Puget Sound.

The state and tribal co-managers also completed an analysis of abundance trends as part of the performance review of the current Puget Sound Chinook harvest plan (Beattie 2008). They applied the method of Gieger and Zhang (2002). The method uses back-casting to estimate the escapement in the year prior to the first year in the data series and applies a 5% threshold in annual decline to determine whether an escapement trend is biologically meaningful. The approach requires a 15 or longer year time series, i.e., at least three generations for Chinook salmon. The approach is designed to address limitations in more traditional statistical significance testing of short time series and the context of the volatility of the escapement data to the life history of the species. The results of the co-managers' analysis are summarized in Table 5.1.4.1-4. The abundance trend information from Table 5.1.4.1-3 is presented for comparison.

The co-managers analysis indicated biologically meaningful increasing trends in thirteen of the nineteen populations for which sufficient data were available for the analysis. These trends were observed in all five of the major regions within the ESU. Decreasing trends were observed in the Suiattle, South Fork Stillaguamish, and Puyallup populations, but did not meet the threshold to be biologically meaningful. However, the trend for the

[6] Reproductive success of hatchery fish is assumed to be 1 (see previous discussion in Section 5.1.3.1 regarding calculation of λ from Goode et al 2005). The median estimate of short-term population growth would be lower if the estimates of the fraction of naturally spawning hatchery fish were available for all populations in the ESU since the presence of hatchery fish masks true productivity of the natural population.

[7] The table lists a strong positive growth rate and increasing escapement trend for the Mid-Hood Canal population. However, escapements since 2000 have been less than 200 and escapements in two of the three rivers within the population have been less than 10 in the last three years.

Puyallup population was close to the threshold (4% vs. 5%), but was heavily influenced by substantial increases in escapement during the last two years in the data series. The strongest trends were seen in the White, Lower Skagit, Upper Skagit, and Lower Sauk populations. These results were similar to the abundance trends presented in Table 5.1.4.1-3 except for the Elwha, Lower Skagit, and Sammamish populations which had stable or decreasing rather than increasing trends. Since the data source used was the same, the difference could be due to the different methods or to the longer data period in the analysis presented in Table 5.1.4.1-3.

Table 5.1.4.1-4. Back-casting analysis of escapement trends for Puget Sound Chinook populations where data were available. Abundance trend results from Table 5.1.4.1-3 is included for comparison purposes. Biologically meaningful trends are noted in bold.

Region	Population (run timing)	Abundance Trend[a] (1990-2007) (Good et al. 2005)	Abundance Trend[a] (1993-2007) (Beattie 2008)
Strait of Georgia	NF Nooksack (early)	1.25	NA
	SF Nooksack (early)	1.06	NA
Whidbey Basin	Lower Skagit (late)	0.99	**Increasing**
	Upper Skagit (moderately early)	1.07	**Increasing**
	Lower Sauk (moderately early)	1.04	**Increasing**
	Upper Cascade (moderately early)	1.05	**Increasing**
	Upper Sauk (early)	1.00	Increasing
	Suiattle (very early)	0.99	Decreasing
	NF Stillaguamish (early)	1.02	Increasing
	SF Stillaguamish[c] (moderately early)	0.93	Decreasing
	Skykomish (late)	1.05	Increasing
	Snoqualmie (late)	1.06	**Increasing**
Central/ South Sound	Sammamish[c] (late)	1.00	**Increasing**
	Cedar (late)	1.05	**Increasing**
	Green (late)	1.04	**Increasing**
	White (early)	1.15	**Increasing**
	Puyallup (late)[d]	0.96	Decreasing
	Nisqually (late)	1.07	**Increasing**
Hood Canal	Skokomish (late)	1.02	**Increasing**
	Mid-Hood Canal[b] (late)	1.01	NA
Strait of Juan de Fuca	Dungeness (early)	1.15	**Increasing**
	Elwha[c] (late)	1.00	**Increasing**

[a] Trends are calculated on all spawners.
[b] The Puget Sound TRT considers Chinook salmon spawning in the Dosewallips, Duckabush, and Hamma Hamma rivers to be subpopulations of the same historically independent population; annual counts in those three streams are variable due to inconsistent visibility during spawning ground surveys.
[c] Estimates of natural escapement do not include volitional returns to the hatchery or those fish gaffed or seined from spawning grounds for broodstock collection.
[d] Trend is just below the 5% threshold (0.04) that would be considered biologically meaningful under the applied approach. The trend is influenced by the last two years in the series which had substantially increases in escapement.

NOAA Fisheries has derived critical and rebuilding escapement thresholds for some of the Puget Sound Chinook salmon populations based on an assessment of current habitat and environmental conditions. After taking into account uncertainty, the critical threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000c). The rebuilding threshold is defined as the escapement that will achieve Maximum Sustained Yield (MSY)[8] under current environmental and habitat conditions (NMFS 2000c). Thresholds were based on population-specific data where available. For populations lacking such data, generic guidance from the Viable Salmonid Paper (McElhaney et al. 2000) or alternative analyses based on habitat capacity have been used (NMFS 2005j. These VSP-derived thresholds offer only general guidance as to what generally represents points of population stability or instability. Some populations may be fairly robust at very low abundances, while other populations in large river systems may become unstable at higher abundances depending on resource location and spawner density. However, without population-specific information, NOAA Fisheries believes these generic guidelines used to derive thresholds for some populations offer the best available information. Table 5.1.4.1-5 compares the recent years' average escapements for each population with their respective critical or upper thresholds. Comparisons are made on the basis of natural-origin escapement where data are available.

It is important to note that the rebuilding thresholds represent a level of spawning escapement, consistent with current environmental conditions, that is associated with rebuilding to recovery. For most populations, these thresholds are below the escapement levels associated with recovery (Table 5.1.4.1-3), but achieving these threshold levels is a necessary step to eventual recovery when habitat and other conditions are more favorable than they currently are. Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on improvements in habitat conditions, and reductions in the effects of hatcheries, in addition to the harvest reforms that have been and are being implemented.

[8] MSY is the point on the spawner-recruit curve that represents the maximum number of progeny produced per spawner. It is the curve itself that describes the overall status of the population. The curve represents both the abundance and the productivity of the population. In this context, NOAA Fisheries uses the MSYpoint to represent that curve. As conditions change over time, the curve will change and the MSY point will change with it. For example, the high productivity recovery planning targets for Puget Sound Chinook populations represents the MSY point on a curve associated with greatly improved habitat condition, i.e., productivity (NMFS 2006). As conditions improve, the natural habitat will support more salmon and the rebuilding thresholds will increase, eventually approaching the recovery planning targets.

Average escapements are above critical thresholds for all populations except for the South Fork Nooksack, South Fork Stillaguamish, and Mid-Hood Canal Rivers populations (Table 5.1.4.1-5). Average escapements for the North Fork Nooksack and Sammamish populations are near their critical thresholds. Adult production originating from the conservation program at the Kendall Creek Hatchery contributes extensively to the annual return abundance of the North Fork Nooksack River Chinook population. If escapement of the hatchery-origin fish to the natural spawning grounds is considered, the average spawning escapement is 1,699 fish for the North Fork Nooksack River. Total natural escapement to the South Fork Nooksack River has averaged 371 fish over the same period due to strays from the Kendall Creek and fall Chinook hatchery programs, and North Fork Nooksack early and localized natural-origin South Fork fall Chinook. The Samammish escapement estimate is a conservative estimate of escapement in the area, since a substantial amount of escapement now occurs outside the survey area historically used to estimate escapement. The co-managers are currently evaluating whether and how to revise escapements to take into account this information. If included, the new information could increase escapement estimates by 50 percent or more. Average escapements for thirteen of the twenty-two populations are above their rebuilding thresholds, although hatchery fish contribute substantially to natural escapement for many populations (Table 5.1.4.1-3).

Table 5.1.4.1-5. Recent average annual escapement levels compared with their critical and rebuilding thresholds for Puget Sound Chinook salmon populations. High productivity recovery targets from the Puget Sound Salmon Recovery Plan (NMFS 2006d) are included for comparison.

Region	Population	1999 to 2007 Geometric mean Escapement	Escapement Thresholds Critical [1]	Rebuilding [2]	High Productivity Recovery Planning Target
Georgia Basin	Natural Spawners North Fork Nooksack South Fork Nooksack Natural-Origin Spawner: N. F. Nooksack River S. F. Nooksack	2,067 1,699 368 272 216 56	 400 200[3] 200[3]	 500 - -	 3,800 2,000

Region	Population	1999 to 2007 Geometric mean Escapement	Escapement Thresholds Critical[1]	Rebuilding[2]	High Productivity Recovery Planning Target
	Natural Spawners:				
	Upper Skagit River	11,061	967	7,454	5,380
	Lower Sauk River	702	200[3]	681	1,400
	Lower Skagit River	2,312	251	2,182	3,900
	Upper Sauk River	391	130	330	750
Whidbey/ Main Basin	Suiattle River	333	170	400	160
	Upper Cascade River	307	170	1,250	290
	N.F. Stillaguamish	1,003			
	River	163	200[3]	300	3,600
	S.F. Stillaguamish				
	River	4,199	1,650	3,500	8,700
		2,005	400	1,250[3]	5,500
	Skykomish River[d]				
	Snoqualmie River				
		579	300	552	4,000
	Natural-Origin Spawners:				
	N.F. Stillaguamish River				
	Natural Spawners:				
	Cedar River	522	200[3]	1,250[3]	2,000
Central/South Sound	Sammamish River	248	200[3]	1,250[3]	1,000
	Duwamish-Green	8,647	835	5,523	-
	River	1,520	200[3]	1,100[4]	-
	White River	1,445	200[3]	1,200[4]	5,300
	Puyallup River	1,514	200[3]	1,100[4]	3,400
	Nisqually River				
	Natural Spawners:				
Hood Canal	Skokomish River	1,325	652	1,160	-
	Mid-Hood Canal	143	200[3]	1,250[3]	1,300
	Rivers				
	Natural Spawners:				
Strait of Juan de Fuca	Dungeness River	502	200[3]	925[4]	1,200
	Elwha River	2,015	200[3]	1,250[3]	6,900

[1] Critical threshold under current habitat and environmental conditions.
[2] Rebuilding thresholds under current habitat and environmental conditions
[3] Based on generic VSP guidance
[4] Based on alternative habitat assessment
[d] Estimates of natural-origin escapement availably only for 1999-2002, 2004, and 2007.
[a] Based on alternative habitat based assessment
[b] Based on generic VSP guidance (McElhaney et al. 2000)

Spatial Structure, Diversity and Extinction Risk

As described earlier, the Puget Sound TRT identified five biogeographical regions within the Puget Sound Chinook ESU and associated each of the 22 populations with one of the regions. This structure is summarized in Table 5.1.4.1-4. It also recommended six delisting criteria that would describe a viable ESU (NMFS 2006d): 1) The viability status of all populations is improved from current condition; 2) Two to four populations in each of the regions achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region; 3) At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable; 4) Tributaries not identified as primary habitat are functioning sufficient to support an ESU-wide recovery scenario; 5) Production from tributaries not identified as primary freshwater habitat occurs in a manner consistent with ESU recovery; and, 6) populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery. The TRT determined that all 22 populations are currently at high risk (NMFS 2006d).

Three of the five biogeographical regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which, according to NOAA Fisheries' delisting criteria, must be recovered to viability. The Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually[9] (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006d).

The previous section described the trends and status of populations within the various regions. In general, the Georgia Basin and Hood Canal regions are at greater risk than the other regions due to critically low abundance of at least one of the two populations in the region and declining growth rates for both populations in the Georgia Basin. In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. It is likely that genetic diversity has also been reduced by this habitat loss. The habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2008i; NMFS 2006e; Shared Strategy for Puget Sound 2007; NMFS 2005e).

The diversity of some populations has been eroded further by hatchery and harvest influences and degraded habitat conditions, all of which have contributed to low population sizes and loss of life history types in some areas (NMFS 2008i, 2005e; WDF et al. 1993). Rearing habitat in the region has been significantly reduced particularly at lower elevations due to loss of wetland, nearshore and estuary habitat, removal or

[9] The TRT noted that the Nisqually watershed is in comparatively good condition, and thus the certainty that the population could be recovered is among the highest in the Central/South Region. NOAA Fisheries concluded in its supplement to the Puget Sound Salmon Recovery Plan that protecting the existing habitat and working toward a viable population in the Nisqually watershed would help to buffer the entire region against further risk (NMFS 2006d).

degradation of riparian vegetation, channelization and bank hardening. In particular, the distribution of early-type Chinook salmon life histories (also called spring-type) was historically much wider in the ESU (WDF et al. 1993; Nehlssen et al. 1991). Early Chinook no longer exist in the Hood Canal Region or in most rivers in the Central/South Sound Region where they occurred historically. Of the seven extant early populations, only those in the Whidbey Basin Region are not supported by conservation hatchery programs.[10] Fall Chinook populations in the Central/South Sound, Hood Canal and Strait of Juan de Fuca Regions are sustained predominately by hatchery production. Indigenous fall Chinook in the Sammamish, Puyallup, Nisqually, Skokomish, and Mid-Hood Canal watersheds have been extirpated due to habitat degradation, hatchery introgression and over-fishing. Genetically, most of the present spawning aggregations in the Central/South Sound and Hood Canal Regions are similar, likely reflecting the extensive influence of transplanted hatchery releases, primarily from the Green River population (Ruckelshaus et al. 2006).

5.1.4.2 Current Rangewide Status of Critical Habitat

Designated critical habitat for the Puget Sound Chinook ESU includes estuarine areas and specific river reaches associated with the following subbasins: Strait of Georgia, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie, Snohomish, Lake Washington, Duwamish, Puyallup, Nisqually, Deschutes, Skokomish, Hood Canal, Kitsap, and Dungeness/Elwha (NMFS 2005b). The designation also includes some nearshore areas extending from extreme high water out to a depth of 30 meters and adjacent to watersheds occupied by the 22 populations because of their importance to rearing and migration for Chinook salmon and their prey, The designation does not otherwise include offshore marine areas. There are 61 watersheds within the range of this ESU. Twelve watersheds received a low rating, 9 received a medium rating, and 40 received a high rating of conservation value to the ESU (NMFS 2005e). Nineteen nearshore marine areas also received a rating of high conservation value. Of the 4,597 miles of stream and nearshore habitat eligible for designation, 3,852 miles are designated critical habitat (NMFS 2005b).

In the Puget Sound areas designated as critical habitat, major management activities affecting PCEs are forestry, grazing, agriculture, channel/bank modifications, road building/maintenance, urbanization, sand and gravel mining, dams, irrigation impoundments and withdrawals, river, estuary, and ocean traffic, wetland loss, and forage fish/species harvest (NMFS 2005e).

[10] A captive brood program began in 2007 for the South Fork Nooksack population.

5.2 Chum Salmon

5.2.1 Hood Canal Summer-Run Chum

5.2.1.1 Current Rangewide Status of the Species

The Hood Canal summer-run chum ESU was listed as threatened in March of 1999 (NMFS 1999h). The ESU has two geographically distinct regions: the Strait of Juan de Fuca and Hood Canal. Summer chum in the two regions share similar life history traits, they are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends. The Puget Sound TRT designated two populations in the ESU corresponding to the two distinct regions and multiple sub-populations (Sands et al. 2007). Of the sixteen sub-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 sub-populations are well distributed throughout the ESU except for the eastern side of Hood Canal (WDFW and PNPTT 2000). Historical information and habitat characteristics of other streams indicate summer chum were once more broadly distributed within the Hood Canal region.

In addition, eight artificial propagation programs are considered part of the ESU. Both the Strait of Juan de Fuca and Hood Canal populations will need to be recovered in order to delist the ESU (NMFS 2007b). In addition, criteria have been established for the sub-populations in order to restore spatial structure and diversity (Sands et al. 2007; NMFS 2007b; WDFW and PNPTT 2000). Differences in environmental conditions and some life history traits exist between the two populations and among the subpopulations within each major population group (Figure 5.2.1.1-1). Adults returning to the Strait of Juan de Fuca streams may enter the Strait of Juan de Fuca earlier than the Hood Canal aggregations. Freshwater adult entry is approximately a week earlier for the Union River subpopulation in southern Hood Canal than for the northern Strait of Juan de Fuca subpopulations. Fry emergence is later for the systems with colder incubation temperatures. Fry from Strait of Juan de Fuca streams emerge later than those in Hood Canal and fry from the west side Hood Canal streams which are mainly snow-melt fed emerge later than those on the Kitsap Peninsula which are warmer, rainfall-fed streams (WDFW and PNPTT 2000) as summarized in Sands et al. 2007).

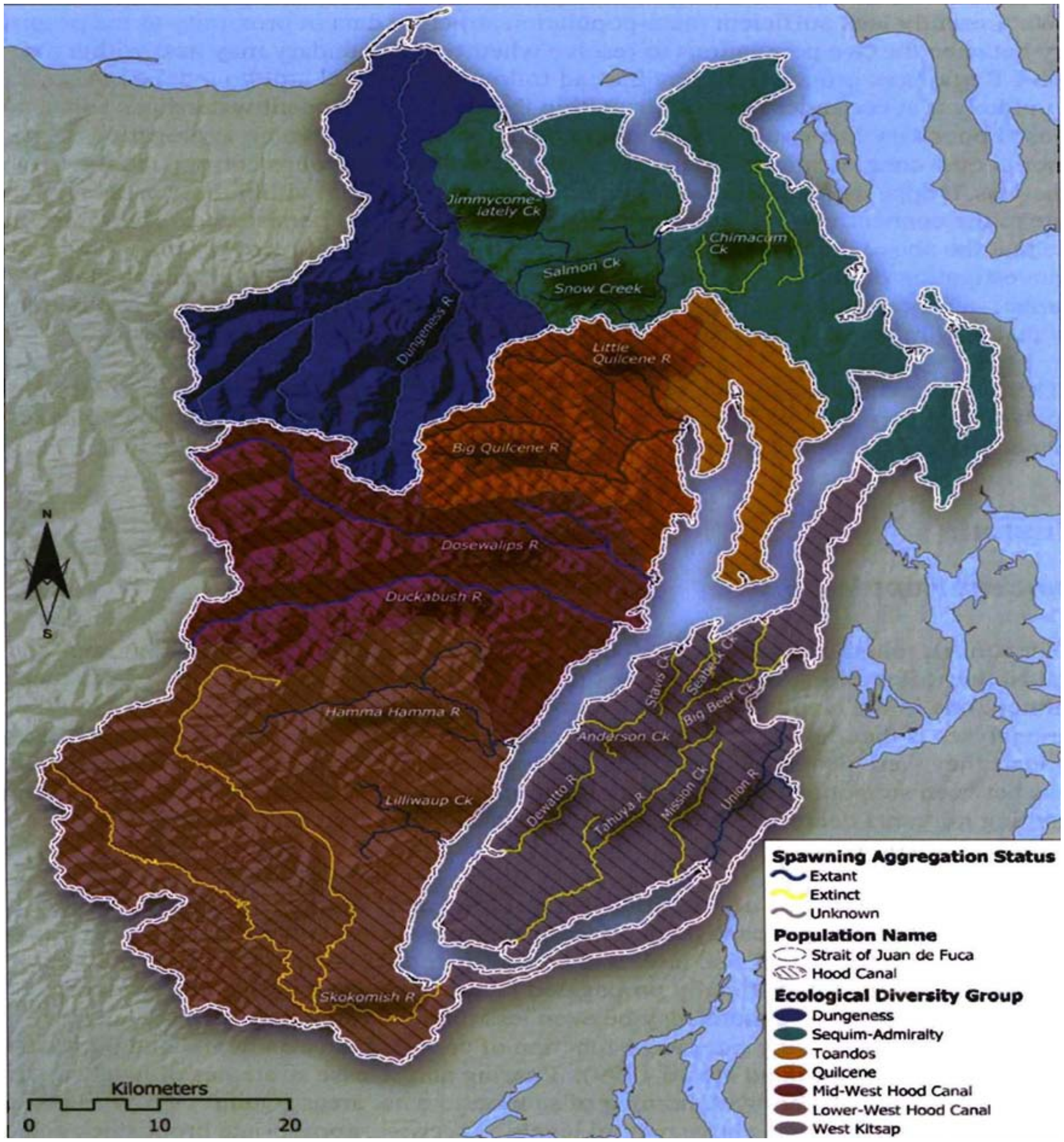


Figure 5.2.1.1-1. The two Hood Canal summer chum populations, sub-populations and ecological diversity groups within the Hood Canal Summer-run Chum ESU (from Sands et al. 2007)

Summer chum salmon spawn from late August through late October, and are "uniquely adapted to exploit spawning habitat when river and stream levels are typically low and before other populations and species of salmon return to spawn" (Sands et al. 2007). Fry emerge from the gravel between early February and May (with peak emergence in March). Emerged fry travel almost immediately downstream where they begin a relatively rapid seaward emigration through nearshore marine environments in Hood Canal and bay estuaries. It appears that survival during this short period of early estuarine and nearshore residence is one critical factor determining the size of the subsequent adult run. After leaving their natal estuaries, summer chum juveniles likely outmigrate in schools along the shorelines of Hood Canal, Admiralty Inlet, and the eastern Strait of Juan de Fuca, and then north and westward through the Strait of Juan de Fuca to reach northeastern Pacific Ocean rearing areas (Tynan 1997; WDFW and PNPTT 2000; HCCC 2005). Juveniles enter seawater by late April and early June for the Hood Canal and Strait of Juan de Fuca subpopulation, respectively (WDFW and PNPTT 2000).

Table 5.2.1.1-1. Life history and population characteristics of Hood Canal Summer-run Chum salmon (Sands et al. 2007; WDFW and PNPTT 2007; Johnson et al. 2006, 2007).

Population	Subpopulation	Emergence Timing	Historical Spawn timing	Average Age at Return
Strait of Juan de Fuca		February-May (mid-March peak)		
	Dungeness		Unk	3.7
	Jimmycomelately		mid-September to early October	3.3
	Salmon/Snow		mid-September to mid-October	3.4
	Chimicum		Unk	3.4
Hood Canal		February-April (early April peak)		
	B. Quilcene/L. Quilcene		September	3.4
	Dosewallips		mid-September to early October	3.7
	Duckabush		mid-September to early October	3.6
	Hamma Hamma		mid-September to early October	3.6
	Lilliwaup		mid-September to early October	3.3
	Dewatto		Unk	3.2
	Big Beef		Unk	3.2
	Union		September	3.3
	Skokomish		Unk	3.7
	Tahuya		Unk	3.0

Summer chum mature primarily at three and four years of age, with low numbers returning at ages two and five. Little is known about the details of the ocean migration and distribution of salmon from the Hood Canal Summer-run chum ESU. Some data suggests that Puget Sound chum, including those in the ESU, 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). 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 (WDFW and PNPTT 2000). 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 (WDFW and PNPTT 2000).

Supplementation programs were instituted in 1992 for the Big/Little Quilcene, the Hamma Hamma and Lilliwaup stocks due to the assessment of high risk of extinction for these stocks (WDFW and PNPTT 2000).Re-introduction programs have been started in several areas where summer chum existed historically. The fraction of naturally spawning hatchery fish exceeds 60 percent for some populations indicating the supplementation programs have been successful at increasing the numbers of naturally spawning fish. Four of the programs (Big/Little Quilcene, Union, Chimacum, Snow/Salmon) were terminated in 2003 after achieving their objectives (WDFW and PNPTT 2007). For the ESU, natural origin fish accounted for 54% to 83% of the natural summer chum escaping from 2001 to 2006, increasing to recent years where it has averaged 78% (WDFW and PNPTT 2007; Johnson et al. 2006, 2007).

Limiting Factors and Threats

Three primary factors combined to cause the observed decline of the Hood Canal summer chum ESU in the 1980s and early 1990s: habitat loss; fishery over-exploitation; and, climate related changes in stream flow patterns (WDFW and PNPTT 2000). Individual stocks likely have been differentially impacted by these identified factors for decline. The widespread degradation and loss of lower floodplain, estuary, and nearshore marine habitat has harmed ESU spatial structure and connectivity. Several key habitat factors were identified as degraded in nearly all watersheds (HCCC 2005); (1) degraded forest conditions along streams used by summer chum; (2) stream-side development, water withdrawal, and channel manipulations; (3) reduced floodwater storage due to diking; and, (4) sub-estuary development resulting in loss or degradation of summer chum rearing habitat. Shoreline development (bulkhead and dock construction) may threaten summer chum habitat at the scale of the entire ESU. Fishery exploitation rates in the 1980s in excess of 50% were too high for the natural productivity of Hood Canal summer chum salmon. Beginning in the mid-1990s, the co-managers limited total exploitation rates to 9 and11% on Strait of Juan de Fuca and Hood Canal stocks, respectively, to allow the rebuilding of these stocks (WDFW and PNPTT 2000).

Abundance, Productivity and Trends

Although the populations all share generally 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. Table 5.2.1.1-2 summarizes abundance and productivity trends for the populations and subpopulations within the ESU. While abundance was high throughout the ESU in the late 1970s, abundance for most summer chum populations in Hood Canal declined rapidly beginning in 1979. 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. Average abundances and abundance trends have been sharply increasing since the mid-1990s (Table 5.2.1.1-2) with escapements since listing orders of magnitude higher than prior to listing. Supplementations programs have generally been quite successful at increasing the number of returning adults as seen from the significant increases in escapement and, for some populations, the moderate to high rates of hatchery contribution to escapement. The programs in the Hamma Hamma and Lilliwaup rivers have been hampered by an inability to collect sufficient broodstock. However, the moderate levels of hatchery contribution and strong productivity values indicate that natural-origin returns are contributing significantly in eight of the ten subpopulations for which data are available and that all extant components of both populations are well in excess of replacing themselves. Natural-origin contribution rates are higher in the most recent years in the data series and should continue to increase given the termination of four of the eight supplementation programs and continuing high productivity rates.

Table 5.2.1.1-2. Available information on abundance and productivity for Hood Canal summer-chum populations. Recent natural origin escapement information is provided where available (Sands et al. 2007; Johnson et al. 2006, 2007; WDFW and PNPTT 2007).

Population	Subpopulation	Geometric mean natural spawners		Recovery Goals (Abund/Escap)	Abundance Trend[a] (1992-2007)	Avg Productivity (1996-00 Broods)	Average % hatchery fish in escapement 2001-2006 (min-max)
		1990-98	1999-2007				
Strait of Juan de Fuca		549	3,025	4,500-18,500	1.24		
	Jimmycomelately[1]	149	637	520/330	1.19	5.8	60% (3-96%)
	Salmon/Snow[1]	587	4088	1,560/970	1.23	4.2	33% (32-66%)
	Chimacum[25]		878	NA			64% (59-85%)
Hood Canal		2,212	15,892	18,300-24,700	1.19		
	Big/Little Quilcene[13]	2980	10,217	4,570/2,860	1.19	3.2	22% (6-52%)
	Dosewallips[4]	1,265	3,283	3,080/1,930	1.19	6.1	13% (8-24%)
	Duckabush[4]	589	1,976	3,290/2,060	1.15	5.7	18% (9-33%)
	Hamma Hamma[1]	246	1,506	6,060/3,790	1.23	6.4	24% (6-55%)
	Lilliwaup[1]	59	616	3,130/1,960	1.24	6.9	81% (55-96%)
	Dewatto	6	22	NA			
	Big Beef[15]		807	NA			93% (91-100%)
	Union[1]	392	3,105	550/340	1.22	5.9	23% (0-44%)
	Skokomish		12				
	Tahuya	2	231				

1Escapement includes broodstock taken for reintroduction and supplementation programs
2 Starts with 1999 returns
3 Includes significant hatchery contribution in some years.
4. Sampled for adipose clips but not otolith marks in 2001 so hatchery contribution likely underestimated in these years.
5 Big Beef and Chimicum are reintroduction programs. Supplementation programs influenced escapement for the Big/Little Quilcene, Lilliwaup,. Hamma Hamma, Snow/Salmon, and Jimmycomelately systems. Big/Little Quilcene, Snow/Salmon, and Chimicum programs were terminated in 2004 (2003 brood year) after meeting their objectives.
6 Subpopulation goals are interim recovery goals providing a logical intermediate step in reaching the long term population goals.

Spatial Structure, Diversity and Extinction Risk

Both spatial structure (connectivity of the subpopulations) and diversity (number and relative abundance of subpopulations) have decreased for both populations in the ESU (Sands et al. 2007; WDFW and PNPTT 2000). As discussed earlier, the historic distribution of summer chum in streams within both populations was broader than currently observed, particularly along the east side of Hood Canal. Based on the historical size of the river and historical tribal fishing records, a major spawning aggregation may once have occurred in the Skokomish River. State and tribal biologists also identified recent extirpations in Big Beef Creek, Anderson Creek, Dewatto River, Tahuya River and Finch Creek. Although the magnitude or frequency of spawning in other streams (Seabeck, Stavis, Big and Little Mission Creeks) is unknown, these smaller streams were also likely historically used by summer chum salmon (WDFW and PNPTT 2000). In the Strait of Juan de Fuca, summer chum in Chimicum Creek were extirpated. There were no systematic surveys for summer chum salmon in the Dungeness River until recent years. However, their presence was routinely noted during escapement surveys for other species. The status of the summer chum population in the Dungeness River is therefore unknown. As described earlier, the co-managers have implemented re-introduction programs in streams where summer chum occurred historically to restore spatial structure and diversity in both populations. The recovery criteria for spatial structure is that: 1) subpopulations are distributed across the historical range of the populations; 2) most subpopulations are within 20 kilometers of adjacent subpopulations; and, 3) major subpopulations are not more than approximately 40 kilometers apart (NMFS 2007b; Sands et al. 2007).

The Puget Sound TRT used two abundance-based indices to assess diversity within the two populations (Sands et al. 2007). For the Strait of Juan de Fuca population, the diversity indices declined during the 1980s and 1990s and now show recent increases. The average over the 1974-1978 period, when the diversity was relatively constant, for the Simpson index is 63% and for the Shannon index is 1.05. The averages for recent years (2001-2005), where an increase is observed, are 45% and 0.86, respectively, and appear to indicate a trajectory toward the earlier levels (Figure 5.2.1.1-2). For the Hood Canal population, diversity values declined during the 1980s and 1990s and show recent increases since about 2000. The average over the 1974-1985 period, when diversity was relatively high and stable, was 80% for Simpson index and 1.86 for the Shannon index. The averages for recent years (2001-2005), where an increase is observed, are 74% and 1.6, respectively, and appear to indicate a trajectory toward the early period averages (Figure 5.2.1.1-3). The recovery criteria for diversity is that, depending on the geographic extent and ecological context of the populations, one or more subpopulations are persistent from each of the two to four major ecological diversity groups historically present within the two populations (NMFS 2007b; Sands et al. 2007).

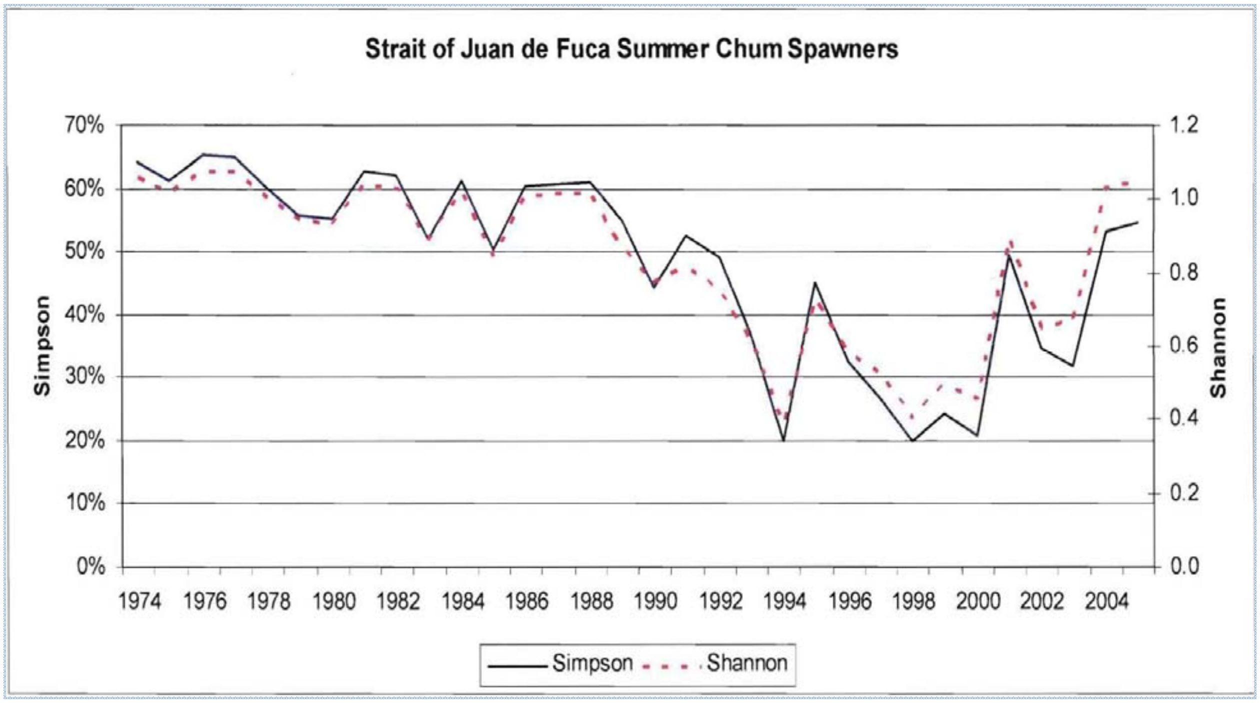


Figure 5.2.1.1-2. Diversity indices for the Strait of Juan de Fuca population. Indices are estimated over the 5 subpopulations in this population (from Sands et al. 2007).

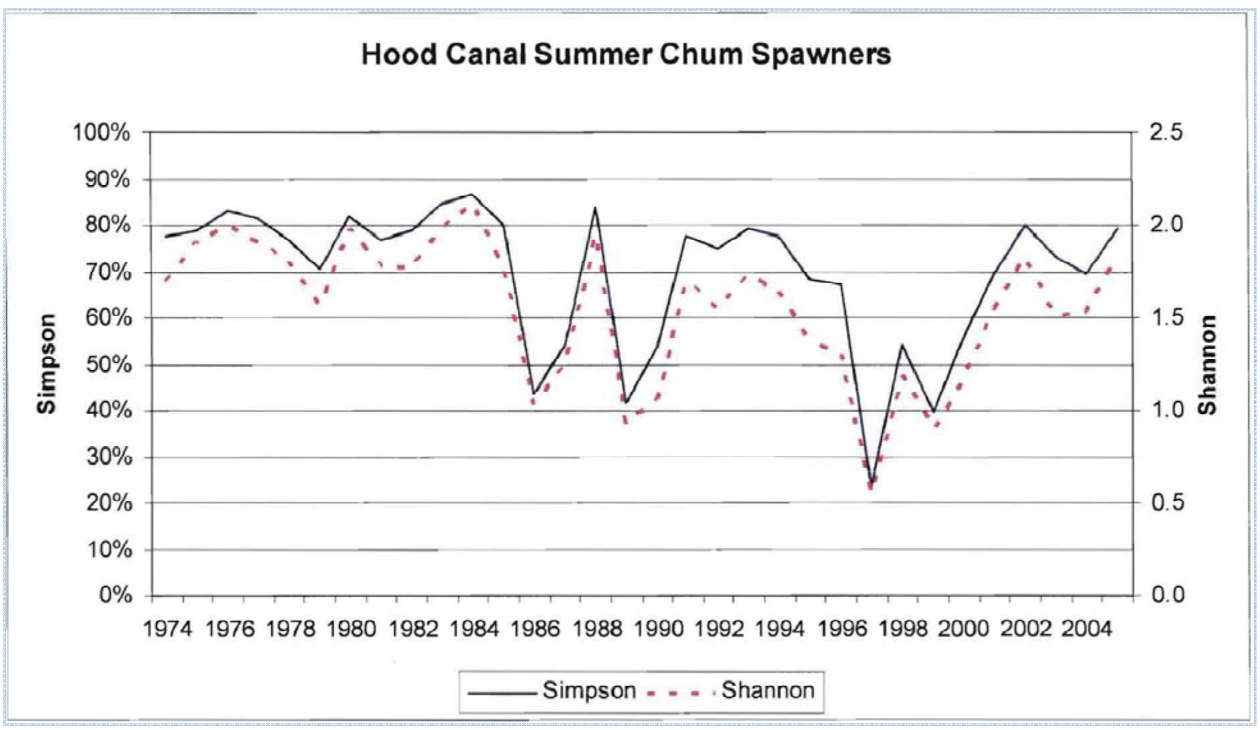


Figure 5.2.1.1-3. Diversity indices for the Hood Canal population. Indices are estimated over the twelve subpopulations in the population (from Sands et al. 2007).

The extinction risk faced by individual summer chum stocks is assessed periodically by the co-managers (WDFW and PNPTT 2000). The most recent assessment was conducted in 2007 using information through 2004. The methods used to assess extinction risk result in the ranking of individual stocks into one of four categories: very high, high, moderate, and special concern. For the purposes of assessment, a “low” category was added for defining stocks that did not fit any of the above categories and are not at risk of extinction. By 1992, six of the twelve summer chum stocks known to have inhabited Hood Canal were extinct, and six were rated at moderate or high risk of extinction; one of the four Strait of Juan de Fuca stocks was extinct, two were rated at high risk of extinction, and one was of unknown status.

Extinction risks for all extant stocks have decreased since the onset of recovery activities, with increases in population sizes, and effective population sizes per generation greater than 500 for all but two stocks. In addition, three stocks have been reintroduced into watersheds where the indigenous stock was extinct, further reducing the extinction risk for the donor stocks and reinitiating natural summer chum production in these streams. Table 5.2.1.1-3 summarizes extinction risk criteria based on escapement data from the four years (one generation) before onset of recovery activities, and from the most recent assessment (2001-2004).

Table 5.2.1.1-3. Mean escapement, effective population size, total population size, population trend and extinction risk rating for Hood Canal and Strait of Juan de Fuca summer chum sub-populations for the 4 years preceding implementation of recovery actions, and the most recent years at the time the assessment was made.

Stock	Escapement (4-year mean)	Effective Population Size (Ne)	Total Population Size (N)	Population Trend	Risk Rating
Union					
1988-1991	391	281	1,406	Stable	Moderate
2001-2004	5,064	3,646	18,230	Increasing	Low
Lilliwaup					
1988-1991	88	63	315	Chronic decline/depression	High
2001-2004	580	418	2,088	Increasing	Moderate
Hamma Hamma					
1988-1991	154	111	555	Chronic decline/depression	High
2001-2004	1,775	1,278	6,390	Increasing	Low
Duckabush					
1988-1991	175	126	631	Chronic decline/depression	High
2001-2004	2,995	2,156	10,780	Increasing	Low
Dosewallips					
1988-1991	234	168	842	Chronic decline/depression	High
2001-2004	5,308	3,822	19,109	Increasing	Low
Big/Little Quilcene					
1988-1991	89	64	319	Chronic decline/depression	High
2001-2004	15,437	11,115	55,572	Stable/increasing	Low
Snow/Salmon					
1989-1992*	283	204	1,018	Precipitous decline	High
2001-2004	5,303	3,818	19,091	Increasing	Low
Jimmycomelately					
1989-1992*	244	176	879	Precipitous decline	High
2001-2004	603	439	2,196	Increasing	Moderate
Dungeness	No data	N/A	N/A	N/A	Special concern

*1989-1992 escapement values used due to later onset of decline of Strait of Juan de Fuca stocks.

5.2.1.2 Current Rangewide Status of Critical Habitat

Designated critical habitat for the Hood Canal summer-run Chum Salmon ESU includes estuarine areas and specific river reaches associated with the following subbasins: Skokomish, Hood Canal, Kitsap, Dungeness/Elwha (NMFS 2005b). The designation also includes some nearshore areas from extreme high water out to a depth of 30 meters and adjacent to watersheds occupied by the ESU because of their importance to rearing and migration for chum salmon and their prey, but does not otherwise include offshore marine areas. There are 12 watersheds within the range of this ESU. Three watersheds received a medium rating and nine received a high rating of conservation value to the ESU (NMFS 2005e). None of the watersheds was considered of low conservation value, primarily because approximately half of the historical populations in this ESU have been extirpated, and the remaining populations occupy a limited area (NMFS 2005e). Five nearshore marine areas also received a rating of high conservation value. Of the 490 miles of stream and nearshore habitat eligible for designation, 456 miles are designated critical habitat (NMFS 2005b).

In the areas designated critical habitat, major management activities affecting PCEs are forestry, agriculture, channel/bank modifications, road building/maintenance, urbanization, sand and gravel mining, dams, river, estuary, and ocean traffic, beaver removal, and forage fish/species harvest (NMFS 2005e).

5.3 Southern Resident Killer Whales

5.3.1 Current Rangewide Status of the Species

The Southern Resident killer whale DPS was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). Southern Residents are designated as "depleted" and "strategic" under the Marine Mammal Protection Act (MMPA) (68 FR 31980; May 29, 2003). The final recovery plan for Southern Residents was issued in January of 2008 (NMFS 2008n). This section summarizes information taken largely from the recovery plan, as well as new data that became available more recently. For more detailed information about this DPS, please refer to the Final Recovery Plan for Southern Resident Killer Whales, which can be found on the internet at www.nwr.noaa.gov.

Range and Distribution

Southern Residents are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia (Figure 5.3.1-1).

Figure 5.3.1-1. Geographic Range (light shading) of the Southern Resident Killer Whale DPS. Source: Wiles 2004.

There is limited information on the distribution and habitat use of Southern Residents along the outer Pacific Coast. Southern Residents are highly mobile and can travel up to 86 nmi (160 km) in a single day (Erickson 1978; Baird 2000). To date, there is no evidence that Southern Residents travel further than 50 km offshore (Ford et al. 2005).

Southern Residents spend considerable time from late spring to early autumn in inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound) (Bigg 1982; Ford et al. 2000; Krahn et al. 2002) (Table 5.3.1-1). Typically, J, K and L pods are increasingly present in May or June and spend considerable time in the core area of Georgia Basin and Puget Sound until at least September. During this time, pods (particularly K and L) make frequent trips from inland waters to the outer coasts of Washington and southern Vancouver Island, which typically last a few days (Ford et al. 2000).

Late summer and early fall movements of Southern Residents in the Georgia Basin have remained fairly consistent since the early 1970s, with strong site fidelity shown to the region as a whole. However, presence in inland waters in the fall has increased in recent years (NMFS 2008n, Table 5.3.1-1). During early autumn, J pod in particular expands their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Osborne 1999). During late fall, winter, and early spring, the ranges and movements of the Southern Residents are less known. Sightings through the Strait of Juan de Fuca in late fall suggest that activity shifts to the outer coasts of Vancouver Island and Washington (Krahn et al. 2002).

The Southern Residents were formerly thought to range southward along the coast to about Grays Harbor (Bigg et al. 1990) or the mouth of the Columbia River (Ford et al. 2000). However, recent sightings of members of K and L pods in Oregon (in 1999 and 2000) and California (in 2000, 2003, 2005, 2006 and 2008) have considerably extended the southern limit of their known range (NMFS 2008e). There have been 45 verified sightings or strandings of J, K or L pods along the outer coast from 1975 to present with most made from January through April (Table 5.3.1-2). These include 16 records off Vancouver Island and the Queen Charlottes, 15 off Washington, 4 off Oregon, and 10 off central California. Most records have occurred since 1996, but this may be because of increased viewing effort along the coast in recent years. Some sightings in Monterey Bay, California have coincided with large runs of salmon, with feeding witnessed in 2000 (Black et al. 2001). However, when Southern Residents were sighted in Monterey Bay during 2008, salmon runs were expected to be very small. L pod was also seen feeding on unidentified salmon off Westport, Washington, in March 2004 during the spring Chinook run in the Columbia River (M. B. Hanson, pers. obs., in Krahn et al. 2004).

Table 5.3.1-1. Average number of days spent by Southern Resident killer whales in inland and coastal waters by month, 2003-2007 (Hanson and Emmons, unpubl. Report 2008).

Months	Lpod		Jpod		Kpod	
	Days Inland	Days Coastal	Days Inland	Days Coastal	Days Inland	Days Coastal
Jan	5	26	3	29	8	23
Feb	0	28	4	24	0	28
March	2	29	7	24	2	29
April	0	30	13	17	0	30
May	2	29	26	5	0	31
June	14	16	26	5	12	18
July	18	13	24	7	17	14
Aug	17	15	17	15	17	14
Sep	20	10	19	11	17	13
Oct	12	19	14	17	8	24
Nov	5	25	13	17	7	23
Dec	1	30	8	23	10	21

Table 5.3.1-2. Known sightings of Southern Resident killer whales along the outer Pacific Ocean coast (NMFS 2008n).

Date	Location	Identification	Source	Comments
British Columbia outer coast				
31 Jan 1982	Barkley Sound, west coast of Vancouver Island	L pod	J. Ford, PBS/DFO	Off shore of Sound
21 Oct 1987	Coal Harbor, north Vancouver Island	Part of L pod	J. Ford, PBS/DFO	Were way up inlet a long distance from open ocean
3 May 1989	Tofino, west coast of Vancouver Island	K pod	WMSA	--
4 July 1995	Hippa Is., south Queen Charlotte Islands	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
May 1996	Cape Scott, north Vancouver Island	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
4 Sep 1997	Off Carmanah Point, sw Vancouver Island	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
14 Apr 2001	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
27 Apr 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
12 May 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
30 May 2003	Langara Is., Queen Charlotte Islands	L pod	M. Joyce, DFO	
17 May 2004	Tofino, west coast of Vancouver Island	K and L pods	M. Joyce, DFO	
9 June 2005	West of Cape Flattery, Washington in Canadian waters	L pod	SWFSC	Whales were exiting the Strait of Juan de Fuca
7 Sep 2005	West of Cape Flattery, Washington in Canadian waters	L pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
18 Mar 2006	North of Neah Bay, Washington in Canadian waters	J pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
8 May 2006	Off Brooks Peninsula, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
1 Dec 2006	Johnstone Strait	L pod	J. Ford PBS/DFO	
Washington Outer Coast				
4 Apr 1986	Off Westport/Grays Harbor	L pod	J. Ford, PBS/DFO	
13 Sep 1989	West of Cape Flattery	L pod	J. Calambokidis, Cascadia	

Date	Location	Identification	Source	Comments
			Research	
17 Mar 1996	3 km offshore Grays Harbor	L pod	J. Calambokidis, Cascadia Research	
20 Sep 1996	Off Sand Point (29 km south of Cape Flattery)	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
15 Apr 2002	Long Beach	L60	D. Duffield, Portland State Univ.	Stranded whale identified by K. Balcomb, CWR
11 Mar 2004 **13 Mar 2004**	Grays Harbor Off Cape Flattery	L pod J pod	B. Hanson, NWFSC B. Hanson, NWFSC	Whales were exiting Strait of Juan de Fuca
22 Mar 2005	Fort Canby-North Head	L pod	J. Zamon, NWFSC	
23 Oct 2005	Off Columbia River	K pod	SWFSC, Cscape	
29 Oct 2005	Off Columbia River	K and L pods	SWFSC, Cscape	
1 Apr 2006	Westport	L pods	PAL	
6 Apr 2006	Westport	K and L pods	Cascadia Research	
13 May 2006	Westport	K and L pods	PAL	
26 May 2006	Westport	K pod	PAL	
29 May 2006	Westport	K pod	PAL	
Oregon				
Apr 1999	Off Depoe Bay	L pod	J. Ford, PBS/DFO	
Mar 2000	Off Yaquina Bay	L pod	J. Ford, PBS/DFO	Seen week of Mar 20
14 Apr 2000	Off Depoe Bay	Southern Residents	K. Balcomb, CWR	
30 Mar 2006	Off Columbia River	K and L pods	B. Hanson, NWFSC	
California				
29 Jan 2000	Monterey Bay	K and L pods	N. Black, MBWW	Seen and photographed feeding on fish
13 Mar 2002	Monterey Bay	L pod	N. Black, MBWW	
16 Feb 2005	Farallon Is	L pod	K. Balcomb, CWR	
26 Jan 2006	Pt. Reyes	L pod	S. Allen	
24 Jan 2007	San Francisco Bay	K pod	N. Black, MBWW	
18 Mar 2007	Fort Bragg	L pod		Reported on CWR website
24-25 Mar 2007	Monterey	K and L pods		Reported on CWR website
30 Oct 2007	Bodega Bay	L pod	Cascadia Research	
27 Jan 2008	Monterey	L pod	N. Black/K. Balcomb	
2 Feb 2008	Monterey	K and L pods	N. Black/K. Balcomb	

Limiting Factors and Threats

Several potential factors identified in the final recovery plan for Southern Residents may have caused the decline or may be limiting recovery of the DPS. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel effects. Oil spills are also a potential risk factor for this species. Research has yet to identify which threats are most significant to the survival and recovery of Southern Residents. It is likely that multiple threats are acting in concert to impact the whales.

Prey

Healthy killer whale populations depend on adequate prey levels. A discussion of the prey requirements of Southern Residents is followed by an assessment of threats to the quality and quantity of prey available.

Prey Requirements

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Scheffer and Slipp 1948; Ford et al. 1998, 2000; Ford and Ellis 2006; Saulitis et al. 2000), but salmon are identified as their preferred prey (96 percent of prey consumed during spring, summer and fall, from long-term study of resident killer whale diet; Ford and Ellis 2006). Feeding records for Southern and Northern Residents show a strong preference for Chinook salmon (72 percent of identified salmonids) during late spring to fall (Ford and Ellis 2006). Chum salmon (23 percent) are also taken in significant amounts, especially in autumn. Other salmon eaten include coho (2 percent), pink (3 percent) steelhead and sockeye (*O. mykiss*, *O. nerka* < 1 percent). The non-salmonids included Pacific herring, sablefish, Pacific halibut, quillback and yelloweye rockfish. Chinook were preferred despite the much lower abundance of Chinook in the study area in comparison to other salmonids (primarily sockeye), probably because of the species' large size, high fat and energy content and year-round occurrence in the area. Killer whales also captured older (i.e., larger) than average Chinook (Ford and Ellis 2006).

Southern Residents are the subject of ongoing research, including direct observation, scale sampling and fecal sampling. Preliminary results of this research provide the best available scientific information on diet composition of Southern Residents in inland waters – the results are specific to Southern Residents, are based on direct observation, and produce three different lines of evidence. This research provides information on (1) the percentage of Chinook in the whales' diet, (2) the predominant river of origin of those Chinook, and (3) the age and/or size of the Chinook. Some of this information is supported by other research and analysis. The results are specific to inland waters.

Percentage of Chinook

From May to September, when Southern Residents spend a high proportion of their time in the "core summer area" (San Juan Islands), their diet consists of approximately 86 percent Chinook salmon and 14 percent other salmon species (n=125 samples; Hanson et al. 2007a; NWFSC unpubl. data). During all sampling months combined (roughly May to December) their diet is approximately 69 percent Chinook and 31 percent other salmon species (n=160 samples in inland waters). During fall months in inland waters, when some Southern Residents are sighted inside Puget Sound, preliminary results indicate an apparent shift to chum salmon (Hanson et al. 2007a; NWFSC unpubl. data).

These data on the predominance of Chinook in the whales' diet are consistent with all previous studies of Southern and Northern resident killer whale diet composition, described above. Killer whales may favor Chinook salmon because Chinook have the highest lipid content (Stanby 1976; Winship and Trites 2003), largest size, and highest caloric value per kg of any salmonid species (Osborne 1999; Ford and Ellis 2006). The preference of Chinook salmon may also relate to size-selectivity. When available, Chinook salmon tend to be consumed more often than chum salmon (2^{nd} largest, Ford and Ellis 2006), and chum salmon appear to be favored over pink salmon (Saulitus et al. 2000).

River of Origin

The ongoing research provides insight into the river of origin of Chinook consumed by the Southern Residents. Genetic analysis of fecal and prey samples from the research indicates that Southern Residents consume Fraser River origin Chinook, as well as salmon from Puget Sound, Washington and Oregon coasts, the Columbia River, and Central Valley California (Hanson et al. 2007a; NWFSC unpubl. data). Fraser River Chinook are the predominant stock identified in samples (Hanson et al. 2007b). The number of samples is small, but this finding is consistent with the fact that Fraser River Chinook returns make up a large proportion of returns to river systems in inland waters.

Age and/or Size

The ongoing research discussed above also collected salmon scales from killer whale feeding events and used them to evaluate the age of the salmon consumed, finding that Southern Residents prefer older (hence larger) Chinook (NWFSC unpubl. data). This finding is consistent with that of Ford and Ellis (2006) who also evaluated the age of prey from killer whale feeding events. Ford and Ellis (2006) estimated size selectivity by comparing the age of fish consumed to the age distribution of fish in the area based on catch data obtained from the Pacific Salmon Commission (Table 5.3.1-3; Figure 5 of Ford and Ellis 2006). NWFSC evaluated the age of kills relative to the age distribution of Chinook in a fisheries management model, FRAM (Table 5.1.3-3; Ward et al. unpubl. report).

Table 5.1.3-3. Mean abundance by age class (%) and kills by age class (%).

Age	NWFSC (n = 75)		Ford & Ellis (2006) (n = 127)	
	%Abundance	% Kills	%Abundance	% Kills
Age 2	59.0	-	9.6	0.7
Age 3	25.8	10.4	35.7	11.3
Age 4	13.4	45.5	48.0	55.9
Age 5	1.7	41.6	6.5	31.5

There is also theoretical support for size-selective prey preferences. Optimal foraging theory predicts that animals maximize the rate and efficiency of energy intake (reviewed by Pyke et al. 1977), this is generally done by consuming prey that maximize the energy intake relative to handling time (Charnov 1976). For apex predators, like killer whales, there are few risks associated with foraging (smaller organisms face risk of predation, killer whales do not), and prey choice is likely determined by the encounter rate of preferred species relative to sub-optimal species. Additional empirical evidence supporting the selection of large prey items has been found in a variety of species, including selection of sockeye salmon by brown bears (Ruggerone et al. 2000; Carlson and Quinn 2007).

Less is known about diet preferences of Southern Residents off the Pacific Coast. Although there are no fecal or prey samples or direct observations of predation events (where the prey was identified to species) in coastal waters, it is likely that salmon are also important when the whales are in coastal waters. Chemical analyses support the importance of salmon in the year-round diet of Southern Residents (Krahn et al. 2002, 2007). Krahn et al. (2002) examined the ratios of DDT (and its metabolites) to various PCB compounds in the whales, and concluded that the whales feed primarily on salmon throughout the year rather than other fish species. Krahn et al. (2007) analyzed stable isotopes from tissue samples collected in 1996 and 2004/2006. Carbon and nitrogen stable isotopes indicated that J and L pods consumed prey from similar trophic levels in 2004/2006 and showed no evidence of a large shift in the trophic level of prey consumed by L pod between 1996 and 2004/2006. The preference of Southern Residents for Chinook in inland waters, even when other species are more abundant, combined with information indicating that the whales consume salmon year round, makes it reasonable to expect that Southern Residents likely prefer Chinook salmon when available in coastal waters.

Quantity of Prey

It is uncertain the extent to which long-term or more recent declines in salmon abundance contributed to the decline of the Southern Resident DPS, or whether current salmon levels are adequate to support the survival and recovery of the Southern Residents. When prey is scarce, whales must spend more time foraging than when it is plentiful. Increased energy expenditure and prey limitation could lead to lower reproductive rates and higher mortality rates. Food scarcity could cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function (discussed further below).

Ford et al. (2005) correlated coastwide reduction in Chinook abundance (Alaska, British Columbia, and Washington) with decreased survival of resident whales (Northern and Southern Residents), but changes in killer whale abundance have not been definitively linked to local areas or changes in specific salmon stock groups. Ward et al. (in review) correlated Chinook abundance trends with changes in fecundity of Southern Resident killer whales, and reported the probability of calving increased by 50 percent between low and high Chinook abundance years. Results indicate the Chinook abundance indices from the West Coast of Vancouver Island are an important predictor of the relationship.

Human influences have had profound impacts on the abundance of many prey species in the northeastern Pacific during the past 150 years, including salmon. The health and abundance of wild salmon stocks have been negatively affected by altered or degraded freshwater and estuarine habitat (i.e., hydro-power systems, urbanization, forestry and agriculture), harmful artificial propagation practices, and overfishing (see information in the review of status for salmon in section 5). Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fish, birds, and marine mammals including killer whales.

While wild salmon stocks have declined in many areas, hatchery production has been generally strong. Hatchery production contributes a significant component of the salmon prey base returning to watersheds within the range of Southern Resident killer whales (i.e., review table 5.1.4.1-3 for Puget Sound, Barnett-Johnson et al. 2007 for Central Valley California, NMFS 2008e). Although hatchery production has off-set some of the historical declines in the abundance of wild salmon within the range of Southern Residents, hatcheries also pose risks to wild salmon populations. In recent decades, managers have been moving toward hatchery reform, and are in the process of reducing risks identified in hatchery programs, through region-wide recovery planning efforts and hatchery program reviews. Healthy wild salmon populations are important to the long-term maintenance of prey populations available to Southern Residents, because it is uncertain whether a hatchery only stock could be sustained indefinitely.

Salmon abundance is also substantially affected by climate variability in freshwater and marine environments, particularly by conditions during early life-history stages of salmon (NMFS 2008e). Sources of variability include inter-annual climatic variations (e.g., El Niño and La Niña), longer term cycles in ocean conditions (e.g., Pacific Decadal Oscillation, Mantua et al. 1997), and ongoing global climate change. For example, climate variability can affect ocean productivity in the marine environment and water storage (e.g. snow pack) and in-stream flow in the freshwater environment. Early life-stage growth and survival of salmon can be negatively affected when climate variability results in conditions that hinder ocean productivity (e.g., Scheurell and Williams 2005) and/or water storage (e.g., ISAB 2007) in marine and freshwater systems, respectively. However, severe flooding in freshwater systems may constrain salmon populations (NMFS 2008e). The availability of adult salmon – prey of Southern Residents – may be reduced in years following unfavorable conditions to the early life-stage growth and survival of salmon. The effects of large scale environmental variation on salmon populations are discussed in more detail in Section 6.6 of the environmental baseline.

Quality of Prey

Contaminant levels in salmon affect the quality of Southern Resident prey. Contaminants enter fresh and marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Recent studies have documented high concentrations of PCBs, DDTs, and PBDEs in killer whales (Ross et al. 2000; Ylitalo et al. 2001; Reijnders and Aguilar 2002; Krahn et al. 2004). As top predators, when killer whales consume contaminated prey they accumulate the contaminants in their blubber. When prey is scarce, killer whales metabolize their blubber and the contaminants are mobilized (Krahn et al. 2002). Nursing females transmit large quantities of contaminants to their offspring. The mobilized contaminants can reduce the whales' resistance to disease and can affect reproduction. Chinook salmon contain higher levels of some contaminants (i.e., PCBs) than other salmon species (O'Neill et al. 2005). Only limited information is available for contaminant levels of Chinook along the west coast (i.e., higher PCB and PBDE levels may distinguish Puget Sound origin stocks, whereas higher DDT-signature may distinguish California origin stocks; Krahn et al. 2007).

Size of individual salmon could affect the foraging efficiency required by Southern Residents. As discussed above, available data suggests that Southern Residents prefer larger prey. In general, the literature indicates a historical decrease in salmon age, size, or size at a given age. Hypotheses advanced to explain declining body size are density-dependent growth and selection of larger, older fish by selective fisheries. Bigler et al. (1996) found a decreasing average body size in 45 of 47 salmon populations in the Northern Pacific. They also found that body size was inversely related to population abundance, and speculated that hatchery programs during the 1980s and 1990s increased population sizes, but reduced growth rates due to competition for food in the ocean. Fish size is influenced by factors such as environmental conditions, selectivity in fishing effort through gear type, fishing season or regulations, and hatchery practices. The available information on size is also confounded by factors including inter-population difference, when the size was recorded, and differing data sources and sampling methods (review in Quinn 2005).

Southern Resident killer whales likely consume both natural and hatchery salmon (Barre 2008). The best available information does not indicate that Southern Residents would be affected differently by consuming natural or hatchery salmon (i.e., no general pattern of differences in size, run-timing, or ocean distribution [e.g., Nickum et al. 2004; NMFS 2008e; Weitkamp and Neely 2002]).Therefore, there is no scientific evidence to generally distinguish the quality of hatchery salmon from natural salmon as prey of Southern Residents across their range.

Contaminants

Many types of chemicals are toxic when present in high concentrations, including organochlorines, polycyclic aromatic hydrocarbons (PAHs), and heavy metals. Emerging contaminants such as brominated flame retardants (BFRs) and perfluorinated compounds are increasingly being linked to harmful biological impacts as well.

Persistent contaminants, such as organochlorines, are ultimately transported to the oceans, where they enter the marine food chain. Organochlorines are also highly fat soluble, and accumulate in the fatty tissues of animals (O'Shea 1999; Reijnders and Aguilar 2002). Bioaccumulation through trophic transfer allows relatively high concentrations of these compounds to build up in top-level marine predators, such as marine mammals (O'Shea 1999). Killer whales are candidates for accumulating high concentrations of organochlorines because of their high position in the food web and long life expectancy (Ylitalo et al. 2001; Grant and Ross 2002). Their exposure to these compounds occurs exclusively through their diet (Hickie et al. 2007).

High levels of persistent organic pollutants (POPs) such as PCBs and DDT are documented in Southern Resident killer whales (Ross et al. 2000; Ylitalo et al. 2001). These and other chemical compounds have the ability to induce immune suppression, impair reproduction, and produce other adverse physiological effects, as observed in studies of other marine mammals (review in NMFS 2008n). Immune suppression may be especially likely during periods of stress and resulting weight loss, when stored organochlorines are released from the blubber and become redistributed to other tissues (Krahn et al. 2002). Although the ban of several contaminants, such as DDT, by Canada and the United States in the 1970s resulted in an initial decline in environmental contamination, Southern Residents may be slow to respond to these reductions because of their body size and the long duration of exposure over the course of their life spans (Hickie et al. 2007).

Sound and Vessel Effects

Vessels have the potential to affect whales through the physical presence and activity of the vessel, increased underwater sound levels generated by boat engines, or a combination of these factors. Vessel strikes are rare, but do occur and can result in injury or mortality (Gaydos and Raverty 2007). In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop 1996; National

Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior.

Killer whale mortalities from vessel strikes have been reported in both Northern and Southern Resident killer whale populations. Although rare, collisions between vessels and killer whales could result in serious injury. Other impacts from vessels are less obvious, but may adversely affect the health of killer whales. The presence of vessels may alter killer whale behavior, including faster swimming, less predictable travel paths, shorter or longer dive times, moving into open water, and altering normal behavioral patterns at the surface (Kruse 1991; Williams et al. 2002a; Bain et al. 2006; Noren, In Review). Chemicals such as unburned fuel and exhaust may be inhaled or ingested, which could contribute to toxic loads (Bain et al. 2006). Noise from vessel traffic may mask echolocation signals (Bain and Dahlheim 1994; Holt 2008), which reduces foraging efficiency or interferes with communication. The sound from vessels may also contribute to stress (Romano et al. 2003) or affect distribution of animals (Bejder 2006).

Southern Resident killer whales are the primary driver for a multi-million dollar whale watching industry in the Pacific Northwest. Commercial whale watching vessels from both the U.S. and Canada view Southern Residents when they are in inland waters in summer months. Mid-frequency sonar generated by military vessels also has the potential to disturb killer whales. To date, there are no directed studies concerning the impacts of military mid-frequency sonar on killer whales, but observations from an event that occurred in the Strait of Juan de Fuca and Haro Strait in 2003 illustrate that mid-frequency sonar can cause behavioral disturbance (NMFS 2004e).

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. Increased levels of anthropogenic sound from vessels and other sources have the potential to mask echolocation and other signals used by the species, as well as to temporarily or permanently damage hearing sensitivity. Exposure to sound may therefore be detrimental to survival by impairing foraging and other behavior, resulting in a negative energy balance (Bain and Dahlheim 1994; Gordon and Moscrop 1996; Erbe 2002; Williams et al. 2002a, 2002b, 2006; Holt 2008). In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop 1996).

Oil Spills

Exposure to petroleum hydrocarbons released into the marine environment from oil spills and other discharge sources represents another potentially serious health threat to killer whales in the northeastern Pacific. Oil spills are also potentially destructive to prey populations and therefore may adversely affect killer whales by reducing food availability.

Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but acute or chronic exposure poses greater toxicological risks (Grant and Ross 2002). In marine mammals, acute exposure can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci and St. Aubin 1990). Vapors inhaled at the water's surface and hydrocarbons ingested during feeding are the likely pathways of exposure. Matkin (1994) reported that killer whales did not attempt to avoid oil-sheened waters following the Exxon Valdez oil spill in Alaska. Retrospective evaluation shows it is highly likely that oil exposure contributed to deaths of resident and transient pods of killer whales that frequented the area of the massive Exxon Valdez oil spill in Prince William Sound, Alaska in 1989 (Matkin et al. 2008). The cohesive social structure of the Southern Residents puts them at risk for a catastrophic oil spill that could affect the entire DPS when they are all in the same place at the same time.

Abundance, Productivity and Trends

Southern Resident killer whales are a long lived species, with late onset of sexual maturity (review in NMFS 2008n). Females produce a low number of surviving calves over the course of their reproductive life span (5.4 surviving calves over 25 years) (Olesiuk et al. 1990; Bain 1990). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg et al. 1990; Baird 2000; Ford et al. 2000). Groups of related matrilines form pods. Three pods – J, K, and L – make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of J clan.

The historical abundance of Southern Resident killer whales is estimated from 140 to 200 whales. The minimum estimate (~140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time of the captures. The maximum estimate (~200) is based on a recent genetic analysis of microsatellite DNA (68 FR 31980; May 29, 2003).

At present, the Southern Resident population has declined to essentially the same size that was estimated during the early 1960s, when it was likely depleted (Olesiuk et al. 1990) (Figure 5.3.1-2). Since censuses began in 1974, J and K pods steadily increased; however, the population suffered an almost 20 percent decline from 1996-2001, largely driven by lower survival rates in L pod. There were increases in the overall population from 2002-2007, however the population declined in 2008 with 85 Southern Resident killer whales counted, 25 in J pod, 19 in K pod and 41 in L pod. Two additional whales have been reported missing since the 2008 census count.

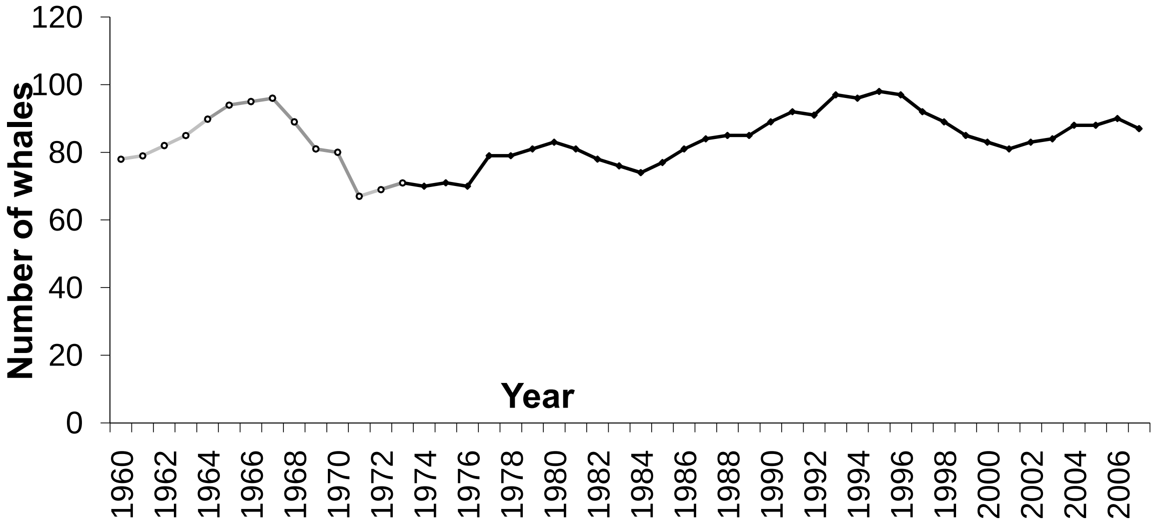


Figure 5.3.1-2. Population size and trend of Southern Resident killer whales, 1960-2008. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2008 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data). Data for these years represent the number of whales present at the end of each calendar year except for 2008, when data extend only through July.

Extinction Risk

A population viability analysis (PVA) for Southern Residents was conducted by the 2004 biological review team (Krahn et al. 2004). Demographic information from the 1970s to fairly recently (1974-2003, 1990-2003, and 1994-2003) were considered to estimate extinction and quasi-extinction risk. "Quasi-extinction" was defined as the stage at which 10 or fewer males or females remained, or a threshold from which the population was not expected to recover. The model evaluated a range in Southern Resident survival rates, based on variability in mean survival rates documented from past time intervals (highest, intermediate, and lowest survival). The model used a single fecundity rate for all simulations. The study considered seven values of carrying capacity for the population ranging from 100 to 400 whales, three levels of catastrophic event (e.g., oil spills and disease outbreaks) frequency ranging from none to twice per century, and three levels of catastrophic event magnitude in which 0, 10, or 20 percent of the animals died per event. Analyses indicated that the Southern Residents have a range of extinction risk from 0.1 to 18.7 percent in 100 years and 1.9 to 94.2 percent in 300 years, and a range of quasi-extinction risk from 1 to 66.5 percent in 100 years and 3.6 to 98.3 percent in 300 years (Table 5.3.1-4). The population is generally at greater risk of extinction over a longer time horizon (300 years) than over a short time horizon (100 years). There is a greater extinction risk associated with increased probability and magnitude of catastrophic events.

Table 5.3.1-4. Range of extinction and quasi-extinction risk for Southern Resident killer whales in 100 and 300 years, assuming a range in survival rates (depicted by time period), a constant rate of fecundity, between 100 and 400 whales, and a range catastrophic probabilities and magnitudes (Krahn et al. 2004).

Time Period	Extinction Risk (%)		Quasi-Extinction Risk (%)	
	100 yrs	300 yrs	100 yrs	300 yrs
highest survival	0.1 – 2.8	1.9 – 42.4	1 – 14.6	3.6 – 67.7
intermediate survival	0.2 – 5.2	14.4 – 65.6	6.1 – 29.8	21.4 – 85.3
lowest survival	5.6 – 18.7	68.2 – 94.2	39.4 – 66.5	76.1 – 98.3

5.3.2 Current Rangewide Status of Critical Habitat

The final designation of critical habitat for the Southern Resident killer whale DPS was published on November 29, 2006 (NMFS 2006c). Critical habitat consists of three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NOAA Fisheries identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

Water Quality

Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership Recommendations and subsequent Action Agenda (Puget Sound Partnership 2006, 2008). For example, toxins in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills (although oil spills can also have long-lasting impacts on other habitat features). The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2007, the Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing recent accomplishments and declining trends in spill incidents per transit (WDOE 2007).

Prey Quantity, Quality, and Availability

As discussed above under human impacts, most wild salmon stocks throughout the Northwest are at fractions of their historic levels. Beginning in the early 1990s, 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California were listed as threatened or endangered under the ESA (Table 5.1). Historically, overfishing and habitat losses were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. While wild salmon stocks have declined in many areas, hatchery production has been generally strong.

Contaminants and pollution also affect the quality of Southern Resident killer whale prey in Puget Sound. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like Southern Resident killer whales. Chemical contamination of prey is a potential threat to Southern Resident killer whale critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. In addition, vessels and sound may reduce the effective zone of echolocation and reduce availability of fish for the whales in their critical habitat (Holt 2008).

Passage

Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whale passage, causing the whales to swim further and change direction more often, which potentially increases energy expenditure for whales and impacts foraging behavior.

6 ▪ Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the broad expanse of the action area considered in this opinion. The status of the species described in Chapter 5 of this opinion is a consequence of those effects. In the following discussion of the environmental baseline we provide an overview of relevant proposed federal actions in the action area that have undergone consultation and are therefore also part of the baseline. The discussion focuses in particular on other harvest activities and their close and complicated relation to the proposed actions. However, the discussion also describes other documents that provide a more detailed description of the past and present activities that affect the species of concern including those related to hydrological development, hatcheries, and habitat actions.

Recovery plans developed in response to the ESA listings that have been completed or are in progress also provide detailed information regarding the species' status and the baseline conditions that have contributed to their decline. For the purpose of ESA recovery planning for the listed salmon and steelhead species, NOAA Fisheries Northwest Region designated five geographically based "recovery domains": Puget Sound and Washington Coast; Interior Columbia; Willamette/Lower Columbia; the Oregon Coast; and the Southern Oregon/Northern California Coast. For each domain, NOAA Fisheries appointed a team of scientists, called a Technical Recovery Team (TRT), nominated for their geographic and species expertise, to provide a solid scientific foundation for recovery plans. NOAA Fisheries also worked with state, tribal, local, and other Federal entities to develop planning forums that build on locally led, regionally specific approaches.

A description of the available information is arranged geographically to cover the circumstances in the Columbia River Basin, the Pacific Coast, and Puget Sound, and North Pacific. There is a separate section dealing with Southern Resident killer whales. Under the heading of Large Scale Environmental Variation, we discuss the effects of environmental variability and the available information related to climate change. Information from the biological opinions, recovery plans, and other sources that are described briefly in the following discussion are incorporated by reference. Pertinent information from these sources is discussed in more detail in subsequent sections of this opinion.

Finally, NOAA Fisheries recognizes the unique status of treaty Indian fisheries and their relation to the environmental baseline. Implementation of treaty Indian fishing rights involves, among other things, application of the sharing principles of *United States v. Washington*, annual calculation of allowable harvest levels and exploitation rates, the application of the "conservation necessity principle" articulated in *United States v. Washington* to the regulation of treaty Indian fisheries, and an understanding of the interaction between treaty rights and the ESA on non-treaty allocations. Exploitation rate calculations, in turn, are dependent upon various biological parameters, including the estimated run sizes for the particular year, the mix of stocks present, the allowable fisheries and the anticipated fishing effort. The treaty fishing right itself exists and must be accounted for in the environmental baseline, although the precise quantification of treaty Indian fishing rights during a particular fishing season cannot be established by a rigid formula.

If, after completing this ESA consultation, circumstances change or unexpected consequences arise from the new agreement that necessitate additional Federal action to avoid jeopardy determinations for ESA listed species, such action will be taken in accordance with standards, principles, and guidelines established under *United States v. Washington*, Secretarial Order 3206, and other applicable laws and policies. The conservation principles of *United States v. Washington* will guide the determination of appropriate fishery responses if additional harvest constraints become necessary. Consistent with the September 23, 2004 Memorandum for the Heads of Executive Departments and Agencies pertaining to Government-to-Government Relationship with Tribal Governments and Executive Order 13175, Departmental and agency consultation policies guiding their implementation, and administrative guidelines developed to implement Secretarial Order 3206, these responses are to be developed through government-to-government discourse involving both technical and policy representatives of the Northwest Region and affected Indian tribes prior to finalizing a proposed course of action.

6.1 Columbia River Basin

6.1.1 Harvest Actions

State, Tribal, and Federal parties to *U.S. v. Oregon* recently completed a new management agreement that applies to non-Treaty and treaty Indian fisheries in the Columbia River for the next ten years through 2017. The agreement is titled 2008-2017 *United States v. Oregon* Management Agreement and is referred to here as the 2008 Management Agreement (*U.S. v. Oregon* Parties 2008). The agreement applies to fisheries in the mainstem Columbia River from its mouth upstream to the Wanapum Dam and in the Snake River up to Lower Granite Dam. It also includes specified treaty Indian tributary fisheries in Washington and Oregon. NOAA Fisheries completed Section 7 consultation on the 2008 Management Agreement (NMFS 2008d). The biological opinion considered the effects of proposed fisheries on the 13 ESA listed salmon and steelhead species in the Columbia River Basin, and on Southern Resident killer whales and the Southern DPS of green sturgeon.

Upper Willamette River Chinook are one of the ESUs considered in more detail in this biological opinion. NOAA Fisheries previously determined that Section 9 take prohibitions under the ESA for Upper Willamette River Chinook do not apply to freshwater fishing activities in the Columbia and Willamette River Basins. The Oregon Department of Fish and Wildlife (ODFW) submitted a Fishery Management and Evaluation Plan (FMEP) pursuant to limit 4 of the ESA Section 4(d) rule. The

Upper Willamette River Chinook FMEP was dated February 7, 2001 (ODFW 2001). NOAA Fisheries reviewed the proposed Plan and determined that it adequately addressed the requirements of the 4(d) rule (Kruzic 2001). The Plan considered all fishing in the Willamette and Lower Columbia rivers that may affect Upper Willamette River Chinook. The Plan is subject to regular reporting requirements and periodic review, but has no specified expiration date. As a consequence freshwater fisheries that affect Upper Willamette River Chinook are considered part of the baseline for the proposed actions.

Other recreational tributary fisheries in the Lower Columbia River have also been reviewed through procedures of the Section 4(d) rule. The Washington Department of Fish and Wildlife (WDFW) submitted an FMEP for Washington tributary fisheries in the lower river that considered the effects on Chinook, steelhead, and chum salmon. ODFW submitted similar but separate FMEPs to consider the effects of their lower river tributary fisheries in Oregon on Chinook, steelhead, and chum salmon. Oregon also completed an FMEP for their Hood River steelhead fishery. NOAA Fisheries determined that all of these FMEPs were consistent with the requirements of the 4(d) rule (Information related to the FMEPs and their approval can be found at NOAA Fisheries' web site at: http://www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/State-Tribal-Management/FMEP-LCR-Fisheries.cfm.). The states have submitted FMEPs related to the effects of tributary fisheries on Lower Columbia River coho and Middle Columbia River steelhead, but the review and approval process for these is not yet complete.

Additional non-Treaty and treaty Indian tributary fisheries in the upper basin have been considered through either the Section 4(d) process or as Section 10 permit applications. These provide a mix of ESA coverage for various local and regional tributary fisheries. These are generally of limited duration and geographic scope. The Idaho Department of Fish and Game, for example, has a Section 10 permit for recreational fisheries in Idaho that extends through the 2009 season.

6.1.2 Other Activities

NOAA Fisheries recently completed Section 7 consultations on the effects of the Federal Columbia River Power System (NMFS 2008c) and the Bureau of Reclamation's Upper Snake River irrigation storage projects (NMFS 2008f). The opinions considered the effects of the proposed actions that would occur over the next ten years through 2017 on the 13 ESA listed salmon and steelhead species in the Columbia River Basin, and Southern Resident killer whales and the Southern DPS of green sturgeon. Information on the status of species, the environmental baseline, and the effects of both proposed actions are reviewed in detail in a Supplemental Comprehensive Analysis (NMFS 2008e). The environmental baseline in the SCA considers the effects from hydro development and operations, tributary habitat, estuary and plume habitat, hatchery, and harvest activities, and large scale environmental variation. The two biological opinions and SCA therefore provide a current and comprehensive overview of baseline conditions in the Columbia River Basin, and the future effects of the FCRPS and Upper Snake River actions that are also part of the baseline. Related documents are posted at: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm

NOAA Fisheries also recently completed a Section 7 consultation on the impact of the Willamette Project, which provides critical flood damage reduction for the entire Willamette Valley, including the cities of Eugene, Salem, and Portland and some hydroelectric generation (about 180 mw annually) along with recreational and fishing opportunities, water quality benefits, and municipal and irrigation water (NMFS 2008g). The Willamette Project also includes maintenance of 42 miles of bank protection projects and operation of a hatchery mitigation program. Reducing the adverse effects of the Willamette Project is one component of the basin's draft ESA recovery plan for salmon and steelhead. The Willamette Project adversely affects Upper Willamette River Chinook and Upper Willamette River steelhead by blocking access to a large amount of their historical habitat (now upstream of the dams) and by degrading the remaining accessible habitat downstream. The Action Agencies proposed action included several measures to address these effects, but many of their proposals were in the form of studies that would determine the most effective action to take. Overall, these actions were not sufficient to ensure the species' survival with an adequate potential for recovery, or to prevent destruction or adverse modification to their critical habitat. Therefore, NOAA Fisheries concluded that the Proposed Action would jeopardize these two species and provided a Reasonable and Prudent Alternative (RPA) with additional measures that, combined with the Proposed Action, will allow for survival of the species with an adequate potential for recovery, and avoid destruction or modification of critical habitat. These RPA measures include providing passage at three dams and temperature control at another, adjustments to downstream flows, improving water quality, improving hatchery practices, screening irrigation diversions and conducting habitat mitigation. Some of the flow modifications have already begun. Other measures will be implemented in the short-term to decrease the species' risk of extinction until the longer-term passage and temperature control measures are completed. Related documents are posted at: http://www.nwr.noaa.gov/Salmon-Hydropower/Willamette-Basin/Willamette-BO.cfm

The states of Oregon and Washington and other co-managers are currently engaged in a substantial review of hatchery management practices through the Hatchery Scientific Review Group (HSRG). The HSRG was established and funded by Congress to provide an independent review of current hatchery programs in the Columbia River Basin. The HSRG has largely completed their work on salmon and steelhead programs in the lower Columbia River and provided their recommendations (HSRG 2007). A general conclusion from the information generated by the HSRG is that the current production programs are not consistent with practices that reduce impacts on naturally-spawning populations, and will have to be modified substantially to reduce the adverse effects of hatchery fish on key natural populations identified in the Interim Recovery Plan as necessary for broad sense recovery of the ESU. The adverse effects are caused in part by excess hatchery adults returning to natural spawning grounds. There are two general options for addressing the problem. In summary form, they are to either substantially reduce or eliminate existing hatchery programs, or to reprogram existing production to reduce straying, increase the ability of fisheries to differentially harvest hatchery fish, and install where appropriate a system of weirs below primary population natural spawning areas. Recommendations from the HSRG review are being implemented and are discussed in more detail, particularly as they related to Lower Columbia River Chinook.

6.1.3 Recovery Planning

Recovery planning in the Columbia River Basin is provided for both the Interior Columbia and Willamette/Lower Columbia domains.

Interior Columbia Domain

There are seven listed species in the Interior Columbia Domain. NOAA Fisheries approved a final recovery plan addressing Upper Columbia Chinook and Upper Columbia steelhead in 2007. NOAA Fisheries issued a proposed recovery plan for Middle Columbia steelhead in September 2008 and a final plan in late winter 2009. This plan will incorporate management unit plans from Oregon, the Washington Gorge, the Yakima, and Southeast Washington. NOAA Fisheries has endorsed the Southeast Washington management unit plan and an early version of the Yakima Plan as Interim Regional Recovery Plans. However, the Yakima management unit plan is presently undergoing substantial revisions. The remaining four Interior Columbia species spawn in the Snake Basin, they are: Snake River fall Chinook, Snake River sockeye, Snake River spring/summer Chinook and Snake River steelhead. NOAA Fisheries will propose a Snake River ESA recovery plan by early 2009. It will address all four species and also incorporate management unit plans from Oregon, Southeast Washington, and Idaho. The Southeast Washington management unit plan is already approved and being implemented as an Interim Regional Recovery Plan. The other management units - Idaho and Oregon - will be included as part of the proposed Snake River plan. Information related to the recovery plans is posted at:

Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (August 2007). http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf

Middle Columbia and Snake Southeast Washington Interim Regional Recovery Plan
Supplement to the Draft Snake River Salmon Recovery Plan for Southeast Washington. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Snake/upload/Wash-Snake-Suppl.pdf[11]

Snake River Salmon Recovery Plan for Southeast Washington (Snake River Salmon Recovery Board 2006). http://www.snakeriverboard.org/resources/library.htm

Willamette/Lower Columbia Domain

There are six listed species in the Willamette/Lower Columbia Recovery Domain. NOAA Fisheries expects to propose a recovery plan in 2009 for the Upper Willamette River which will address Upper Willamette Chinook and Upper Willamette winter steelhead. A separate recovery plan for Lower Columbia species will address Lower Columbia River Chinook, Lower Columbia River steelhead, Lower Columbia River chum and Lower Columbia River coho. NOAA Fisheries endorsed an Interim Regional Recovery Plan for the Washington management unit of Lower Columbia River Chinook, steelhead and chum in 2005. That management unit plan will

[11] This plan addresses portions of the Mid Columbia steelhead DPS

be amended to address Lower Columbia River coho, and along with a management unit plan from Oregon, will be incorporated into a Lower Columbia River Recovery Plan for all 4 species in early 2009. Information related to the Interim Regional recovery plan is posted at:

Interim Regional ESA Salmon Recovery Plan for the Washington Management Unit of the Lower Columbia River (LCFRB 2004).
http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Willamette-Lower-Columbia/Interim-Recovery.cfm

Oregon is well along with their recovery planning process and has posted drafts of their recovery plans for the Upper Willamette River and Lower Columbia River regions (ODFW 2007a, 2007b). These are posted at: http://www.dfw.state.or.us/fish/esa/

6.2 Pacific Coast

6.2.1 Harvest Actions

Pacific Coast Salmon Fisheries

NOAA Fisheries promulgates regulations for fisheries in the Exclusive Economic Zone (EEZ) off the Pacific Coast of Washington, Oregon, and California pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The Pacific Coast Salmon Plan (FMP) provides a framework for setting annual regulations that define catch levels and allocations based on year specific circumstances (PFMC 1999). The Pacific Fishery Management Council (PFMC) implements the FMP through a public process that leads to recommendations to NOAA Fisheries for annual regulations. The current FMP requires that the PFMC manage fisheries consistent with NOAA Fisheries' ESA-related consultation standards or recovery plans to meet the immediate needs for conservation and long-term recovery for all ESA listed species (PFMC 1999). These standards are provided annually to the PFMC by NOAA Fisheries at the start of the pre-season planning process. The PFMC then uses these ESA standards, and other conservation and allocation objectives for planning fisheries that are then recommended to NOAA Fisheries for approval.

Since 1991, 28 salmon ESUs and steelhead DPSs from the west coast of the U.S have been listed under the ESA. Beginning in 1991, NOAA Fisheries considered the effects of PFMC fisheries on salmon species listed under the ESA and issued biological opinions based on the regulations implemented each year rather than the FMP itself. In a biological opinion dated March 8, 1996, NOAA Fisheries considered the impacts on all salmon species, then listed under the ESA, resulting from implementation of the salmon FMP including spring/summer Chinook, fall Chinook, and sockeye salmon from the Snake River and Sacramento River winter Chinook (NMFS 1996). Subsequent biological opinions considered the effects of PFMC fisheries on the growing catalogue of listed species. NOAA Fisheries has reinitiated consultation when new information became available on the status of a species or the impacts of the FMP on a species, or when new species were listed. Table 6.2.1-1 lists the current biological opinions that considered the effects of the PFMC fisheries on listed species and their duration.

Table 6.2.1-1. NOAA Fisheries' ESA decisions regarding ESUs and DPSs affected by PFMC fisheries and the duration of the 4(d) Limit determination or biological opinion (BO). Only those decisions currently in effect are included.

Date (Decision type)	Duration	Citation	ESU considered
March 8, 1996 (BO)	until reinitiated	NMFS 1996	Snake River spring/summer and fall Chinook, and sockeye
April 28, 1999 (BO)	until reinitiated	NMFS 1999f	S. Oregon/N. California Coast coho Central California Coast coho Oregon Coast coho
April, 2000 (BO)	until reinitiated	NMFS 2000b	Central valley Spring-run Chinook California Coastal Chinook
April, 2001 (4(d) Limit)	until withdrawn	NMFS 2001a	Hood Canal summer-run chum
April, 2001 (BO)	until reinitiated	NMFS 2001d	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead ESUs
April, 2004 (BO)	until 2010	NMFS 2004d	Sacramento River winter-run Chinook
March 4, 2005 (4(d) Limit)	until May, 2010	NMFS 2005d	Puget Sound Chinook
June 13, 2005 (BO)	until reinitiated	NMFS 2005h	California Coastal Chinook
April 30, 2007 (BO)	until reinitiated	NMFS 2007c	North American Green Sturgeon
April 29, 2008 (BO)	until reinitiated	NMFS 2008l	Lower Columbia River coho Puget Sound steelhead Lower Columbia River Chinook (2008 only)
May 19, 2008 (BO)	until May, 2009	NMFS 2008m	Southern Resident killer whales

As a result of these previous consultations, the effects of PFMC fisheries for virtually all of the currently listed salmon and steelhead species are covered by long term biological opinions. The one exception is Lower Columbia River Chinook. In 2008 NOAA Fisheries completed a biological opinion that considered the effects of the PFMC fisheries on Lower Columbia River Chinook and Lower Columbia River coho, and newly listed Puget Sound steelhead. The opinion provided a long term management structure for coho, and concluded that PFMC fisheries are not likely to adversely affect Puget Sound steelhead. Further consideration of the effects of PFMC fisheries on Lower Columbia River Chinook will be required in 2009, but the FMP ensures that PFMC fisheries will satisfy NOAA Fisheries' ESA related guidance. For the purposes of this consultation on SEAK fisheries and the 2008 PST Agreement, PFMC salmon fisheries are considered part of the baseline.

Current biological opinions for some of the listed salmon species define harvest limits that are inclusive and overlap management jurisdictions. For Snake River fall Chinook, NOAA Fisheries Service requires that the Southeast Alaskan, Canadian, and PFMC fisheries, in combination, achieve a 30% reduction in the age-3 and age-4 adult equivalent total exploitation rate relative to the 1988-1993 base period (NMFS 1996, 1999a). The opinion therefore sets a total exploitation rate limit for all ocean fisheries. In recent years, the 1999 PST Agreement has defined allowable catches in the SEAK and BC fisheries. The PFMC has then been obligated to manage their fisheries to ensure that the overall standard is met. In recent years, because of other harvest constraints, the exploitation rate limit for Snake River fall Chinook has not been limiting. Nonetheless, the total exploitation rate limit will be used in this opinion as a benchmark for evaluating the effects of the proposed actions.

The tule component of the Lower Columbia River Chinook ESU has also been managed in recent years subject to a maximum exploitation rate, but in this case the exploitation rate limit applies to all marine and freshwater fisheries. The exploitation rate limit used by NOAA Fisheries for consultation purposes has declined over the years as a consequence of ongoing consultation. In 2001fisheries were managed subject to a total exploitation rate limit of 65%. From 2002 to 2006, all marine and freshwater fisheries were managed to a 49% exploitation rate limit. The limit was reduced to a total exploitation rate of 41% in 2008 (NMFS 2008h). The exploitation rate limit that will be used in 2009 and thereafter is still under review. NOAA Fisheries considered the possibility that the 41% exploitation rate limit may continue indefinitely in the recent opinion on PFMC fisheries (NMFS 2008h), but also indicated that it might decrease as a result of the ongoing review. Circumstances are such that the exploitation rate limit is not likely to increase in the foreseeable future. Nonetheless, we expect that PST, PFMC, and Columbia River fisheries will be managed in the future subject to a total exploitation rate limit. The current limit of 41% is therefore also used as a benchmark for evaluating the proposed actions.

Oregon Coast coho and Lower Columbia coho are also managed subject to total exploitation rate limits. The allowable rate varies by year according to a matrix that depends on brood year escapement and indicators of marine survival. The effect of proposed fisheries on Oregon Coast and Lower Columbia River coho will also be a consideration, although most of the harvest occurs off Washington and Oregon, with relatively few caught in southern British Columbia.

Additional information on baseline conditions on the West Coast is available from several recent documents. Every year the PFMC releases its annual Review of Ocean Salmon Fisheries. The most recent report was released in February 2008 (PFMC 2008a). The Review focuses in particular on the status of salmon stocks that is reflected by escapement trends over recent decades. The review also provides detailed catch information for the West Coast salmon fishery.

Pacific Coast Groundfish Fisheries

Salmon are also taken incidentally in the groundfish fishery off Washington, Oregon, and California. NOAA Fisheries regulates the groundfish fisheries, and as with salmon, relies on the PFMC to develop management recommendations. NOAA Fisheries has conducted section 7 consultations on the impacts of fishing conducted under the Pacific Coast Groundfish Fishery Management Plan (PCGFMP) on ESA listed salmon and steelhead and concluded that impacts were low and not likely to jeopardize the listed species. The most recent biological opinion was completed in 2006 (NMFS 2006f).

There are two principal components of the groundfish fishery that affect salmon including a midwater trawl fishery directed at whiting, and a bottom trawl fishery directed at a variety of other species. Chinook salmon are the primary salmonid caught incidentally in both fisheries. The incidental catch of coho and chum salmon are a few tens or at most hundreds of fish per year. Sockeye salmon and steelhead are rarely caught in the groundfish fisheries (NMFS 2006f). The incidental take statement of the biological opinion specifies an expected annual bycatch of 11,000 Chinook in the whiting fishery and 9,000 in the bottom trawl fishery. Since 1998 the bycatch of Chinook in the whiting fishery has averaged about 7,500. From 2002 to 2004 the incidental catch of Chinook in the bottom trawl fishery averaged 11,300 which was one of the reasons for reinitiating consultation in 2006. The bycatch of Chinook in the fishery declined dramatically in recent years. The estimates of Chinook bycatch in 2005 and 2006 were 799 and 96, respectively (Bellman and Hastie 2008).

Additional information is available from the PFMC's recent report on the Status of the Pacific Coast Groundfish Fishery – Stock Assessment and Fishery Evaluation (PFMC 2008b). The report focuses on the status of Pacific coast groundfish stocks and provides an overview of the groundfish fishery management regime that is part of the baseline. The Report also discusses the west coast marine environment and the effect of groundfish fisheries on ESA-listed salmonids and other protected species.

6.2.2 Other Activities

Information on the ocean environment, particularly as it relates to salmon survival, is contained in a recent report from the NOAA's Northwest Fisheries Science Center (Peterson et al. 2006).

The report provides background information on various ocean indicators and how they can be interpreted. The ocean indicators are monitored and updated routinely with current information posted on the Science Center's website (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm).

6.2.3 Recovery Planning

Recovery planning along the Pacific Coast is provided for both the Oregon Coast and Southern Oregon Northern California Coho domains.

Oregon Coast Domain

The State of Oregon has prepared an Oregon Coast Coho Conservation Plan that provides a solid foundation for developing an ESA recovery plan. A proposed ESA recovery plan could be available by late 2009. Information related to the recovery plans is posted at:

Oregon Coast Coho Conservation Plan for the State of Oregon.
http://www.oregon.gov/OPSW/cohoproject/PDFs/November2007_pdfs/Coho_Plan.pdf

Southern Oregon/Northern California Coho Domain

A proposed Southern Oregon/Northern California Coho ESA recovery plan is expected by 2009.

6.3 Puget Sound

6.3.1 Harvest Actions

Since 2004, the state and tribal fishery co-managers have managed Chinook mortality in Puget Sound salmon and tribal steelhead net fisheries to meet the conservation and allocation objectives described in the jointly-developed Puget Sound Chinook Harvest Resource Management Plan (RMP), which expires April 30, 2010. The RMP encompasses commercial, recreational, ceremonial, and subsistence salmon fisheries potentially affecting the listed Puget Sound Chinook ESU within the marine and freshwater areas of Puget Sound from Cape Flattery at the entrance of the Strait of Juan de Fuca inward. The RMP excludes Washington Commercial Salmon Management Catch Reporting Area 4B fisheries during the months of May to September, when this area is under the jurisdiction of the Pacific Fishery Management Council. Harvest objectives specified in the RMP account for fisheries-related mortality of Puget Sound Chinook throughout the migratory range of this species – from Oregon and Washington to Southeast Alaska. The RMP also includes implementation, monitoring, and evaluation procedures designed to ensure fisheries are managed consistent with the RMP's objectives for conservation and use. NOAA Fisheries evaluated the Puget Sound Chinook RMP and found that it met the requirements of Limit 6 of the Endangered Species Act (ESA) 4(d) Rule (NMFS 2005). A section 7 consultation was also conducted as part of the 4(d) evaluation on the plan and NOAA Fisheries concluded fisheries managed consistent with the terms of the plan would not jeopardize the survival and recovery of the ESU (Information related to the RMP and its approval can be found at NOAA Fisheries' web site at: http://www.nwr.noaa.gov/Salmon-

Harvest-Hatcheries/State-Tribal-Management/PS-Chinook-RMPs.cfm). The RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan which includes the Puget Sound Chinook ESU.

Since 2001, the co-managers have also managed Puget Sound salmon fisheries affecting the listed Hood Canal summer-run chum ESU under harvest management objectives specified in the Summer Chum Salmon Conservation Initiative. Fisheries, and their scope, encompassed by the initiative are the same as those described above for Chinook except that it does not explicitly include summer chum impacts in tribal steelhead net fisheries. However, adult run timing of listed Hood Canal summer chum does not overlap with steelhead returning to Hood Canal rivers and extant summer chum are not present in the rivers where steelhead fisheries occur. Although the Puget Sound Technical Recovery Team identified two populations in the ESU, fisheries are managed to meet harvest objectives identified for the 10 extant sub-stocks within the two populations and to complement re-introduction programs in the ESU. Chum salmon are not targeted and are rarely caught in U.S. ocean fisheries. Fishery exploitation rates in the 1980s in excess of 50% were too high for the natural productivity of Hood Canal summer chum salmon. Puget Sound salmon fisheries are now managed to minimize incidental take of listed summer-chum with expected U.S. exploitation rates of 2.5 (range 0.5-3.5%) and 4.6 (range= 1.0-7%) percent on the Strait of Juan de Fuca and Hood Canal populations, respectively. As a result, exploitation rates in Puget Sound fisheries have been consistently below 1 percent for the Strait of Juan de Fuca population and averaged 16.9% for the Hood Canal population (Johnson et al. 2006, 2007; WDFW and PNPTT 2007).

The higher than anticipated Puget Sound exploitation rate on the Hood Canal population has resulted from incidental harvest of summer chum in terminal fisheries directed at coho salmon returning to the Quilcene National Fish Hatchery. However, Quilcene summer chum consistently have exceeded their escapement goals by 50 percent or more since 2000. The co-managers have taken additional steps to reduce summer chum bycatch at the fishery. The initiative also includes harvest guidelines for listed summer-chum taken in Canadian fisheries although the U.S. has no enforcement mechanism to see the guidelines are met.

The current Chum Annex of the PST requires Canadian fishers to release chum caught in purse seine gear in Area 20 from July 1 through September 15 when Hood Canal summer chum are thought to be present. As a result, exploitation rates in Canadian fisheries have been consistently below 0.5%, well below the guideline of 6.3% (Johnson et al. 2007, 2006; WDFW and PNPTT 2007). The initiative does not have an expiration date, but includes implementation, monitoring, evaluation and reporting procedures and requirements designed to ensure fisheries are consistent with the initiative’s objectives for conservation and use. NOAA Fisheries evaluated the Hood Canal summer chum initiative and found that it met the requirements of Limit 6 of the Endangered Species Act (ESA) 4(d) Rule. A section 7 consultation was also conducted as part of the 4(d) evaluation on the plan and NOAA Fisheries concluded fisheries managed consistent with the terms of the plan would not jeopardize the survival and recovery of the ESU

(Information related to the RMP and its approval can be found at NOAA Fisheries' website at: http://www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/State-Tribal-Management/HC-Chum-RMP.cfm).

Fisheries on steelhead and trout occur in rivers and lakes throughout Puget Sound. The non-treaty harvest of steelhead in Puget Sound occurs primarily in recreational hook-and-line fisheries targeting adipose fin clipped hatchery winter-run and summer-run steelhead only. The treaty fishery for winter steelhead targets primarily hatchery steelhead by fishing during the early winter months when hatchery steelhead are returning to spawn and wild steelhead are at low abundance. Wild summer-run steelhead are captured incidentally in treaty fisheries targeting other salmon species, but overall impacts are low. Both the treaty and non treaty fisheries generally target Chambers Creek winter-run or Skamania hatchery lineage summer run steelhead that have been delineated as out-of-DPS stocks (NMFS 2005c). These hatchery stocks were therefore not included in the NOAA Fisheries ESA listing of the Puget Sound steelhead DPS and are not subject to protective take prohibitions of the Act (NMFS 2007f). The fisheries management strategy applied by WDFW and the tribes allows for continued fishing while simultaneously minimizing impacts to listed, natural, Puget Sound steelhead. Tribal harvest in all marine and freshwater areas of winter and summer hatchery and wild steelhead has averaged 1,412 annually since 2001 (NWIFC unpublished data. 2008). Recreational catch over the same time period has averaged 14,477 winter and summer-run steelhead annually; less than 4% of which are wild (Leland, pers. comm. 2008). NOAA Fisheries determined that the current harvest management strategy that has eliminated direct harvest of wild steelhead in Puget Sound has largely addressed the threat of decline to the listed DPS posed by harvest (NMFS 2007f). In November 2008, the co-managers provided a harvest management plan for Puget Sound steelhead to NOAA Fisheries for consideration under Limit 6 of the 4(d) Rule. The plan encompasses take of listed Puget Sound steelhead in marine and freshwater salmon and steelhead fisheries, and take of Puget Sound Chinook in steelhead fisheries. NOAA Fisheries is currently evaluating the plan against the Limit 6 criteria.

Available information indicates harvest of listed Lake Ozette sockeye in marine or freshwater fisheries is unlikely (NMFS 2008j). The early return timing of Ozette sockeye (May through late June entry into freshwater) substantially limits their presence in marine migratory areas when and where commercial and sport fisheries directed at salmon species and groundfish occur. Review of Washington State and tribal catch information for Washington ocean Chinook and coho salmon and groundfish fisheries that occur during the Ozette sockeye migration period indicates that the fisheries rarely encounter sockeye salmon. The Ozette River is closed annually to all sport fishing until August 1. Very few sockeye are still in the river after August 1. When the river is open, selective fishery rules apply and all sockeye must immediately be released. No tribal salmon fisheries have been conducted within the watershed since 1982. Under National Park Service regulations, the lake is open to catch and release salmonid fishing, but the fish must be immediately released. The sockeye smolt emigration period begins before the annual sport fishery opens, and the majority of sockeye smolts are in the lake during the first few weeks of the fishery. However, fingerling (age 0) sockeye are unlikely to be susceptible to fishing because of their small size.

The effects of the harvest activities described above on ESA listed species are discussed in more detail in section 7 of this biological opinion.

6.3.2 Other Activities

Human activities have degraded extensive areas of Chinook salmon spawning and rearing habitat in Puget Sound. Development activities have limited access to historical spawning grounds and altered downstream flow and thermal conditions. Urbanization affects many parts of the aquatic environment. It has caused direct loss of riparian vegetation and soils, significantly altered hydrologic and erosional rates and processes by creating impermeable surfaces (roads, buildings, parking lots, sidewalks etc.), and polluting waterways. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have increased sedimentation, raised water temperatures, decreased large woody debris (LWD) recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996). Large areas of lower river meanders (formerly mixing zones between fresh and salt water) have been channelized and diked for flood control and to protect agricultural, industrial and residential development. Habitat degradation in upstream areas has exacerbated flood events in these areas with adverse effects on Chinook salmon populations.

Degradation of riverine, estuarine, and nearshore habitat has resulted in the loss of an average of 83% of the potential production of 42 steelhead populations assessed in Washington. There are substantial habitat blockages by dams in the Skagit and Elwha River basins, and minor blockages, including impassable culverts, throughout the region. The Washington State Salmon and Steelhead Stock Inventory (SASSI) (WDF et al. 1993) appendices noted habitat problems, including flooding, unstable soils, and poor land management practices, for most stocks in this region. In general, habitat has been degraded from its pristine condition, and this trend is likely to continue with further population growth and resultant urbanization in the Puget Sound region.

Most devastating to the long term viability of salmon has been the modification of the fundamental natural processes which allowed habitat to form, and recover from disturbances such as floods, landslides, and droughts. Among the physical and chemical processes basic to habitat formation and salmon persistence are floods and droughts, sediment transport, heat and light, nutrient cycling, water chemistry, woody debris recruitment and floodplain structure (Shared Strategy for Puget Sound 2007). The development of land for agricultural purposes has resulted in reductions in river braiding, sinuosity, and side channels through the construction of dikes, hardening of banks with riprap, and channelization of the river mainstems. Constriction of the rivers, especially during high flow events increases the likelihood of gravel scour and the dislocation of rearing juvenile steelhead. Poor forest practices in upper watersheds have resulted in bank destabilization, excessive sedimentation and removal of riparian and other shade vegetation important for water quality, temperature regulation and other aspects of salmon rearing and spawning habitat. Hardening of nearshore bank areas with riprap or other material has altered marine shorelines; changing sediment transport patterns and reducing important juvenile habitat.

Over the last several years, NOAA Fisheries has completed several section 7 consultations on large scale habitat projects affecting listed species in Puget Sound. Among these are the Washington State Forest Practices HCP (NMFS 2006e), and consultations on Washington State Water Quality Standards (NMFS 2008r) and the National Flood Plain Insurance Program (NMFS 2008i). These documents considered the effects of the proposed actions that would occur up to the next 50 years on the ESA listed salmon and steelhead species in the Puget Sound basin, listed Southern Resident killer whales and the listed southern distinct population segment of green sturgeon. Information on the status of these species, the environmental baseline, and the effects of the proposed actions are reviewed in detail. The environmental baselines in these documents consider the effects from timber, agriculture and irrigation practices, urbanization, hatcheries and tributary habitat, estuary, and large scale environmental variation. These biological opinions and HCPs therefore provide a current and comprehensive overview of baseline habitat conditions in Puget Sound

6.3.3 Recovery Plans

Recovery planning for Puget Sound is provided in for the Puget Sound and Washington Coast domain.

Puget Sound and Washington Coast Domain

There are four listed species in the Puget Sound and Washington Coast domain. Puget Sound Chinook and Hood Canal summer chum salmon have final ESA recovery plans. These plans are each made up of two documents: a locally developed recovery plan and a NOAA Fisheries-developed supplement. NOAA Fisheries has issued a proposed recovery plan for Lake Ozette sockeye and expects to finalize this plan in late 2008. Finally, a recovery plan for Puget Sound steelhead is just getting underway. The projection for NOAA Fisheries to issue this plan is late 2009 or early 2010. Information related to the recovery plans is posted at:

Hood Canal Summer Chum

Final Supplement to the Hood Canal & Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan (NMFS 2007b). http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/HCC Supplement.pdf;

Hood River Canal & Eastern Strait of Juan de Fuca Summer Chum Recovery Plan (Hood Canal Coordinating Council-HCCC 2005) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/HCC_Plan.pdf

Puget Sound Chinook

Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006d). http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/PS-Supplement.pdf.

Puget Sound Salmon Recovery Plan (Shared Strategy for Puget Sound 2007). http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm.

Lake Ozette Sockeye

Proposed Recovery Plan for Lake Ozette Sockeye Salmon (*Oncorhynchus nerka*) (NMFS 2008j) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/Ozette-Prop-Plan.pdf.

6.4 North Pacific

6.4.1 Harvest Actions

Bering Sea/Aleutian Islands and Gulf of Alaska Groundfish Fisheries

Salmon are taken incidentally in the Bering Sea/Aleutian Islands and Gulf of Alaska (GOA) groundfish fisheries. NOAA Fisheries has conducted section 7 consultations on the impacts of fishing conducted under the Bering Sea and Aleutian Islands, and Gulf of Alaska Fishery Management Plans (BSAI/GOA FMP) of the North Pacific Fishery Management Council (NPFMC). The Bering Sea and Aleutian Islands fisheries occur outside the action area for the actions considered in this biological opinion. NOAA Fisheries consulted on the BSAI fishery in 1999 (NMFS 1999g). The associated incidental take statement specified an annual expected bycatch of 55,000 Chinook salmon. The bycatch of Chinook in the fishery began increasing in 2003 and exceeded the 55,000 take level for the first time in 2004 (the bycatch was about 60,000). The bycatch increased each year thereafter to a maximum of over 130,000 in 2007. As a result, NOAA Fisheries reinitiated consultation (NMFS 2007d). Although the increasing bycatch has been a high profile event and great concern for the regional managers including the NPFMC, our most recent review indicates that impacts to ESA listed salmon species in the BSAI fishery is still quite limited (NMFS 2007d). It also is apparent that the bycatch in 2008 is much reduced and will likely be less that 55,000 for the first time since 2003.

Groundfish fishing areas in the Gulf of Alaska and salmon fishing areas in SEAK overlap although most of the groundfish fishing occurs to the west of the salmon fishing areas. NOAA Fisheries' most recent consultation on the GOA fishery was completed in 1999 (NMFS 1999g). The incidental bycatch of salmonids is limited primarily to Chinook and chum salmon. The opinion concluded that listed chum salmon were unlikely to be caught in the fishery. The incidental take statement of the 1999 opinion specified an expected annual bycatch of 40,000 Chinook in the GOA fishery. From 2003 to 2007 the bycatch of Chinook has averaged 26,100 and ranged from 15,500 to 40,200 (Balsiger 2008).

6.4.2 Other Activities

Additional information on the baseline conditions in the BASI and GOA is included in a recent Final Environmental Impact Statement (FEIS) that considers alternative harvest strategies for the BSAI and GOA fisheries. The FEIS considers alternatives for setting Total Allowable Catch (TAC) levels to comply with the MSA, ESA, and other applicable law. The FEIS discusses future actions that are reasonably certain to occur, the status of the target species and other fish species and animals, and the status of the environment, and how it may be affected by the management alternatives. The FEIS therefore provides an overview of information related to the environmental baseline in the BSAI and GOA portion of the action area. The FEIS is available on the web at http://www.fakr.noaa.gov/analyses/specs/eis/final.pdf.

6.5 Southern Resident Killer Whales

All of the categories of human activities have contributed to the current status of Southern Resident killer whales within the action area. The following discussion summarizes the principal human and natural factors within the action area (other than the proposed action) that are known to affect the likelihood that Southern Resident killer whales will survive and recover in the wild, and the likelihood that their critical habitat will function to support their recovery.

6.5.1 Natural Mortality

Seasonal mortality rates among Southern and Northern Resident whales are believed to be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer field research seasons. At least 12 newborn calves (9 in southern community and 3 in northern community) were seen outside the summer field season and disappeared by the next field season. Additionally, stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004). Southern Resident strandings in coastal waters offshore include three separate events (1995 and 1996 off of Northern Vancouver Island and the Queen Charlotte Islands, and 2002 offshore of Long Beach, Washington State), and the causes of death are unknown (NMFS 2008n).

In recent years, sighting reports indicate anecdotal evidence of thin killer whales returning to inland waters in the spring. For example in March 2006, a thin female from the Southern Resident population (L54) with a nursing calf was sighted off Westport, WA. The sighting report indicated she had lost so much blubber that her ribs were showing under the skin (Cascadia Research Collective 2008).

The official 2008 census for Southern Resident killer whales was 85 whales (annually conducted and reported by The Center for Whale Research, down from 87 whales in 2007). After the official census, two additional whales were observed missing. However, a whale is not declared dead until found missing in the following year during the census. In total, seven whales were declared dead or suspected missing in the current year (Balcomb, pers. comm., 2008). None of these whales were recovered and cause of death is unknown. Two of the seven were calves that by convention had not been counted as part of the population prior to their deaths. Death of calves is not unusual. Two of the mortalities were old whales (K7 and L21, 98 and 56 years old, respectively), and mortality in this age group is not surprising. The remaining dead or declared missing whales were in age groups with typically low mortality. Two were reproductive females (J11 and L67, 35 and 32 years old, respectively). It is more unusual to see mortality of reproductive females. One was a sub-adult male (L101, 5 years old). However, L101's death may have been related to the condition of L67 (mother of L101). Reportedly, L67 did not look well (identified as a thin whale during aerial survey, Durban, pers. comm., 2008) when last seen in September.

6.5.2 Human Related Activities

6.5.2.1 Entrapment and Entanglement in Fishing Gear

Drowning from accidental entanglements in nets and longlines is a minor source of fishing-related mortality in killer whales. In Washington, Sheffer and Slipp (1948) documented several deaths of animals caught in gillnets between 1929 and 1943. More recently, one killer whale was reported interacting with a salmon gillnet in British Columbia in 1994, but did not get entangled (Guenther et al. 1995). Typically, killer whales are able to avoid nets by swimming around or underneath them (Jacobsen 1986; Matkin 1994), and not all entanglements automatically result in death.

Entanglements of marine mammal must be reported in accordance with the Marine Mammal Protection Act (MMPA). MMPA Section 118 established the Marine Mammal Authorization Program (MMAP) in 1994. Under MMAP all fishers are required to report any incidental taking (injuries or mortalities) of marine mammals during fishing operations. The incidental taking of marine mammals in Category III fisheries are by definition rare events and are authorized by statute with no further requirements for fishers except take reporting, whereas owners of vessels participating in Category I or II fisheries must register and obtain an authorization for the purpose of incidentally taking marine mammals. Any animal that ingests fishing gear or is released with fishing gear entangled, trailing, or perforating any part of the body is considered injured, and must be reported (review of reporting requirements and procedures, 50 CFR 229.6 and http://www.nmfs.noaa.gov/pr/pdfs/interactions/mmap_reporting_form.pdf). No entanglements, injuries or mortalities have been reported in recent years.

6.5.2.2 Prey Availability

Chinook salmon are the preferred prey of Southern Resident killer whales in inland waters (see further discussion in Chapter 5, Status of the Species). Chemical analyses support the importance of salmon in the year round diet of Southern Residents. Based on persuasive scientific information that Southern Residents prefer Chinook in inland waters, Southern Residents may also prefer Chinook salmon when available in coastal waters. This analysis therefore focuses on the effects of harvest actions on Chinook abundance in coastal and inland waters based on the seasonal proportion of time Southern Residents spend in the respective portions of their range. Focusing on Chinook provides a conservative estimate of potential effects of the actions on Southern Residents, because the total abundance of all salmon and other potential prey species is orders of magnitude larger than the total abundance of Chinook. In addition, this analysis considers a reasonable range of prey size selectivity of Southern Residents, given the best available scientific data (described in Status of the Species).

When prey is scarce, whales must spend more time foraging than when it is plentiful, leading to increased energy expenditure and decreased fitness, which can result in relatively lower reproductive rates and relatively higher mortality rates. Food scarcity would cause whales to draw on fat stores, mobilizing contaminants stored in their fat. It is uncertain to what extent long-term or more recent declines in salmon abundance contributed to the decline of the Southern Resident DPS, or whether current levels are adequate to support the survival and recovery of the Southern Residents (more details are available in the Status of the Species section, which discusses the correlative relationships between Southern Resident killer whale survival and fecundity and Chinook abundance).

The availability of Chinook to Southern Residents is affected by a number of natural and human actions. Details regarding baseline conditions of those Chinook salmon affected in the action area that are listed under the Endangered Species Act are described above in this chapter. As discussed above, adult salmon are affected by fisheries harvest in fresh and marine waters. In addition, climate effects from Pacific decadal oscillation and the El Nino/Southern oscillation conditions and events cause changes in ocean productivity which can affect natural mortality of salmon, as described in more detail in Section 6.6, Large-scale Environmental Variation. Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals (including Southern Resident killer whales).

As discussed in the environmental baseline for salmon, harvest actions that have undergone consultation, other than the proposed actions, are part of the environmental baseline. Southern Resident killer whales were recently listed under the Endangered Species Act (NMFS 200c). As a result, past consultation on harvest actions have only recently sought coverage for Southern Resident killer whales. Therefore, the environmental baseline for Southern Residents differs from salmon stocks, which have been listed for a longer duration and have a longer history of past consultations.

The proposed actions will apply from 2009 to 2018 (review Chapter 3). Past harvest consultations with long-term coverage for Southern Resident killer whales are the only U.S. harvest actions included in the environmental baseline for killer whales, because of the long-term nature of the proposed actions. NOAA Fisheries has consulted on an annual basis regarding the effects of U.S. Fraser Panel fisheries (i.e., NMFS 2008o) and Pacific Coast Salmon Plan fisheries (i.e., NMFS 2008p) on Southern Residents; however, these fisheries do not have long-term coverage for Southern Residents. The *U.S. v. Oregon* 2008 Management Agreement (2008-2017, described in 6.1.1 Harvest Actions) is the only harvest action with long-term coverage for Southern Residents that spans the duration of the proposed actions, and therefore, is the only U.S. fishery that is part of the environmental baseline. NOAA Fisheries concluded that the *U.S. v. Oregon* 2008 Management Agreement is likely to reduce the number of Chinook available in the ocean as killer whale prey by a small amount, but this small reduction is not likely to jeopardize the continued existence of Southern Resident killer whales. Effects of Puget Sound fisheries on Southern Residents is subject to future consultation, and will be evaluated when consultation is re-initiated on the U.S. Fraser Panel fisheries in 2009 and the Puget Sound Harvest Management Plan in 2010 (current ESA Section 4(d) approval for salmon extends through April 30, 2010). Effects of the Pacific Coast Salmon Plan will also be re-initiated in 2009.

Canadian fisheries are not governed by the ESA. To determine the environmental baseline for Canadian harvest, NOAA Fisheries made informed assumptions about the level of fishing that would occur in the absence of an agreement (described in more detail in 7.2.9, Effects of Prey Reduction). Overall, the environmental baseline for Southern Residents was no U.S. fishing with the exception of fisheries managed under *U.S. v. Oregon*, and likely Canadian harvest levels in the absence of an agreement.

6.5.2.3 Prey Quality

Contaminants enter marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Freshwater contamination is also a concern because it may contaminate salmon that are later consumed by the whales in marine habitats. As discussed in the Status of the Species section, recent studies have documented high concentrations of PCBs, DDTs, and PBDEs in killer whales (Ross et al. 2000; Ylitalo et al. 2001; Reijnders and Aguilar 2002; Krahn et al. 2004). Harmful contaminants are stored in blubber; however, contaminants can be released from the blubber and become redistributed to other tissues increasing risk of immune or reproductive effects during weight loss from reductions in prey (Krahn et al. 2002).

Killer whales accumulate the contaminants in their blubber when they consume contaminated prey. The whales can metabolize their blubber when prey is scarce, which mobilizes contaminants, and can reduce their resistance to disease and affect reproduction. Chinook salmon contain higher levels of some contaminants than other salmon species, but only limited information is available for contaminant levels of Chinook along the west coast (Krahn et al. 2007, described in Chapter 5, Status of the Species).

6.5.2.4 Vessel Activities and Sound

Commercial shipping and military, recreational and fishing vessels occur in the coastal range of Southern Residents and additional whale watching, ferry operations, recreational and fishing vessel traffic in their inland range. The density of traffic is lower in coastal waters compared to inland waters of Washington State and British Columbia. Several studies in inland waters of Washington State and British Columbia have linked interactions of vessels and Northern and Southern Resident killer whales with short-term behavioral changes (Kruse 1991; Williams et al. 2002a, 2002b; Foote et al. 2004; Bain et al. 2006; Noren, In Review; Holt 2008). Although the potential impacts from vessels and the sounds they generate are poorly understood, these activities may affect foraging efficiency, communication, and/or energy expenditure through their physical presence, increased underwater sound level, or both. Collisions of killer whales with vessels are rare, but remain a potential source of serious injury and mortality.

Vessel sounds in coastal waters are most likely from large ships, tankers and tugs, whereas vessel sounds in inland waters also come from whale watch platforms, ferry operations and smaller recreational vessels. Sound generated by large vessels is a source of low frequency (5 to 500 Hz) human-generated sound in the world's oceans (National Research Council 2003). While larger ships generate some broadband noise in the hearing range of whales, the majority of energy is below their peak hearing sensitivity. Such vessels do not target whales, move at relatively slow speed and are likely detected and avoided by Southern Residents. Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (National Research Council 2003). Frequencies fall between 1 and 500 kHz, which is within the hearing range of some marine mammals including killer whales and may have masking effects.

In inland waters, the majority of vessels in close proximity to the whales are commercial and recreational whale watching vessels and the average number of boats accompanying whales can be great during the summer months (i.e., from 1998 to 2006 an average of 18 to 22 boats were within ½ mile in inland waters from May to September; Koski 2007). Sound generated from whale watch vessels varies by vessel size, engine type, and operating speed (Holt 2008). Although investigators have documented numerous short-term behavioral responses to whale watching vessels, new studies are only beginning to evaluate the consequences of these effects on the health of the population (Williams et al. 2006). There is ongoing research to evaluate changes in energy expenditure from behavioral responses and effects of sound on echolocation and foraging efficiency, which may translate to fitness effects. Currently, NOAA Fisheries is considering vessel management regulations to protect Southern Residents from vessel effects (72 FR 13464; March 22, 2007, and discussed below under Recovery Planning).

6.5.2.5 Non-Vessel Sound

Anthropogenic (human-generated) sound in the range of Southern Residents is generated by other sources besides vessels, including oil and gas exploration, construction activities, and military operations. Natural sounds in the marine environment include wind, waves, surf noise, precipitation, thunder, and biological noise from other marine species. The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (e.g., hearing, echolocation, communication).

In-water construction activities are permitted by the Army Corps of Engineers (ACOE) under section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval (HPA) program. Consultations on these permits have been conducted and conservation measures have been included to minimize or eliminate potential effects of in-water activities, such as pile driving, to marine mammals. Sound, such as sonar generated by military vessels also has the potential to disturb killer whales in inland and coastal waters within their range.

6.5.2.6 Oil Spills

Oil spills have occurred in the range of Southern Residents in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by Southern Residents remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers in inland waters. Numerous oil tankers transit through the range of Southern Residents throughout the year. The magnitude of risk posed by oil discharges in the action area is difficult to precisely quantify, but the volume of spills is decreasing (i.e., seven year comparison 2001-2007, for Seattle-Sector USCG, Smith unpubl. data). New oil spill prevention procedures in the state of Washington likely positively contribute to the decrease in spill volume (WDOE 2007).

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes adverse effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Geraci and St. Aubin 1990). In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect Southern Residents by reducing food availability.

6.5.2.7 Scientific Research

Most of the scientific research conducted on Southern Resident killer whales occurs in inland waters of Washington State and British Columbia. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. In 2006, NOAA Fisheries issued scientific research permits to seven investigators who intend to study Southern Resident killer whales (NMFS 2006g). Additionally in 2008, NOAA Fisheries issued another scientific permit to one investigator intending to study Southern Residents (NMFS 2008q). Research activities are typically conducted between May and October in inland waters; however, some permits include authorization to conduct research in coastal waters.

In the biological opinions NOAA Fisheries prepared to assess the impact of issuing the permits, we determined that the effects of these disturbances on Southern Residents were likely to adversely affect, but not jeopardize the continued existence of, the Southern Resident killer whales (NMFS 2006g, 2008q). Most of the authorized takes would occur in inland waters, with a small portion in the coastal range of Southern Residents. In light of the number of permits, associated takes, and research vessels and personnel present in the environment, repeated disturbance of individual killer whales is likely to occur in some instances. In recognition of the potential for disturbance and takes, NOAA Fisheries took steps to limit repeated harassment and avoid unnecessary duplication of effort through conditions included in the permits requiring coordination among Permit Holders.

6.5.3 Recovery Planning

The final recovery plan for Southern Resident killer whales was issued in January 2008 (NMFS 2008n). Recovery implementation of the Southern Resident killer whale recovery plan is currently in progress. To date, recovery planning and implementation has incorporated a range of actions, including additional scientific research to better understand threats to recovery, and directed actions to reduce the risk associated with identified threats. Directed actions include oil spill response planning (details available at: http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Status/Recovery-Implement.cfm) and proposed rulemaking for regulations on vessel effects (details available at: http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Status/Orca-Vessel-Regs.cfm). Actions that reduce the risk associated with identified threats will benefit Southern Resident killer whales. Additionally, recovery planning for salmon (review above Section 6.1.3, 6.2.3 and 6.3.3 salmon recovery planning domains) will benefit Southern Resident killer whales, where actions improve the quantity and quality of prey available to Southern Resident killer whales.

6.5.4 Summary of Environmental Baseline

Southern Resident killer whales are exposed to a wide variety of past and present state, federal or private actions and other human activities in the coastal and inland waters area that comprise the Action Area, as well as federal projects in this area that have already undergone formal section 7 consultation, and state or private actions that are contemporaneous with this consultation. All of the activities discussed in the above section are likely to have some level of impact on Southern Residents when they are in inland and coastal waters of their range.

No single threat has been directly linked to or identified as the cause of the recent decline of the Southern Resident killer whales, although the three primary threats are identified as prey availability, environmental contaminants, and vessel effects and sound, (Krahn et al. 2002). Researchers are unsure about which threats are most significant. There is limited information on how these factors or additional unknown factors may be affecting Southern Resident killer whales when in coastal waters and during the winter. For reasons discussed earlier, it is possible that two or more of these factors may act together to harm the whales. The small size of the population increases the level of concern about all of these risks (NMFS 2008n).

6.6 Large-scale Environmental Variation

Salmonid population abundance is affected substantially by inter-annual changes in the freshwater and marine environments, particularly by conditions early in their life histories. Generally, the inland environment (including rivers, tributaries, and the associated uplands) is most favorable to salmon when there is a cold, wet winter, leading to substantial snowpack. This normally results in higher levels of runoff during spring and early summer, when many of the juvenile salmon are migrating to the ocean. The higher levels of runoff are associated with lower water temperatures, greater turbidity, and higher velocity in the river, all of which are beneficial to juvenile salmon. However, severe flooding may constrain populations. The low return of Lewis River bright fall Chinook salmon in 1999, for example, has been attributed to flood events during 1995 and 1996.

Within the ocean environment, near-shore upwelling, which brings nutrients up from deep into the photic zone, is a key determinant of ocean productivity as it affects the availability of food for juvenile salmon at the critical point when they first enter the ocean. The upwelling results from ocean currents that appear to be driven by spring and early summer winds which, in turn, result from oscillations in the jet stream that follow certain cycles. Within a year, there are cycles of 20-40 days that affect upwelling, and among years there are longer-lasting conditions, such as El Nino/La Nina cycles of 2-3 years and the Pacific Decadal Oscillation (PDO) which may have cycles of 30-40 years or more that influence upwelling.

Scheuerell and Williams (2005) showed that the coastal upwelling index is a strong determinant of year-class strength and subsequent smolt-to-adult return ratios. The Northwest Fisheries Science Center currently monitors a number of ocean conditions and provides a forecast on their website for salmon returns to the Columbia River based on these and other observations.

In some instances, the inland conditions and ocean conditions appear to be correlated; that is, the same weather patterns producing a cold, wet winter with good snowpack and high spring runoff are also likely to bring the later winds that yield good upwelling and favorable feeding conditions in the ocean. However, it is also possible for inland and ocean conditions to diverge, and years have been observed where there have been favorable river conditions but poor ocean conditions, and vice versa.

While strong salmon runs are a product of both good in-river conditions and good ocean conditions, favorable ocean conditions appear to be especially important. For example, 2001 was the second-lowest flow year recorded on the Columbia River, but the near-shore temperatures were generally cool, observed ocean productivity was good, and resulting adult returns from the 2001 juvenile outmigration class were in the average or better range for most of the runs.

This section discusses inter-annual climatic variations (e.g. El Niño and La Niña), longer term cycles in ocean conditions pertinent to salmon survival (e.g. Pacific Decadal Oscillation), and ongoing global climate change and its implications for both oceanic and inland habitats and fish survivals. Because these phenomena have the potential to affect salmonids survival over their entire range and multiple life stages, they are an area of substantial scientific investigation.

6.6.1 The Southern Oscillation Index, El Niño & La Niña

In an effort to predict the likely strength of the annual monsoons over India in the 1920s, which greatly affected human life through floods and famines, Sir Gilbert Walker conducted extensive statistical analyses of long-term weather observations for many locations around the globe. Among his many findings was that deviations from long-term average seasonal differences in atmospheric pressure between the western Pacific and the eastern Pacific (typically Darwin, Australia to Tahiti), correlated strongly with subsequent climatic conditions in other parts of the globe. Walker termed these deviations, the "Southern Oscillation Index" (SOI). In general, substantial negative SOIs tend to correlate well with above average tropical sea-surface temperatures and positive SOIs tend to correlate with below average sea-surface temperatures, particularly in the eastern Pacific. Both have been found to have "teleconnections" to climatic and oceanic conditions in regions far distant from the south Pacific, including the Pacific Northwest. Although in modern usage a broader array of oceanic and atmospheric characteristics have been found to provide greater predictive power, these teleconnections between conditions in the south Pacific and subsequent climatic conditions elsewhere have come into routine use, including pre-season predictions of runoff in some portions of the Columbia basin.

Atmospheric conditions correlated with unseasonably warm south Pacific sea-surface temperatures are termed El Niños. El Niños typically last 6 to 18 months. Among the consequences are warmer near-surface ocean water temperatures along the U.S. west coast and generally warmer, drier weather in the inland Pacific Northwest, particularly during the winter. When winds do not blow south, the forces that create upwelling off the U.S. coast are reduced, as are nutrient inputs to the euphotic zone (well lit, near surface zone), reducing near-shore ocean productivity. This reduction in ocean productivity has been shown to reduce juvenile salmon growth and survival (Scheurell and Williams 2005). Warmer surface waters can also change the spatial distribution of marine fishes with potential predator-prey effects on salmon.

The warmer, drier weather in the Pacific Northwest often associated with El Niño can also cause or increase the severity of regional droughts. Droughts reduce streamflows through the Columbia and Snake River migratory corridor, increase water temperatures, and reduce the extent of suitable habitat in some drainages. Each of these physical effects has been shown to reduce salmon survival. Thus, El Niño events are associated with poor returns of salmon and steelhead.

Unseasonably cool south Pacific sea surface temperatures, typically associated with a positive SOI, tend to have quite different effects in the north Pacific and the Columbia basin. Termed La Niña, positive SOIs tend to be associated with cooler north Pacific surface water temperatures, and cooler, wetter fall and winter conditions inland. Conditions associated with La Niña tend to increase snowpack and runoff in the Columbia basin, improving outmigration conditions, and ocean conditions tend to be more conducive for coastal upwelling early in the spring, providing better feeding conditions for young salmon.

Currently, NOAA Physical Sciences Division calculates a "Multivariate El Niño Southern Oscillation Index" or MEI, which effectively inverts the SOI relationships: a positive MEI indicates El Niño conditions and a negative MEI a La Niña. Once established, El Niño and La Niña conditions tend to persist for a few months to two years although prevalent El Niño conditions have dominated the Pacific since 1977 and persisted from 1990 through 1995 (Figure 6.6.1-1 below). It is likely that the dominance of El Niño conditions since the late 1970s has contributed to the depressed status of many stocks of anadromous fish in the PNW.

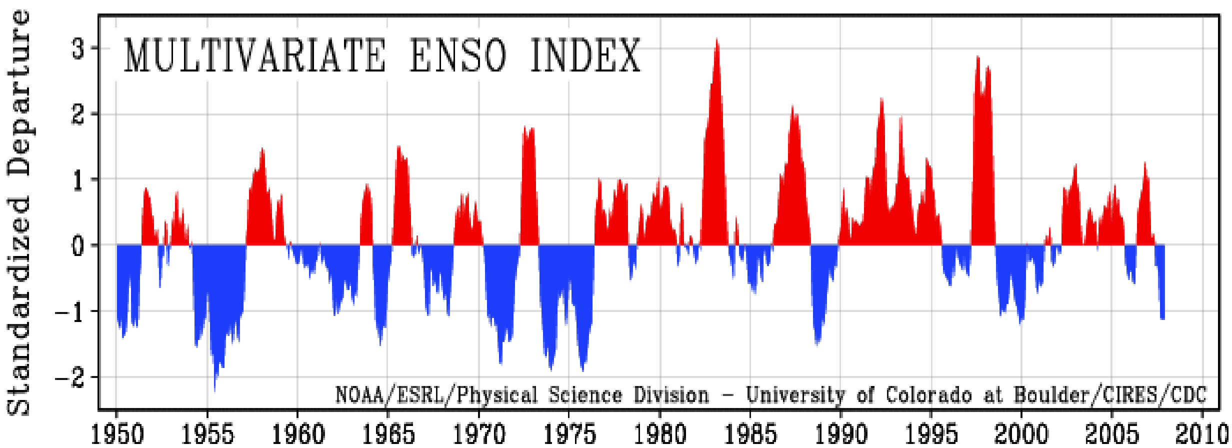


Figure 6.6.1-1. Time-series of MEI conditions from 1950 through November 2007. Source: NMFS 2008c.

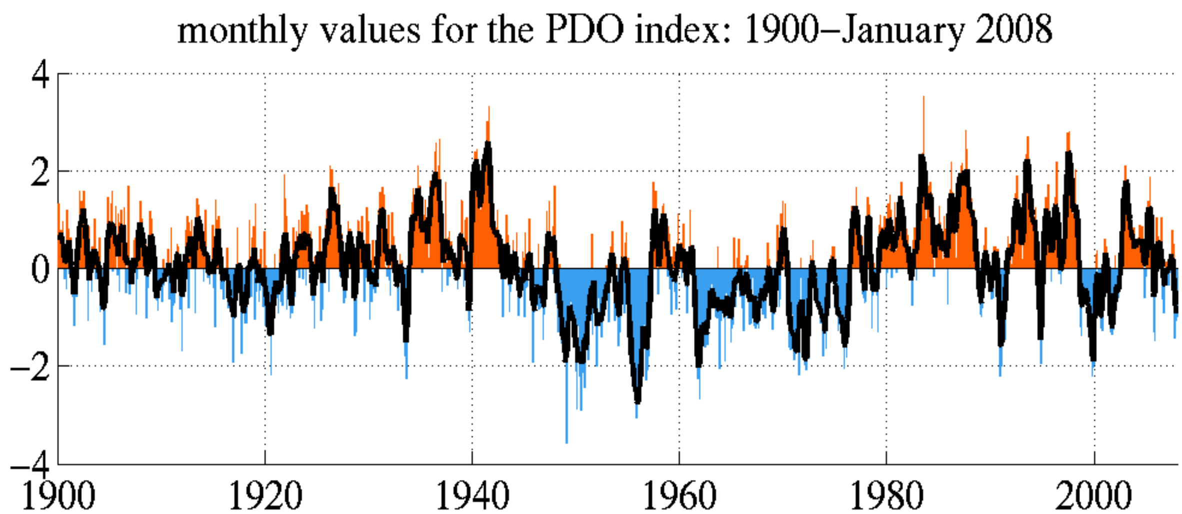
6.6.2 Pacific Decadal Oscillation

First defined by Steven Hare in 1996, the Pacific Decadal Oscillation (PDO) index is the leading principal component (a statistical term) of North Pacific sea surface temperature variability (poleward of 20° N to the 1900-1993 period (Mantua et al. 1997).

Major changes in northeast Pacific marine ecosystems have been correlated with phase changes in the PDO; warm eras have seen enhanced coastal ocean biological productivity in Alaska and inhibited productivity off the west coast of the contiguous United States, while cool PDO eras have seen the opposite north-south pattern of marine ecosystem productivity (e.g., Hare et al. 1999). Thus, smolt-to-adult return ratios for Columbia basin salmon tend to be high when the PDO is in a cool phase and low when the PDO is in a warm phase.

Two main characteristics distinguish the PDO from El Niño: first, 20th century PDO "events" persisted for 20-to-30 years, while typical El Niño events persisted for 6 to 18 months; second, the climatic fingerprints of the PDO are most visible in the North Pacific/North American sector, while secondary signatures exist in the tropics – the opposite is true for El Niño. Several independent studies find evidence for just two full PDO cycles in the past century: "cool" PDO regimes prevailed from 1890-1924 and again from 1947-1976, while "warm" PDO regimes dominated from 1925-1946 and from 1977 through (at least) the mid-1990s (Figure 6.6.2-1). Shoshiro Minobe (1997) has shown that 20th century PDO fluctuations were most energetic in two general periods, one from 15 to 25 years, and the other from 50 to 70 years.

Figure 6.6.2-1. Monthly Values for the PDO Index: 1900-January 2008.



Mantua and Hare (2002) state, “The physical mechanisms behind the PDO are not currently known.” Likewise, the potential for predicting this climate oscillation is not known. Some climate simulation models produce PDO-like oscillations, although often for different reasons. Discovery of mechanisms giving rise to the PDO will determine whether skillful decades-long PDO climate predictions are possible. For example, if a PDO arises from air-sea interactions that require 10 year ocean adjustment times, then aspects of the phenomenon could, theoretically, be predictable at lead times of up to 10 years. Even in the absence of a theoretical understanding, PDO climate information improves season-to-season and year-to-year climate forecasts for North America because of its strong tendency for multi-season and multi-year persistence. From the perspective of societal impact, recognition of PDO is important because it shows that "normal" climate conditions can vary over time scales (decades) used to describe the length of a human's lifetime.

Recent evidence suggests that marine survival of salmonids fluctuates in response to the PDO’s 20 to 30 year cycles of climatic conditions and ocean productivity (Cramer et al. 1999). Ocean conditions that affect the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and to have been an important contributor to the decline of many stocks. The survival and recovery of these species will depend on their ability to persist through periods of unfavorable hydrologic and oceanographic conditions.

6.6.3 Global Climate Change

Ongoing global climate change has implications for the current and likely future status of anadromous fish in the Pacific Northwest. Recent studies, particularly by the Independent Scientific Advisory Board (ISAB 2007), describe the potential impacts of climate change in the Columbia River Basin. These effects, according to the ISAB, may alter precipitation and temperature levels in the basin and, in particular, impact the hydrosystem and habitat life-stages of Columbia Basin salmon and steelhead. In a basin reliant on cooler winter temperatures to store a spring/summer water supply in the snowpack, alterations to the precipitation and temperature levels may have the following physical impacts:

- Warmer air temperatures will result in a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a shift to more rain and less snow, the snowpacks will diminish in those areas that typically accumulate and store water until the spring freshet.
- With a smaller snowpack, these watersheds will see their runoff diminished and exhausted earlier in the season, resulting in lower streamflows in the June through September period.
- River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures will continue to rise, especially during the summer months when lower streamflow and warmer air temperatures will contribute to the warming regional waters.

Such responses to warming air temperatures and precipitation alterations will not be spatially homogeneous across the entire Columbia River Basin. Following anticipated air temperature increases, the distribution and duration of snowpack in those portions of the basin at elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation contribute little to total streamflow. This condition would also be relatively unaffected. The most noticeable changes will occur in the “transient snow” watersheds where the threshold between freezing and non-freezing temperatures is much more sensitive to warming (e.g. the Willamette Basin). Not only would changes in the distribution of precipitation between rain and snow affect the shape of the annual hydrograph and water temperature regimes, but more frequent and more severe rain on snow events could affect flood frequency with implications for scouring out incubating and young-of-the-year-fish (ISAB 2007).

According to the ISAB report, it is anticipated that large-scale ecological changes will also occur over a 35 year time period. For example, the scale of insect infestations of forested lands and the frequency and intensity of forest fires are likely to become more prevalent during this time period as well. As reported by the ISAB (2007), "fire frequency and intensity have already increased in the past 50 years, and especially the past 15 years, in the shrub steppe and forested regions of the West. Drought and hot, dry weather already have led to an increase in outbreaks of insects in the Columbia Basin, especially mountain pine beetle, and insect outbreaks are likely to become more common and widespread."[12] Such landscape changes have implications for salmon habitat and survival.

The ISAB (2007) identified the following list of likely effects of projected climate changes on Columbia basin salmon:

- Anticipated water temperature increases, and the subsequent depletion of cold water habitat, could reduce the areal extent of suitable inland salmon habitats. O'Neal (2002, as cited in ISAB 2007) assessed the potential impacts of climate warming on Pacific Northwest salmon habitat. Locations that were likely to experience an average weekly maximum temperature that exceeded the upper thermal tolerance limit for a species were considered to be lost habitat. Projected salmon habitat loss would be most severe in Oregon and Idaho with potential losses exceeding 40% of current by 2090. Loss of salmon habitat in Washington would be a less severe case of about 22% loss by 2090. O'Neal's approach assumed a high rate of greenhouse gas emissions and used a climate model that projected a 5 degree C increase in global temperatures by 2090, a value that is higher than the scenarios considered most likely (ISAB 2007). This estimate of potential habitat loss does not consider the associated impact of changing hydrology.

- Variations in intensity of precipitation may alter the seasonal hydrograph. With reduced snowpack and greater rainfall, the timing of stream flow will likely shift, depreciably reducing spring and summer stream flow, and increasing peak river flows (ISAB 2007). This reduction in stream flow may impact the quality and quantity of tributary rearing habitat, greatly affecting spring and summer salmon and steelhead runs. In addition, the Pacific Northwest's low late-summer and early-fall stream flows are likely to be further reduced. Reduced late-summer and early-fall flows, in conjunction with rising water temperatures, are likely to adversely impact juvenile fall Chinook and chum salmon by depleting essential summer shallow mainstem rearing habitat.

- Considering both the water temperature and hydrologic effects of climate change, Crozier et al. (2008) showed that the abundance of four studied Snake River spring/summer Chinook populations would be substantially decreased (20-50% decline from simulated average abundance based on historical 1915-2002 climate) and extinction risks substantially increased

[12] Removal of trees from riparian areas by fire or insects will lead, at least temporarily, to an increase in solar radiation reaching the water and exacerbate the water temperature. The potential for climate-induced fire and insect outbreaks has the potential to disproportionately impact habitats of key importance to native fish and wildlife populations (ISAB 2007).

by long-term exposure to climate conditions likely to exist in 2040. Hydrologic and physical changes in the Pacific Northwest environment have implications for the habitat, populations, and spatial distributions of Pacific salmonids (Zabel et al. 2006).

- Eggs of fall and winter spawning fish, including Chinook, coho, chum, and sockeye salmon, may suffer higher levels of mortality when exposed to increased flood flows. Higher winter water temperatures also could accelerate embryo development and cause premature emergence of fry.

- Increases in seasonal mainstem Snake and Columbia River water temperature would accelerate the rate of egg development of fall Chinook that spawn in the mainstem of the Snake and Columbia rivers, and lead to earlier emergence at a smaller average size than historically. Also, dam and reservoir passage survival is affected by water temperatures with the lowest rates of survival typically occurring when water temperatures are warmest. Potential impacts of increased water temperatures on adult salmon include delay in dam passage, failure to enter fish ladders, increased fallback, and loss of energy reserves due to increased metabolic demand. Increases in mortality also may be caused by fish pathogens and parasites as these organisms often do not become injurious until their host becomes thermally stressed.

- Earlier snowmelt and earlier, higher spring flows, warmer temperatures, and a greater proportion of precipitation falling as rain rather than snow, may cause spring Chinook and steelhead yearlings to smolt and emigrate to the estuary and ocean earlier in the spring. The early emigration coupled with a projected delay in the onset of coastal upwelling could cause these fish to enter the ocean before foraging conditions are optimal. The first few weeks in the ocean are thought to be critical to the survival of salmon off Oregon and Washington, so a growing mismatch between smolt migrations and coastal upwelling would likely have significant negative impacts on early ocean survival rates.

- Within the Columbia estuary, increased sea levels in conjunction with higher winter river flows could cause the degradation of estuary habitats created by increasing wave damage during storms. Numerous warm-adapted fish species, including several non-indigenous species, normally found in freshwater have been reported from the estuary and might expand their populations with the warmer water and seasonal expansion of freshwater habitats. Climate change also may affect the trophic dynamics of the estuary due to upstream extension of the salt wedge in spring-early summer caused by reduced river flows. The landward head of the salt wedge is characterized by a turbulent region known as the estuary turbidity maximum, an area with high concentrations of fish food organisms such as harpacticoid copepods. Changes in the upstream extension of the salt wedge will influence the location of this zone, but it is difficult to forecast the effect this change will have on juvenile salmon.

- Scientific evidence strongly suggests that global climate change is already altering marine ecosystems from the tropics to polar seas. Physical changes associated with warming include increases in ocean temperature, increased stratification of the water column, and changes in the intensity and timing of coastal upwelling. These changes will alter primary and secondary productivity, the structure of marine communities, and, in turn, the growth, productivity, survival, and migrations of salmonids.

- Changing ocean temperatures may alter salmon behavior, distribution, and migrations, increasing the distance to migrations from their home streams to ocean feeding areas. Energetic demands are increased at warmer temperatures, requiring increased consumption of prey to maintain a given growth rate. This could lead to intensified competition among species, as well as an increased reduction in growth rates, further exacerbating the prey/predator relationship. In addition, food availability in the ocean may be altered by climate change. Increasing concentrations of CO_2 in the oceans lowers pH, which reduces the availability of carbonate for shell-forming marine animals. Pteropods are expected to be negatively affected, and they can comprise up to 40% or more of the diet of some salmon species although another suitable prey item might replace them in the ecosystem. If salmon migrate farther to the north and/or food is less available, longer times may be required to reach maturity, delaying the usual times of adult migrations into coastal water and rivers.

- Global climate change in the Pacific Northwest may be similar to those experienced during past periods of strong El Niños and warm phases of the PDO.

The effects of climate change are considered both quantitatively and qualitatively in Chapter 7 of this opinion. The effect of a sustained and broad scale down turn in the productivity and abundance of Chinook salmon that could occur as a consequence of long term cycles in ocean conditions or global climate change are considered in particular through the retrospective analysis.

7 ▪ Effects of the Actions

The purpose of this section is to discuss the effects of the proposed actions on the listed species. Several analytical methods are used to assist with our analysis of the effects of the actions on some Chinook populations and ESUs. The *Viable Risk Assessment Procedure* (VRAP) has been used for the last several years to assess the effects of harvest on Chinook salmon. The *Salmon Population AnalyZer* (SPAZ) was used for the first time in NOAA Fisheries' consultation on the effects of 2008 PFMC fisheries on Lower Columbia River Chinook, but has been used elsewhere to analyze population status. We provide a short summary of these methods below, and use the results from the analyses in the following discussion. More detailed descriptions of the methods are included in appendices to this opinion. The *retrospective analysis* was developed specifically to assist with NOAA Fisheries' assessment of the proposed actions considered in this opinion. Because the retrospective analysis is used here for the first time, it is described in more detail below. As indicated in Chapter 5 the following analysis of the effects of the proposed actions focuses in greatest detail on four Chinook ESUs and Southern Resident killer whales. However, sufficient information is provided regarding the other salmon and steelhead species, green sturgeon, and steller sea lions in the effects section to support the necessary conclusions.

7.1 Viability Risk Assessment Procedure

NOAA Fisheries analyzes the effects of harvest actions on populations using quantitative analyses where possible (i.e., where a sufficiently reliable time series of data is available) and more qualitative considerations where necessary. The VRAP is an example of a quantitative risk assessment method developed by NOAA Fisheries that so far has been applied primarily for analyzing harvest impacts on certain Puget Sound Chinook populations and Lower Columbia River tule Chinook. VRAP has not been used for other populations because of the lack of data, resources to do the necessary analysis, or because we have relied on other risk assessment techniques. VRAP provides estimates of the maximum population-specific exploitation rates (called Rebuilding Exploitation Rates or RERs) that are thought to be consistent with survival and recovery of that population. Proposed fisheries are then evaluated, in part, by comparing the rates that would result from the proposed harvest plan to those RERs over a given time period. Generally speaking, where estimated impacts of the proposed plan are less than or equal to the RERs, NOAA Fisheries considers the harvest plan to present a low risk to that population. This comparison, however, must take into account uncertainties associated with predicting the impacts of the harvest plan, and uncertainties regarding the estimated RER itself, which can change over time as additional and/or improved data become available or environmental conditions change. The results of this comparison, together with more qualitative considerations for populations where RERs cannot be calculated, are then used in making the jeopardy determination for the ESU as a whole. However, RERs are not used in isolation as jeopardy standards. The risk to a population that is not meeting its RER requires consideration of other available information. The risk to the ESU associated with an individual population not meeting its RER also must be considered within the broader context of other information. A brief summary of VRAP and how it is used to estimate an RER is provided in Appendix 1. For a more detailed explanation see NMFS (2000a) and NMFS (2004c).

7.2 Salmon Population AnalyZer

The Salmon Population AnalyZer (SPAZ) is a program designed for analyzing salmon population data and is used for fitting population growth models to data, and assessing population viability or extinction risk. Although the SPAZ was not designed specifically to assess the effects of harvest on population viability, it can be used to estimate how various levels of harvest affect the related metrics. The SPAZ was used for the first time to analyze the effects of harvest on Lower Columbia River tule populations in the 2008 opinion on PFMC fisheries (NMFS 2008h). The relationship between VRAP and SPAZ and resulting outputs is still an area of active research. The concepts and methods underlying SPAZ are described in detail in the most recent WLC TRT viability report (WLCTRT and ODFW 2006), which builds on the basic framework in the NOAA Technical Memorandum on Viable Salmonid Populations (VSP) (McElhany et al. 2000). The SPAZ uses alternative techniques to analyze similar information and provides additional information regarding the status of the species and the effects of the proposed actions. Interpreting the implications of VRAP or SPAZ or other sources of information requires some understanding of the nature of the analysis and what they are attempting to estimate. A summary of the program and its applications is provided in Appendix 2.

7.3 Retrospective Analysis

The effect of the 2008 Agreement on exploitation rates and natural escapement for ESA listed Chinook was compared using the Fishery Regulation Assessment Model (FRAM) in a retrospective approach. The FRAM is the tool used primarily for assessing Chinook and coho fisheries south of Canada during the annual Pacific Fishery Management Council and North of Cape Falcon management processes.

The FRAM is a single-pool deterministic fishery simulation model that is based on stock-specific escapement and catch data from analysis of coded-wire-tags (CWT) recovered in fisheries and escapement areas (PFMC 2007a). The FRAM essentially is an accounting tool that links the year-specific stock abundances with the catches by fishery according to historic catch distribution data from CWTs. There are 38 Chinook stocks and their marked and unmarked subcomponents in FRAM, representing production from southern British Columbia to California. FRAM contains 73 pre-terminal and terminal fisheries from southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon and California. Each run of FRAM incorporates the stock abundances and catches covering one management year that runs from May through the following April.

The Chinook FRAM model has four time steps: October through April, May through June, July through September, and October through April of the next year. The initial age-specific cohort size for each stock is set at the beginning of the first time period (October through April) based on the year specific estimates of abundance from post-season run reconstruction. At the start of each time period 'prefishing' abundances are first reduced by applying an age specific natural mortality rate, then reduced again by impacts in preterminal fisheries derived from the FRAM data set of stock, age, and fishery specific exploitation rates. After preterminal fishery impacts are subtracted, an age and stock specific maturation rate is applied to the remainder to produce a mature cohort representing the portion of the run that is returning to spawn in that time period and subject to fisheries in the terminal areas. The non-mature remainder becomes the initial starting cohort in the next time step and the same stepwise accounting continues in the next time period. Most stocks only mature during the July to September time period; hence, the mature cohort is zero in October through June. Columbia River spring-run Chinook mature in October through April. This general stepwise accounting system in FRAM produces stock, age, and time specific estimates of cohort abundances and fishing impacts for each model run year. Each year this is evaluated independently; there is no direct connection between adjacent years.

The FRAM model uses the coded-wire tags and fishing patterns during a base period when fisheries were widespread in time and area. The base period information is then scaled to reflect the fishery pattern relative to the base years, and the abundance of the Chinook stocks in each year. An alternative approach that provides a more direct assessment of mortalities is to use coded-wire tag recoveries in each year to assess impacts on tag groups representing individual stocks or stock aggregates. The Pacific Salmon Commission Joint Chinook Technical Committee (CTC) does this as part of an annual exploitation rate analysis. However the data is often limited by inadequate escapement sampling or discontinuous or limited time series that may limit its utility in assessing harvest trends over time. The CTC exploitation rate analysis from coded-wire tag recoveries is not easily adapted to scenario comparisons. Estimates of exploitation rate for a given stock derived from FRAM and the CWT data may differ, sometimes significantly. Neither method can be considered the preferred method. Where differences exist it is necessary to look at the source data for the stock and consider why the difference may occur.

The retrospective analysis relies on a review of past circumstances to develop an understanding of the likely effect of the 2008 Agreement on the fisheries, and on the exploitation rates and escapements of ESA listed species and other stocks of concern. Actual outcomes over the next ten years will depend on year-specific circumstances related to individual stock abundance, the combined abundances of stocks in particular fisheries, and how fisheries actually are managed in response to these circumstances.

The 2008 Agreement sets limits on harvest in both AABM and ISBM fisheries. It is important to understand the context within which the limits were established. The fishery limits in the 2008 Agreement are the result of a complex bilateral negotiation wherein the Parties sought to find an acceptable and effective distribution of harvest opportunities and fishery constraints that, when combined with domestic fishery management constraints, would be consistent with the fundamental conservation and sharing objectives of the Treaty. The bilateral fishing regimes are reflective of many considerations, including the historical relationship among fisheries, the variable and evolving nature of the resource base in both countries, and a balancing among fisheries to allocate fishing opportunities and fishery constraints between and among mixed stock and more-terminal fisheries in the two countries. In specific circumstances, side payments are made to mitigate for adjustments in fisheries or to improve scientific knowledge of the resource. The fishery and stock-specific annual limits in the agreed regimes were negotiated with the clear understanding that more restrictive fishery and stock-specific measures often would be required and applied in each country as necessary to meet domestic objectives , such as those required to meet ESA obligations for listed species (L.Rutter, PSC Commissioner, pers. comm.).

Our actual experience has borne out this relationship between the international limits established in the PST agreements and domestic constraints: fisheries often have been more constrained by ESA and/or other Canadian or U.S. domestic management considerations than was necessary to comply with the applicable bilateral Agreement. From 1999 to 2002, for example, Canadian AABM fisheries were reduced greatly relative to what was allowed under the 1999 Agreement because of domestic concerns particularly for their WCVI Chinook stock. Southern U.S. fisheries in Puget Sound and along the coast were also often constrained beyond the applicable ISBM requirements because of ESA and other management considerations and conservation constraints. This difference between what is required by the bilateral 2008 Agreement and the tighter constraints that are actually applied for domestic reasons forms the basis of some of the scenarios described below and analyzed herein in the retrospective analysis.

The retrospective analysis uses years from the recent past (1990 through 2006) because they provide a known set of prior circumstances regarding stock abundance and actual fishery affects. The retrospective analysis considers how outcomes would have changed under alternative management scenarios. The scenarios are explained in more detail below, but generally represent 1) what actually occurred based on post season estimates of stock abundance and fishery catches; 2) what would have occurred each year given the preseason estimates of stock abundance if fisheries were managed subject only to the limits prescribed in the 1999 Agreement, i.e., in the absence of additional domestic constraints; 3) what would have occurred each year given the preseason estimates of stock abundance if fisheries were managed subject only to the limits prescribed in the 2008 Agreement, i.e., in the absence of additional domestic constraints; 4) what we can reasonably expect to occur under the 2008 Agreement given an informed assessment of how fisheries are likely to be managed in the future, i.e., with domestic constraints in addition to those prescribed in the 2008 Agreement ; and 5) how the AABM fishery provisions in the 2008 Agreement would perform if there was an unexpected and broad scale reduction of 40% in the abundance of Chinook salmon, measured in terms of the AABM fisheries' effect on exploitation rates. The 40% reduction scenario is unlikely to occur during the term of the 2008 Agreement but is included to cover the situation of a prolonged and broad scale down turn in productivity and abundance that could occur as a consequence of long term cycles in ocean conditions or global climate change.

For this analysis, the following five scenarios were run in FRAM using a retrospective analysis of the 1990-2006 fishing years:

FRAM Validation

FRAM runs using actual post-season fishery catches and best available estimates of annual stock abundances. The FRAM Validation scenario approximates what actually occurred based on post season information. These runs are also used in other forums to evaluate the model and the management system and their relative success in meeting fishery and stock specific management objectives.

1999 Agreement

FRAM runs using year specific abundances and all fisheries modeled as described in the 1999 Chinook Annex Agreement. The 1999 Agreement scenario approximates what would have occurred had all marine fisheries been managed subject *only* to the 1999 Agreement without additional domestic management constraints. The AABM fisheries (southeast Alaska troll, net, and sport; northern and central British Columbia troll and sport; and West Coast Vancouver Island troll and sport) were modeled as Total Allowable Catch quotas using the relationship of the post-season Abundance Index (AI) and Harvest Rate Index (HRI) as described in the 1999 Agreement. The catch in the southeast Alaska net fishery was set at 20,000 annually. Other marine area fisheries in the south were modeled at the maximum fishing rate index for U.S. (0.6 index, i.e., 60% of base period average exploitation rate) and Canadian (0.635 index, i.e., 63.5% of base period average exploitation rate) fisheries under ISBM.[13] Freshwater fisheries were modeled at the same terminal area harvest rate as in the FRAM Validation runs.

2008 Agreement

FRAM runs using year specific abundances with all fisheries modeled as described in the proposed 2008 Chinook Annex Agreement. The 2008 Agreement scenario approximates what would have occurred had all marine fisheries been managed subject *only* to the 2008 Agreement without additional domestic management constraints. The scenario reduces the southeast Alaska AABM fishery combined TAC by 15% from the 1999 Agreement levels as specified in the proposed new agreement. The catch in the southeast Alaska net fishery was set at 17,000 annually. The TAC in the northern and central BC fishery was not changed in the 2008 Agreement. The overall TAC in the West Coast Vancouver Island troll and sport fisheries was reduced 30% per the relationship of AI and HRI as described in the proposed new agreement. ISBM and freshwater fisheries were modeled at the same rate as in the 1999 Agreement scenario. These assumptions allow the 2008 Agreement scenario to be compared directly to those of the

[13] The Agreement contains a general obligation that limits the maximum fishing rate in *all* fisheries for PSC indicator stocks to 60% of the 1979-82 base for U.S. stocks and to 63.5% for Canadian stocks. Individual fisheries may exceed these percentages as long as the aggregate exploitation rate in all ISBM fisheries satisfies the obligation.

1999 Agreement scenario thus giving a sense of the effect of reductions in AABM fisheries that are key changes in the proposed new agreement relative to the regime it replaces.

2008 Likely

FRAM runs using recent year (1999-onward) fishing effort rates for ISBM fisheries and 2008 Agreement AABM fishery TAC quotas applied to actual abundances for 1990-2006. These runs are intended to approximate the exploitation rates and natural escapements under a "likely" range of fishing levels during the next ten years. ISBM fisheries in the U.S. and Canada have been constrained well below ISBM limits in recent years because of domestic concerns. In the 2008 Likely scenario we approximate our expectation of future constraints by assuming that fish levels will be similar to those observed in recent years. The 1990-1998 ISBM fishing levels were based on the average fishing effort rates for 1999-2002. The ISBM fishing levels for 1999-2006 were based on the annual fishing effort rates as estimated in the FRAM Validation runs. In this scenario, WCVI sport was modeled at 50,000 fish quota in all years with the troll catch as the difference between this and the overall TAC under the 2008 Agreement. Also, the WCVI troll fishery was modeled with adjustments to stock impacts as derived by the PSC Chinook Technical Committee reflecting the "shoulder" fishing pattern observed in recent years.

Since the early 2000s, the WCVI troll fishery has shifted its season structure from a summer fishery to the fall and spring ("shoulder fishing pattern"). Because WCVI fisheries in the base period occurred primarily during the summer, FRAM calculates impacts assuming there is no effect from shifting to a shoulder pattern unless adjustments are made to the model data that incorporate this effect. The stock specific effect of this shoulder fishing pattern has been estimated by the CTC and incorporated into the 2008 Likely and 40% Reduction scenarios. Both higher and lower impacts were estimated as a result of the changed pattern depending on the stock. The overall effect of the shoulder fishing pattern on the total exploitation rate will depend on the proportion of each stock's total exploitation in the WCVI troll fishery, and how the catch of that stock is distributed between the summer, and spring and fall fishing seasons.

40 Percent Reduction

Similar to the 2008 Likely scenario except all stock abundances and the AABM AI's are reduced 40%. AABM fishery AI's were reduced 40% and a new TAC was calculated from the HRI per the tiered formulae in the 2008 Agreement. ISBM fisheries were modeled using the same fishing rates as in the 2008 Likely scenario, i.e., by incorporating domestic constraints. The WCVI sport catch was calculated as the lesser of the combined WCVI TAC or 50,000. Consequently, in some years the troll fishery was closed. The 40% reduction scenario is best compared to the 2008 Likely scenario to provide a perspective on how the AABM provisions in the proposed agreement will respond to reduced abundance in terms of affect on exploitation rates in those fisheries and resulting escapements. Because the ISBM fisheries were modeled as rates, the comparison isolates the effect of the AABM fisheries provisions in response to a 40% reduction in overall abundance. If the abundance of Chinook did in fact decline by 40%, catches in ISBM fisheries would likely be reduced relative to the rates used in these model runs to address stock specific conservation concerns. Because of the many stocks and fisheries involved, it was not possible to analyze alternative outcomes for ISBM fisheries given the available time.

For each of the ESA listed natural Chinook stocks, exploitation rates were graphed for the five scenarios covering the 1990-2006 fishing years. Separate exploitation rates were graphed for all fisheries (Total ER), fisheries in Alaska and Canada only (northern fisheries), and fisheries south of Canada (southern fisheries). The total exploitation rate graphs show Rebuilding Exploitation Rates (RER) for those stocks that have NOAA Fisheries derived RERs. Estimates of escapement are also shown for most stocks, particularly for those with escapement goals or other escapement related metrics. For example, Rebuilding/Upper Escapement Thresholds (UET) and Critical Escapement Thresholds (CET), which are described in more detail in Appendix 1, are shown where available. Projected escapements are not shown for Snake River fall Chinook, Upper Willamette River Chinook, or the Lower Columbia River Chinook populations for a variety of reasons related to the specifics for those populations. Generally, the FRAM is not designed and has not been used to predict escapements for these populations.

Results from the retrospective analysis for Snake River fall Chinook are expressed in terms of the Snake River Fall Chinook Index (SRFI) rather than as exploitation rates or escapements. As explained in more detail below, ocean fisheries have been managed subject to an ESA standard referred to as the SRFI since 1996. The ESA standard requires a 30% reduction in the 1988 to 1993 average base period exploitation rate. A SRFI of 1.0 represents an exploitation rate equivalent to that which occurred in the base period; a value of 0.70 represents a 30% reduction relative to the base period average.

The variety of models and assessment techniques used to analyze various populations or ESUs can be confusing. This diversity of information becomes apparent particularly in a complex consultation like this one that considers such a broad range of species from several geographic domains. Unfortunately, it is simply a fact that methods have evolved over the last 16 years since the original ESA listings of salmon in 1992 based on circumstance at the time and the available information. We have made progress in bringing consistency to our reviews. The VSP paper, for example, provides a consistent context for assessing the status of populations (McElhany et. al. 2000). But even now there is no single best method for assessing the effects of harvest or other types of actions. NOAA Fisheries relies on the best information available at the time of any particular consultation, and will continue to do so despite its apparent complexity.

7.4 Chinook Salmon

Chapter 3 of Annex IV of the 2008 Agreement pertains to the management of Chinook fisheries in Alaska, Canada, and the southern United States. Chapter 3 of the Annex is the most complex of the several regimes included in the proposed new agreement. It is also the regime with the greatest impact on the largest number of ESA listed salmon species. Because of its complexity, provisions of the proposed 2008 Agreement related to the management of Chinook fisheries are explained in more detail in Chapter 3 of this opinion under the heading of Proposed Actions.

As discussed above, there are four Chinook ESUs that are subject to significant harvest as a result of the proposed actions. The ESUs include Snake River fall Chinook, Upper Willamette River Chinook, Lower Columbia River Chinook, and Puget Sound Chinook. The following discussion considers the effects of the proposed actions on these ESUs in detail. The effects on other Chinook ESUs are considered more briefly, but sufficient information is provided to support the necessary conclusions.

7.4.1 Snake River Fall Chinook

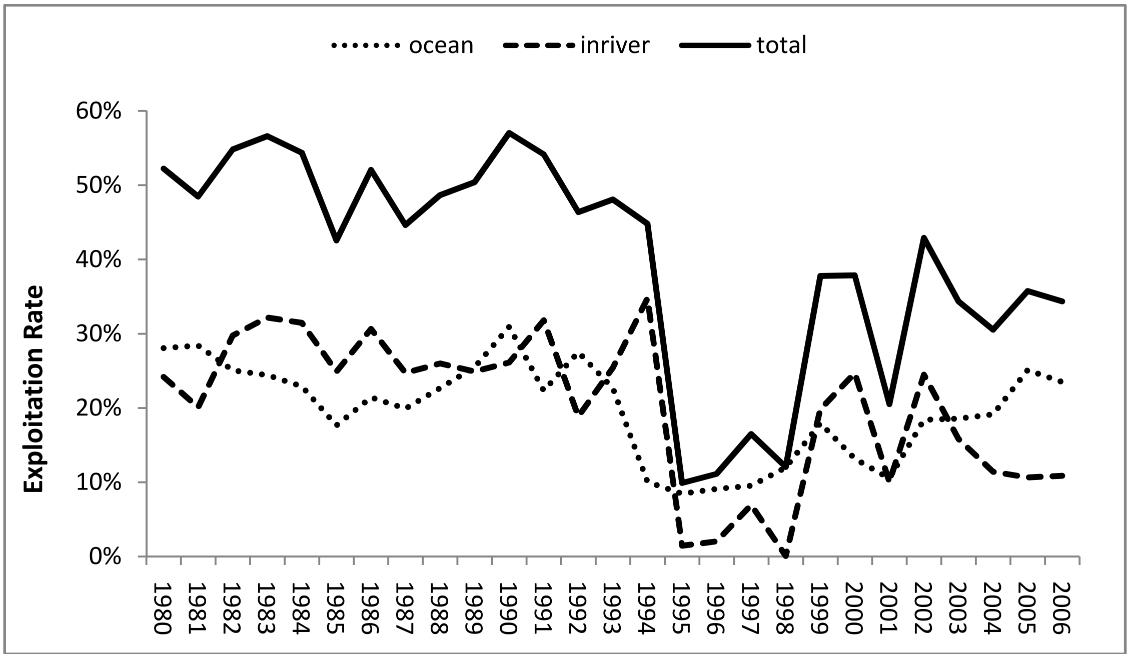
In evaluating the effects of the proposed actions on Snake River fall Chinook we first summarize the magnitude of harvest, past and present, and how we expect it to change as a result of the proposed actions (the general effect of the agreement will be to reduce harvest from what it has been in recent years). We then consider the likelihood that the ESA standard used to evaluate ocean fisheries for Snake River fall Chinook will be met under the proposed agreement (since 1996 ocean fisheries have been managed subject to an ESA section 7 consultation standard – a 30% reduction in a specific base period exploitation rate). Finally, we reconsider the basis for the standard and whether the current standard remains appropriate and consistent with our expectations for the survival and recovery of the species.

Trends in Harvest Mortality

The harvest of Snake River fall Chinook is characterized using two different but related metrics, the first an exploitation rate, and the second an exploitation rate index. Exploitation rates are used to compare and combine estimates of ocean and inriver harvest and the overall effect of all fisheries. The ESA standard used for Snake River fall Chinook for ocean fisheries in recent years is an exploitation rate index. The ESA standard requires that the Southeast Alaskan, Canadian, and PFMC ocean fisheries collectively achieve a 30% reduction in the age-3 and age-4 adult equivalent total exploitation rate relative to the 1988 to 1993 base period. The 30% reduction standard is generally reported as a proportion (referred to as the Snake River fall Chinook index (SRFI)). A 30% reduction in the average base period exploitation rate equates to an index value of 0.70. A value less than 0.70 therefore represents a reduction that exceeds the 30% standard. An index of 0.60 equates to a 40% reduction in exploitation rate relative to the base period average.

The total harvest of Snake River fall Chinook was reduced substantially after they were first listed under the ESA in 1992. From 1986 to 1991 the total exploitation in ocean and inriver fisheries averaged 75%. Since 1992 the total exploitation rate for all fisheries averaged 48%. Approximately two thirds of all harvest occurs in ocean fisheries that have been subject to similar levels of reduction. The exploitation rate in ocean fisheries averaged 46% from 1986 to 1991 and 31% since 1992.

Figure 7.4.1-1. Ocean and inriver exploitation rates for Snake River fall Chinook.



The most significant changes in fishing resulting from the proposed agreement will be reductions in the west coast Vancouver Island and southeast Alaska fisheries of 30% and 15%, respectively, relative to what was allowed under the 1999 Agreement. Snake River fall Chinook are distributed broadly from northern California to Alaska. However, Snake River fall Chinook migrate primarily north of the Columbia River. The center of their ocean distribution is located off WCVI. As a result, one third or more of all ocean harvest has occurred in the WCVI fishery. Snake River fall Chinook will therefore benefit directly from the proposed reduction in the WCVI fishery, and to a lesser, but still significant degree from the reduction in the SEAK fishery. Because the proposed 2008 Agreement secures permanent reductions in the fishing levels, we can reasonably expect a reduction in harvest of Snake River fall Chinook over what was allowed under the prior agreement.

Results from the Retrospective Analysis

The FRAM Validation scenario provides estimates of the SRFI based on postseason estimates of stock abundance and catches (results from the retrospective analysis are shown graphically in the following figures and are tabulated in Appendix 3). The results indicate that ocean fisheries have been well below the ESA standard of 0.70 (representing a 30% reduction in base period harvest) since 1996. From 1996 to 2002 Canadian fisheries were reduced significantly relative to what was allowed under the 1999 Agreement because of domestic concerns for WCVI and other stocks. By 2003 Canada had reshaped their fisheries away from the traditional summer fishery to focus on spring and fall season fisheries. This shift lessened the impacts on domestic stocks and allowed Canada to manage their fisheries up to the AABM limits for the first time in several years. As a result, the harvest of Snake River fall Chinook increased, but still remained within the 0.70 standard. The one exception was in 2005 with a post season estimate of 0.96. This was a consequence of higher than expected impacts in both Canadian and U.S ocean fisheries, particularly in the area south of Cape Falcon, Oregon.

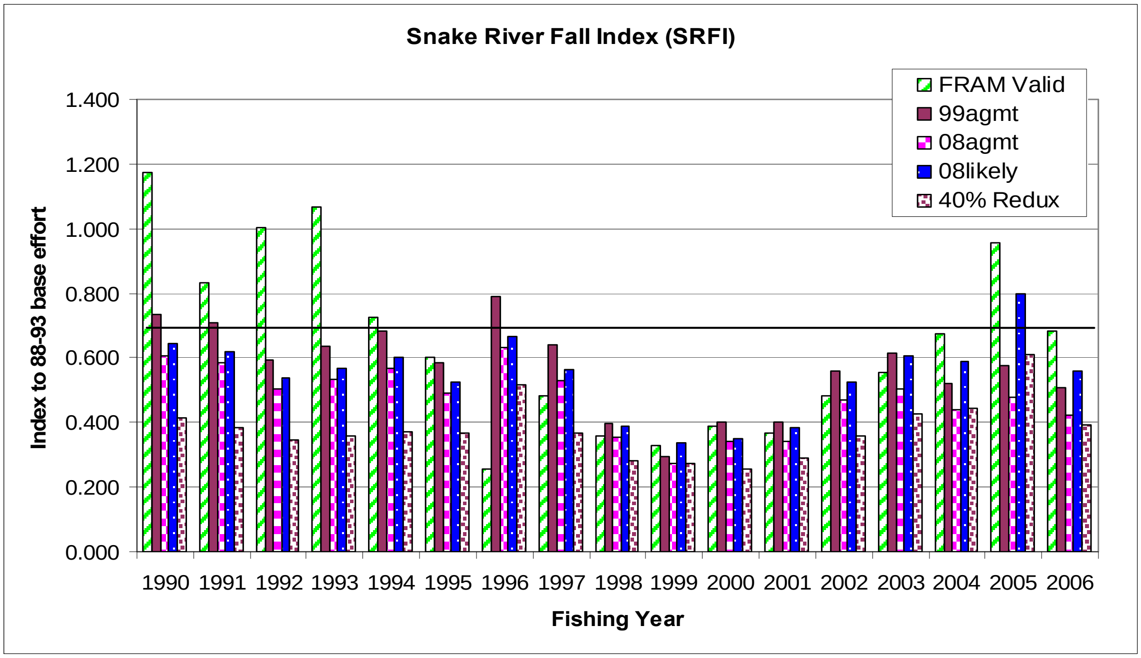
The magnitude of the reduction resulting from the 2008 Agreement will depend on the year specific circumstances. However, the retrospective analysis provides a sense of the range of reductions in exploitation rate that is likely to occur. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that would be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. ocean fisheries were managed subject to the limits for ISBM fisheries. The scenarios suggest an average reduction in the Snake River fall Chinook index under the 2008 Agreement of about nine percentage points relative to the 1999 Agreement from about 0.57 to 0.48. Given the nature of the retrospective analysis, it is most appropriate to use these results to approximate the relative reduction in harvest that can be expected rather than as a prediction of the absolute magnitude of future harvest reductions. Nonetheless, the analysis confirms the qualitative generality made above that the 2008 Agreement will result in reduced harvest with a concomitant reduction in the exploitation on Snake River fall Chinook.

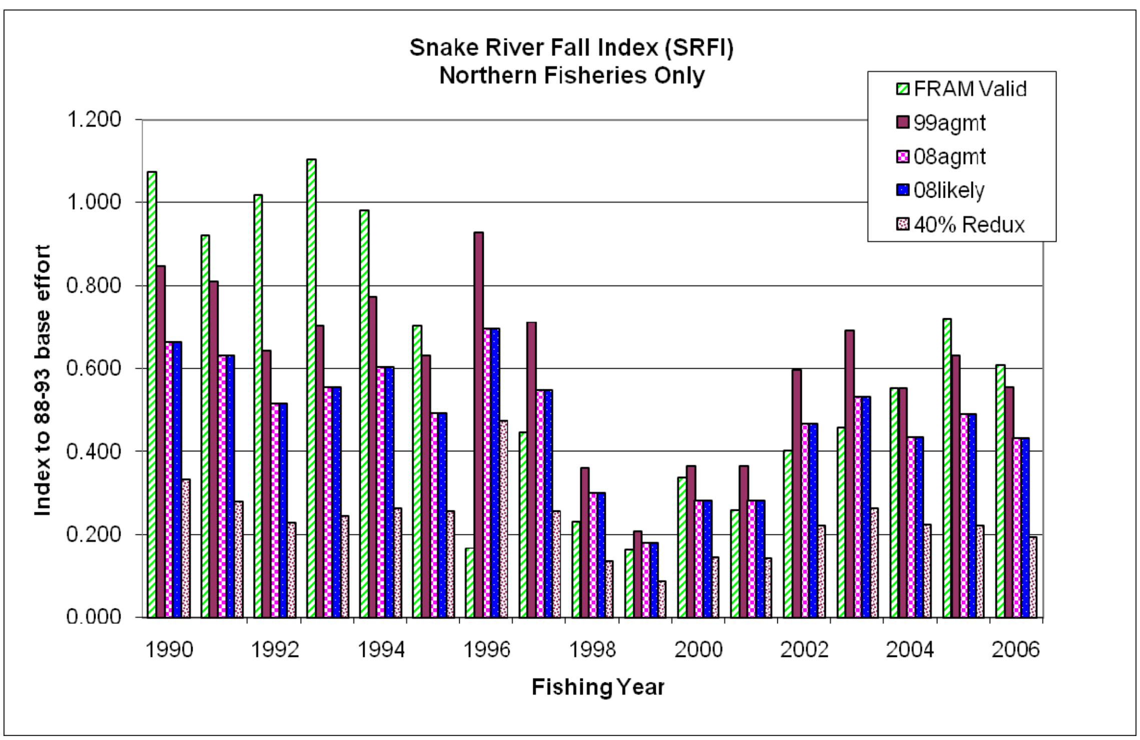
A result that is unique to Snake River fall Chinook is that projected harvest index under the 2008 Likely scenario is higher than under the 2008 Agreement scenario (Figure 7.4.1-2). The northern AABM fisheries were modeled using the same catch levels for the 2008 Agreement and 2008 Likely scenarios, although there was some redistribution of the catch between the troll and sport fisheries and fishing seasons in the WCVI fishery. So the difference is related primarily to assumptions for the PFMC fisheries. The PFMC fisheries in the 2008 Agreement scenario were modeled at the maximum ISBM fishing rate index (0.6). The PFMC fisheries in the 2008 Likely scenario were modeled at the rates experienced in recent years which were collectively slightly higher than the maximum ISBM rate (Snake River fall Chinook is not one of the PST stocks under the 0.6 ISBM maximum rate). Because the SRFI only includes ocean fisheries, reductions in other fisheries in the Columbia River would not be incorporated. The results from the 2008 Likely scenario indicate that the SRFI would average 0.55, well below the 0.70 requirement. The SRFI is higher than the standard in one year. In 2005 the estimated SRFI for the 2008 Likely scenario is 0.80.In practice PFMC fisheries are required by terms of the applicable biological opinion to meet 0.70 ESA standard which are set through the preseason planning process and thus could not be scheduled to exceed the 0.70 standard.

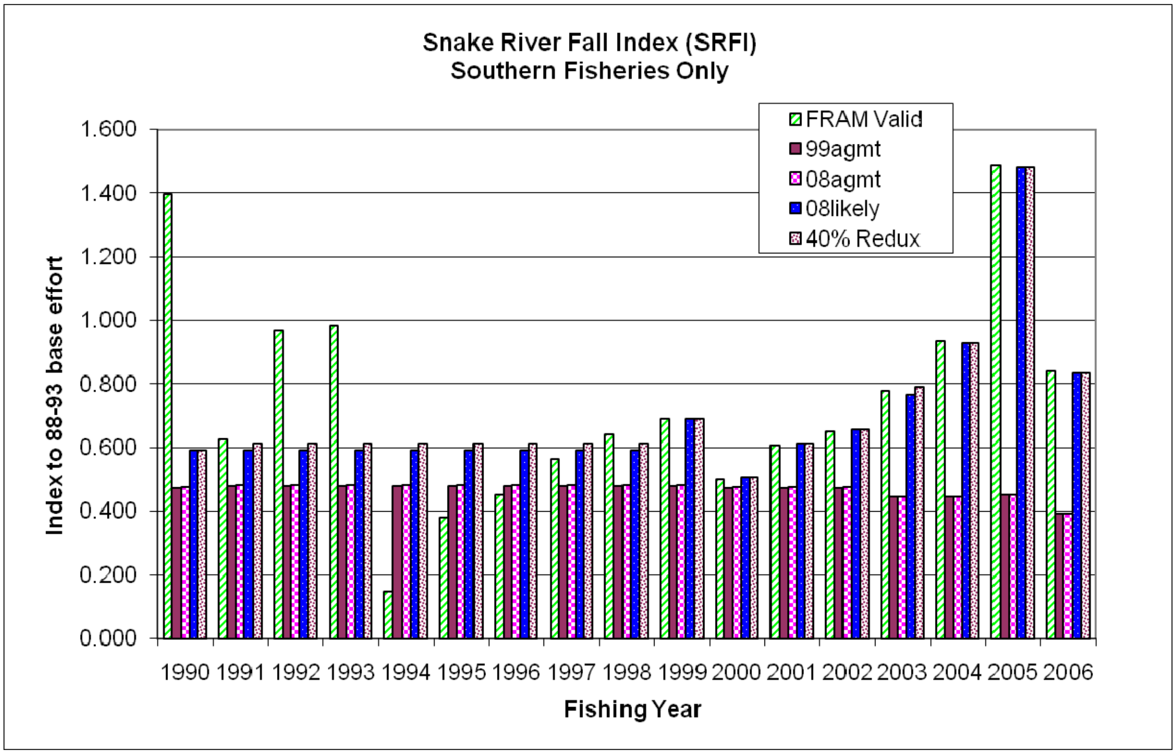
The 40% reduction scenario provides perspective on the effects when the total abundance of Chinook is reduced. Catch levels in the AABM fisheries were adjusted down relative to the 2008

Likely scenario as required by the tiered formula of the 2008 Agreement. ISBM fisheries were modeled with the same rates as in the 2008 Likely scenario. Resultant catches were lower given the reduced abundance. Reductions in catch quotas in southern fisheries would be required to address the many stock specific conservation concerns that would likely result from such a broad scale reduction in abundance. Results from the 40% Reduction scenario indicate that the harvest of Snake River fall Chinook would decline significantly if there was a significant decrease in the overall abundance of Chinook salmon. The averages of the SRFI estimates under the 2008 likely and 40% reduction scenarios for 1990 to 2006 are 0.55 and 0.38. Exploitation rates in the northern AABM fisheries would be reduced by half. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance that might occur as a consequence of unfavorable ocean conditions or global climate change. The retrospective analysis thus suggests that the management regime does compensate for reduced abundance as intended. If abundance is reduced by 40%, catch would have to be reduced substantially (greater than 40% in the AABM fisheries per the agreement) to compensate for the reduced abundance, and maintain or even further reduce the overall exploitation rate. Because of their distribution and concentration in the WCVI fishery, the reduction in harvest for Snake River fall Chinook is significant. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Figure 7.4.1-2. Estimates of the Snake River fall Chinook index (SRFI) from the retrospective analysis for all *ocean* fisheries combined and for AABM (northern) and southern *ocean* fisheries only. The Snake River fall Chinook Index (SRFI) of 0.70 that is used as an ESA-related harvest limit is shown for reference.







ESA Consultation Standard

NOAA Fisheries has managed ocean fisheries subject to a single ESA section 7 consultation standard since 1996. As explained above, the standard requires that all ocean fisheries including the Southeast Alaskan, Canadian, and PFMC fisheries collectively achieve a 30% reduction in the age-3 and age-4 adult equivalent total exploitation rate relative to the 1988 to 1993 base period. The current standard was initially applied in 1996 in a section 7 consultation on the PFMC's salmon Framework Management Plan (NMFS 1996). The 1996 biological opinion requires that Council fisheries be managed such that all ocean fisheries meet the 30% reduction criterion. Because catch levels for the Alaskan and Canadian fisheries are set before the Council's preseason process, and the Council is obligated to manage their fisheries to meet the standard for all ocean fisheries, preseason fishing plans for all ocean fisheries necessarily meet or exceed the 30% reduction criterion. Management considerations for other stocks often limit fisheries beyond what is required to meet the ESA standard for Snake River fall Chinook. In 2006 and 2007, for example, proposed ocean fisheries were expected to achieve 32% and 53% reductions compared to the 30% base period standard.

Given the structure of the reduction standard we can say with certainty that ocean fisheries will be managed preseason to meet or exceed the 30% reduction requirement. Fisheries and stock abundances do not always go as planned and it is possible that a postseason analysis will indicate that management objectives for any stock have been missed. The validation scenario in the retrospective analysis has postseason estimates of the SRFI averaging 0.64 (compared to a 0.70

limit) since 1996, and was exceeded once, in 2005. Further reductions in harvest resulting from the 2008 Agreement will reduce the likelihood of missing the standard due to management error.

The 30% reduction standard was also used in our consultation on the 1999 PST Agreement. NOAA Fisheries concluded in that opinion that fisheries managed subject to the 1999 Agreement were likely to meet the reduction standard (NMFS 1999b), a conclusion that helped support the no jeopardy conclusion. NOAA Fisheries confirms each year that the standard continues to apply through our annual guidance letter to the Council which describes ESA related standards for all listed species that will be used for evaluating fisheries proposed through the annual preseason planning process (see for example our guidance letter for 2008, NMFS 2008). For Snake River fall Chinook our guidance letter reiterates that the 30% reduction standard continues to apply.

Finally, in the following discussion, we review the basis for the 30% reduction standard and whether it remains appropriate and consistent with our expectations for the survival and recovery of the species. Considerations for the consultation standard in the 1996 and 1999 biological opinions were largely qualitative. The 1996 opinion depended in part on recommendations from the Proposed Recovery Plan for Snake River Salmon (NMFS 1995a). The Recovery plan emphasized the need for development of a comprehensive rebuilding strategy for fisheries managed under the PST, a strategy that was finally agreed to in 1999. In the meantime, the 1996 opinion secured a reduction in ocean harvest through the 30% reduction standard. It was clear at the time that mortality of Snake River fall Chinook had to be reduced in order to ensure the species survival and recovery. It was not clear how much of a reduction was required or how the conservation burden should be shared between harvest and other factors affecting the species' survival. The proposed recovery plan provided a template for making the initial determinations with the understanding that further adjustments in harvest and other actions may be required depending on subsequent information. The 1996 biological opinion concluded that fisheries managed subject to the reduction standard were not likely to jeopardize the species.

Conclusion of the 1999 PST agreement finally resolved what had been a long and acrimonious dispute over management of the PST fisheries and addressed the need articulated in the proposed recovery plan for a comprehensive harvest management strategy. Despite some reservations, the agreement was judged preferable to no agreement in part because it removed the uncertainty as to how Canadian fisheries would be managed, fisheries which were otherwise beyond U.S. control. It was apparent that the agreement would secure reductions in fishing levels in northern fisheries compared to what had occurred in the past. A retrospective analysis of the proposed 1999 Agreement indicated that there was a high likelihood of meeting the 30% reduction standard. By 1999 it was apparent that there were gradual, but consistent increases in escapement of Snake River fall Chinook over the very low levels observed at the time of the listing. By that time we were also seeing the initial returns from a hatchery supplementation program that was designed to reduce the risk of extinction and contribute to rebuilding. This initial sense of progress helped provide a check for evaluating the adequacy of the harvest reductions associated with the 30% standard and other actions that were being taken as part of a comprehensive strategy for survival and recovery. Finally, it was understood that the 1999 Agreement was a ten year commitment between the United States and Canadian governments and as such we would not have the opportunity to reconsider the agreement with Canada for ten years without their concurrence; we would not be able to "reinitiate" our consultation on our agreement with the Canadian government. Nonetheless, it was apparent that further action could be taken in U.S. fisheries if new information developed indicating that further action on harvest was required thus providing a safeguard against an unanticipated down turn in the species status. The 1999 biological opinion concluded that managing fisheries subject to the 1999 Agreement was not likely to jeopardize Snake River fall Chinook.

The prospects for the survival and recovery of Snake River fall Chinook were reviewed recently (May 2008) and in more detail in the concurrent biological opinions on the *U.S. v. Oregon* Agreement, FCRPS, and Upper Snake River projects. The analysis and related conclusions for these actions are pertinent to our considerations of the 2008 Agreement.

Assessment of these actions relied on a common analysis referred to as the Supplemental Comprehensive Analysis (SCA) (NMFS 2008e). The SCA describes a quantitative assessment of the species status, the environmental baseline, cumulative effects, and the effects of what is referred to as the Prospective Actions. Qualitative considerations were also used to assess the effects of actions that could not be quantified. The analysis evaluated extinction risk of Snake River fall Chinook, and each of the VSP criteria including abundance, productivity, spatial structure, and diversity. The structure of the analysis is complicated and detailed and so is incorporated here by reference. We refer in particular to Chapter 7 of the SCA for a description of the analytical methods, and Section 8.2 of the FCRPS opinion (NMFS 2008c) for a discussion of the results and conclusions that are specific to Snake River fall Chinook.

The SCA and associated opinions considered explicitly the prospects for the survival and recovery of the species.

With respect to survival, the opinions concluded that:

> *… the combination of all the factors above indicates that the SR fall Chinook ESU is likely to have a low short-term extinction risk when the environmental baseline and cumulative effects are considered along with implementation of the Prospective Actions. The status of the species has been improving in recent years, compared to the base condition, and abundance is expected to increase in the future as a result of additional improvements. These improvements will result in lower short-term extinction risk than in recent years. Current abundance is well above the quasi-extinction threshold considered by the ICTRT. Quantitative analyses also support this conclusion. In addition, there are hydrosystem improvements with benefits that cannot be quantified, which will further reduce this risk compared to quantitative estimates. SR fall Chinook are heavily supplemented and the hatchery fish are part of the ESU,*

> *contributing to abundance and thereby reducing short-term extinction risk. However, over time this level of supplementation poses long-term risks to diversity and natural productivity as described in Section 8.2.5. Implementation of the Prospective Actions will help to reduce this long-term diversity risk and will confirm the benefits and risks of the hatchery mitigation program. In summary, it is likely that the SR fall Chinook ESU will have a low short-term extinction risk.*

With respect to recovery, the opinions concluded that:

> *… the combination of all the qualitative and quantitative factors indicates that the ESU as a whole is likely to trend toward recovery when the environmental baseline and cumulative effects are considered along with implementation of the Prospective Actions. The status of the species has been improving in recent years, compared to the base condition, and abundance is expected to increase in the future as a result of additional improvements. Quantitative estimates indicate that survival will be sufficient for the population to grow and that the abundance of spawners will have a positive trend. Prospective Actions, which will implement programmatic funding criteria including those that will reform FCRPS hatchery operations to reduce genetic and ecological effects on ESA-listed salmon, will reduce the current diversity risk of SR fall Chinook.*
>
> *This does not mean, however, that recovery will be achieved without additional improvements in various life stages. As discussed in Chapter 7, increased productivity will result in higher abundance, which in turn will lead to an eventual decrease in productivity due to density effects, until additional improvements resulting from recovery plan implementation are expressed. However, the survival changes resulting from the Prospective Actions and other continuing actions in the environmental baseline and cumulative effects will ensure a level of improvement that results in the ESU being on a trend toward recovery.*

Effects on Critical Habitat

Designated critical habitat for Snake River fall Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake rivers and additional specified areas in the Snake River basin (see section 5.1.1.2). Designated areas consist of the water, waterway bottom, and the adjacent riparian zone. Designated critical habitat does not include marine areas beyond the Columbia River estuary. Ocean fisheries that occur consistent with the proposed actions therefore occur beyond the limits of designated critical habitat. Fisheries that are consistent with the proposed actions do occur in the Columbia River basin.

Most of the harvest related activities in the Columbia River occur from boats or along river banks with most of the fishing activity in the mainstem Columbia River. The gears that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of the Snake River fall Chinook salmon ESU from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for Snake River fall Chinook.

7.4.2 Upper Willamette River Chinook

Trends in Harvest Mortality

Upper Willamette River Chinook are caught in fisheries in the ocean, and in the lower Columbia River, and Willamette River and its tributaries. In recent years, approximately half the harvest has occurred in ocean fisheries. Upper Willamette River Chinook are a far north migrating stock that return to the Columbia River from late February through April, and thus before ocean fisheries off the Washington coast open on May 1 of each year. As a consequence, most ocean harvest occurs in Alaska and northern British Columbia.

There are two models that provide somewhat different estimates of the total exploitation rate of Upper Willamette River Chinook. In this analysis we use the CTC model to estimate the absolute magnitude of the exploitation rate (Figure 7.4.2-1), and the FRAM model and associated retrospective analysis to describe the relative change in exploitation rate that we expect under the various scenarios (Figure 7.4.2-2). Estimates of exploitation rate from the FRAM model are generally about ten percentage points higher than those from the CTC model. The reason for these varying estimates of exploitation rate relate to differences in the coded wire tag groups used in the respective models. The source of these differences and reasons for the choices made regarding use of the models are discussed in more detail in Appendix 5.

The harvest of Upper Willamette River Chinook was reduced substantially beginning in 1996 primarily due to harvest reductions in the Canadian and freshwater fisheries. Harvest in freshwater fisheries was reduced further in 2002 when mark selective fishing was fully implemented (discussed in more detail below). From 1980 to 1995 the total exploitation rate in ocean and inriver fisheries averaged 51% (Figure 7.4.2-1) based on the CTC model analysis. Since 1996 the total exploitation rate for all fisheries averaged 21%. For the two time periods the exploitation rate in ocean fisheries averaged 16% and 11%, respectively.

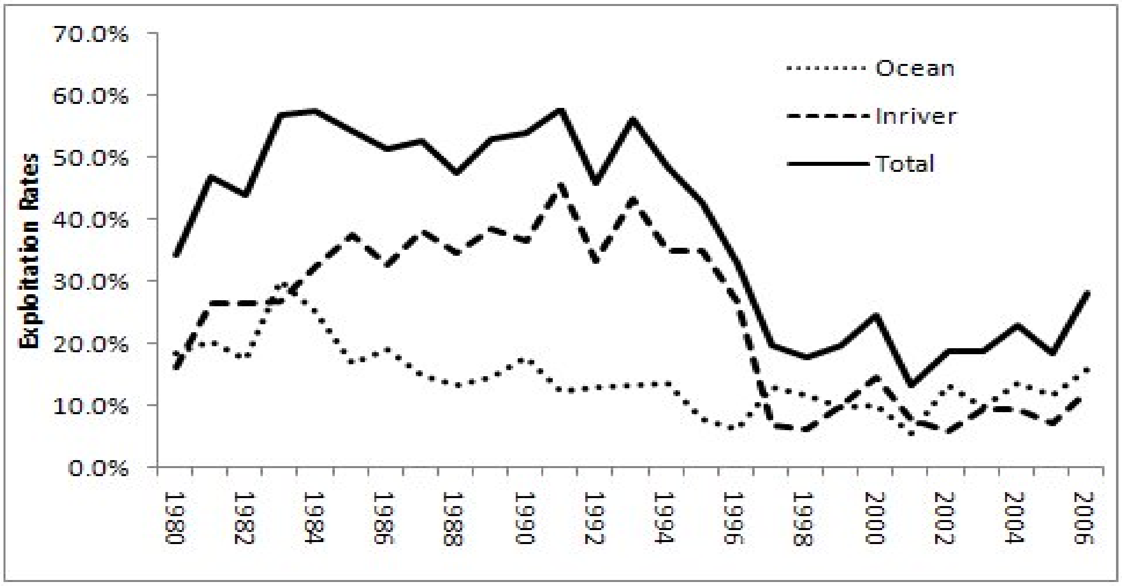


Figure 7.4.2-1. Ocean and inriver estimates of total exploitation rates for Upper Willamette River Chinook from the PSC CTC model.

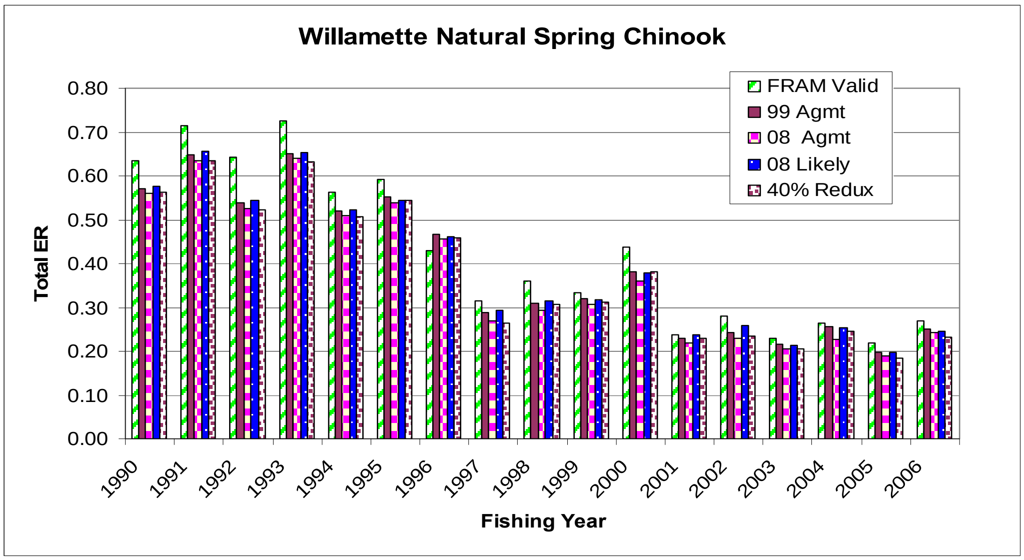
Results from the Retrospective Analysis

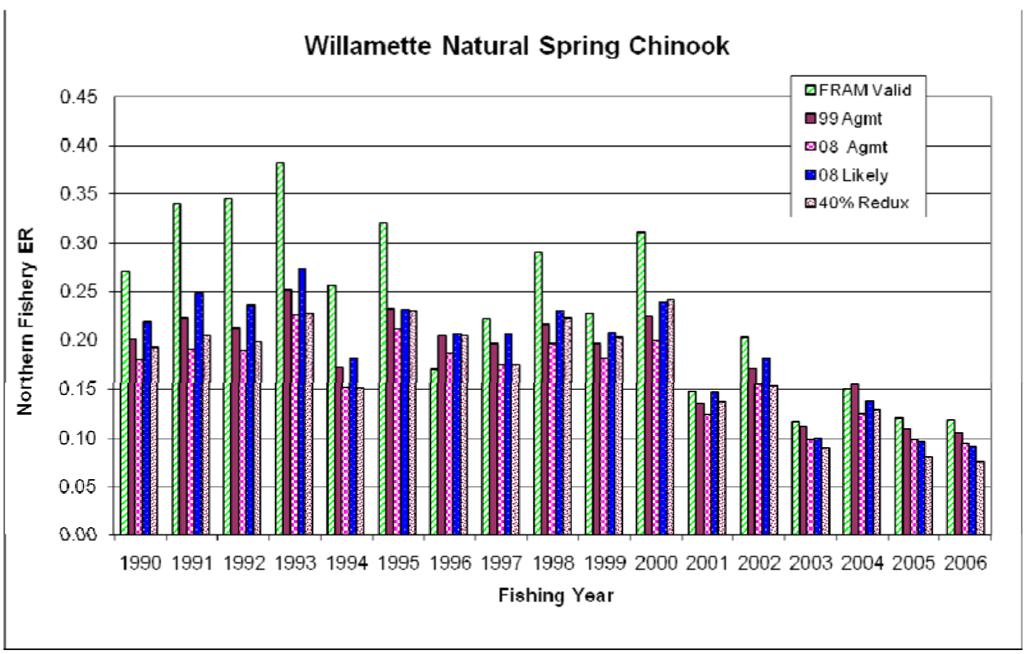
Although estimates of exploitation rate from the FRAM model are higher than those from the CTC model, the pattern of change in harvest over time is the same. The FRAM validation scenario confirms that harvest was relatively high through the mid-1990s and was reduced significantly thereafter. Estimates of exploitation rate from the FRAM based retrospective analysis are shown graphically in Figure 7.4.2-2 and are tabulated in Appendix 3.

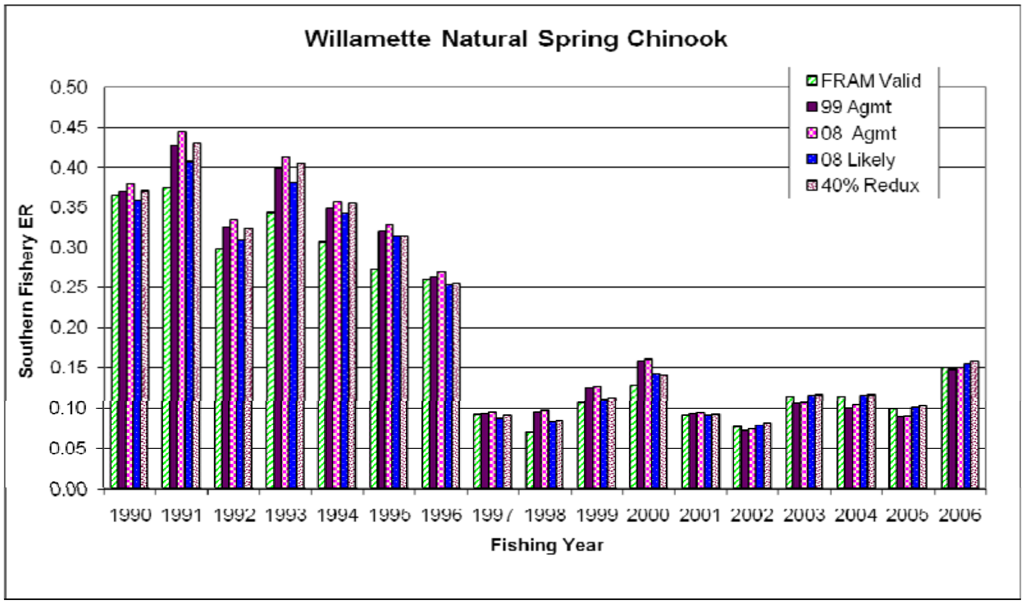
The most significant changes in fishing resulting from the proposed agreement will be from the reductions in the west coast Vancouver Island and southeast Alaska fisheries of 30% and 15%, respectively, relative to what was allowed under the 1999 Agreement. Upper Willamette River Chinook are a far north migrating stock and are caught primarily in the Alaska and northern British Columbia fisheries. Upper Willamette River Chinook will benefit primarily from the proposed reduction in the SEAK fishery. Because the proposed 2008 Agreement secures permanent reductions in the fishing levels, we can reasonably expect a reduction in harvest of Upper Willamette River Chinook over what was allowed under the prior agreement.

The magnitude of the reduction resulting from the 2008 Agreement will depend on the year specific circumstances. However, the retrospective analysis provides a sense of the range of reductions in exploitation rate that is likely to occur. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that would be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. fisheries were managed subject to the limits for ISBM fisheries. For Upper Willamette River Chinook the difference between the 1999 Agreement and 2008 Agreement scenarios is small. The scenarios suggest an average reduction in the Upper Willamette River Chinook exploitation rate of about one percentage point from 0.39 to 0.38. Exploitation rates in the northern AABM fisheries would be reduced from 0.18 to 0.16 or about 10% of the base for the northern AABM fishery. Given the nature of the retrospective analysis, it is most appropriate to use these results to approximate the relative reduction in harvest that can be expected rather than as a prediction of the absolute magnitude of future harvest reductions. Nonetheless, the analysis confirms the qualitative generality that 2008 Agreement will result in reduced harvest with a concomitant reduction in the exploitation on Upper Willamette River Chinook. The reduction will be relatively small because of the distribution of the Upper Willamette River Chinook.

Figure 7.4.2-2. Estimates of exploitation rates for Upper Willamette River Chinook from the retrospective analysis for all fisheries combined (Total) and for AABM (northern) and ISBM (southern) fisheries.







The 2008 Likely scenario estimates the exploitation rates under a "likely" range of fishing levels during the next ten years given current constraints on ESA listed Chinook stocks. AABM fisheries in the 2008 Likely scenario were modeled using the same abundance levels and quotas as in the 2008 Agreement scenario, although there is some redistribution of the catch between fisheries and fishing seasons in the WCVI fishery. The ISBM fisheries were modeled with fishing effort rates observed in recent years. Because Upper Willamette River Chinook is affected marginally by the WCVI or southern ocean fisheries, there is little difference in the exploitation rates estimated for the 2008 Agreement and 2008 Likely scenarios that are 0.38 and 0.39, respectively.

The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. The 40% Reduction scenario assesses the likely affect on stock specific exploitation rates. The average exploitation rates under the 2008 likely and 40% reduction scenarios from 1990 to 2006 are 0.39 and 0.38. Exploitation rates in northern AABM fisheries will be reduced by an average of two percentage points, from 0.19 to 0.17. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. The retrospective analysis suggests that the management regime does compensate for reduced abundance as intended. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. Because of their distribution and concentration in the Alaskan and northern British Columbian fisheries, the reduction in the exploitation rate for Upper Willamette River Chinook is modest. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Review of Harvest through the FMEP

The effects of harvest on Upper Willamette River Chinook were considered recently through review of the ODFW's FMEP (NMFS 2001d) for freshwater fisheries, and the Willamette River Basin Flood Control Project (NMFS 2008g). Through its FMEP ODFW proposed to revise its harvest management strategy and significantly reduce the harvest of natural origin fish by mass marking all hatchery fish and implementing mark selective fisheries. Mark selective fisheries in the Columbia and Willamette rivers were fully implemented in 2002. The FMEP pertained to management of all freshwater fisheries, but ocean harvest was included in the overall assessment as well. Ocean harvest rates for future years were modeled at 12% with a coefficient variation of 35%. Actual harvest rates since completing the FMEP have been consistent with expectations.

NOAA Fisheries review of the FMEP was based in part on a population viability analysis that focused on the McKenzie River population. The model used in the analysis included a stock-recruitment relationship, normal variability in mortality rates, ocean and freshwater fisheries, and hatchery and wild components. Sensitivity analyses were used to explore the effects of parameter uncertainty. Key features of the analysis and the associated results are summarized here and described in more detail in Beamesderfer (2000).

The effects of fishing on the Upper Willamette River Chinook were evaluated based on an analysis of extinction risk and recovery potential. Extinction risk was described as the probability of declining below a small population threshold where the ability to rebound was in question because of depensatory population processes or genetic effects. A "critical population threshold" of 300 spawners was used rather than an actual extinction level because recovery from single digit population sizes was assumed to be unrealistic. Use of the critical population threshold thus provided a "quasi-extinction risk" and was conservative relative to the actual risk of extinction. Sensitivity analyses were included to investigate the effect of the selection of the critical population threshold on risks associated with fishing.

Recovery potential was assessed by comparing the average number of spawners during the last 8 years of the 30 year simulations to a recovery benchmark. The analysis also considered the probability of achieving large run sizes as a component of the recovery standard because of the need to develop better estimates of productivity and capacity of the natural-origin populations. Recruitment estimates over a wide range of spawning escapements are needed so that future monitoring can accurately estimate stock-recruitment parameters. "Large" run sizes were defined as >75% of the spawner replacement abundance.

The model was used to assess the risk associated with a variety of harvest strategies. A range of fixed harvest rate and fixed escapement goal strategies were considered in addition to some mixed strategies based on those implemented in past years. A zero freshwater harvest scenario was also analyzed for comparison. Historic harvest rates associated with implementation of the Willamette River management plan used prior to 1998 averaged nearly 40% in freshwater fisheries. The analysis indicated that there was a 31% risk that the McKenzie population would fall below the quasi-extinction threshold (300 spawners) if past practices were continued. There was also little chance of seeing large escapements near the replacement abundance or average escapements exceeding 50% of carrying capacity unless the stock was highly productive. Alternatively, under a 15% fixed harvest rate strategy, the risk of falling below the quasi-extinction threshold was less than 0.1%. The probability of meeting the recovery criterion (50% of basin capacity) was also 0.50 under the most conservative assumptions. Under average or high productivity assumptions, the probability of meeting the recovery criterion was 0.95 or more. Under the 15% fixed harvest rate plan, the probability of meeting the large run size criterion during the last eight years of the simulation (75% of replacement abundance), ranged from 0.15 to 0.48, again depending on the assumed productivity. The proposed plan therefore provides for periodic large escapements needed to assess the production dynamics of the population. Further discussion in Beamsderfer (2000) provides a more systematic review of the results of the model analysis.

ODFW's management plan for Upper Willamette River Chinook proposes to use a 15% harvest rate cap for all freshwater fisheries and as a safeguard against excess harvest. Since 2002 the harvest rate has averaged approximately 10% (ODFW 2008c). Ocean harvest rates in recent years have been consistent with those considered in the analysis. As discussed above, further reductions in ocean harvest can be expected as a result of implementing the 2008 PST Agreement. The risk assessment described above therefore provides conservative estimates of risk.

The risk assessment supports the conclusion that the ocean harvest that would occur under the 2008 PST Agreement and the freshwater harvest are consistent with the survival and recovery of the McKenzie population. Abundance and other characteristics of the Clackamas population are similar to those of the McKenzie, and it is reasonable to extrapolate the results of the analysis to the Clackamas population as well. The analysis does not address the circumstances for other populations in the ESU.

Draft Upper Willamette River Recovery Plan

The status of the populations of the Upper Willamette River Chinook ESU is reviewed in ODFW’s draft recovery plan using methods developed by the WLC TRT. Conclusions of that review are summarized in Section 5 of this opinion. The Clackamas and McKenzie populations are categorized as being at low or moderate risk (Figure 5.1.2.1-4). In recent years, escapement for these populations has been well above the TRT minimum abundance threshold of 1,300, and at or above the broad sense recovery goals identified in the draft recovery plan. Risks remain with respect to spatial structure and diversity, but the causes are primarily related to habitat access and hatchery introgression. The other five populations in the ESU are all at very high risk; some are considered functionally extirpated.

The draft recovery plan concludes that actions taken to address the effects of harvest, particularly in freshwater but including ocean fisheries, are sufficient. The recovery plan unequivocally concludes that harvest is not a key or even secondary limiting factor for any of the populations in the ESU (see for example Chapter 6 in ODFW 2007a). There is clearly a policy element in this conclusion, but it is one that recognizes that the status of the Upper Willamette River Chinook populations is limited by factors other than harvest and that the survival and recovery of these populations can only be addressed by actions that focus on the proximate cause of the species current status. Key limiting factors and threats are categorized under the headings of hatchery management, hydropower and flood control management, and land management. Populations are blocked from native spawning and rearing habitat, limited to degraded habitat, and otherwise compromised by hatchery management practices.

The conclusions of the draft recovery plan regarding harvest recognize that there is little more that harvest can do to improve the status of the Upper Willamette River Chinook populations unless these other limiting factors and threats are addressed.

Willamette River Basin Flood Control Project

The biological opinion on the Willamette Project incorporates the conclusions of the draft recovery plan regarding population status and reiterates that harvest is not a limiting factor (NMFS 2008g). The biological opinion concludes that the proposed Willamette Project is likely to jeopardize Upper Willamette River Chinook. The opinion then follows with a comprehensive Reasonable and Prudent Alternative (RPA) that supplements the Proposed Action to systematically address the limiting factors and threats for each population.

The beneficial effects of the Willamette Project RPA, the Proposed Action, and recent improvements in project facilities and operations, are expected to address the harm to Upper Willamette River Chinook caused by the project. The RPA is designed to increase the abundance, productivity, spatial structure and diversity of the natural-origin Middle Fork Willamette, McKenzie, and South and North Santiam Chinook populations, as well as to increase the genetic diversity of the Calapooia, Molalla, and Clackamas populations. The loss of access to historical habitat will be ameliorated by the rebuilding of fish collection facilities below Fall Creek, Dexter, Foster, and Big Cliff dams to allow significantly safer capture, handling, and transport of Chinook for release above the project dams. Downstream passage facilities will be constructed for three populations (Middle Fork, McKenzie, and North Santiam) to provide significantly higher survival of emigrating Chinook than under either current operations or the Proposed Action. Interim and long-term water temperature control operations in the North Santiam River will improve altered water temperatures that have depressed natural production in the habitat below the dams. Hatchery reform actions will limit the risk of genetic introgression into the natural-origin populations, promoting life-history diversity and increasing the abundance and productivity of each population. Increases in the viability of these populations will contribute to increases in the status of the ESU as a whole, thereby lowering the risk of extinction.

The opinion concludes that the RPA and Proposed Action, when combined with recent improvements in project facilities, are not likely to jeopardize the continued existence of the Upper Willamette River Chinook ESU (NMFS 2008g).

Effects on Critical Habitat

Designated critical habitat for Upper Willamette River Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River, as well as specified areas in several tributaries to the Willamette River. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed actions do occur in the lower Columbia and Willamette rivers.

Most of the harvest related activities in the Columbia and Willamette rivers occur from boats or along river banks with most of the fishing activity in the mainstem areas. The gears that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of the Upper Willamette River Chinook salmon ESU from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the preceding analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for Upper Willamette River Chinook.

7.4.3 Lower Columbia River Chinook

The Lower Columbia River Chinook ESU has a complex structure consisting of three life history types, each with multiple populations that are distributed across three ecological regions or MPGs (Table 5.1.3.1-2). Consideration of the jeopardy decision requires a review of the various components of the ESU. The contribution of hatchery fish and their effect is also an important consideration for some populations in the ESU. Consideration of jeopardy as it pertains to the proposed actions also requires an understanding of the scope and status of the ongoing review of information, and of reform and recovery related activities. For tule populations, in particular, consideration of jeopardy is made in the context of a rapidly evolving set of circumstances that are described most recently in the biological opinion on the 2008 PFMC fisheries (NMFS 2008h). The PFMC opinion is incorporated by reference to this opinion. Key points from that opinion that are relevant to our consideration of the effects of the proposed actions are discussed in this section.

7.4.3.1 Spring Chinook Populations

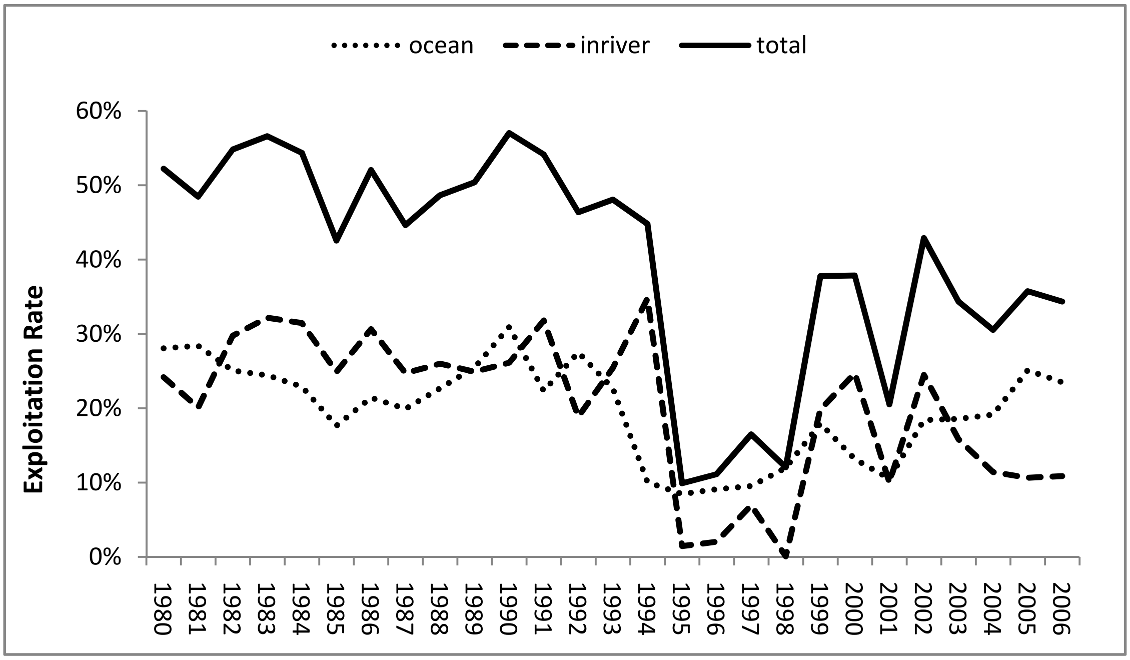
There are four extant spring Chinook populations remaining in the ESU. The Hood River spring Chinook population is considered extinct, although there is an effort to reestablish the population using an out of basin spring Chinook stock. The return of spring Chinook to the Cowlitz, Kalama, Lewis, and Sandy river populations have all numbered in the thousands in recent years (Table 5.1.3.1-5). The Cowlitz and Lewis populations on the Washington side are managed for hatchery production since most of the historical spawning habitat is inaccessible due to hydro development in the upper basins. A supplementation program is now operated on the Cowlitz River that involves trap and haul of adults and juveniles. A supplementation program is also being developed on the Kalama with fish being passed above the ladder at Kalama Falls. Historically, the Kalama was a relatively small system compared to the other three (Table 5.1.3.1-10). A supplementation program is also being developed for the Lewis River, but the population is still dependent on hatchery production. The Cowlitz, Lewis, and Kalama systems have all met their respective hatchery escapement goals in recent years, and are expected to continue to do so for the foreseeable future. The existence of the hatchery programs mitigates the risk to these populations. Because of passage constraints, the Cowlitz and Lewis populations, in particular, would be extinct if not for the hatchery programs currently in place.

The Sandy River is managed with an integrated hatchery supplementation program that incorporates natural-origin brood stock. There is some spawning in the lower river, but the area above Marmot Dam is preserved for natural-origin production. The return of natural-origin fish to Marmot Dam has averaged almost 1,700 since 2000. This does not account for the additional spawning of natural-origin fish below the dam. The tentative delisting and broad sense recovery goals for Sandy River spring Chinook are 1,400 and 1,900, respectively, although these goals are subject to further review through Oregon's ongoing recovery planning process. The total return of spring Chinook to the Sandy including hatchery fish has averaged more than 6,000 since 2000 (Table 5.1.3.1-5).

Trends in Harvest Mortality

The harvest of Lower Columbia River spring Chinook was reduced in 1992, and more significantly in following years, as fisheries were increasingly restricted as a result of ESA listings and other conservation concerns. From 1980 to 1991, the total exploitation rate in ocean and inriver fisheries averaged 51%. Since 1992 the total exploitation rate for all fisheries averaged 31%. Approximately half of all harvest occurs in ocean fisheries. The exploitation rate in ocean fisheries averaged 24% from 1980 to 1991 and 17% from 1992 to 2006 (Figure 7.4.3.1-1).

Figure 7.4.3.1-1. Ocean and inriver exploitation rates for Lower Columbia River spring Chinook.



Results from the Retrospective Analysis

The FRAM Validation scenario shows a pattern of change in harvest over time similar to that described above (results from the retrospective analysis are shown graphically in the following figures and are tabulated in Appendix 3). Harvest was relatively high through the mid-1990s and was variable, but generally lower thereafter. Much of the variability resulted from changes in southern fisheries, particularly as freshwater fisheries were adjusted to meet year specific escapement needs.

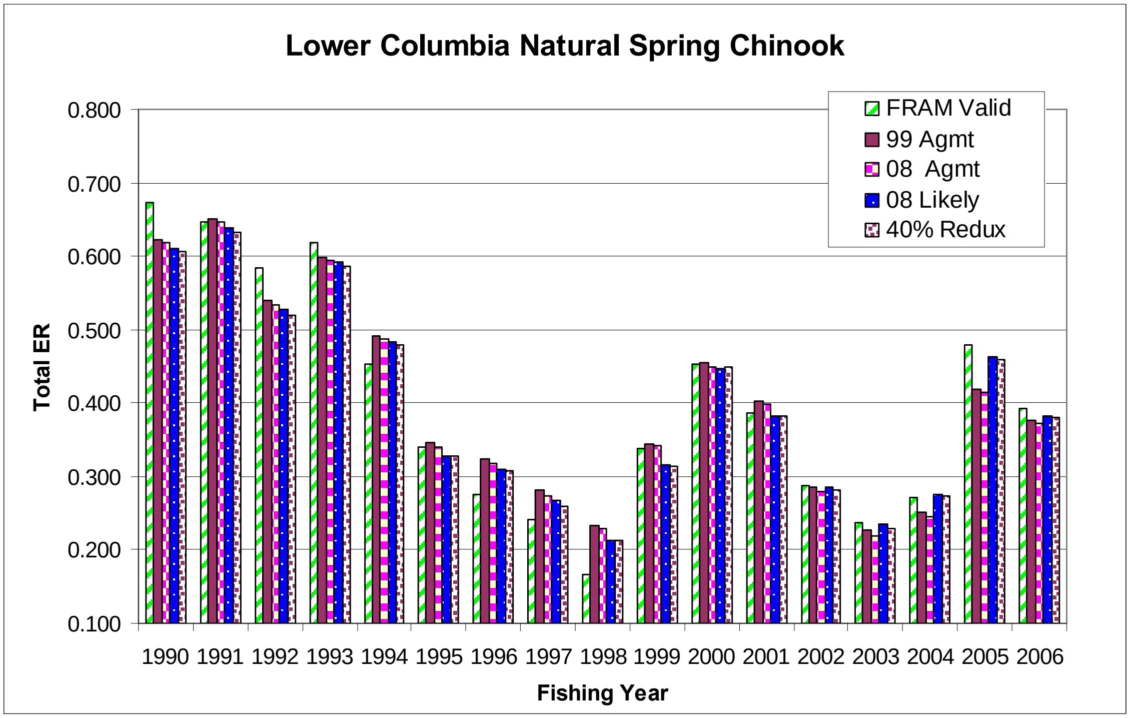
Lower Columbia River spring Chinook are generally distributed to the south. They are subject to some harvest in Alaskan and Canadian fisheries, but their harvest even in the WCVI fishery is relatively limited. Most harvest occurs in ocean fisheries off Washington and Oregon and in the Columbia River. As a consequence, the change in harvest resulting from reductions in the AABM fisheries is low.

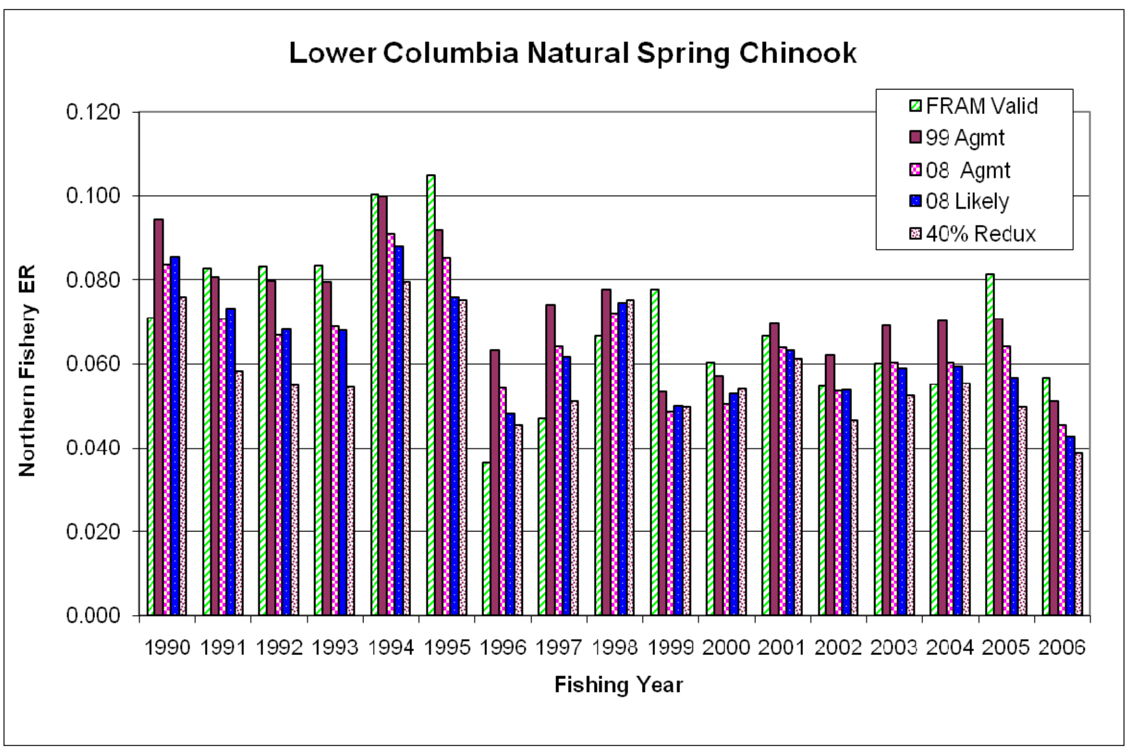
The magnitude of the reduction resulting from the 2008 Agreement will depend on the year specific circumstances. However, the retrospective analysis provides a sense of the range of reductions in exploitation rate that is likely to occur. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. fisheries were managed subject to the limits for ISBM fisheries. For Lower Columbia River spring Chinook, the difference between the 1999 Agreement and 2008 Agreement scenarios is minor. The scenarios indicate that the total exploitation rate of Lower Columbia River spring Chinook will average 0.40 under both scenarios. For the northern AABM fisheries the average exploitation will be reduced from 0.07 to 0.06. Given the nature of the retrospective analysis, it is most appropriate to use these results to approximate the relative reduction in harvest that can be expected rather than as a prediction of the absolute magnitude of future harvest reductions.

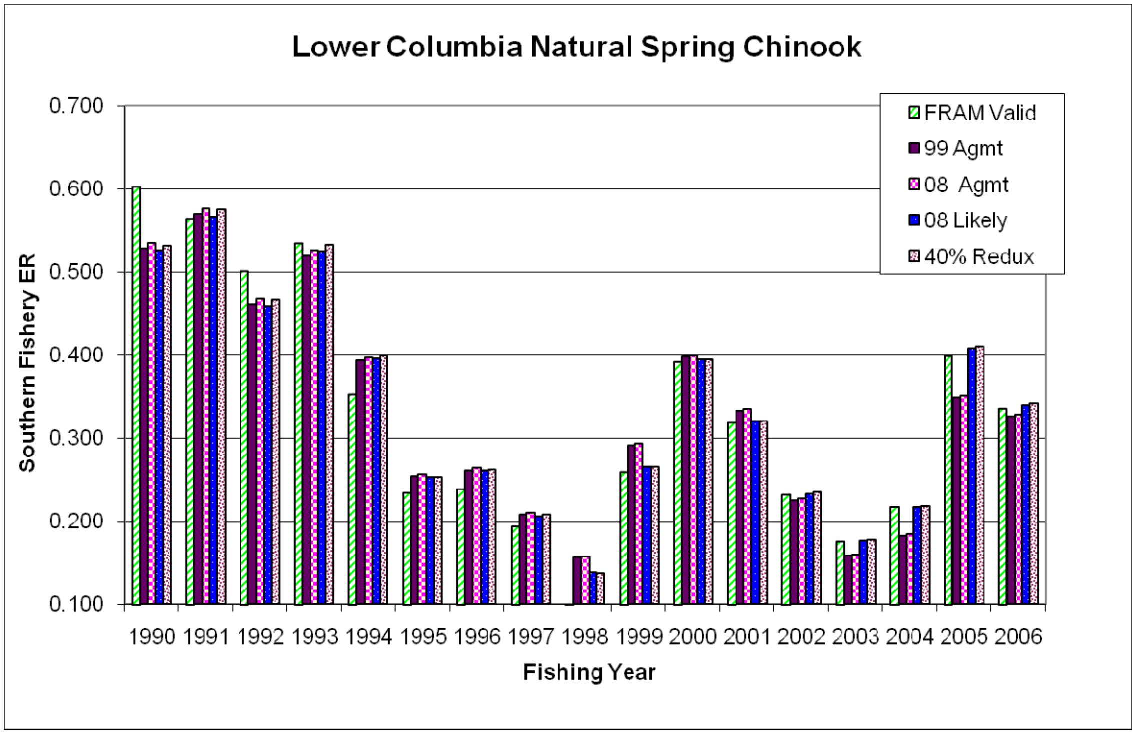
The 2008 Likely scenario estimates the exploitation rates under a “likely” range of fishing levels during the next ten years given current constraints on ESA listed Chinook stocks. AABM fisheries in the 2008 Likely scenario were modeled using the same abundance levels and quotas as in the 2008 Agreement scenario, although there is some redistribution of the catch between the troll and sport fisheries, and between fishing seasons in the WCVI fishery. The ISBM fisheries were modeled with fishing effort rates observed in recent years. Because Lower Columbia River spring Chinook are not affected much by the northern AABM fisheries, there is no measurable difference in the exploitation rates estimated for the 2008 Agreement and 2008 Likely scenarios. The total exploitation rate is 0.40 for both scenarios.

The 40% reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. The 40% reduction scenario assesses the likely effect on stock specific exploitation rates. The average exploitation rates under the 2008 likely and 40% reduction scenarios for 1990 to 2006 are 0.40 and 0.39, respectively. Exploitation rates on Lower Columbia River spring Chinook in the northern AABM fisheries are small, differing by only a fraction of a percent. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis did not try to identify additional reductions in the southern ISBM fisheries that will need to occur to respond to the 40% reduction in abundance.

Figure 7.4.3.1-2. Estimates of exploitation rates for Lower Columbia River spring Chinook from the retrospective analysis for all fisheries combined (Total) and for AABM (northern) and ISBM (southern) fisheries.







7.4.3.2 Bright Chinook Populations

Trends in Harvest Mortality

The harvest of Lower Columbia River bright Chinook was reduced in 1993 as a result of management actions taken because of the ESA listing of Snake River fall Chinook and other conservation concerns. From 1979 to 1992, the total exploitation rate in ocean and inriver fisheries averaged 54%. Since 1993, the total exploitation rate for all fisheries averaged 34%. Approximately 60% of all harvest occurs in ocean fisheries. The exploitation rate in ocean fisheries averaged 30% from 1979 to 1992 and 21% from 1993 to 2006 (Figure 7.4.3.2-1).

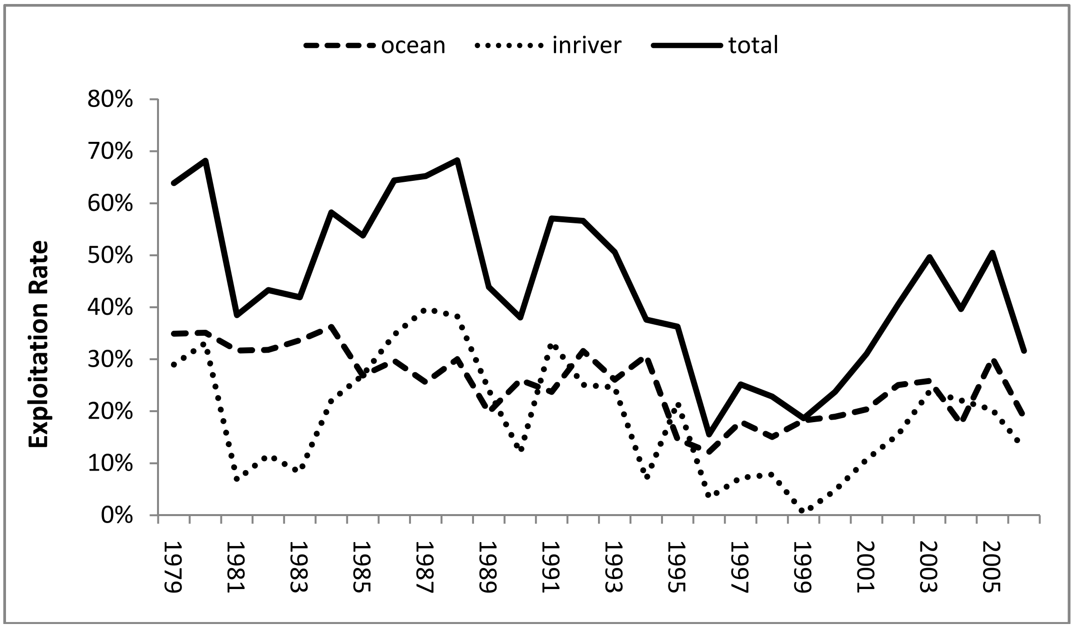


Figure 7.4.3.2-1. Ocean and inriver exploitation rates for Lower Columbia River bright Chinook.

Results from the Retrospective Analysis

The FRAM validation scenario shows a pattern of change in harvest over time similar to that described above (results from the retrospective analysis are shown graphically in the following figures and are tabulated in Appendix 3). Harvest was relatively high through the early-1990s, but declined significantly through the rest of the decade, and then increased again beginning in 2000. Much of the variability in harvest can be attributed to changes in southern fisheries, but there have been modest and more gradual reductions in the northern AABM fisheries as well.

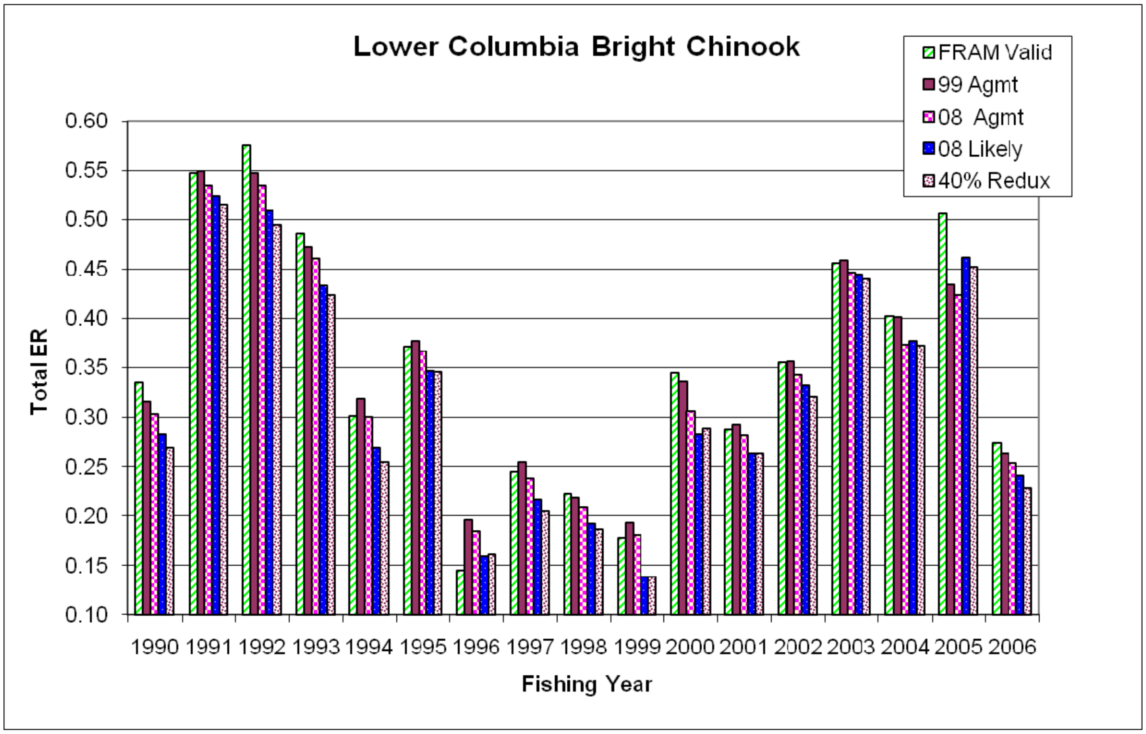
Lower Columbia River bright Chinook are a far north migrating stock that is subject to significant harvest in Alaska, but is also caught in other ocean fisheries. Because of their northerly distribution, the benefits of the 2008 Agreement to Lower Columbia River bright Chinook will be measurable, but relatively minor.

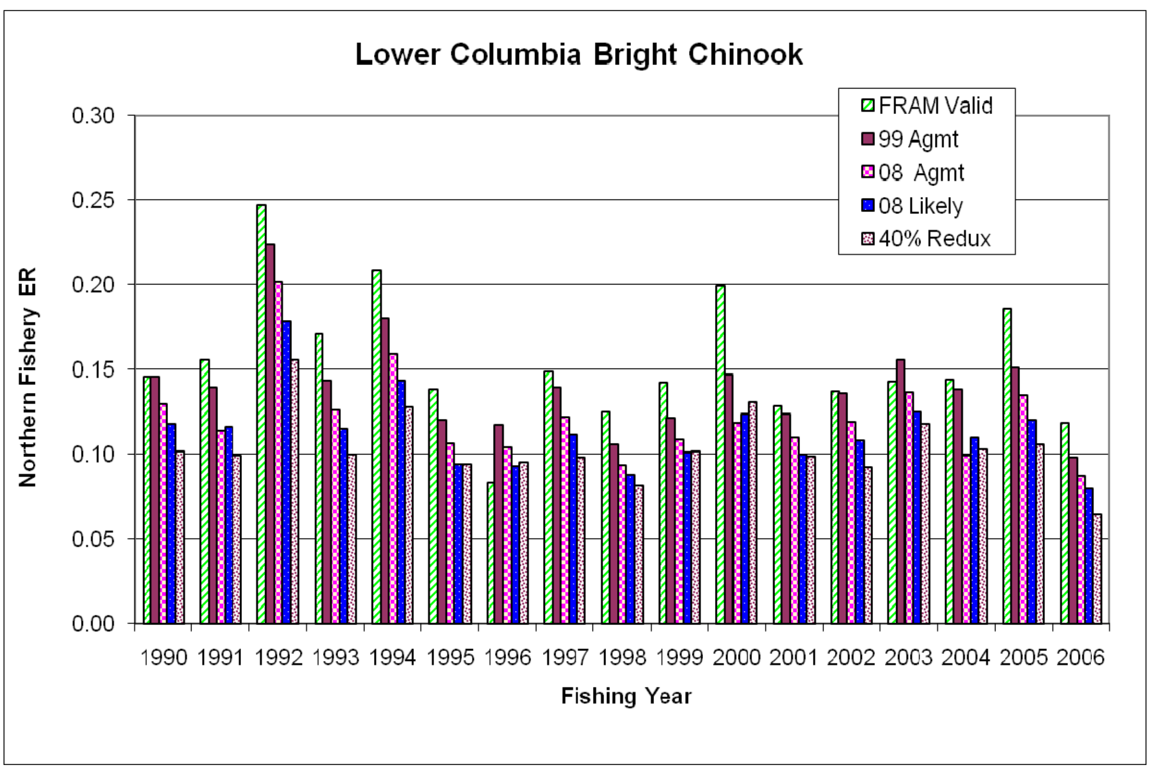
The magnitude of the reduction resulting from the 2008 Agreement will depend on the year specific circumstances. However, the retrospective analysis provides a sense of the range of reductions in exploitation rate that is likely to occur. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. fisheries are managed subject only to the minimum requirements for ISBM fisheries. For Lower Columbia River bright Chinook the difference between the 1999 Agreement and 2008 Agreement scenarios is minor. Modeling results indicate that the total exploitation rate of Lower Columbia River bright Chinook will be reduced by one percentage point from an average of 0.35 to 0.34 under the respective scenarios. For the northern AABM fisheries, the average exploitation would be reduced from 0.14 to 0.12. Given the nature of the retrospective analysis, it is most appropriate to use these results to approximate the relative reduction in harvest that can be expected rather than as a prediction of the absolute magnitude of future harvest reductions.

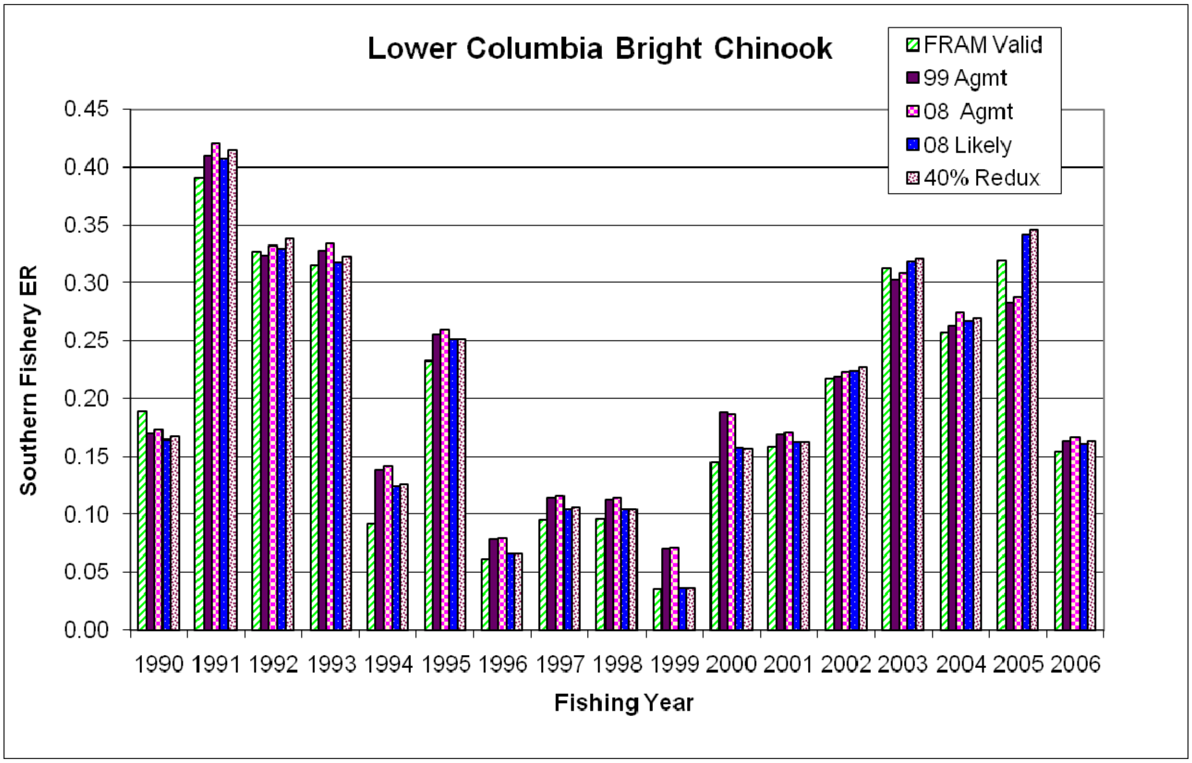
The 2008 Likely scenario estimates the exploitation rates under a "likely" range of fishing levels during the next ten years given current constraints on ESA listed Chinook stocks. AABM fisheries in the 2008 Likely scenario were modeled using the same abundance levels and quotas as in the 2008 Agreement scenario, although there is some redistribution of the catch between the troll and sport fisheries, and between fishing seasons in the WCVI fishery. The ISBM fisheries were modeled with fishing effort rates observed in recent years. The total exploitation rate under the 2008 Agreement of 0.34 would be reduced to 0.32 under the 2008 Likely scenario. In the northern AABM fisheries the exploitation rate will be reduced from 0.12 to 0.11.

The 40% reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. It assesses how the proposed agreement would respond under these circumstances in terms of the likely effect on stock specific exploitation rates. The average exploitation rates under the 2008 likely and 40% reduction scenarios from 1990 to 2006 are both 0.32 and indistinguishable due to rounding. In the northern AABM fisheries the exploitation rate will be reduced from 0.11 to 0.10. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. The retrospective analysis suggests that the management regime does compensate for reduced abundance as intended. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. Because of their distribution and concentration in the Alaskan and northern British Columbian fisheries and their relatively low exploitation rate, the reduction in harvest for Lower Columbia River bright Chinook is modest. The retrospective analysis did not try to identify additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Figure 7.4.3.2-2. Estimates of exploitation rates for Lower Columbia River bright Chinook from the retrospective analysis for all fisheries combined (Total) and for AABM (northern) and ISBM (southern) fisheries.







The Interim Regional Recovery Plan (LCFRB 2004) recommends that the North Fork Lewis bright population continue to be managed for an escapement goal of 5,700. Oregon's draft recovery plan concludes that the Sandy River bright population is at low risk of extinction, and that the population is viable under the current harvest pattern (ODFW 2007b).

7.4.3.3 Tule Chinook Populations

The circumstances related to Lower Columbia River tule Chinook and the effects of harvest on those populations were considered in some detail in the biological opinion on the 2008 PFMC fisheries (NMFS 2008h). NOAA Fisheries' indicated in that opinion and through its guidance to the Council that fisheries in 2008 should be managed subject to a total exploitation rate limit of 41%. NOAA Fisheries also indicated that it would continue its review of the status of the tule populations and the effects of harvest, and implement changes that are consistent with the evolving information, the expected evolution of the hatchery programs, and the long term goal of recovery articulated in the Interim Regional Recovery Plan. NOAA Fisheries consulted on PFMC fisheries for 2008 using the assumption that exploitation rates in 2009 and thereafter would be no greater than 41%, and informed the Council that further reductions in harvest may be required.

The prevailing theme in the PFMC opinion was one of change and the need to anticipate and consider new information as it becomes available. Areas of ongoing work include recovery planning, hatchery reform, population risk assessment, and efforts to integrate harvest, hatchery, and habitat related actions that will in combination lead to recovery. Progress has been made on all of these fronts since May 2008 when the PFMC opinion was completed, but we continue to expect that new information will accumulate gradually, and that key decisions will be made over the next several years, not the next few months. It is therefore necessary to recognize the dynamic nature of the current circumstances as we consider the effects of the proposed actions on Lower Columbia River tule Chinook populations in particular.

Trends in Harvest Mortality

The harvest of Lower Columbia River tule Chinook was reduced in 1994 as a result of management actions taken because of ESA listings and other conservation concerns. From 1983 to 1993, the total exploitation rate in ocean and in-river fisheries averaged 69%. Since 1994 the total exploitation rate for all fisheries averaged 42%. Approximately 80% of all harvest occurs in ocean fisheries. The exploitation rate in ocean fisheries averaged 53% from 1983 to 1993, and 34% from 1994 to 2006 (Figure 7.4.3.3-1). Harvest has been reduced in recent years as a consequence of NOAA Fisheries ESA related guidance. In 2001, fisheries were subject to a total exploitation rate limit of 65%. From 2002 to 2006 fisheries were managed subject to a limit of 49%. The limit was reduced further to 42% in 2007 and 41% in 2008.

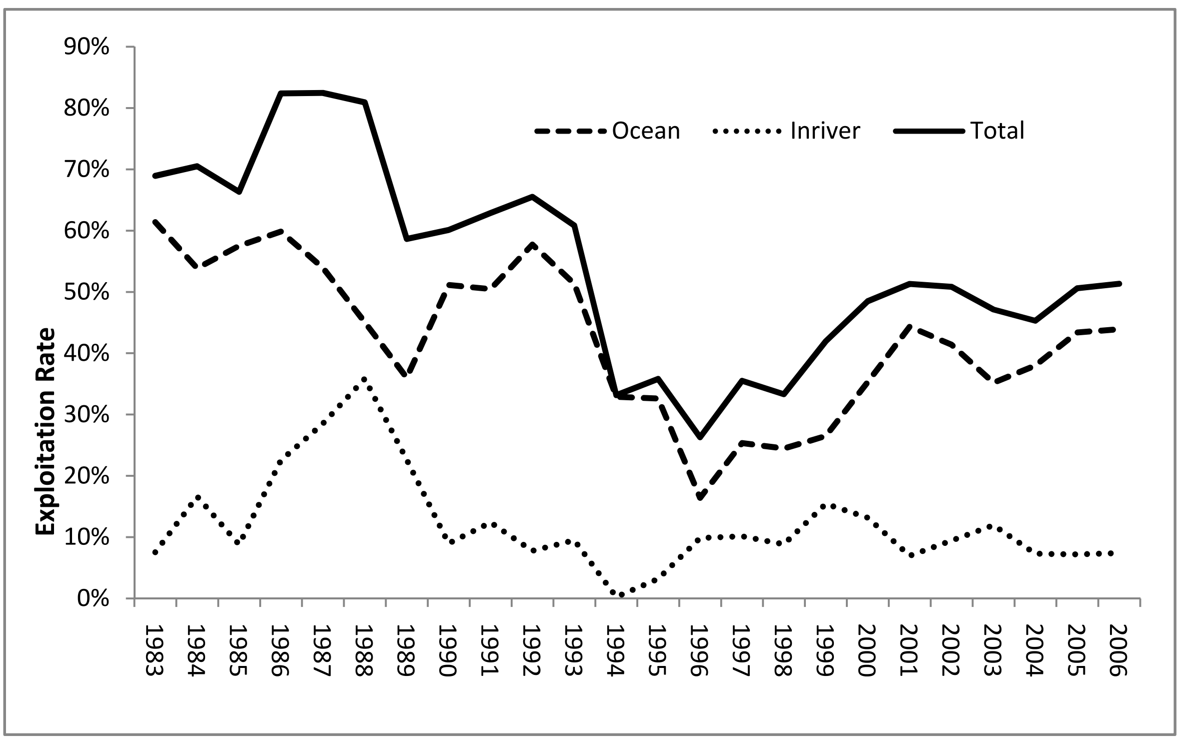


Figure 7.4.3.3-1. Ocean and inriver exploitation rates for Lower Columbia River tule Chinook.

Results from the Retrospective Analysis

The FRAM validation scenario shows a pattern of change in harvest over time similar to that described above (results from the retrospective analysis are shown graphically in Figure 7.4.3.3-2 and are tabulated in Appendix 3). Harvest was relatively high through the early-1990s, declined significantly through the mid part of the decade, and was then higher but variable through 2006. Much of the increase in recent years occurred in ocean fisheries.

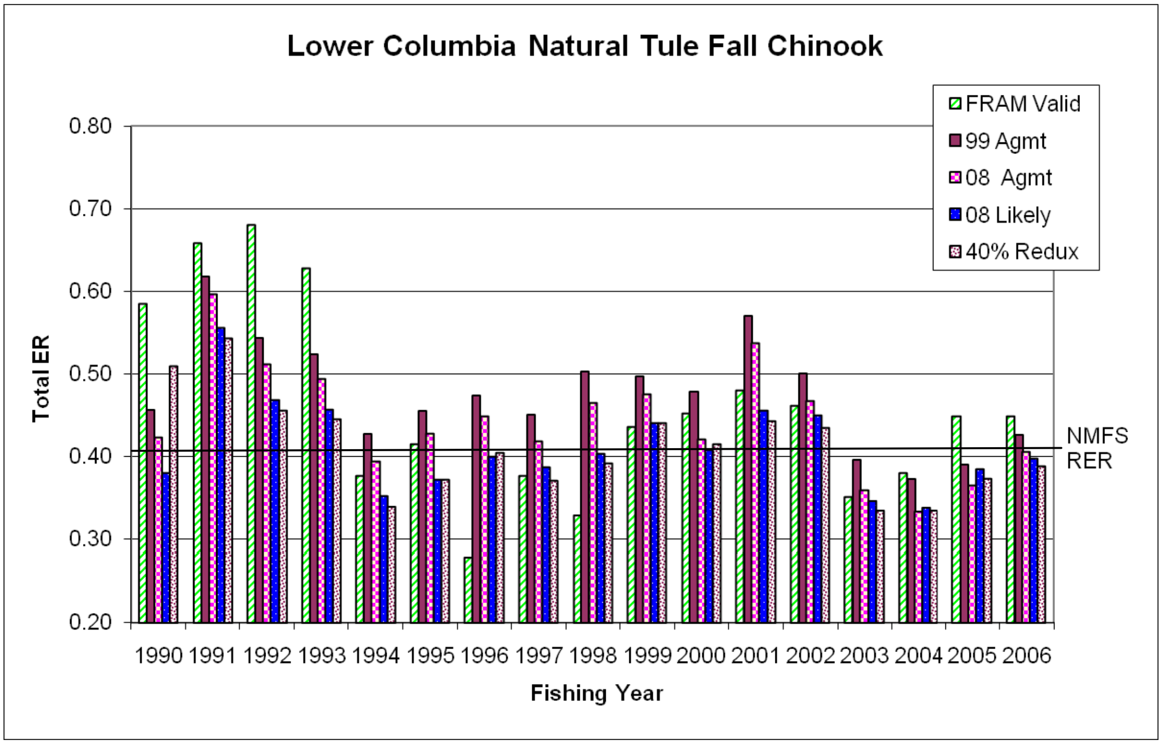
Lower Columbia River tule Chinook are a north migrating stock that is subject to significant harvest in the WCVI and Washington coastal fisheries, with relatively little catch further to the north. Because of their distribution and concentration in the WCVI fishery in particular, the harvest of Lower Columbia River tule Chinook is reduced significantly by the 2008 Agreement.

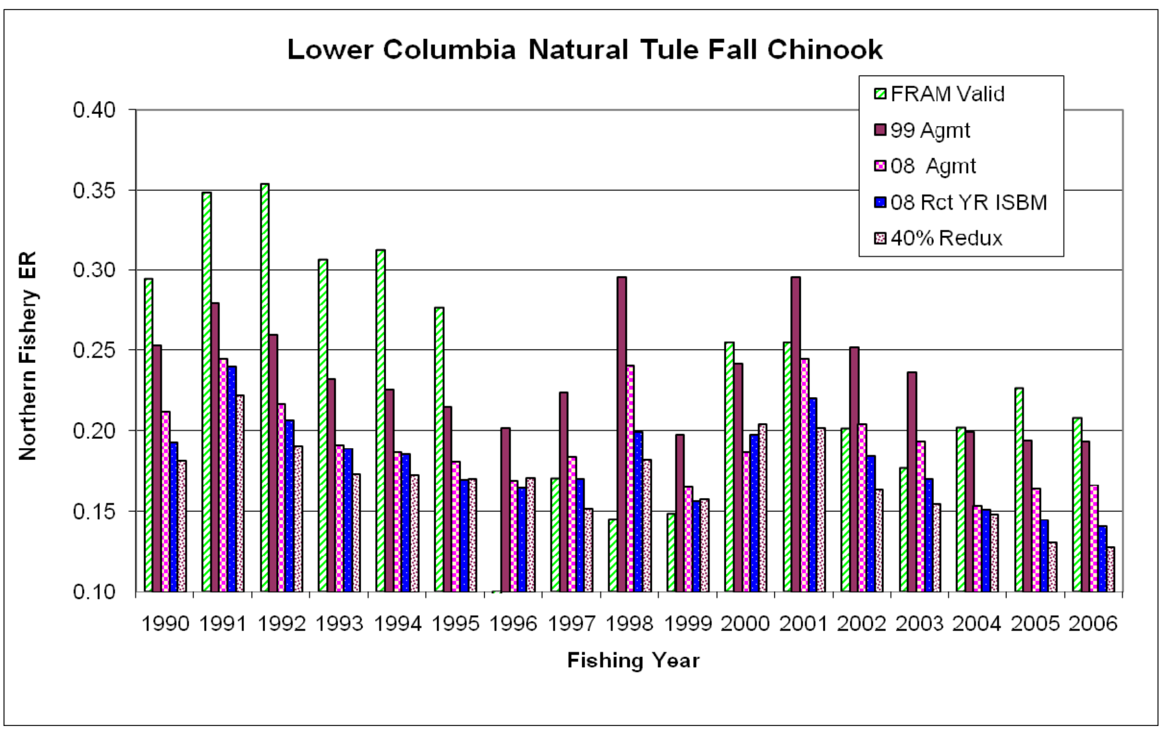
The magnitude of the reduction resulting from the 2008 Agreement will depend on the year specific circumstances. However, the retrospective analysis provides a sense of the range of reductions in exploitation rate that is likely to occur. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. fisheries are managed subject only to the limits for ISBM fisheries. For Lower Columbia River tule Chinook the difference between the 1999 Agreement and 2008 Agreement scenarios is significant. The scenarios indicate that the total exploitation rate of Lower Columbia River tule Chinook would be reduced by three percentage points from an average of 0.476 to 0.444 under the respective scenarios. For the northern AABM fisheries the average exploitation will be reduced from 0.235 to 0.194. In these scenarios ISBM fisheries in the south are constrained only by the general obligation for ISBM fisheries and therefore do not reflect what further reductions would be required to meet ESA standards for tule populations or other stocks of concern. Given the nature of the retrospective analysis, it is most appropriate to use these results to approximate the relative reduction in harvest that can be expected rather than as a prediction of the absolute magnitude of future harvest reductions.

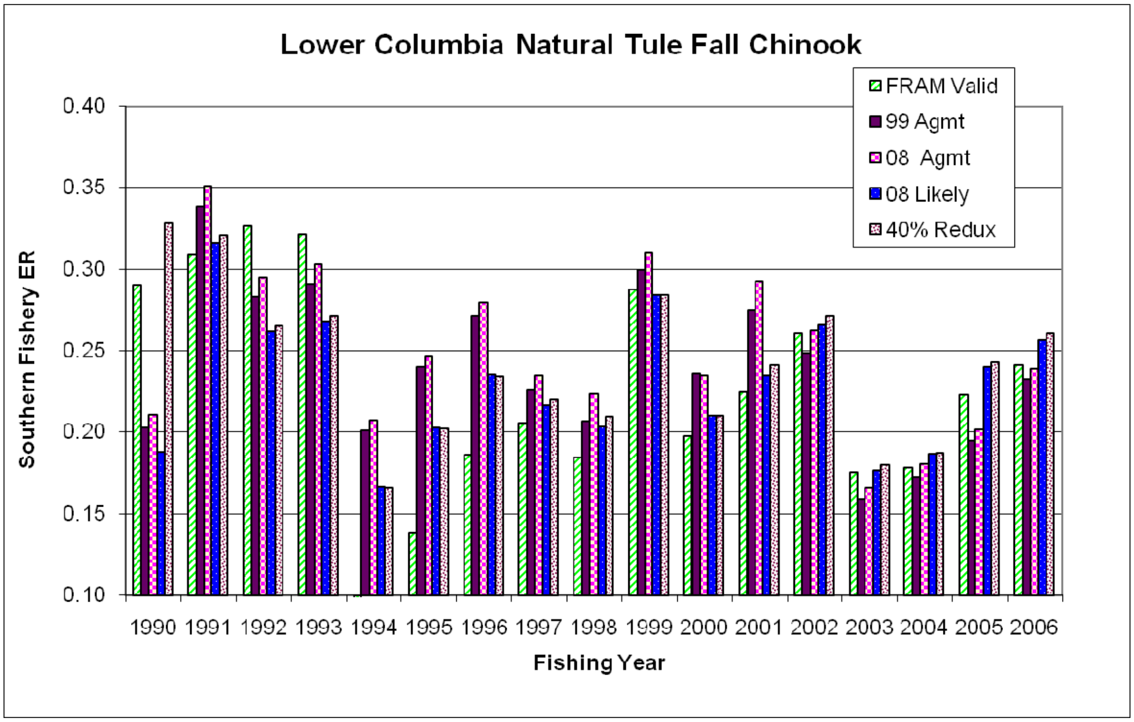
The 2008 Likely scenario estimates the exploitation rates under a “likely” range of fishing levels during the next ten years given current constraints on ESA listed Chinook stocks. AABM fisheries in the 2008 Likely scenario were modeled using the same abundance levels and quotas as in the 2008 Agreement scenario, although there is some redistribution of the catch between the troll and sport fisheries, and between fishing seasons in the WCVI fishery. The ISBM fisheries were modeled with fishing effort rates observed in recent years. The total exploitation rate under the 2008 Agreement and 2008 Likely scenarios will be reduced from 0.44 to 0.41. In the northern AABM fisheries the exploitation rate will be reduced from 0.19 to 0.18. These results indicate that Lower Columbia River tule Chinook will benefit from the 30% reductions in catch in the WCVI fishery, and from the redistribution of catch between troll and sport fisheries and seasons. The 2008 Likely scenario approximates the sort of reductions expected to occur in southern fisheries based on observations from recent years. The results indicate that on average the current 41% limit would be achieved. However, as is currently the case, southern fisheries would have to be managed purposely every year to achieve the 41% standard or whatever alternative standard NOAA Fisheries eventually articulates through its subsequent guidance and related consultations. Because more than half of the harvest mortality occurs in southern fisheries, there is sufficient opportunity and discretion to reduce harvest as needed to meet the 41% limit or any other reasonably foreseeable exploitation rate limit.

The 40% reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. It assesses how the agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific exploitation rates. The average exploitation rates under the 2008 Likely and 40% Reduction scenarios from 1990 to 2006 are both 0.41. In the northern AABM fisheries, the exploitation rate will be reduced from 0.18 to 0.17. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Figure 7.4.3.3-2. Estimates of exploitation rates for Lower Columbia River tule Chinook from the retrospective analysis for all fisheries combined (Total) and for AABM (northern) and ISBM (southern) fisheries. A Rebuilding Exploitation Rate (RER) of 0.41 was the total ESA-related limit used in 2008 and is shown for reference.







Life Cycle Modeling Results

NOAA Fisheries considered results from life cycle modeling analyses to evaluate the effects of harvest on Lower Columbia River tule Chinook. We considered the results from the VRAP and SPAZ models, and from life cycle modeling scenarios developed through the Hatchery Scientific Review Group (HSRG) process and those associated with Washington and Oregon recovery planning.

The VRAP and SPAZ models were used to analyze the Coweeman, East Fork Lewis, and Gray's river populations. These populations were selected as indicators because of the availability of necessary data and because these populations were less subject to complications related hatchery straying. As discussed in section 5.1.3, the Lower Columbia River ESU is stratified into three ecological zones. The Coweeman and East Fork Lewis river populations are located in the Cascade stratum. The Grays River is in the Coastal stratum. Generally, the Coweeman and East Fork Lewis populations are considered indicators of larger natural-origin populations in the Cascade stratum. The Grays is representative of smaller populations that are more typical of the Coastal stratum. However, even within strata the relative contribution of hatchery fish varies widely between populations. The Coweeman and East Fork Lewis are in the same stratum as the Washougal and Kalama populations, but they differ significantly because of the relative contribution of hatchery fish on the spawning grounds (Table 5.1.3.1-7). Whether one population is a good indicator for another depends on context of the comparison being made.

The VRAP and SPAZ analysis procedures are similar in that they use available data to estimate the production dynamics of a population based on a time series of abundance data. Both models incorporate uncertainty and are used to project future outcomes. VRAP is designed to identify a rebuilding exploitation rate (RER) that is associated with a small increase (5%) in the frequency of escapements that are below the critical escapement threshold relative to no harvest, and a high probability (80%) that the upper escapement threshold will be met by the end of a 25 year projected time series. SPAZ on the other hand focuses on extinction risk, where extinction is defined as the probability that the population will fall below the critical escapement threshold, based on a four year average, any time during a 100 year forward projection. SPAZ can be used to assess the effects of harvest by estimating how the extinction risk changes for various levels of assumed harvest (e.g., 0%, 25%, 50%). SPAZ does not directly address the prospect of recovery. The VRAP and SPAZ models are described in more detail in Appendices 1 and 2. The analysis of the three indicator populations in discussed in more detail in the biological opinion on the 2008 PFMC fisheries (NMFS 2008h).

The results from the VRAP analysis varied for each population depending on the spawner-recruit model used (Ricker, Beverton-Holt, Hockey Stick), and assumptions about age structure, and the abundance thresholds used in the analysis. Only results from models that incorporated estimates of marine survival as a covariate are reported because they substantially improved the fit to the data.

The RER estimates for the Coweeman population range from 34% to 58% depending on the spawner-recruit model used in the analysis. Estimates for the East Fork Lewis population range from 44% to 52% and also depended on the spawner-recruit model used in the analysis. The most recent estimates for the Grays River range from 0% to 20% (Table 7.4.3.3-1). These results are significantly different from those available from an earlier report when the RER estimates ranged from 16% to 54% (LCTCWG 2008). The change was again most directly related to the use of the marine survival covariate.

Table 7.4.3.3-1. Rebuilding exploitation rates for the Coweeman, East Fork Lewis, and Grays river populations.

Population	RER
Coweemen	0.34 – 0.58
East Fork Lewis	0.44 – 0.52
Grays	0.00 – 0.20

Results from the SPAZ analysis are best displayed by the color contour graphics as shown and discussed in more detail in Appendix 2. The graphical results of the most recent SPAZ analysis for the three tule indicator populations are shown in the original report (LCTCWG 2008). For convenience, the results can also be summarized in tabular form.

Results of the SPAZ analysis are sensitive to the quasi extinction threshold (QET) values used in the analysis. As expected, probabilities associated with meeting viability criteria decreased as exploitation rates increase. For the Coweeman and East Fork Lewis populations the probabilities of meeting the viability criteria were high with exploitation rates of 50% and QET values of 50; 0.95 and 0.80 for the Coweeman and East Fork Lewis populations, respectively (Table 7.4.3.3.-2). With QET values of 150 the viability probabilities were still high with exploitation rates of 25%, but were reduced when the exploitation rates were as high as 50%. Results from the SPAZ analysis were similar to those of the VRAP for the Grays River population. The probability of meeting the viability criteria was low regardless of the QET value or exploitation rate scenario. Recall that SPAZ estimates the probability that the populations will fall below the QET value, based on a four year average, anytime in a 100 year projection. When the abundance of fish is low to begin with, as it is for populations like the Grays (Table 5.1.3.1-7), the probability of falling below the QET value sometime in the next 100 years is high.

Table 7.4.3.3-2. Results for the SPAZ analysis results indicating the probability of persistence associated with exploitation rates of 0%, 25%, and 50% for QETs of 50 and 150. Persistence is defined as the probability of not falling below the specified QET value, based on a four year average, any time in a 100 year projection.

Population	Probability of meeting viability criteria					
	QET = 50			QET = 150		
	0 harvest	25% harvest	50% harvest	0 harvest	25% harvest	50% harvest
Coweeman	1.00	0.99	0.95	0.99	0.95	0.56
EF Lewis	1.00	0.99	0.80	0.99	0.80	0.05
Grays	0.43	0.10	0.00	0.00	0.00	0.00

For both VRAP and SPAZ, predictions of future outcomes are based on estimates of population abundance and productivity from the time series of available information representing past and present conditions. The VRAP procedure projects 25 years into the future while SPAZ utilizes a 100 year forward analysis. If abundance or productivity changes in the future for better or worse the projections may likewise be either too optimistic or pessimistic. This point is discussed in more detail below, particularly as it pertains to the Grays River population.

The HSRG analysis takes a different approach that considers alternative future outcomes including those associated with harvest. The HSRG analysis models future outcomes based on the assumption that productivity will improve if actions are taken to address key limiting factors. For example, if actions are taken to reduce adverse hatchery interactions, the HSRG assumes associated improvements in population productivity consistent with related scientific evidence.

The HSRG analysis results in population specific scenarios (HSRG 2007). One of the assumptions underlying the HSRG analysis is that population productivity (defined as spawner-to-spawner return) will increase if the influence of hatchery fish on natural-origin spawners can be reduced. For the Grays River, for example, the HSRG assumes that population productivity will double over the long term, if hatchery influence is eliminated. Productivity improvements are also assumed to occur as a result of habitat and harvest related actions. For the Coweeman, Grays, and East Fork Lewis populations, that HSRG analysis assumed 10% improvements in productivity associated with habitat actions, and that the exploitation rate on natural origin fish would be reduced to 32% to 34% (depending on the population) as mark selective fisheries are implemented. Mark selective fisheries would presumably be phased in gradually beginning in 2011, the first year when all hatchery origin tule Chinook would have a visible external mark. The Interim Regional Recovery Plan also describes alternative scenarios for achieving recovery (LCFRB 2004). The Recovery Plan analysis is similar to that of the HSRG in that it models improvements in survival associated with harvest reductions, and remedial habitat and hatchery actions and thereby develops a scenario for balancing conservation actions to achieve recovery. Some of the initial analysis in the Interim Plan has been updated (LCFRB 2007). The scenario described in the updated Interim Plan for the Grays River assumes an improvement in productivity for habitat of 42% coupled with a 38% exploitation rate on natural origin fish. Survival improvements required for the Coweeman and East Fork Lewis in particular, and other tule populations in general, are substantially less than those required for the Grays.

Oregon recovery planners have taken a similar approach. Their analysis assumes that exploitation rates on tule populations will be reduced to 35%, and that additional survival improvements will occur as a result of actions taken to reduce the effects of hatchery strays and through action to improve the habitat. The scenarios described in the Interim Regional Recovery Plan and Oregon's Recovery Plan were developed for planning purposes and as an initial step that seeks to allocate necessary survival improvements across various actions and sectors. The scenarios are not predictions representing presumed final solutions, but do reflect the general goal to spread the conservation burden and achieve recovery using a combination of actions that the recovery planners considered feasible.

Table 7.4.3.3-3. Target exploitation rates for Lower Columbia tule populations developed through the HSRG and Washington and Oregon recovery planning processes.

Target Exploitation Rate	
HSRG	0.32 – 0.34
Washington Rec Planning	0.38
Oregon Rec Planning	0.35

Priority Populations for a Recovery Scenario

Recovery planning for the Lower Columbia River is an ongoing process. As discussed in section 6.1.3, NOAA Fisheries endorsed an Interim Regional Recovery Plan for the Washington side of the Lower Columbia River Chinook ESU in 2005. Oregon is actively engaged in the recovery planning process and has made progress with their recovery planning efforts since our last review of the tule populations in the 2008 PFMC opinion. Eventually, the Washington and Oregon components will have to be reconciled into a single plan for Lower Columbia River Chinook and the other ESUs in the Lower Columbia River domain.

One of the important tasks of recovery planning is to identify delisting goals and a recovery scenario that designates which populations will be prioritized for high viability. The Interim Regional Recovery Plan provided a tentative list of priority populations and made some judgments about how Oregon populations might be managed. Washington has since made some changes in their original designations based on further review and consideration. Oregon has also now made tentative designations of its own. Washington and Oregon use different terminologies for these designations. The Interim Regional Plan refers to Primary, Contributing or Stabilizing populations. Oregon categorizes populations according to their prospective risk of extinction. Populations at low or very low risk are those that are prioritized for recovery. Table 7.4.3.3-4 shows the current tentative designations for Lower Columbia River tule populations. These can be compared to the designations suggested in the Interim Regional Recovery Plan shown in Table 5.1.3.1-8. We have used Oregon's terminology in the table to minimize confusion. There may still be some changes in the details of these designations, but based on conversations with the recovery planners and actions taken to date, the recovery scenario shown here, particularly with respect to designated low risk populations, is likely complete.

Table 7.4.3.3-4. Lower Columbia River tule populations and associated strata, state, and target extinction risk categories. Notations for extinction risk are very low (VL), low (L), moderate (M), and high (H) or very high (VH). The Interim Regional Recovery Plan uses different terminology for Washington populations. The equivalent extinction risks for Primary populations are VL or L, Contributing populations are M, and Stabilizing populations are H or VH.

Population	State	Target Extinction Risk	Rebuilding Exploitation Rate (RER)
Coastal Fall			
Grays/Chinook	W	L	0.0 - 0.20
Eloch/Skam	W	L	
Mill/Aber/Germ	W	M	
Youngs Bay	O	H	
Big Creek	O	H	
Clatskanie	O	L	
Scappoose	O	VL	
Cascade Fall			
Lower Cowlitz	W	M	
Upper Cowlitz	W	H	
Toutle	W	L	
Coweeman	W	VL	0.34 – 0.58
Kalama	W	M	
EF Lewis/Salmon	W	VL	0.44 – 0.52
Washougal	W	L	
Clackamas	O	VL	
Sandy	O	M	
Gorge Fall			
Lower Gorge	W/O	M	
Upper Gorge	W/O	H	
White Salmon	W	M	
Hood	O	M	

The considerations and more detailed analysis of Lower Columbia River tule populations has focused mostly on the Coweeman, East Fork Lewis, and Grays river populations. These are all priority populations designated for low or very low risk of extinction. Generally, the Coweeman and East Fork Lewis populations are considered indicators of larger natural-origin populations in the Cascade stratum. The Grays is representative of smaller populations that are more typical of the Coastal stratum. The next step is to consider how results from the analysis of these indicator populations can be applied to other populations in their respective strata to assess the effects of the proposed actions on the Lower Columbia River tule populations. Designation of priority populations through recovery planning provides information that is relevant to this goal.

The Grays River is the indicator for populations in the Coastal stratum. However, use of the VRAP and SPAZ results for the Grays to represent other populations is complicated by the varying contribution of hatchery fish. For example, the escapement to the Grays River has been just a few hundred fish in recent years (Table 5.1.3.1-7). Results for the VRAP and SPAZ analysis suggests that the Grays is at risk even with little or no harvest. The risk is high largely because the abundance is low so there is a relatively high probability that the population will fall below the low abundance threshold in the future if nothing is done to improve the productivity of the population. The Elochoman and Mills/Abernathy/Germany populations are in the Coastal stratum too, but escapements to those populations have numbered in the thousands in recent years, largely due to hatchery strays (Table 5.1.3.1-7). These populations may be at risk because of hatchery influence or other considerations, but their status is not directly comparable to that of the Grays. They are not currently at risk because of low abundance. Of these only the Elochoman is designated as a primary population that requires achieving a low target extinction risk.

As discussed above, Oregon has designated the Clatskanie and Scappoose populations for low risk through their recovery planning efforts. The Grays may be more representative of populations like the Clatskanie or Scappoose. Available information for the Clatskanie suggests that escapements are somewhat lower than on the Grays, that the hatchery contribution is relatively low, although both the long term trend and median growth rates are positive (Table 5.1.3.1-4). The population is currently considered at high risk. There is no comparable escapement information for the Scappoose, but it too is considered at high risk. Oregon has indicated the need for more work to determine how many natural origin fish are returning to these rivers and how much natural production is occurring. All hatchery tule Chinook have been marked with an adipose fin clips in recent years. Beginning in 2011 all returning hatchery fish will be marked. This will provide the first good opportunity to assess the relative contribution of hatchery and natural origin fish to these populations. Oregon has indicated their intention to conduct intensive surveys at that time. The Big Creek and Youngs Bay populations are contiguous with large hatchery net pen programs designed to support terminal area fisheries. They are therefore also likely recipients of large numbers of hatchery strays. Oregon proposes to continue to use these areas to support fisheries and expects that these populations will remain at high risk.

The Coweeman and East Fork Lewis are indicator populations for the Cascade stratum. The analytical results for the Coweeman and East Fork Lewis are more optimistic compared to those for the Grays River. Escapements to these have been several hundred to a thousand fish or more in recent years (Table 5.1.3.1-7). Results from VRAP and SPAZ suggest that these populations can sustain higher exploitation rates consistent with the expectation of survival and recovery. Escapements to other populations in the stratum including the Cowlitz, Kalama, and Washougal have been thousands of fish per year, again largely due to hatchery influence. Of these only the Washougal is designated for low risk.

The three indicator populations are natural-origin populations that are essential to the recovery of the ESU. Their status as primary populations is not likely to change. It is therefore appropriate that we use results from VRAP, SPAZ, HSRG, and other life cycle analyses to assess the status of these populations and the effects of the proposed actions. However, it is also important to understand the pervasive effects of hatchery production on tule populations in the ESU, and how it complicates the analysis and the application of results from the indicator populations to other populations in the ESU. It also underscores the necessity of a comprehensive solution that includes hatchery reform, harvest constraints, and actions to address other limiting factors that affect the status and productivity of the populations over the long term.

Recent Actions Taken to Improve Survival

As noted above, a common characteristic of the VRAP and SPAZ methods is that they rely on observations of abundance from recent years and resulting estimates of population productivity. The current circumstances are then projected into the future for 25 years (for VRAP) or 100 years (for SPAZ) to estimate risk. A key assumption of both models is that productivity and the associated variability will not change in the future. The life cycle modeling done in conjunction with the HSRG and recovery planning, on the other hand, presumes that actions either have been or will be taken to improve productivity, and considers scenarios and the magnitude of improvements that will be required to achieve recovery. The first set of models considers the prospect for survival and recovery under current conditions without the prospect for improvement; the second set of models considers the prospects for survival and recovery if we take action to improve current conditions.

A number of actions have been taken that would improve the status of populations in the ESU. If productivity is higher than presumed, the results from the VRAP and SPAZ analyses may be conservative. In the following discussion, we use the Grays as an example, but the general point applies to other populations as well. In going through the list of beneficial actions we need to be careful to distinguish those that either have occurred or are reasonable certain to occur, from those that are more speculative and therefore cannot be relied upon.

One of the assumptions underlying the HSRG analysis and similar reviews done associated with recovery planning is that population productivity will increase if the influence of hatchery fish on natural-origin spawners can be reduced (HSRG 2007). For the Grays River, the HSRG assumes that population productivity will double over the long term if hatchery influence on natural-origin spawners is eliminated. Steps have already been taken to reduce the effect of hatchery spawning on the Grays population. The Chinook hatchery on the Grays was closed with last releases in 1997 and last returns in 2000 or 2001. The states' program that is designed to address the adverse effects of hatcheries called for the construction of a weir on the lower Grays to further reduce the effects of out of basin hatchery strays. The design and permitting phase of the weir project was funded and scheduled for completion in 2008 with construction planned for 2009 (Anderson and Bowles 2008). The weir will greatly improve the ability to monitor the status of the population and make it feasible to remove a substantial portion of the hatchery origin fish that stray from other systems.

There have been several habitat restoration activities specific to the Grays River. A comprehensive assessment and restoration plan, conducted by the Pacific Northwest National Laboratory (PNNL) in cooperation with Washington Department of Fish and Wildlife (WDFW) and Pacific States Marine Fisheries Commission (PSMFC), was completed in 2006. There have been several additional design related and implementation projects and site specific restoration programs (see attachment to Lohn and McInnis 2008). The site specific restoration projects referred to are either underway or already complete. The Washington Department of Fish and Wildlife recently drew the attention of the LCFRB to the importance of the Grays River and asked that they continue to support habitat related improvement activities (Anderson 2008).

Other survival benefits can be attributed to actions taken in conjunction with the FCRPS and the associated Reasonable and Prudent Alternative (RPA) (NMFS 2008c). Several actions that would benefit fall Chinook populations in the lower river either have been taken or will be taken because they are required by the RPA. In some cases, the magnitude of the expected survival improvements for these actions is qualitative; in other cases, survival benefits are quantified and specific to particular life history types (NMFS 2008c). Nonetheless, it is apparent that actions have been taken to improve conditions in the lower Columbia River. Survival improvements that will benefit tule Chinook are expected to accrue from tributary habitat activities, improvements in the estuary habitat, and efforts to reduce predation from birds and fish predators.

The prevailing theme in this biological opinion, particularly as it relates to Lower Columbia River tule populations, is one of change. NOAA Fisheries is using the best available information to evaluate the effects of the proposed actions. But consideration of the proposed actions also requires an understanding of ongoing recovery and reform activities that affect the species status. NOAA Fisheries articulated in its 2008 Guidance letter to the Council and related biological opinion (Lohn and McInnis 2008; NMFS 2008h) increased focus on integrating its harvest analysis with other efforts to rebuild and recover tule populations. With regard to hatchery production, NOAA Fisheries highlighted a choice to the Council framed by the results of the HSRG report that emphasized the need to reduce the effect of hatchery-origin fish on natural-spawning populations. The two general options for addressing the problem were to either substantially reduce or eliminate existing hatchery programs, or to reprogram existing production to reduce straying, increase the ability of fisheries to differentially harvest hatchery fish, and install a system of weirs in key locations that can be used to manage the interactions between hatchery and natural-origin fish. In either case, it remains clear that hatchery programs and the fisheries they support must change significantly over the next several years.

In response, the states have considered the HSRG recommendations, the Interim Regional Recovery Plan and other information in order to develop a comprehensive and integrated hatchery and harvest reform program. A framework of that reform plan was provided to NOAA Fisheries in January and includes (Anderson and Bowles 2008):

- mass marking hatchery produced tule Chinook to allow for brood stock management, assessment and control of hatchery strays, and implementation of mark selective fisheries;
- developing a system of weirs and hatchery intake improvements to manage returning fish;
- reducing some programs and transferring hatchery releases between programs to maximize production and minimize the adverse effects of hatchery strays on priority populations, and
- developing techniques to enable commercial-scale mark selective fisheries.

NOAA Fisheries appreciates the scale and complexity of the reforms proposed by the states and commends them for their undertaking.

To be effective the program obviously must be implemented. The states propose that changes be phased in over time. Much of the program is currently unfunded and there will be complexities related to the design, permitting, and construction of each project. However, NOAA Fisheries is aware that substantive and essential steps already have been taken to implement elements of the program. First, the program depends fundamentally on the requirement that all hatchery fish be mass marked with an adipose fin clip so they can be distinguished visually. Visual identification of hatchery fish allows for mark selective fisheries, sorting of hatchery fish returning to the rivers, and identification of hatchery fish in natural-origin spawning areas. Federal legislation requires that all hatchery fish intended for harvest, and produced in federal hatcheries or supported by federal funding, be marked with an adipose fin clip. NOAA Fisheries' recent letter reiterates the marking requirement and reminds the states who manage the hatcheries that marking is required regardless of funding limitations. If necessary, production will have to be reduced to meet the marking requirement (Turner 2007). The marking phase of the reform initiative can be counted on as reasonably certain to occur.

The states' proposal also calls for the design, permitting, and construction of eight hatchery weirs or hatchery intake modifications (Anderson and Bowles 2008). The associated work schedule calls for completion in 2012. Much of the work is contingent on future funding, but several elements of the project are either completed or already funded. Funding proposals have been submitted for subsequent steps. The weir on the Grays River was installed this year, a year ahead of schedule. Design and permitting for the Washougal weir was funded with work scheduled for completion in 2008. Installation of the weir is scheduled for 2010 when most of the returning hatchery fish will be marked (all returning fish will be marked in 2011). Funding proposals have been submitted for other design, permitting, and construction elements of the project. Potential sources for funding include, but are not limited to, Pacific Coastal Salmon Recovery Funds and Mitchell Act money.

Part of the plan also calls for reductions and the redistribution of hatchery releases to maximize production and minimize the adverse effects of hatchery strays. Chinook production on the Grays River was halted in 1997. The initial plan called for production to be reduced at the Elochoman Hatchery, but Washington subsequently decided to close the Elochoman Hatchery following release of the 2008 brood year. Production of tule Chinook at the Washougal Hatchery has been reduced from 4.0 million to 3.0 million. This is the first step in a planned reduction to 0.9 million.

The HSRG, and both recovery plans call for the development and implementation of mark selective fisheries for fall Chinook to help reduce hatchery straying and the harvest of natural origin fish. Implementation of mark selective fisheries can not start until 2011 when all of the returning hatchery fish will be marked. In the meantime, the states are planning on phasing in mark selective commercial troll and recreational hook-and-line fisheries and researching gears and opportunities to implement more selective commercial net fisheries in the lower Columbia River.

NOAA Fisheries concludes that substantive and essential steps have been taken to implement elements of the program. NOAA Fisheries will continue to monitor progress related to the program and support the states' efforts to ensure it is implemented.

Effects on Critical Habitat

Designated critical habitat for Lower Columbia River Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood River, as well as specified areas in several tributaries to the Lower Columbia River. Ocean fisheries that occur as a result of the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are part of the proposed actions do occur in the lower Columbia River and its tributaries.

Most of the harvest related activities in the Columbia River occur from boats or along river banks with most of the fishing activity in the Columbia River mainstem. The gear that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning and rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of the Lower Columbia River Chinook salmon ESU from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest may affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for Lower Columbia River Chinook.

7.4.4 Puget Sound Chinook

Although component populations contribute fundamentally to the structure and diversity of the ESU, it is the ESU, not an individual population, which is the listed "species" under the ESA. NOAA Fisheries' supplement to the Puget Sound Salmon Recovery Plan identifies the biological characteristics of a recovered ESU as part of developing delisting and recovery criteria. These biological characteristics are based on the collective viability of the individual populations, their characteristics, and their distributions throughout the ESU. Different scenarios of ESU recovery may be based on choosing different degrees of acceptable risk of extinction for different combinations of populations across the ESU. The final ESU-wide scenario for delisting will likely include populations with a range of risk levels, but when considered in the aggregate, the collective risk will be sufficiently low to assure persistence of the ESU. The geographical distribution of viable populations across the Puget Sound Chinook Salmon ESU is important for the ESU's recovery (NMFS 2006d). The Puget Sound Chinook ESU includes 22 populations distributed across five geographic regions based on similarities in hydrographic, biogeographic, and geologic characteristics, which also correspond to regions where groups of populations could be affected similarly by catastrophes (volcanic events, earthquakes, oil spills, etc.).

A Puget Sound Chinook ESU-wide recovery scenario should include at least two to four viable Chinook salmon populations in each of the five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (NMFS 2008d). An ESU-wide recovery scenario should also include within each of these geographic regions one or more viable populations from each major genetic and life history group historically present within that geographic region (NMFS 2008d). While changes in harvest alone cannot recover the Puget Sound Chinook Salmon ESU NOAA Fisheries can use the delisting criteria for assistance in evaluating whether the proposed action would impede recovery of the ESU. In assessing jeopardy, the role and contribution of hatchery fish and their effect, as well as the character of the population and its habitat are also important considerations for some populations in the ESU. Consideration of jeopardy as it pertains to the proposed action also requires an understanding of the scope and status of the ongoing review of information, and of recovery related activities.

NOAA Fisheries has established RERs for ten individual populations within the ESU and for the Nooksack Management Unit (Table 7.4.4-1), (the method for deriving RERs is discussed in Section 7.1 with more detail provided in Appendix 1). Both the original RERs and their FRAM-based equivalents are presented (for a discussion of the distinction between RERs and a FRAM-based RER see the end of Appendix 1). For each population the FRAM-based RER is used to assess effects of the proposed action since FRAM is the analytical tool used to determine harvest impacts. For other populations in the ESU, adequate data were not available to assess current productivity or analysis is as yet incomplete. For these populations surrogate RERs are used based on similarities in population size, life history, watershed size and hatchery dominance with other populations in the ESU for which RERs have been derived. For individual populations, exploitation rates at or below the RERs are not likely to appreciably reduce the likelihood of rebuilding that population, assuming that current environmental conditions continue. However, RERs are not jeopardy standards. The risk to the ESU associated with an individual population not meeting its RER must be considered within the broader context of the information available.

Table 7.4.4-1. Rebuilding Exploitation Rates by Puget Sound Chinook population. Surrogate RERs are italicized.

Region	Population	Rebuilding Exploitation Rate	FRAM-based Rebuilding Exploitation Rate
Strait of Georgia	N.F. Nooksack	21%	23%
	S.F. Nooksack		
Whidbey/Main Basin	Upper Skagit River	54%	60%
	Lower Skagit River	36%	51%
	Lower Sauk River	33%	49%
	Upper Sauk River	46%	38%
	Suiattle River	50%	41%
	Upper Cascade		38-41%
	N.F. Stillaguamish River	45%	30%
	S.F. Stillaguamish River	28%	18%
	Skykomish River	24%	18%
	Snoqualmie		18%
South Sound	Sammamish[a]		18%
	Cedar[a]		30%
	Duwamish-Green	62%	46%
	White[b]		23%
	Puyallup[c]		33-46%
	Nisqually[c]		33-46%
Hood Canal	Mid-Hood Canal[d]		18-23%
	Skokomish	36%	33%
Strait of Juan de Fuca	Dungeness[e]		23%
	Elwha[e]		23%

[a]Uses North Fork Stillaguamish RER as a surrogate for the Cedar (30%) and the South Fork Stillaguamish RER as a surrogate for the Sammamish (18%) given similarity of current abundance and escapement trends. Inclusion of escapement outside the current survey area would substantially increase escapement to the Sammamish River (W. Beattie, pers. com.) In this case, the North Fork Stillaguamish might be a more appropriate surrogate for the Sammamish population.

[b] Uses Nooksack early Chinook as surrogate

[c] Uses range encompassing Skokomish (33%) and Green River (46%) as surrogates

[d] Uses range including Nooksack early Chinook (23%) and South Fork Stillaguamish (18%) as surrogates

[e] Uses Nooksack early Chinook as surrogate

NOAA Fisheries will use the RERs, and the critical and rebuilding escapement thresholds described in Chapter 5 (Table 7.4.4-2) to assist it in evaluating the proposed action on survival and recovery of the ESU. As emphasized earlier, for most populations, these thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Therefore, NOAA Fisheries has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. A population will be identified in this proposed evaluation as having a potential increased level of risk[14] when the abundance of that population does not meet its critical threshold. Populations with abundance slightly above the critical threshold will also be highlighted and identified as populations of concern.

Table 7.4.4-2. Critical and rebuilding thresholds for Puget Sound Chinook salmon populations. The high productivity recovery targets are included for comparison.

Region	Population	Escapement Thresholds Critical [1]	Rebuilding [2]	High Productivity Recovery Planning Target
Georgia Basin	Nooksack Management Unit	400	500	
	North Fork Nooksack	200[3]	-	3,800
	South Fork Nooksack	200[3]	-	2,000
Whidbey/ Main Basin	Upper Skagit River	967	7,454	5,380
	Lower Sauk River	200[3]	681	1,400
	Lower Skagit River	251	2,182	3,900
	Upper Sauk River	130	330	750
	Suiattle River	170	400	160
	Upper Cascade River	170	1,250	290
	N.F. Stillaguamish River	300	552	4,000
	S.F. Stillaguamish River	200[3]	300	3,600
	Skykomish River	1,650	3,500	8,700
	Snoqualmie River	400	1,250[3]	5,500
Central/South Sound	Cedar River	200[3]	1,250[3]	2,000
	Sammamish River	200[3]	1,250[3]	1,000
	Duwamish-Green River	835	5,523	-
	White River	200[3]	1,100[4]	-
	Puyallup River	200[3]	1,200[4]	5,300
	Nisqually River	200[3]	1,100[4]	3,400
Hood Canal	Skokomish River	652	1,160	-
	Mid-Hood Canal Rivers	200[3]	1,250[3]	1,300
Strait of Juan de Fuca	Dungeness River	200[3]	925[4]	1,200
	Elwha River	200[3]	1,250[3]	6,900

[1] Critical threshold under current habitat and environmental conditions.
[2] Rebuilding thresholds under current habitat and environmental conditions
[3] Based on generic VSP guidance
[4] Based on alternative habitat assessment

[14] When compared to a population otherwise at or above its critical threshold.

The model used to evaluate the various scenarios in the retrospective analysis (FRAM) is based on management units for several of the Puget Sound Chinook populations, i.e., aggregates of two or more individual populations. The co-managers use management units as their basis of management for Puget Sound Chinook. However, since individual populations are the basic components of the ESU, NOAA Fisheries must assess the effects of the proposed action on the individual populations as a first step in assessing jeopardy for the ESU, if that information is available. To assess abundance status relative to their critical and rebuilding escapement thresholds, management unit escapements were broken out to their individual Puget Sound populations by multiplying the management unit escapement by the percent of the observed escapement an individual population contributed in that year. For example, if the North Fork Nooksack population contributed 75% of the total Nooksack spring Chinook escapement in 2003 based on observed data, then the Nooksack spring Chinook management unit escapement anticipated under each scenario in the retrospective analysis was multiplied by 0.75 to derive the escapement for the North Fork Nooksack population for each of the scenarios in 2003. We note that there is some additional uncertainty in taking this step. Since the model does not predict the outcome for individual populations, this step assumes that the distribution of escapement would be exactly the same, even across the different fishing regimes represented by the different scenarios. Less abundant populations will likely have more uncertainty in the absolute escapement values than larger populations because a small change in the absolute number of spawners results in a much larger difference in the actual distribution. Regardless, although some years may deviate substantially, the general distribution pattern across all years for populations within a management unit is relatively stable. Therefore, NOAA Fisheries considers this the best approach to assess the general status of individual populations within the Puget Sound ESU and will focus on the pattern across years rather than comparisons of absolute numbers of escapement to thresholds in any individual year.

Estimated impacts from the proposed action will vary by population and region, depending on the terms of the 2008 Agreement. Consistent with the recovery plan guidance to assess ESU-wide effects, the following is an evaluation of the effects of the proposed action on the ESU, first by individual populations and then by region. The Conclusions chapter of the opinion summarizes information related to the species status, the environmental baseline, cumulative effects, and the effects of the proposed actions on the ESU as a whole. The following analysis compares the differences in exploitation rates and escapements among the five scenarios in the retrospective analysis, and against RERs and abundance thresholds.

7.4.4.1 Georgia Basin Region

There are two populations within the Georgia Basin Region: the North Fork Nooksack River and the South Fork Nooksack River populations. Both populations are currently classified as Category 1 populations, exhibit early timed life histories, and both are required to be viable to recover the Puget Sound Chinook ESU. The broodstock used for the Kendall Creek Hatchery program, located on the North Fork Nooksack River, retains the genetic characteristics of the wild population and is considered essential for the survival and recovery of the population given the very low productivity of the habitat for naturally spawning fish in both populations (Table 5.1.4.1-3). Adult fish produced by the Kendall Creek Hatchery program are expected to buffer genetic and demographic risks to the natural-origin North Fork Nooksack River population. A captive brood program was started in 2007 in an effort to protect and rebuild the remaining native population in the South Fork Nooksack given the critically low numbers of returning adults and the time it will take until benefits from habitat improvements are realized.

Trends in Harvest Mortality

Estimates of exploitation rate are available from the FRAM Validation scenario. Exploitation rates on Nooksack spring Chinook have been declining steadily since the mid-1980s (Figure 7.4.4.1-1). From 1983 to 1993 the total exploitation rate averaged 36%. Since 1994 the total exploitation rate for all fisheries averaged 22%. Seventy percent or more of all harvest occurs in Alaskan and Canadian fisheries (Figure 7.4.4.1-1), primarily in the WCVI troll and Georgia Strait sport fisheries (PSC 2008). Exploitation rates in southern U.S. fisheries have generally been low. Since 1998 exploitation rates have been 5% or less. Most of the reduction in exploitation rates has come from reductions in northern fisheries in response to domestic conservation and allocation concerns. Because of the limitations in the ability of FRAM to fully account for the impacts in the shift in the WCVI fishing pattern in recent years, exploitation rates since 2003 may be underestimated. Recent coded-wire tag analysis by the Pacific Salmon Commission Joint Chinook Technical Committee (PSC 2006) showed a higher proportion of the northern fishery catch is in the WCVI troll and sport fishery than is estimated by FRAM.

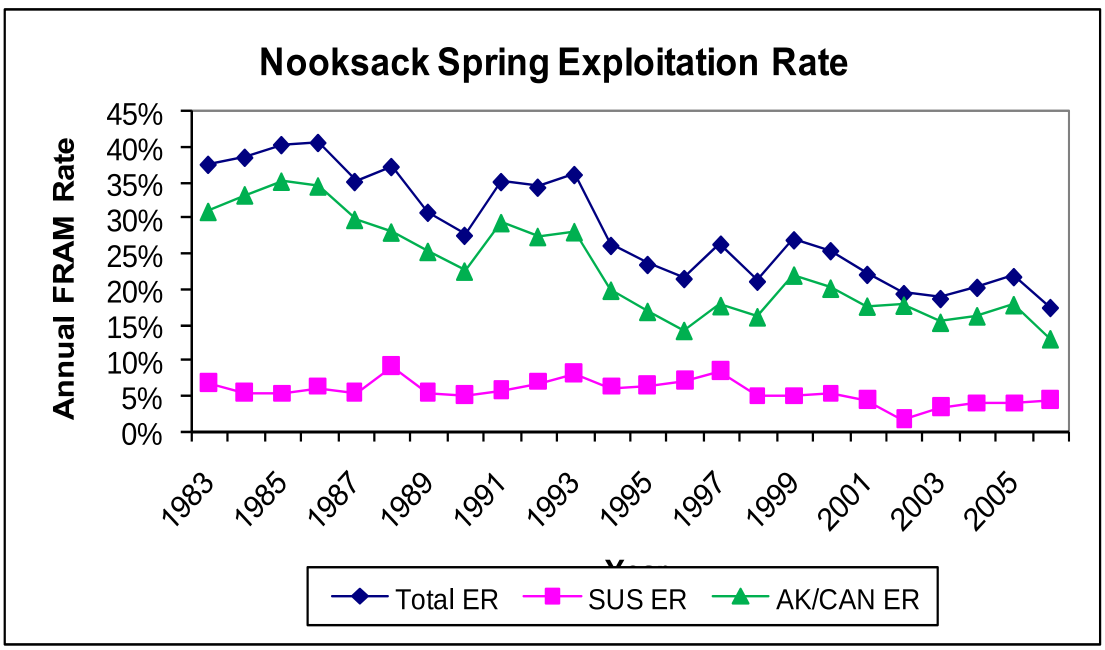


Figure 7.4.4.1-1. Comparison of total exploitation rates over time with those in southern U.S. and northern fisheries based on the most recent FRAM validation results (NMFS unpublished data).

Results from the Retrospective Analysis

Figures 7.4.4.1-2 provides results of the retrospective analysis for the Georgia Basin populations. (Results from the retrospective analysis are also shown in tabular form in Appendix 3). The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. and Canadian ISBM fisheries are managed subject to the limits for ISBM fisheries. Comparison of the 1999 Agreement and 2008 Agreement scenarios suggests that any reduction in exploitation rate resulting from changes in AABM fisheries in the new agreement would be small (Figure 7.4.4.1-2). The average total exploitation rate under both scenarios is 26% when rounded to the nearest percent. The average exploitation rate in northern fisheries would be reduced from 21 to 20% (Figure 7.4.4.1-2). Exploitation rates in southern fisheries would be essentially the same under both scenarios at 5% (Figure 7.4.4.1-2). Under the 2008 Agreement scenario, the total exploitation rate exceeds the FRAM-based RER of 23% in all years; usually by 1-3 percentage points (Figure 7.4.4.1-2).

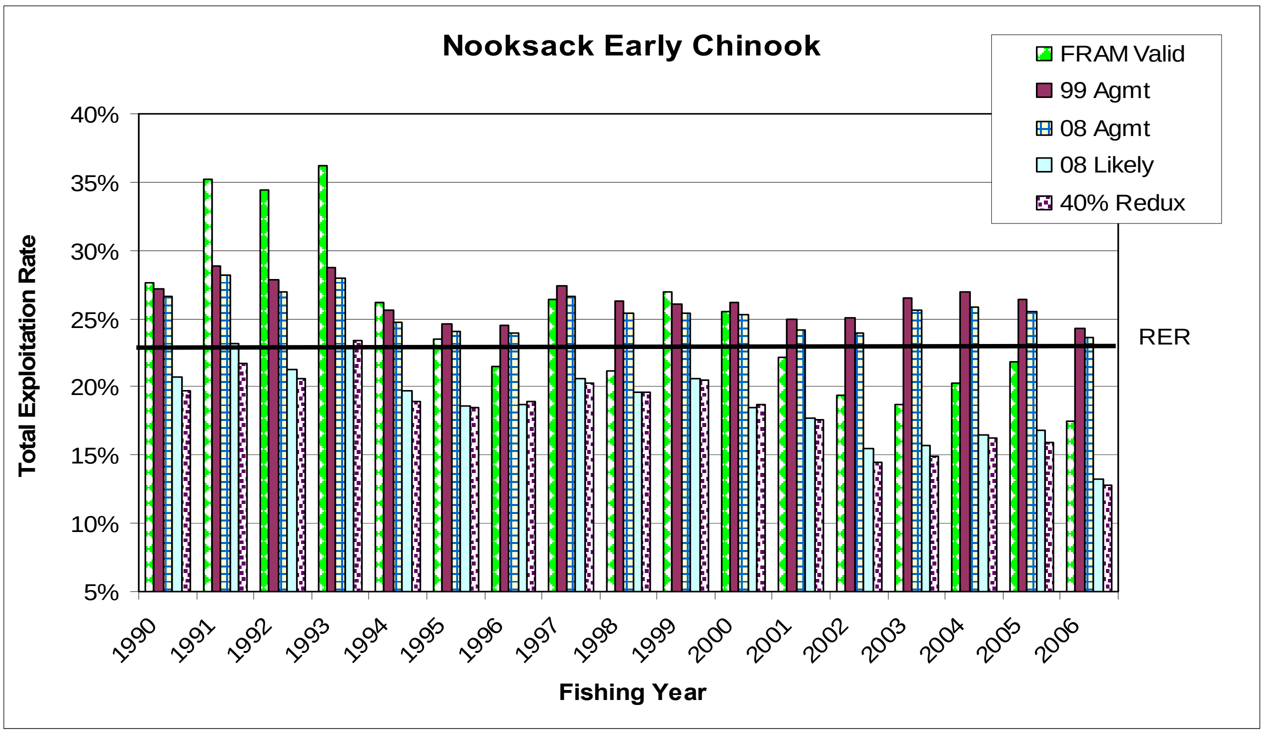
The 2008 Likely Scenario estimates the exploitation rates under the range of fishing levels that are expected over the next 10 years based on the current constraints on ISBM fisheries. The exploitation rate under the 2008 Agreement scenario will be reduced substantially under the 2008 Likely scenario from 26% to 19%. In northern fisheries exploitation rates will be reduced from 20% to 14%. Under the 2008 Likely scenario total exploitation rates are below the RER of 23% is all years but two (1991 at 23.2% and 1993 at 23.4%) when they exceed the RER by less than 0.5 percentage points. The difference between the full implementation of the 2008 Agreement and the 2008 Likely scenario are due to additional constraints in ISBM fisheries taken by both countries since the late 1990s or early 2000s to address domestic conservation and allocation concerns, and the shift in the WCVI fishing pattern.

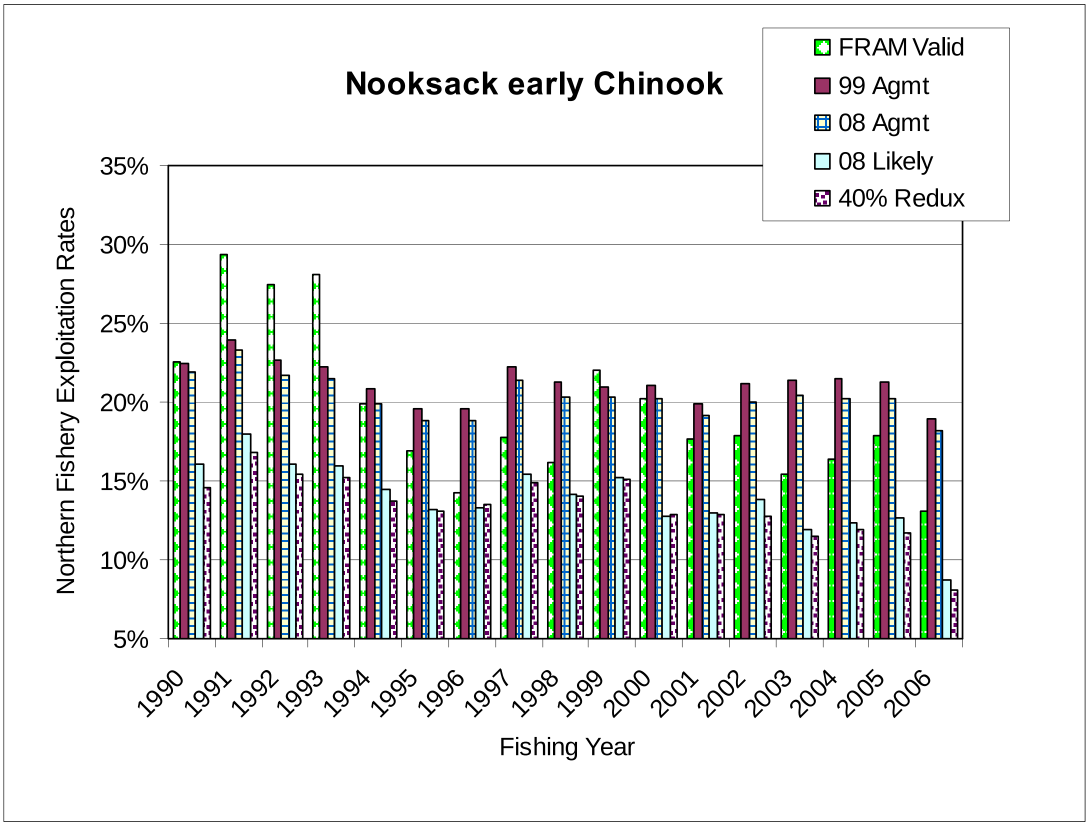
The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. The average exploitation rate is reduced slightly under the 40% Reduction scenarios 19% compared with the 2008 Likely scenario (18%), exploitation rates are below the RER for all years. In northern fisheries the exploitation rate will be reduced from 14% to 13%. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Table 7.4.4.1-1. Average exploitation rates (1990-2006) from the retrospective analysis for the population groups within the Georgia Strait Basin Region. Shaded values indicate averages exceeding RERs.

Management Unit	Fishery	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
Nooksack early (North Fork Nooksack South Fork Nooksack)	Total North South	26% [a] 21% 5%	26% [a] 20% 5%	19% 14% 5%	18% 13% 5%

Figure 7.4.4.1-2. Estimates of exploitation rates for Nooksack spring Chinook from the retrospective analysis for all fisheries combined (Total), northern and southern fisheries.




Nooksack early Chinook
FRAM Valid
99 Agmt
08 Agmt
08 Likely
40% Redux
Northern Fishery Exploitation Rates
35%
30%
25%
20%
15%
10%
5%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
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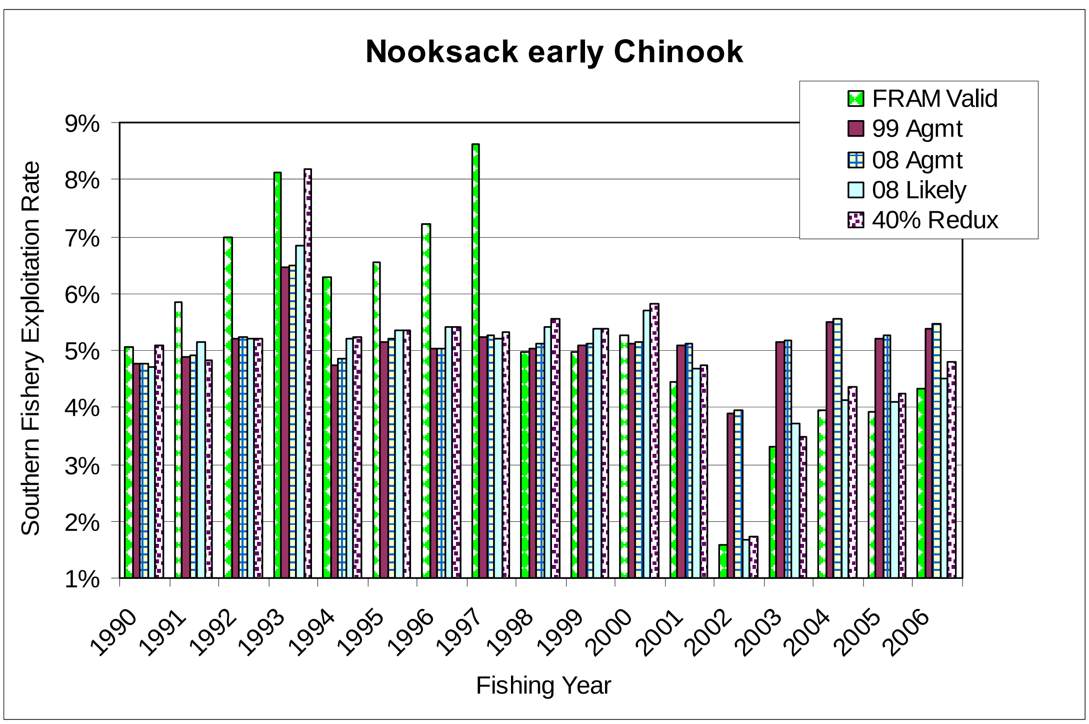
2003
2004
2005
2006
Fishing Year

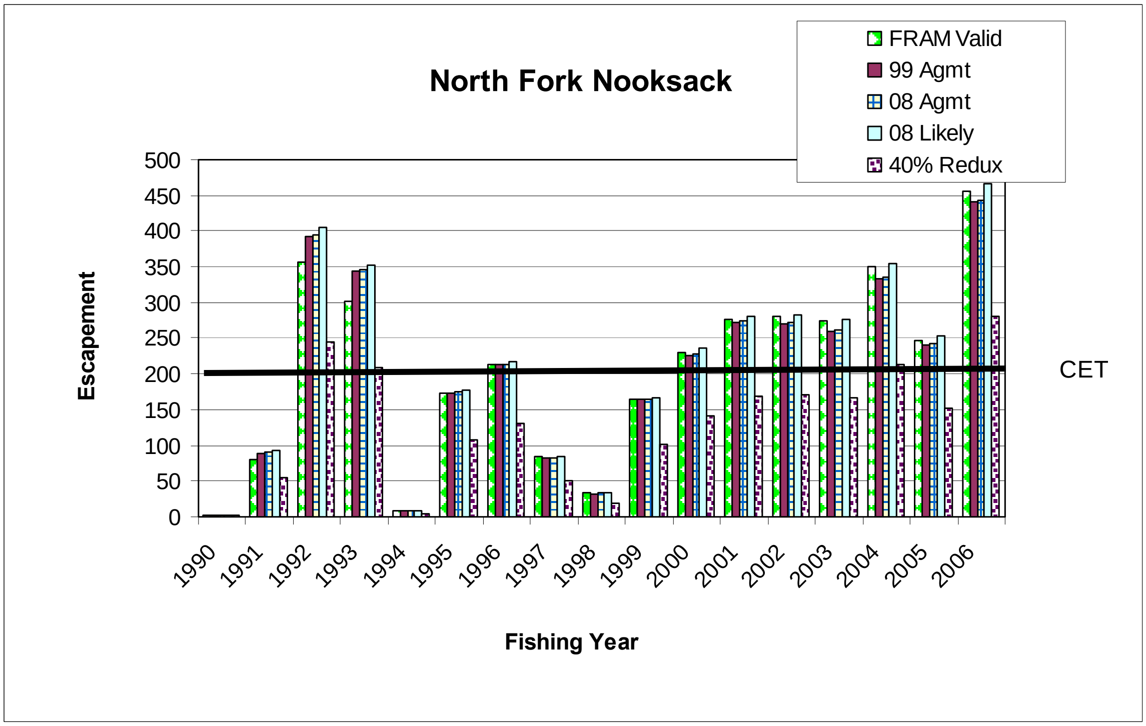

Nooksack early Chinook
FRAM Valid
99 Agmt
08 Agmt
08 Likely
40% Redux
Southern Fishery Exploitation Rate
9%
8%
7%
6%
5%
4%
3%
2%
1%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
Fishing Year

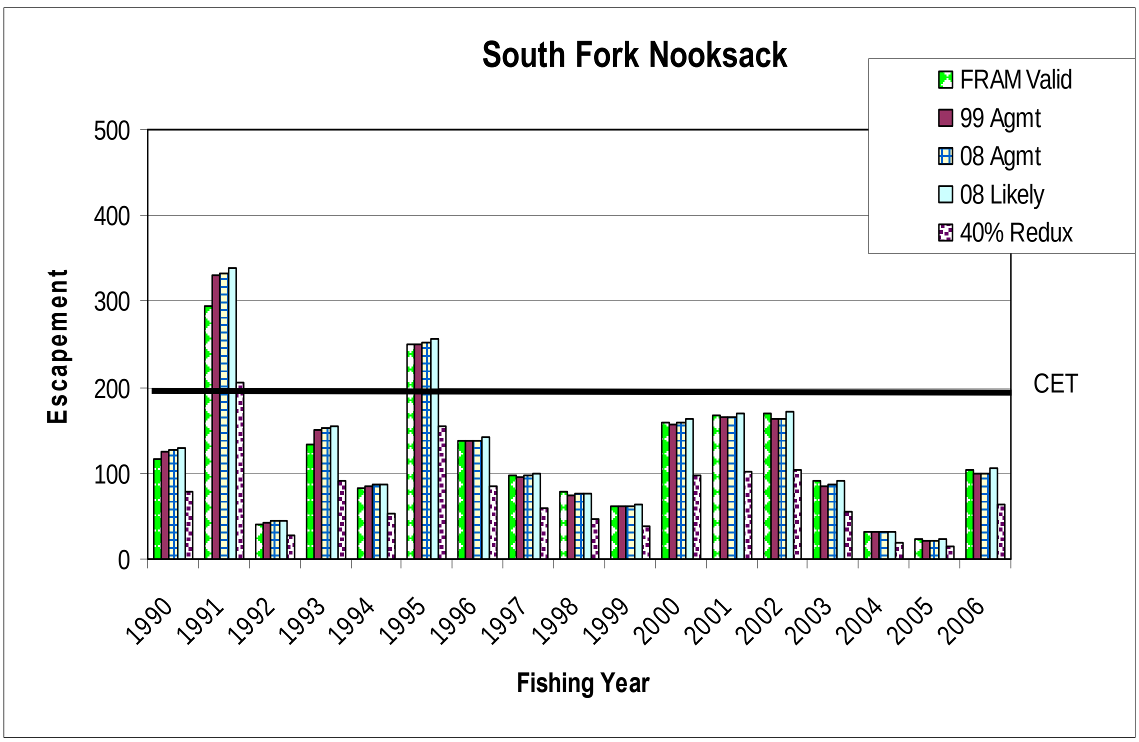
Trends in Escapement

Both Nooksack River populations have exhibited increasing escapement trends in overall abundance, although the trend in underlying growth has been negative (Table 5.1.4.1-3). The 1999 to 2007 average escapement of 216 natural-origin spawners for the North Fork Nooksack River population is just above the NOAA Fisheries-derived critical threshold of 200 fish. The critical threshold for the Nooksack Management Unit is based on natural-origin fish. However, when including Kendall Creek hatchery-origin fish, an average aggregate escapement of 1,699 natural spawners for the North Fork Nooksack River has been observed since listing. The 1999 to 2007 average escapement of 56 natural-origin spawners for the South Fork Nooksack River population is significantly below the NOAA Fisheries-derived critical threshold of 200 fish. Fish from the Kendall Hatchery and North Fork Nooksack River have contributed in significant numbers to the South Fork Nooksack escapement (Chapman 2008) resulting in a 1999-2007 average total escapement of 371 adults.

The retrospective analysis indicates that natural-origin escapement for both populations is expected to remain at critically depressed levels (Results from the retrospective analysis are also shown in tabular form in Appendix 3). The South Fork is expected to remain at critically depressed levels, well below its critical threshold. The North Fork population also shows critically depressed levels, particularly in years prior to listing, but escapements are above the critical threshold under all scenarios except the 40% Reduction scenario in the most recent years (2000-2006). Although implementation of the 2008 Agreement is expected to result in small increases in escapement in some years when compared with the 1999 Agreement, there is no difference in the average escapement across the 1990-2006 period for either population between the two scenarios (Figure 7.4.4.1-3). Similarly, despite the sizeable reductions in exploitation rates (from 26% to 19%), the 2008 Likely scenario shows only a slight increase in escapement (11 fish for both populations combined) compared with full implementation of the 1999 or 2008 Agreements. As expected given the current low natural-origin abundance and negative growth rates, the 40% Reduction scenario results in natural-origin escapements below critical thresholds for all but a few years for either population. Based on the lack of response in natural-origin escapement from the substantial reductions in exploitation rates for the 2008 Likely scenario due to the very low natural productivity of the habitat, and considering the already low exploitation rates in the northern (14%) and southern fisheries (5%), further fishery constraints would not substantively reduce the risk to the populations. For both populations, and the North Fork in particular, the low escapement of natural-origin fish should continue to be mitigated to some degree by the additional returns of hatchery origin fish.

Figure 7.4.4.1-3. Estimates of natural origin escapement for the North Fork and South Fork Nooksack spring Chinook populations from the retrospective analysis.





7.4.4.2 Whidbey/Main Basin Region

The largest river systems in Puget Sound are found within the Whidbey/Main Basin Region. There are ten populations within the Whidbey/Main Basin Region: the Upper Sauk, Suiattle, Upper Cascade, Upper Skagit, Lower Sauk, and Lower Skagit populations in the Skagit River basin; the Skykomish and Snoqualmie River populations in the Snohomish River Basin and the North Fork Stillaguamish and South Fork Stillaguamish populations in the Stillaguamish River basin. All populations are currently classified as Category 1 populations. The populations vary in run timing and life history type. The Upper Sauk, Suiattle, Cascade and Skykomish populations exhibit a substantial level of yearling (i.e., juvenile overwinter in freshwater before emigration) production unlike the remaining populations in the region and Puget Sound which exhibit overwhelmingly fingerling (i.e., move within weeks to marine waters) production.

Eleven Chinook hatchery programs operate in this region: three stock recovery programs, three combination research/harvest augmentation programs, one temporarily suspended Tulalip tribal program producing spring Chinook for tribal ceremonial and subsistence (C&S) use, and four harvest augmentation programs. The three stock recovery programs are specifically designed to reduce the risk of extinction for the North Fork Stillaguamish and South Fork Stillaguamish River Chinook which are currently considered at moderate or high risk of extinction. Except for the C&S fishery program, all of the hatchery populations propagated in the region are designated as part of the Puget Sound Chinook ESU and listed with the natural populations (NMFS 2004b).

NOAA Fisheries has determined that the Suiattle (very early run timing) and one each of the early (Upper Sauk, North Fork Stillaguamish), moderately early (Upper Skagit, Lower Sauk, Upper Cascade, South Fork Stillaguamish), and late (Lower Skagit, Skykomish, Snoqualmie) run time forms will need to be viable for the Puget Sound Chinook ESU to recover.

Trends in Harvest Mortality

Exploitation rates on all populations in the region have declined steadily since the late1980s (Figure 7.4.4.2-1). Table 7.4.4.2-1 summarizes the changes in exploitation rate over time for the various population groups from the FRAM Validation scenario. From 1987 to 1997, average total exploitation rates ranged from 46% for Stillaguamish Chinook to 57% for Skagit summer/fall stocks. Since 1998, total exploitation rates have averaged 23% for Stillaguamish Chinook to 40% for Skagit summer/fall stocks, representing decreases of 30 to 52% in exploitation rates (Table 7.4.4.2-1.) Most of the reduction in exploitation rates over time has come from reductions in southern fisheries in response to domestic conservation concerns (Figure 7.4.4.2-1). Since 2000, exploitation rates in southern U.S. fisheries have averaged 9 to 16% (Table 7.4.4.2-1). Fifty percent or more of all harvest since 1999 has occurred in Alaskan and Canadian fisheries, primarily in the WCVI sport and troll and Georgia Strait sport fisheries (PSC 2008). As with the Nooksack population, the limits of the FRAM to fully assess the impacts associated with the shift in WCVI fishing pattern may underestimate the exploitation rate in recent years for the Skagit spring populations (PSC 2006). However, the amount of the underestimate would be less because less of the catch occurs in the WCVI troll fishery as compared with the Nooksack populations (PSC 2008).

Figure 7.4.4.2-1. Trends in exploitation rates for Chinook populations in the Whidbey/Main Basin Region (LaVoy 2008).

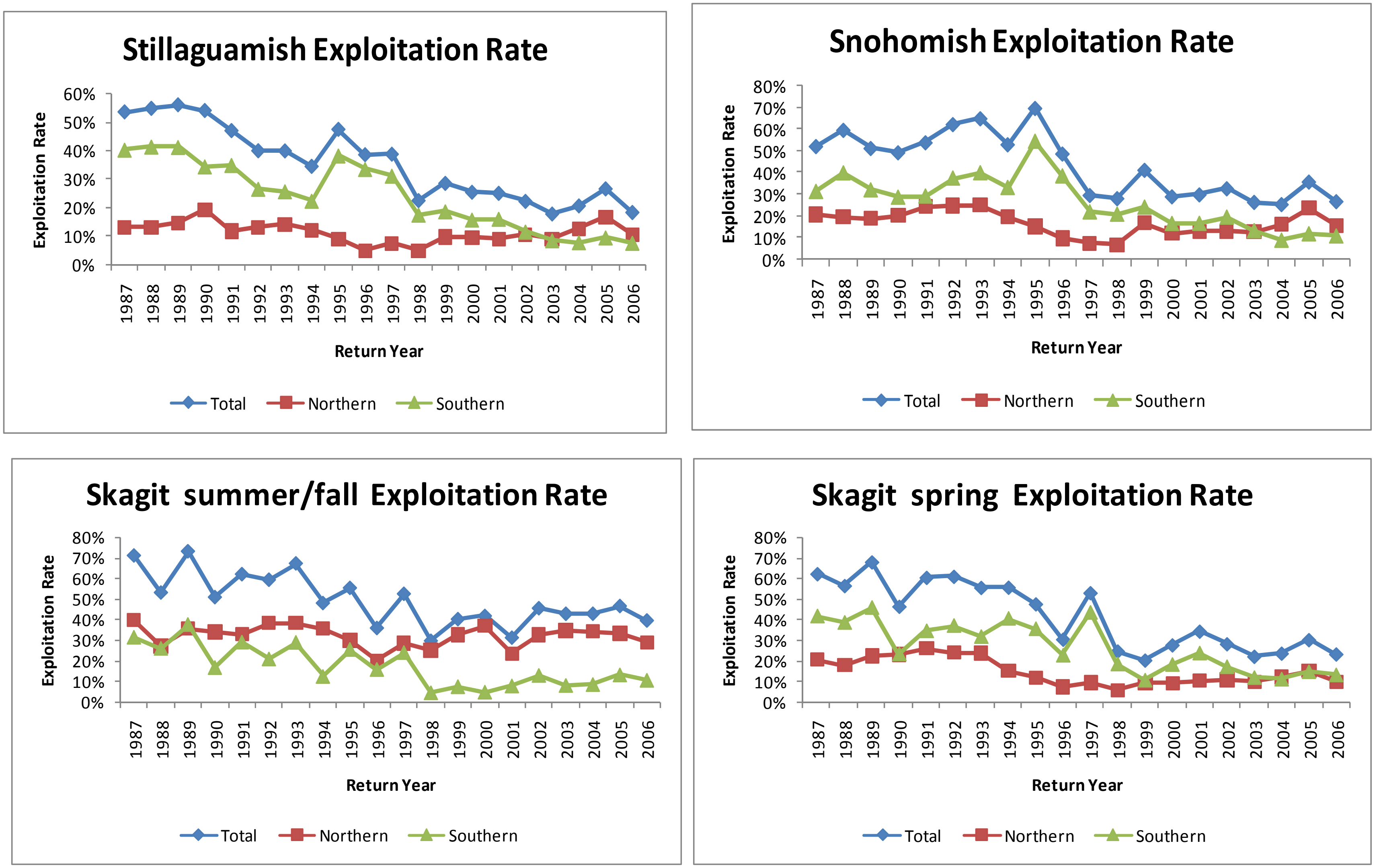


Table 7.4.4.2-1. Summary of changes in exploitation rates over time for Chinook populations in the Whidbey/Main Basin Region.

Management Unit	Average Total Exploitation Rate		% Change	Southern U.S. 2000-2006 avg. exploitation rate
	1987-1997	1998-2006		
Skagit summer/fall	57%	40%	-30%	9%
Skagit spring	54%	26%	-52%	16%
Stillaguamish	46%	23%	-50%	11%
Snohomish	54%	30%	-44%	14%

Results from the Retrospective Analysis

Table 7.4.4.2-2, and Figures 7.4.4.2-2 and 7.4.4.2-3 compare the results of the retrospective analysis by population group (Results from the retrospective analysis are also shown in tabular form in Appendix 3.). The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. and Canadian ISBM fisheries are managed subject only to the limits for ISBM fisheries Although the total exploitation rates vary by management unit ranging from 35 to 58%, comparison of the scenarios indicates that exploitation rates would be reduced by about one percentage point (ranging from 34 to 57%) comparing the 1999 with the 2008 Agreement scenario (Table 7.4.4.2-2). Average exploitation rates in northern fisheries range from 10 to 37%, with a reduction of 1-2 percentage points comparing the 1999 with the 2008 Agreement scenario (Table 7.4.4.2-2 and Figure 7.4.4.2-3). Exploitation rates in southern fisheries range from 18 to 37% (Table 7.4.4.2-2) and remain essentially unchanged between the two scenarios. Average total exploitation rates are below the RER for the Upper Skagit, and above the RERs or RER surrogates for the other nine populations in the region (Table 7.4.4.2-3 and Figure 7.4.4.2-2). The total exploitation rate exceeds the FRAM-based RERs or RER surrogates for these nine populations in 10 or more of the 17 years in the analysis period (Table 7.4.4.2-3 and Figure 7.4.4.2). The average exploitation rate in northern fisheries alone exceeds the RER for the Skykomish and Snoqualmie populations of 18% (Table 7.4.4.2-2 and Figure 7.4.4.2-3). The 2008 Agreement would represent a 7-37 percent increase in average total exploitation rates compared with those observed over the analysis period (Appendix 3).

The 2008 Likely Scenario estimates the exploitation rates under the range of fishing levels that are expected over the next ten years based on the current constraints on ISBM fisheries. The exploitation rates will be reduced substantially under the 2008 Likely scenario compared with the 2008 Agreement scenario, with the magnitude of the reduction depending on the population (Table 7.4.4.2-2 and Figure 7.4.4.2-3). The difference between the 2008 Agreement and 2008 Likely scenario are due to additional constraints in U.S. and Canadian ISBM fisheries taken by both countries since the late 1990s or early 2000s to address domestic conservation and allocation concerns, and the shift in the WCVI fishing pattern. The 2008 Likely scenario represents a 15-32% reduction in average total exploitation rates from those observed over the analysis period (Appendix 3).

The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. There is little change in the average exploitation rates for the various populations under the 2008 Likely and 40% Reduction scenarios (Table 7.4.4.2-2). The 40% Reduction scenario represents a 15-29% reduction in average total exploitation rates from those observed over the analysis period (Appendix 3). The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Under the 2008 Likely and 40% Reduction scenarios, total exploitation rates are below their RERs or RER surrogates in all years or almost all years for 7 of the 10 populations in the region. The exceptions are the Skykomish, Snoqualmie and South Fork Stillaguamish populations(Table 7.4.4.2-3 and Figure 7.4.4.2-2). Under these scenarios, exploitation rates are lower overall since 1997, consistent with the pattern described under Trends in Mortality. In the case of the Skykomish and Snoqualmie populations, average exploitation rates in northern fisheries alone under both scenarios approach the RER of 18% (Table 7.4.4.2-2 and Figure 7.4.4.2-3) and exceed it in some years.

Table 7.4.4.2-2. Average exploitation rates (1990-2006) from the retrospective analysis for the population groups within the Whidbey/Main Basin Region. Shaded values indicate averages exceeding RERs.

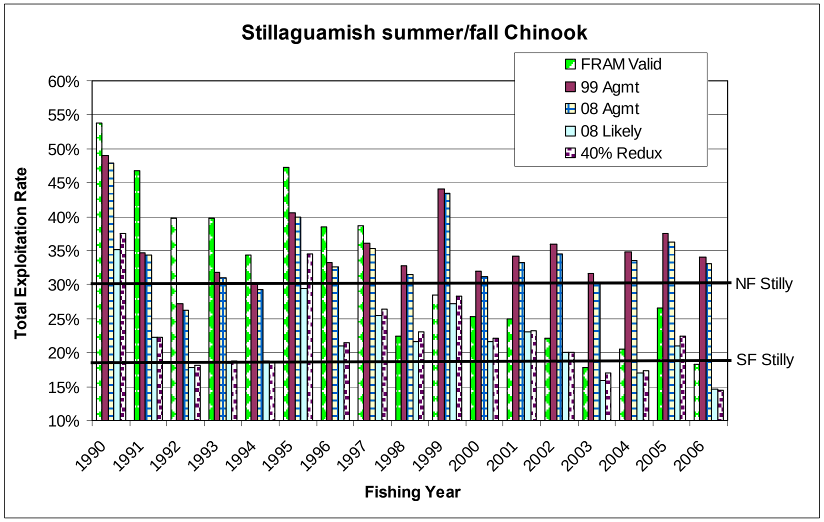
Management Unit	Fishery	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
Skagit summer/fall (Upper Skagit, Lower Skagit, Lower Sauk)	Total	54% [a]	53% [a]	40%	40%
	North	37%	35%	27%	27%
	South	17%	18%	12%	13%
Skagit spring (Suiattle, Upper Sauk, Upper Cascade)	Total	46%	45%	28%	28%
	North	20%	19%	11%	11%
	South	26%	26%	17%	17%
Stillaguamish (North Fork Stillaguamish, South Fork Stillagamish)	Total	35%	34%	22% [b]	23% [b]
	North	11%	10%	8%	8%
	South	24%	24%	14%	15%
Snohomish (Skykomish, Snoqualmie)	Total	58%	57%	32%	32%
	North	21%	19%	15%	14%
	South	37%	37%	17%	18%

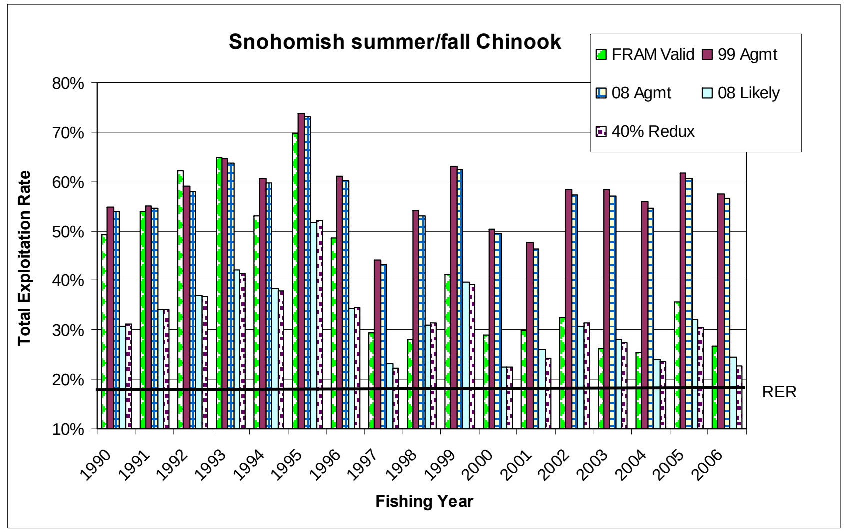
[a] Exceeds the Lower Skagit (51%) and Lower Sauk (49%) RERs, but not the Upper Skagit RER (60%)
[b] Exceeds the South Fork Stillaguamish RER (18%), but not the North Fork Stillaguamish RER (30%)

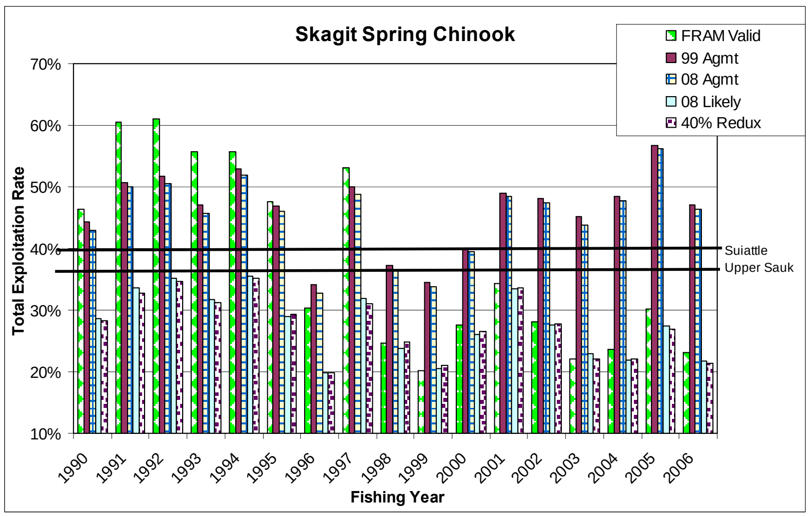
Table 7.4.4.2-3. Average exploitation rates (1990-2006) from the retrospective analysis and the number of years during the period that exploitation rates exceed FRAM-based RERs for the population groups within the Whidbey/Main Basin Region.

Management Unit	Population	FRAM-Based RER	2008 Agreement		2008 Likely		40% Reduction	
			Avg. Rate	# years above	Avg. Rate	# years above	Avg. Rate	# years above
Skagit summer/fall	Upper Skagit Lower Skagit Lower Sauk	60% 51% 49%	53%	1/17 10/17 14/17	40%	0/17 1/17 1/17	40%	0/17 1/17 2/17
Skagit spring	Suiattle Upper Sauk Upper Cascade	41% 38% 38-41%	48%	13/17 14/17	28%	0/17 0/17	28%	0/17 0/17
Stillaguamish	N.F. Stillaguamish S.F. Stillaguamish	30% 18%	34%	15/17 17/17	22%	1/17 13/17	23%	2/17 14/17
Snohomish	Skykomish Snoqualmie	18%	 57%	17/17	32%	17/17	32%	17/17

Figure 7.4.4.2-2. Estimates of total exploitation rates for the Chinook population groups within the Whidbey/Main Basin Region from the retrospective analysis.







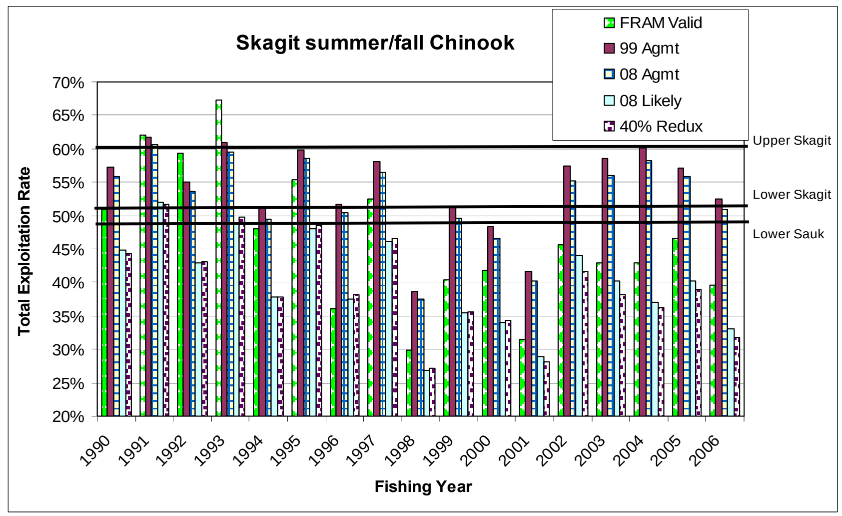
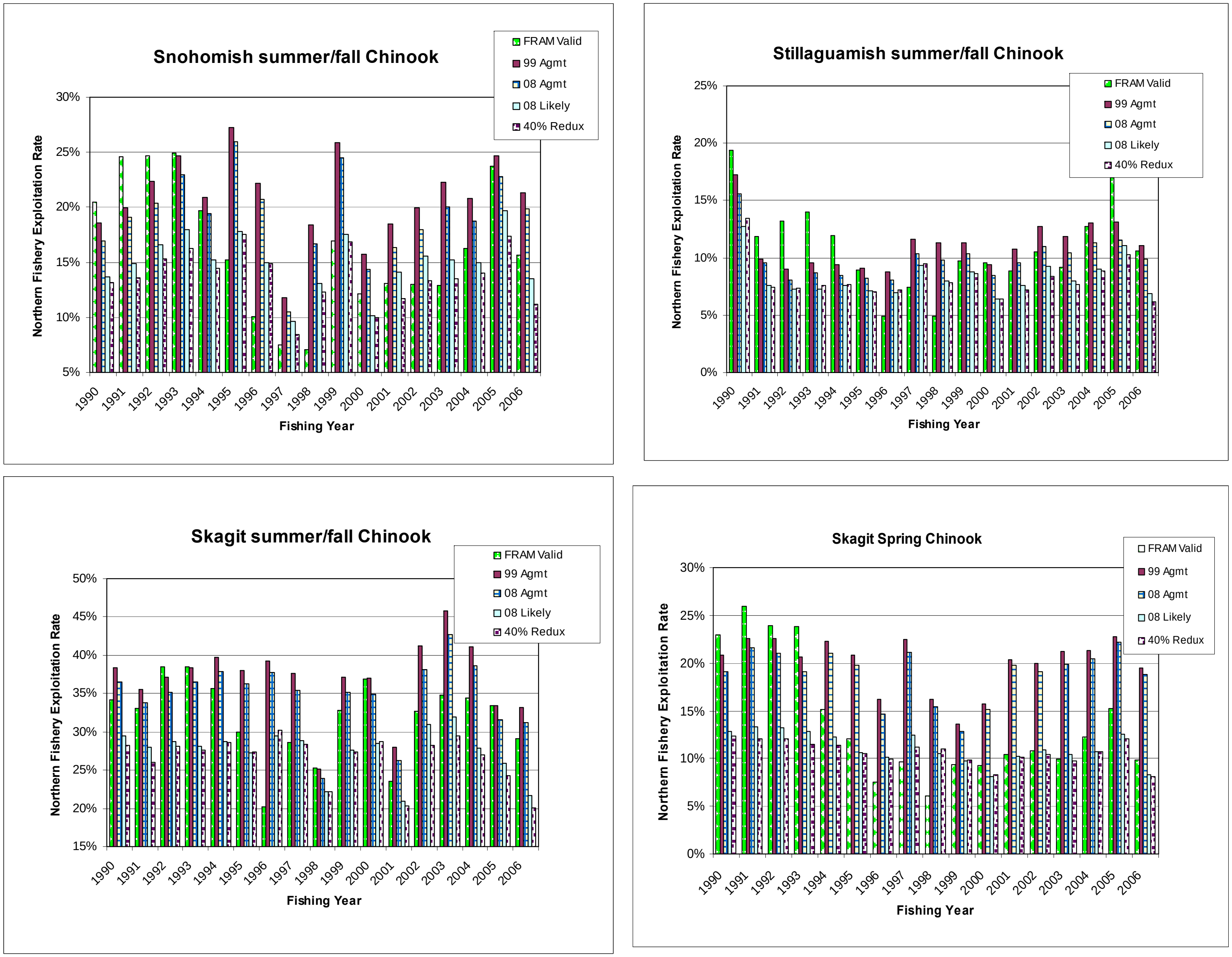


Figure 7.4.4.2-3. Estimates of exploitation rates in northern fisheries for the Chinook population groups within the Whidbey/Main Basin Region from the retrospective analysis.



Trends in Escapement

Overall escapement trends are positive for all populations within the region except for the Suiattle and South Fork Stillaguamish, although the trend in underlying growth for five of the ten populations has been negative (Table 5.1.4.1-3). The 1999 to 2007 average natural escapements for seven of the populations exceed their rebuilding escapement thresholds, and all exceed their critical thresholds by 81 to 1,100% except for the South Fork Stillaguamish population (Table 7.4.4-2). Moderate amounts of hatchery fish contribute to natural escapement for the North Fork Stillaguamish, Skykomish and Snoqualmie populations, but contribution information is not available in recent years for the latter two populations to calculate natural origin escapement.

Table 7.4.4.2-4 summarizes the results of the analyses across the scenarios and compares them with the appropriate critical and rebuilding escapement thresholds. Estimated escapements are expected to increase under implementation of the 2008 Agreement when compared with the 1999 Agreement, but the increases are relatively small. Under the 2008 Agreement scenario, the retrospective analysis indicates that escapements for all of the populations within the region are expected to exceed their critical escapement thresholds in 12 or more of the 17 years in the analysis period (≥70%). However, the South Fork Stillaguamish remains fairly close to its critical threshold (Table 7.4.4.2-4). Under the 2008 Agreement scenario, 5 of the 10 populations in the region (Upper Skagit, Lower Sauk, Suiattle, Upper Sauk and North Fork Stillaguamish) are expected to exceed their rebuilding thresholds. Average escapement for the Lower Skagit population is very close to its rebuilding threshold.

The substantial reductions in exploitation rates under the 2008 Likely scenario result in low to moderate increases in average escapements (range = 7% for Stillaguamish to 44% for Snohomish), eliminating the number of years below critical for the Skykomish population and increasing the number of times abundances are above their rebuilding thresholds (Table 7.4.4.2-4). The South Fork Stillaguamish remains relatively close to its critical threshold. The number of populations exceeding their rebuilding threshold increase from five to seven with the addition of the Lower Skagit and Snoqualmie populations. The effect of the 40% Reduction scenario is primarily on the ability to meet rebuilding thresholds. Only the Upper Sauk and North Fork Stillaguamish average escapements exceed their rebuilding threshold and the frequency of escapements above the rebuilding threshold drops substantially. Importantly, all populations are anticipated to remain above their critical thresholds on average under the 40% Reduction scenario except for the South Fork Stillaguamish population. The frequency of times above the critical threshold decreases for 6 of the10 populations under the 40% Reduction scenario as compared with the 2008 Agreement and 2008 Likely scenarios, but not as often as would be expected with such a significant reduction in abundance. The exception is the South Fork Stillaguamish which would only exceed its critical threshold in 2 of the 17 years in the analysis period. But also recall that the 40% reduction scenario did not try to model further reductions in southern fisheries that would likely occur in response to a 40% decline in total abundance.

Table 7.4.4.2-4. Average estimated escapements (1990-2006) from the retrospective analysis compared with escapement thresholds for the population groups within the Whidbey/Main Basin Region. Shaded areas exceed thresholds.

Population	Threshold	1999 Agreement		2008 Agreement		2008 Likely		40% Reduction	
		Avg. Esc.	# years above	Avg. Esc.	# years above	Avg. Esc.	# years above	Avg. Esc	# years above
Critical Threshold									
Upper Skagit Lower Skagit Lower Sauk	967 251 200	9,393 2,104 687	17/17 17/17 17/17	9,591 2,149 702	17/17 17/17 17/17	11,147 2,489 812	17/17 17/17 17/17	6,705 1,498 489	17/17 17/17 14/17
Suiattle Upper Sauk Upper Cascade	130 170 170	495 517 337	16/17 16/17 15/17	502 524 342	16/17 16/17 15/16	583 611 398	16/17 16/17 15/17	350 367 239	14/17 16/17 13/17
N.F. Stillaguamish S.F. Stillaguamish	300 200	879 235	17/17 12/17	887 237	17/17 12/17	949 253	17/17 12/17	566 151	15/17 2/17
Skykomish Snoqualmie	1,650 400	2,326 1,131	15/17 16/17	2,361 1,149	15/17 16/17	3,396 1,643	17/17 16/17	2,039 987	12/17 16/17
Rebuilding Threshold									
Upper Skagit Lower Skagit Lower Sauk	7,454 2,182 681	9,393 2,104 687	11/17 7/17 8/17	9,591 2,149 702	11/17 7/17 9/17	11,147 2,489 812	13/17 9/17 9/17	6,705 1,498 489	6/17 4/17 5/17
Suiattle Upper Sauk Upper Cascade	400 330 1,250	495 517 337	9/17 9/17 0/17	502 524 342	9/17 9/17 0/17	583 611 398	13/17 13/17 0/17	350 367 239	6/17 8/17 0/17
N.F. Stillaguamish S.F. Stillaguamish	552 300	879 235	15/17 4/17	887 237	15/17 4/17	949 253	15/17 5/17	566 151	8/17 0/17
Skykomish Snoqualmie	3,500 1,250	2,326 1,131	2/17 5/17	2,361 1,149	2/17 5/17	3,396 1,643	6/17 10/17	2,039 987	1/17 4/17

7.4.4.3 Central/South Sound Region

There are six populations delineated within the Central/South Puget Sound Region: the Sammamish and Cedar River populations in the Lake Washington basin; the Green/Duwamish; the Puyallup and White River populations in the Puyallup basin, and the Nisqually River population. The White River population is the only remaining early-timed (spring) run in the region. The other five populations are late-timed (fall) runs. The White, Cedar and Green River populations are considered Category 1 populations. The Sammamish, Puyallup and Nisqually populations are Category 2 populations. Genetically, the present fall spawning aggregations in the region are similar, likely reflecting the extensive influence of transplanted stock hatchery releases, primarily from the Green River population (Ruckleshaus et al. 2006). Most Chinook salmon in the region have similar life history traits, e.g., ocean type rearing and age. Consequently, life history and genetic variations were not useful in delineating most populations within the Central/South Sound Region (Ruckelshaus et al. 2006). NOAA Fisheries has determined that the White River and Nisqually[15] populations must eventually be at low risk to recover the ESU.

The basins in this region are the most urbanized and some of the most degraded in the ESU. The lower reaches of all these system flow through lowland areas that have been developed for agricultural, residential, urban or industrial use. Much of the watersheds or migration corridors for five of the six populations in the region are within the cities of Tacoma or Seattle or their environments (Sammamish, Cedar, Duwamish/Green, Puyallup and White). Natural production is limited by stream flows, physical barriers, poor water quality and limited spawning and rearing habitat related to timber harvest and residential, industrial and commercial development.

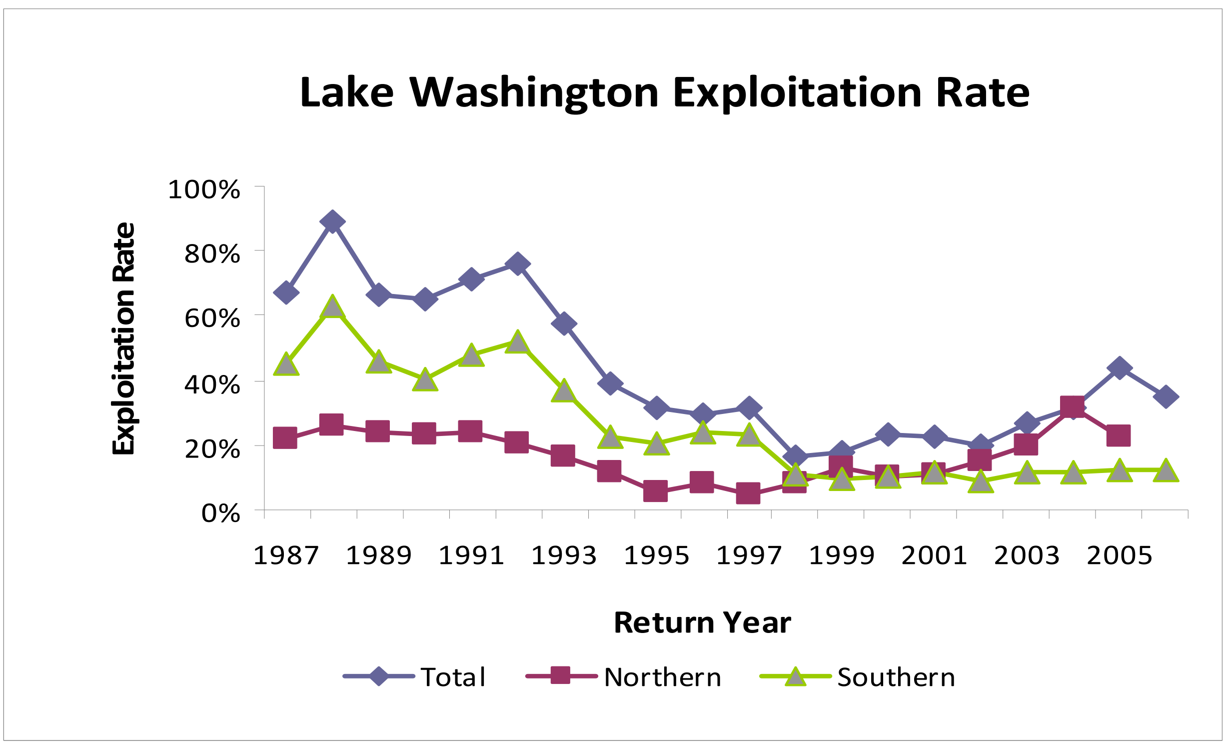
Numerous hatcheries in this area account for the majority of Chinook salmon produced in Puget Sound. With the exception of the White River program, the purpose of hatchery production in the region is primarily for fishery augmentation. Until the mid-1990s, inter-basin transfers of Chinook between hatcheries were common and extensive, with the Green River stock propagated at the WDFW Soos Creek Hatchery serving as the primary source for broodstock. Although stray rates have not been quantified for most areas, hatchery fish are believed to contribute heavily to the naturally spawning populations. Because of chronically low abundance, a conservation-based hatchery program was initiated in the mid-1970s to help rebuild White River spring Chinook salmon.

[15] The Puget Sound TRT noted that the Nisqually watershed is in comparatively good condition, and thus the certainty that the population could be recovered is among the highest in the Central/South Region. NOAA Fisheries concluded in its supplement to the Puget Sound Salmon Recovery Plan that protecting the existing habitat and working toward a viable population in the Nisqually watershed would help to buffer the entire region against further risk (NMFS 2006d).

Trends in Harvest Mortality

Exploitation rates on the Chinook populations in Lake Washington and the Duwamish/Green and White rivers have declined since the mid-1980s (Figure 7.4.4.3-1) Unlike populations in the Strait of Georgia and Whidbey/Main Basin regions, most of the harvest of the Central/South Sound populations occurs in southern U.S. fisheries (PSC 2008; LaVoy 2008). The exceptions are the populations in Lake Washington where approximately 60% of the harvest on average is taken in northern fisheries, primarily due to significant constraints in southern U.S. fisheries including closures of terminal area fisheries. Table 7.4.4.3-1 summarizes the changes in exploitation rate over time for the various populations. From 1987 to 1997, average total exploitation rates ranged from 30% to 82%. Since 1998, total exploitation rates have averaged 19% to 77% representing a decrease of 6 to 54% in exploitation rates. Total exploitation rates remain high for the Nisqually and Puyallup river populations. Most of the reduction in exploitation rates has come from reductions in southern fisheries as a response to domestic conservation concerns. Although exploitation rates in northern fisheries decreased in the first half of the period, they are now at levels similar to those in the late 1980s. Since 2000, exploitation rates in southern U.S. fisheries for the six Central/South Sound populations have averaged 11 to 61%.

Figure 7.4.4.3-1. Trends in exploitation rates for Chinook populations in the Central/South Sound Region (LaVoy 2008).



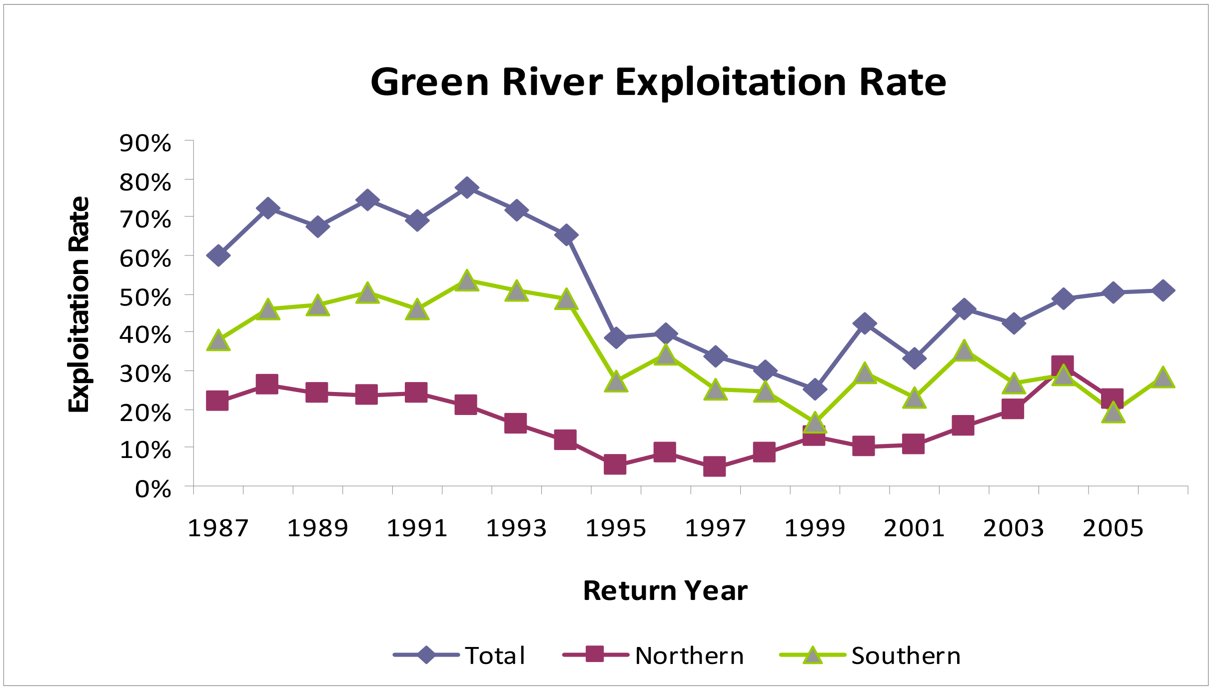
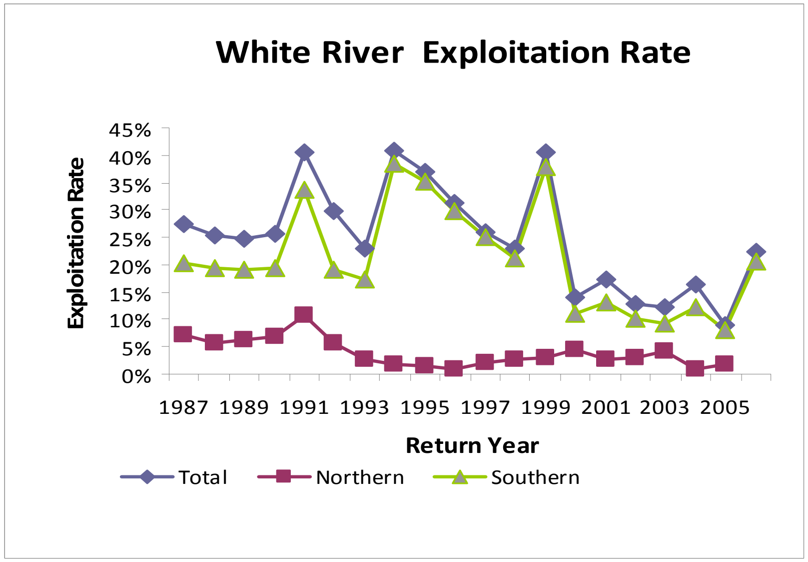
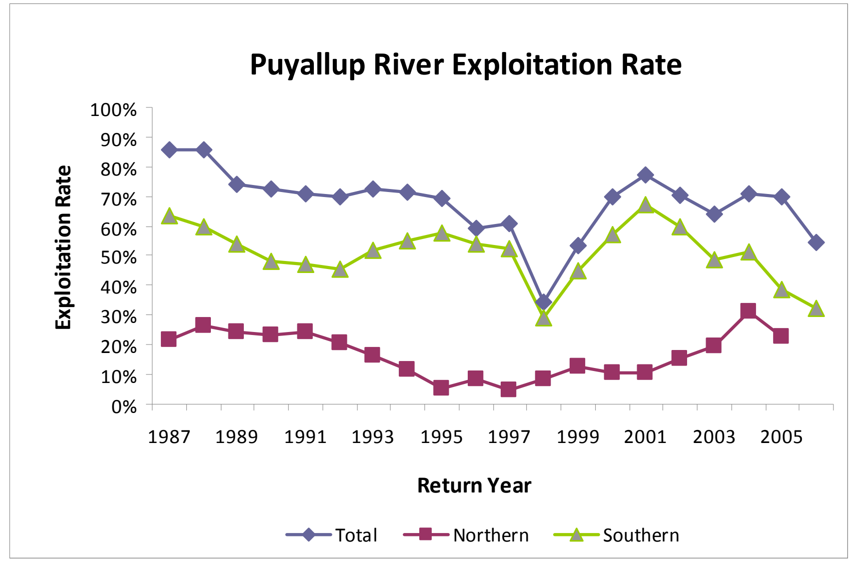

Green River Exploitation Rate
Exploitation Rate
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
Return Year
Total
Northern
Southern

Figure 7.4.4.3-1 (continued). Trends in exploitation rates for Chinook populations in the Central/South Sound Region (LaVoy 2008).





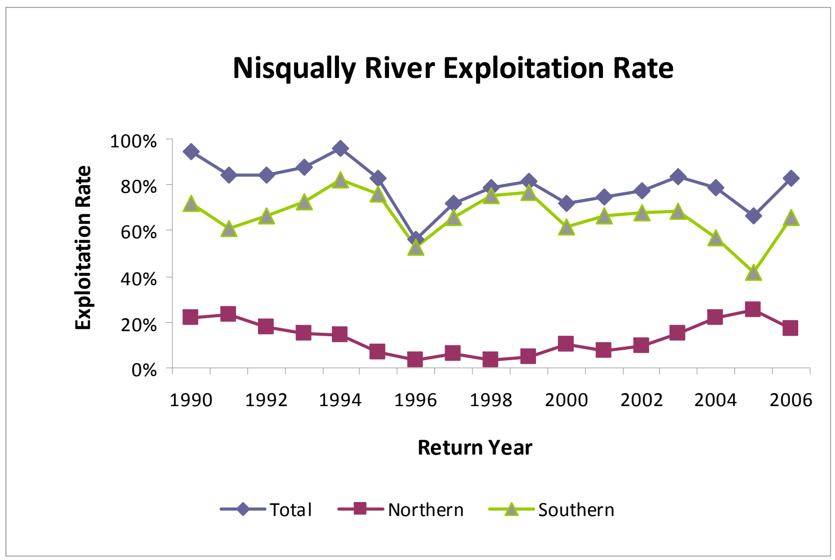


Table 7.4.4.3-1. Summary of changes in exploitation rates over time for Chinook populations in the Central/South Sound Region.

Management Unit	Average Total Exploitation Rate		% Change	Southern U.S. 2000-2006 avg.
	1987-1997	1998-2006		
Lake Washington (Cedar, Sammamish)	57%	26%	-54%	11%
Green River	61%	41%	-33%	27%
White River	30%	19%	-38%	12%
Puyallup	72%	63%	-13%	51%
Nisqually	82%	77%	-6%	61%

Results from the Retrospective Analysis

Table 7.4.4.3-2 and Figure 7.4.4.3-2 compare the results of the retrospective analysis by population (Results from the retrospective analysis are also shown in tabular form in Appendix 3.). The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year, and assuming that southern U.S. and Canadian ISBM fisheries are managed subject to the limits for ISBM fisheries. Differences in exploitation rates between the two scenarios are small. Although the total exploitation rates vary by management unit (ranging from 33 to 86%), comparison of the scenarios indicates that exploitation rates would be reduced by about one percentage point (ranging from 33 to 85%) (Table 7.4.4.3-2). Average exploitation rates in northern fisheries range from 5 to 16% with a reduction of 2-3 percentage points anticipated for most populations under the 2008 Agreement scenario compared with the 1999 Agreement scenario (Table 7.4.4.3-2 and Figure 7.4.4.3-2). Exploitation rates in southern fisheries under the two scenarios range from 27 to 17% (Table 7.4.4.3-2) and remain essentially unchanged or increase slightly under the 2008 Agreement scenario.[16] The 2008 Agreement would represent a 2-34% increase in average total exploitation rates compared with those observed over the analysis period (Appendix 3).

The Duwamish/Green is the only population in this region for which NOAA Fisheries has developed a RER (the FRAM-based RER is 46%, Table 7.4.4-1). However we can make some extrapolations from other populations in the ESU with similar status and life histories for which NOAA Fisheries has developed RERs, taking into account habitat condition and associated hatchery production. When RERs are developed for these populations, the results presented here are likely to change, but until then, this provides a reasonable approach to assess exploitation rates under the proposed actions. Under the 2008 Agreement scenario, the total average

[16] The slight increase is due to modeling the fisheries using harvest rates. More fish become available to southern fisheries due to the decreases in northern fisheries. Applying rates yields slightly higher catches in southern fisheries that produce slightly higher exploitation rates.

exploitation rate exceeds the FRAM-based RER or RER surrogates for all six populations. The RERs for these populations are exceeded in 11 or more years (Table 7.4.4.3-3 and Figure 7.4.4.3-2).

The 2008 Likely Scenario estimates the exploitation rates under the range of fishing levels that are expected over the next ten years based on the current constraints on ISBM fisheries. Total exploitation rates are reduced for all populations and substantially so for 4 of the 6 populations (Sammamish, Cedar, White, Duwamish/Green) when compared with the 2008 Agreement scenario. The reductions are primarily due to reductions in southern fishery impacts. Under the 2008 Likely scenario, the total average exploitation rate exceeds the FRAM-based RER or RER surrogates for three of the six populations (Table 7.4.4.3-3 and Figure 7.4.4.3-2). Exploitation rates are below the RER surrogate for the White River, Duwaumish-Green and Cedar River populations in most years. Average total exploitation rates are significantly above the surrogate RERs for the Sammamish, Puyallup and Nisqually populations in all or almost all years (Table 7.4.4.3-3). The 2008 Likely scenario would represent a 4-32% reduction in average total exploitation rates compared with those observed over the analysis period (Appendix 3).

The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. Average exploitation rates for the various populations under the 40% Reduction scenario are similar to those described under the 2008 Likely scenario (Table 7.4.4.3-2). The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

It is important to take into account when assessing the risks for Category 2 populations (Sammamish, Puyallup and Nisqually in the Central/South Sound Region), that unlike the Category 1 populations in the ESU, the indigenous populations in these watersheds were extirpated from a variety of causes and the current populations are not genetically distinct from other Green River lineage stocks because of a history of hatchery introgression and degradation of the productive habitat. For these populations, particularly the Nisqually population which is essential to recovery of the Puget Sound Chinook ESU, the appropriate course is to gradually transition to a Category 1 type designation over time by reducing the effects of hatchery straying and harvest, and improving habitat to the degree necessary for the population to adapt and rebuild natural production. In addition, the timing and magnitude of changes in harvest that occur in these watersheds must be coordinated with the pace of habitat recovery and with the implementation of hatchery actions, and take into account the status of the population. The total exploitation rates anticipated to result from the likely implementation of the 2008 Agreement for the Nisqually in particular are likely too high for such a transitional strategy, particularly in recent years. Most of the harvest of the Nisqually population is in southern U.S. fisheries.

Table 7.4.4.3-2. Average exploitation rates (1990-2006) from the retrospective analysis for the population groups within the Central/South Sound Region.

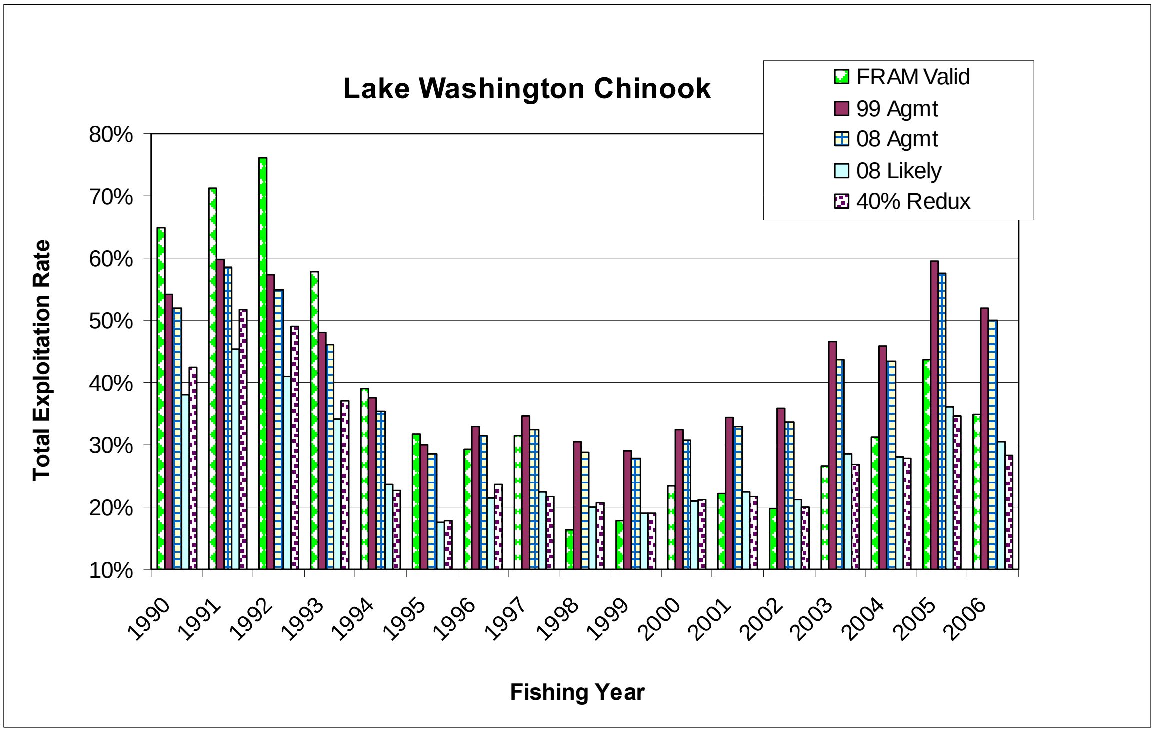
Population	Fishery	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
Lake Washington (Sammamish, Cedar River)	Total North South	42% 16% 27%	40% 13% 27%	28% 14% 14%	29% 13% 16%
Duwamish/Green River	Total North South	54% 16% 39%	53% 13% 40%	41% 14% 27%	40% 13% 28%
White River	Total North South	33% 5% 28%	33% 5% 28%	17% 3% 14%	17% 3% 14%
Puyallup River	Total North South	68% 16% 52%	67% 13% 54%	59% 14% 45%	59% 13% 46%
Nisqually	Total North South	86% 15% 71%	85% 13% 72%	77% 11% 66%	77% 10% 66%

Table 7.4.4.3-3. Average exploitation rates (1990-2006) from the retrospective analysis for the populations within the Central/South Sound Region. Shaded values indicate averages exceeding RERs.

Population/ Management Unit	FRAM-Based RER	2008 Agreement		2008 Likely		40% Reduction	
		Avg. Rate	# years above	Avg. Rate	# years above	Avg. Rate	# years above
Lake Washington (Sammamish, Cedar River)	18% 30%	40%	17/17 14/17	28%*	16/17 6/17	29%*	16/17 5/17
Duwamish/Green River	46%	53%	11/17	41%	8/17	42%	7/17
White River	23%	33%	13/17	17%	1/17	17%	2/17
Puyallup River	33% 46%	67%	17/17 16/17	59%	17/17 15/17	59%	17/17 15/17
Nisqually	33%- 46%	85%	17/17 17/17	77%	17/17 17/17	77%	17/17 17/17

*Exploitation rate exceeds the surrogate RER for the Sammamish population (18%) but not the Cedar River population (30%)

Figure 7.4.4.3-2. Estimates of total exploitation rates for the Chinook population groups within the Central/South Sound Region from the retrospective analysis.



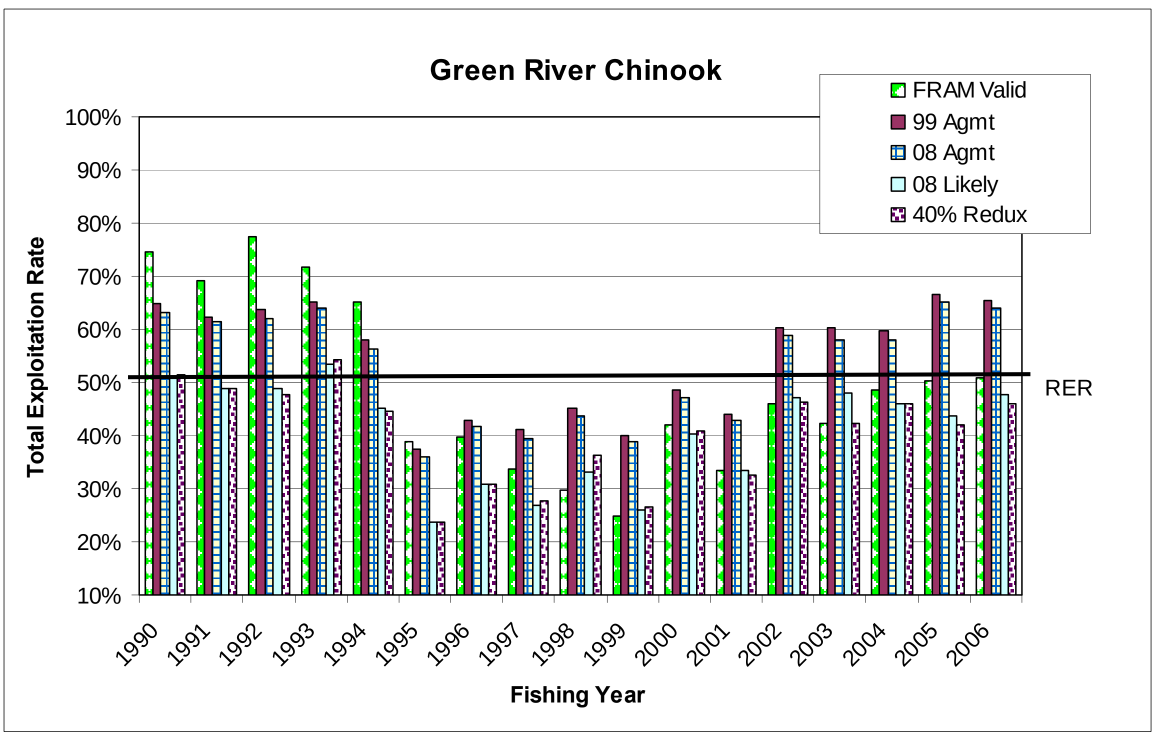
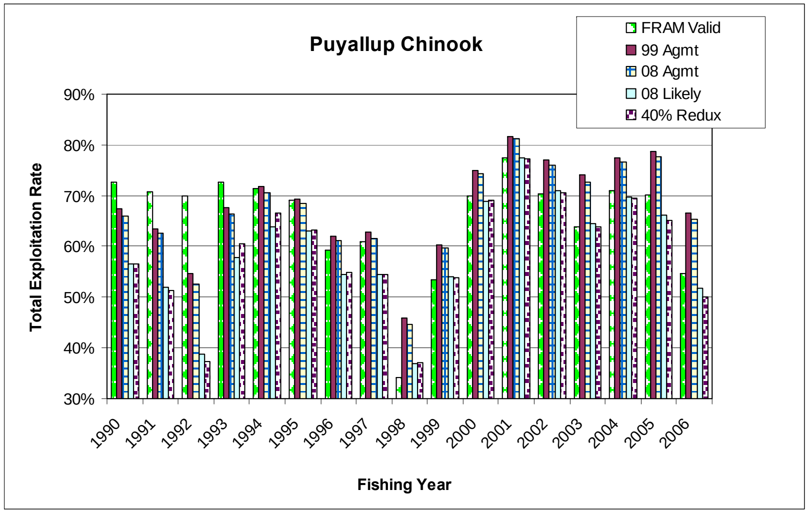
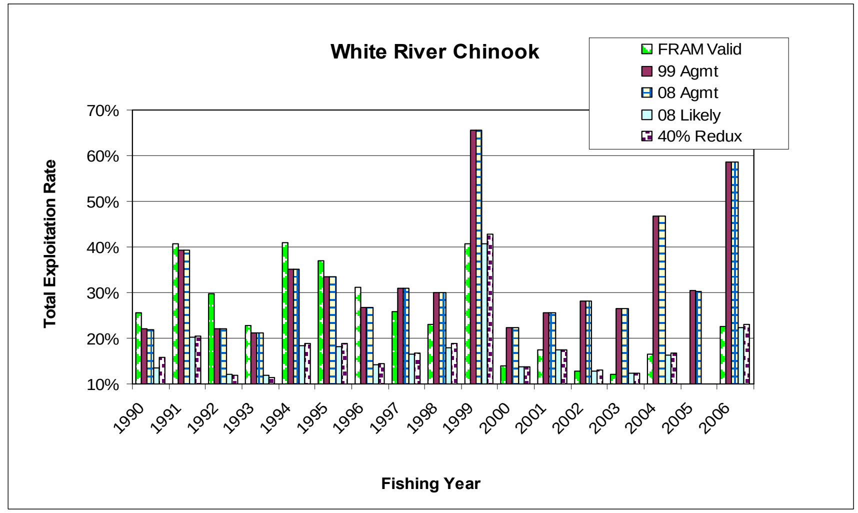
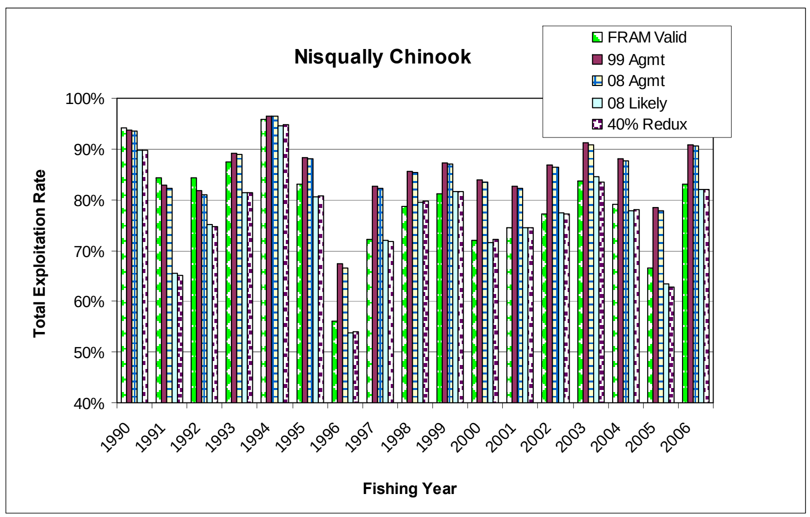


Figure 7.4.4.3-2 Continued.







Trends in Escapement

Escapement trends in overall abundance are stable or positive for all populations within the region except for the Puyallup, although the underlying growth rate has been negative for the Cedar and Green populations as well (Table 5.1.4.1.3). Except for the Cedar and Sammamish Chinook populations, the 1999 to 2007 average natural escapements of the other 4 populations have exceeded their rebuilding escapement thresholds, and all exceed their critical thresholds by 24 to 900% (Table 5.1.4.1.3 and Table 7.4.4.3-3). However, the magnitude of hatchery fish on the spawning grounds is likely masking the true level of natural production (PSIT and WDFW 2004; Good et al. 2005). Since 2000, escapements in the Cedar and Sammamish populations have come close to or have fallen below their critical escapement thresholds in one and five years, respectively, although the Cedar has shown strong increases in escapement in recent years. Escapement estimates for the Sammamish River population do not include escapement into some of the tributary areas. Therefore, a direct comparison of escapements with the VSP generic guidance of a critical threshold of 200 fish should be considered conservative, as the total escapements are likely greater. However, we note the possible risk to these populations from potential low abundance over the next several years. The Duwamish-Green River population has achieved its rebuilding threshold of 5,523 in all but two years since 1995 by significant margins (range = 3,692 to 13,950).

Table 7.4.4.3-3 summarizes the results of the analyses across the scenarios and compares them with the appropriate critical and rebuilding escapement thresholds. The retrospective analysis indicates that escapements for all of the populations within the region , except the Sammamish population are expected to exceed their critical escapement thresholds in 14 or more of the 17 years in the analysis period (>80%) under all scenarios (Table 7.4.4.3-3). Escapements are expected to increase under implementation of the 2008 Agreement when compared with the 1999 Agreement, but the increases are relatively small. Under the 2008 Agreement scenario, the Duwamish/Green, White and Puyallup populations are expected to exceed their rebuilding thresholds.

The reductions in exploitation rates under the 2008 Likely scenario result in low to moderate increases in average escapements, reducing the number of years below critical for the Lake Washington and Nisqually populations and increasing the frequency of abundances above their rebuilding thresholds (Table 7.4.4.3-3). The effect of the 40% Reduction scenario is primarily on the ability of populations to meet rebuilding thresholds. Two instead of three populations would exceed their rebuilding thresholds (Table 7.4.4.3-3). Importantly, all populations are anticipated to remain above their critical thresholds on average under the 40% Reduction scenario except for the Sammamish population. The frequency of times below the critical threshold increases for 4 of the 6 populations under the 40% Reduction scenario as compared with the 2008 Agreement and 2008 Likely scenarios, but not as often as would be expected with such a significant reduction in abundance. Escapements for all but the Sammamish population are expected to remain above their critical thresholds in 11 or more of the 17 years in the analysis period. Recall that the 40% reduction scenario did not try to model further reductions in southern fisheries that would likely occur in response to a 40% decline in total abundance.

Table 7.4.4.3-3. Average escapements (1990-2006) from the retrospective analysis compared with escapement thresholds for the population groups within the Central/South Sound Region. Shaded areas indicate escapements that exceed thresholds.

Population	Threshold	1999 Agreement		2008 Agreement		2008 Likely		40% Reduction	
		Avg. Esc.	# years above	Avg. Esc.	# years above	Avg. Esc.	# years above	Avg. Esc	# years above
Critical Threshold									
Sammamish Cedar	200 200	189 370	9/17 13/17	194 380	9/17 13/17	223 442	11/17 15/17	131 258	5/17 11/17
Duwamish/ Green	835	8,254	17/17	8,452	17/17	10,104	17/17	6,705	17/17
White	200	1,446	17/17	1,446	17/17	1,608	17/17	964	16/17
Puyallup	200	1,754	17/17	1,801	17/17	2,107	17/17	1,258	17/17
Nisqually	200	695	15/17	709	15/17	993	16/17	598	14/17
Rebuilding Threshold									
Sammamish Cedar	1,250 1,250	189 370	0/17 0/17	194 380	0/17 0/17	223 442	0/17 0/17	131 258	0/17 0/17
Duwamish/ Green	5,523	8,254	14/17	8,452	14/17	10,104	14/17	6,705	10/17
White	1,000	1,446	9/17	1,446	9/17	1,608	9/17	964	6/17
Puyallup	1,200	1,754	11/17	1,801	11/17	2,107	14/17	1,258	5/17
Nisqually	1,100	695	3/17	709	3/17	993	7/17	598	2/17

7.4.4.4 Hood Canal Region

The Hood Canal Region has two fall Chinook salmon populations, one in the Skokomish River, and a second in the mid-Hood Canal that encompasses three Hood Canal rivers (Dosewallips, Duckabush and Hamma Hamma rivers)(Ruckelshaus et al. 2006). Both the Skokomish and Mid-Hood Canal Rivers populations are considered watershed Category 2 populations and thus are a composite of natural- and hatchery-origin fish that are genetically indistinguishable from each other and where the indigenous stock has been extirpated.. NOAA Fisheries determined that both populations will eventually need to be at low risk to recover the ESU. Historically, the Skokomish River supported the largest natural Chinook run in Hood Canal. Natural production in the North Fork Skokomish has been limited as a result of impacts associated with dams that block anadromous passage at river miles 17 and 19 and greatly limited in-stream flow due to an out of basin diversion. Natural production in the South Fork is further limited by the effects of intensive logging activity (WDF et al. 1993). A great deal of uncertainty remains about the relationship among Chinook in the three rivers of the Mid-Hood Canal population. Little information is available about the populations prior to significant habitat alteration and hatchery supplementation in these rivers. The largest uncertainty within the Hood Canal populations is the degree to which Chinook salmon spawning aggregations are demographically linked in the Hamma Hamma, Duckabush, and the Dosewallips Rivers. The Puget Sound TRT identified two possible alternative scenarios to the current delineation. One that the Chinook salmon in the Hamma Hamma, Duckabush, and Dosewallips were independent populations (Ruckelshaus et al. 2006); the other that Chinook in the three rivers were subpopulations of a single, large Hood Canal Chinook salmon population with a primary spawning aggregation in the Skokomish River. The Puget Sound TRT indicated that additional monitoring of abundance and straying as well as any additional historical information may be useful in further evaluating the plausibility of each of the possible delineations.

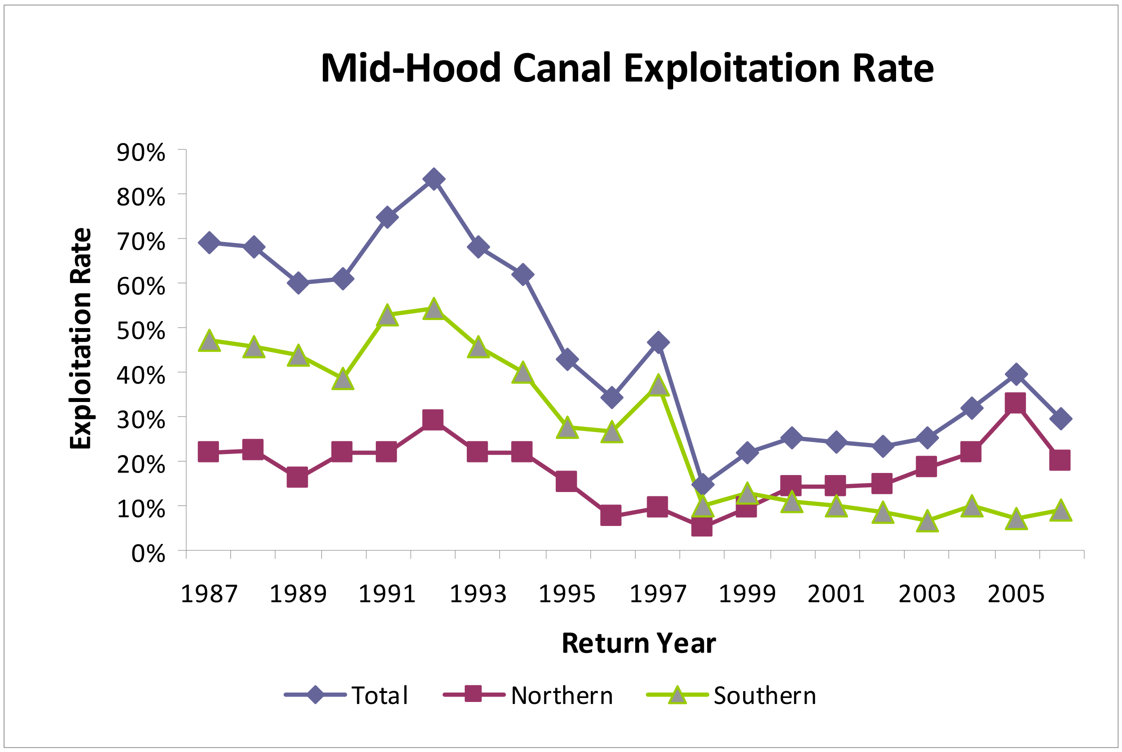
Trends in Harvest Mortality

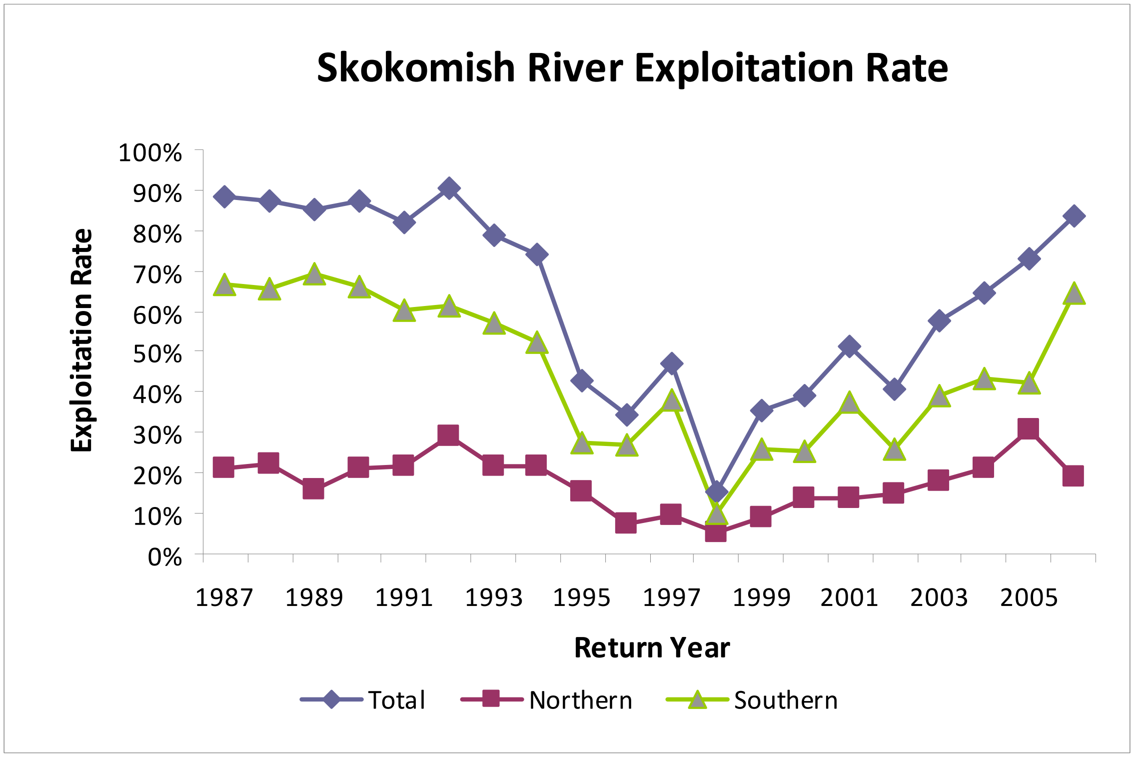
Exploitation rates on the Hood Canal populations declined since the late 1980s, but have increased in recent years (Figure 7.4.4.4-1), approaching 1980s levels, particularly for the Skokomish population. Increases in exploitation rates for Mid-Hood Canal are due to increased rates in northern fisheries. Terminal-area harvest impacts in southern U.S. fisheries have been virtually eliminated for the Mid-Hood population. Increases in Skokomish exploitation rates have occurred in both northern and southern fisheries, but the largest increases are in southern fisheries. Since 1999, 64% of the harvest of Mid-Hood Canal population (up to 80% in recent years) and 30-40% of the harvest of the Skokomish population occurs in northern fisheries on average (PSC 2008; LaVoy 2008). Compared with years prior to 1998, average total exploitation rates have been reduced by 57 and 30% for the Mid-Hood Calan and Skokomish populations, respectively. From 1987 to 1997, total exploitation rates averaged 61% and 73% for the Mid-Hood Canal and Skokomish populations, respectively (Table 7.4.4.4-1). By comparison, total exploitation rates since 1998 averaged 26% and 51% for the Mid-Hood Canal and Skokomish populations, respectively.

Table 7.4.4.4-1. Summary of changes in exploitation rates over time for Chinook populations in the Hood Canal Region.

Management Unit	Average Total Exploitation Rate		% Change	Southern U.S. 2000-2006 avg.
	1987-1997	1998-2006		
Mid-Hood Canal	61%	26%	-57%	9%
Skokomish	73%	51%	-30%	42%

Figure 7.4.4.4-1. Trends in exploitation rates for Chinook populations in the Central/South Sound Region (LaVoy 2008).





Results from the Retrospective Analysis

Table 7.4.4.4-2 and Figure 7.4.4.4-2 summarize information from the retrospective analysis for the Skokomish and Mid-Hood Canal populations (Results from the retrospective analysis are also shown in tabular form in Appendix 3). The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. and Canadian ISBM fisheries are managed subject to the limits of ISBM fisheries. The 2008 Agreement scenario would result in a small reduction in the total exploitation rate relative to the 1999 Agreement. The average total exploitation rates are 49% and 47% for the Mid-Hood Canal population, and 71% and 70% for the Skokomish population for the 1999Agreement and 2008 Agreement scenarios, respectively. The average exploitation rate in northern fisheries would be reduced from 17 to 14% for the Mid-Hood Canal, and 15 to 12% for the Skokomish populations (Figure 7.4.4.4-2). Exploitation rates in southern ISBM fisheries would increase by 1 to 2 percentage points under implementation of the 2008 Agreement compared with the 1999 Agreement (Figure 7.4.4.4-2).[17] The 2008 Agreement would represent a 12 and 19% increase in average total exploitation rates for the Mid-Hood Canal and Skokomish populations, respectively, compared with those observed over the analysis period (Appendix 3).

[17] The slight increase is due to modeling the fisheries using harvest rates. More fish become available to southern fisheries due to the decreases in northern fisheries. Applying rates yields slightly higher catches in southern fisheries that produce slightly higher exploitation rates.

NOAA Fisheries has derived a RER for the Skokomish population (the FRAM-base RER is 33%, Table 7.4.4-1), but not for the Mid-Hood Canal population. However, RERs for other populations within the ESU with similarly very low abundances can be used as reasonable surrogates, i.e., the Nooksack (23%) and South Fork Stillaguamish (18%). The total exploitation rate exceeds the Skokomish FRAM-based RER of 33% and the Mid-Hood Canal RER surrogates in all years under the 2008 Agreement scenario.

The 2008 Likely Scenario estimates the exploitation rates under the range of fishing levels that are expected over the next 10 years based on the current constraints on ISBM fisheries. Compared with the 2008 Agreement scenario, total exploitation rates under the 2008 Likely scenario would be reduced substantially from 47% to 32% for the Mid-Hood Canal population, and from 70% to 53% for the Skokomish population (Table 7.4.4.4-2). In northern fisheries exploitation rates would actually increase by 4 or 5 percentage points. Under the 2008 Likely scenario exploitation rates in southern fisheries would be reduced substantially relative to the 2008 Agreement scenario; from 33% to 15% for the Mid-Hood Canal population, and from 58% to 36% for the Skokomish population. The differences in exploitation rates under the 2008 Agreement and 2008 Likely scenarios are due to additional constraints in ISBM fisheries taken by both countries since the late 1990s or early 2000s to address domestic conservation and allocation concerns, and the shift in the WCVI fishing pattern. The 2008 Agreement would represent a 10-23% decrease in average total exploitation rates for the Mid-Hood Canal and Skokomish populations compared with those observed over the analysis period (Appendix 3).

The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. The average exploitation rates under the 2008 Likely and 40% Reduction scenarios are basically unchanged for the two populations. The total exploitation rate for the Mid-Hood Canal population increases from 32% to 33% under the 40% Reduction scenario, but decreases from 53% to 52% for the Skokomish population. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended by not increasing exploitation rates. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

The total exploitation rate exceeds the Skokomish FRAM-based RER and the Mid-Hood Canal surrogates in almost all years for the 2008 Likely and 40% Reduction scenarios (Figure 7.4.4.4-2), particularly in recent years. Northern rates alone approach or exceed the surrogate RERs for the Mid-Hood Canal population under the 2008 Likely and 40% Reduction scenarios.

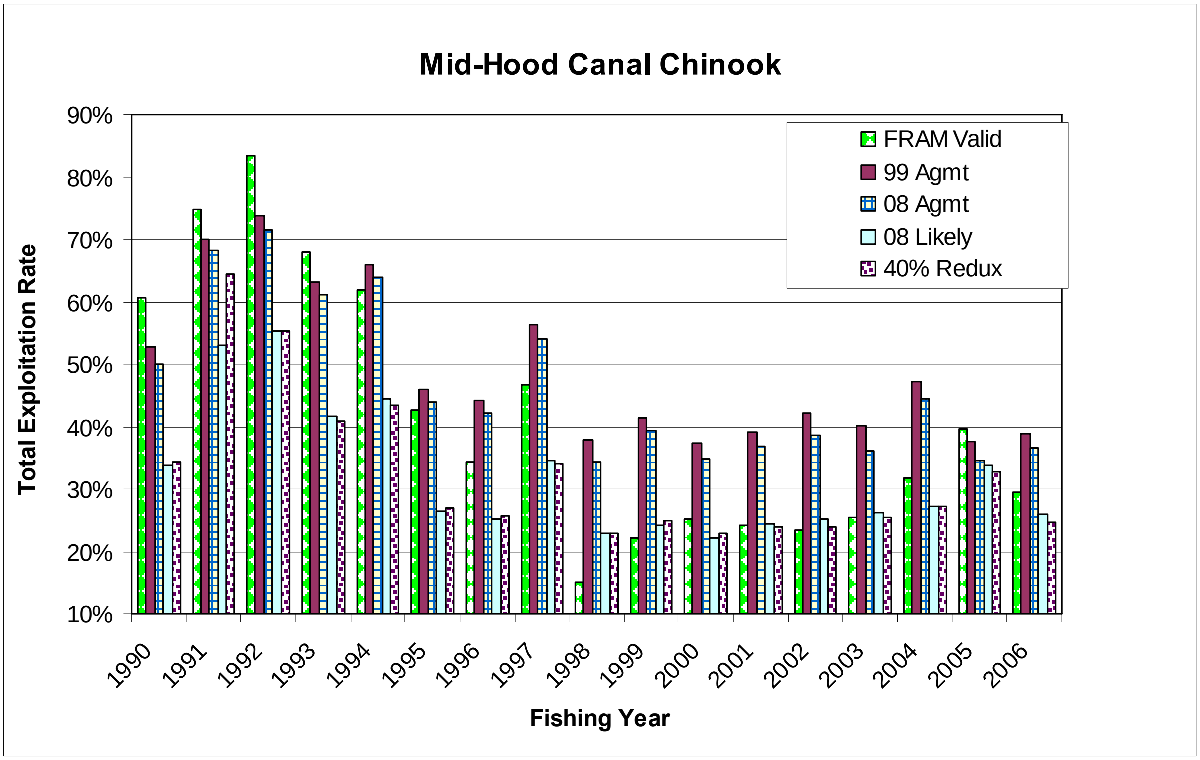
It is important to take into account when assessing the risks to the populations of exceeding the RERs, that these are Category 2 populations, and unlike the other populations in the ESU for which NOAA Fisheries has developed RERs. The indigenous populations in these watersheds were extirpated from a variety of causes and the current populations are not genetically distinct from other Green River lineage stocks. In addition, the habitat in the Skokomish watershed has been severely degraded resulting in very little natural production. Both of these populations are essential to recovery of the Puget Sound Chinook ESU, so the appropriate course is to gradually transition to a Category 1 type designation over time by reducing the effects of hatchery straying and harvest, and improving habitat to the degree necessary for the population to adapt and rebuild natural production. In addition, the timing and magnitude of changes in harvest that occur in these watersheds must be coordinated with the pace of habitat recovery and with the implementation of hatchery actions, and take into account the status of the population. The total exploitation rates anticipated to result from the likely implementation of the 2008 Agreement are likely too high for such a transitional strategy, particularly in recent years. Most of the harvest of the Skokomish population is in southern U.S. fisheries.

For the Mid-Hood Canal population, northern fisheries account for the majority of harvest and approach or exceed the surrogate RER which is a concern for a population at such low abundance. Along with its status as a Category 2 population, it is important to consider the practical benefits of further fishery reductions and the feasibility of achieving those reductions in northern fisheries. Let us conservatively assume that escapements will remain more similar to the 2002-2006 estimated average escapement in the retrospective analysis (95 fish) than the 1990-2006 average (186 fish), which includes years of substantially higher abundance. Given the ratio of recent year escapements into the individual river systems in the Mid-Hood Canal population, a total closure of northern fisheries would result in an estimated increase of at most 25 adults to the Mid-Hood Canal population including 14 to the Hamma Hamma, 9 to the Dosewallips, and 2 to the Duckabush. Fewer fish than these would return due to natural mortality and any reductions in northern fisheries would be less than full closure. Therefore, further restrictions in northern fisheries, if achievable, would result in little benefit to the Mid-Hood Canal population. Nevertheless, the increased exploitation rates in northern fisheries in recent years are a concern for a population at such low abundance which is essential to recovery of the ESU.

Table 7.4.4.4-2. Average exploitation rates (1990-2006) from the retrospective analysis for the population groups within the Hood Canal Region.

Population	Fishery	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
Mid-Hood Canal	Total North South	49% 17% 32%	47% 14% 33%	32% 18% 15%	33% 17% 16%
Skokomish	Total North South	71% 15% 56%	70% 12% 58%	53% 17% 36%	52% 16% 36%

Figure 7.4.4.4-2. Estimates of exploitation rates for Hood Canal populations from the retrospective analysis for all fisheries combined (Total), for northern and southern fisheries.



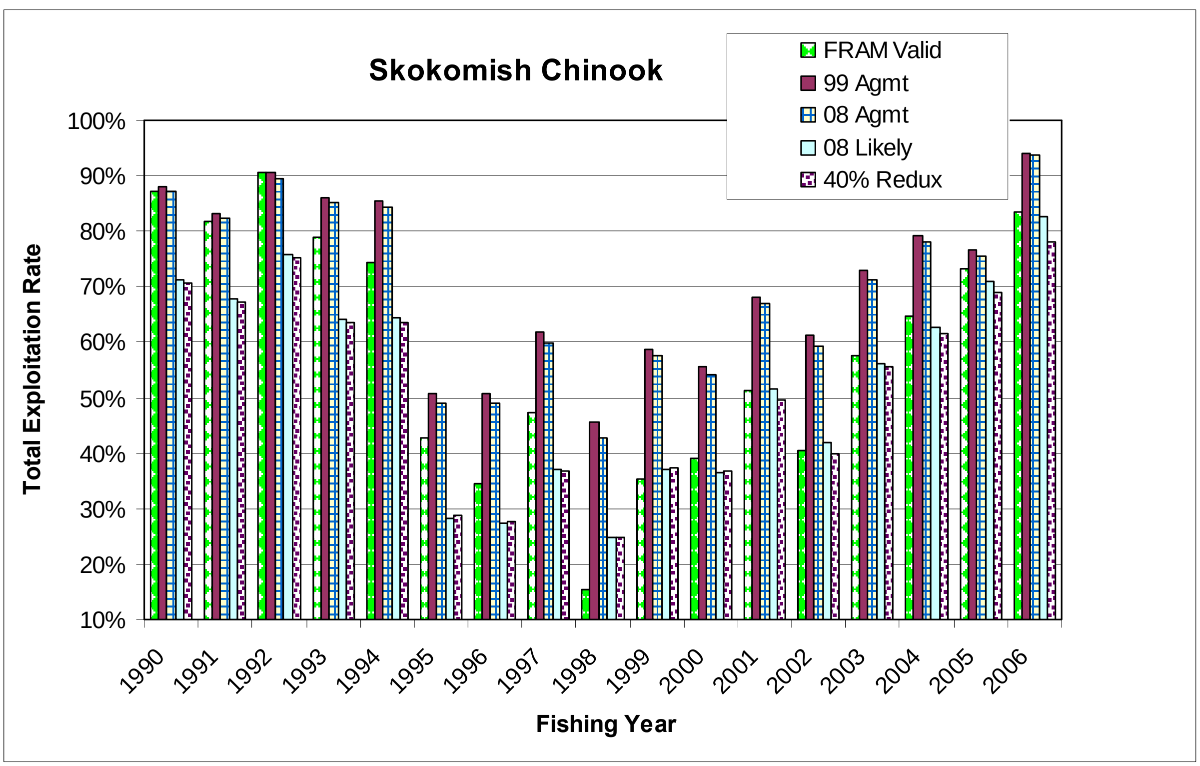
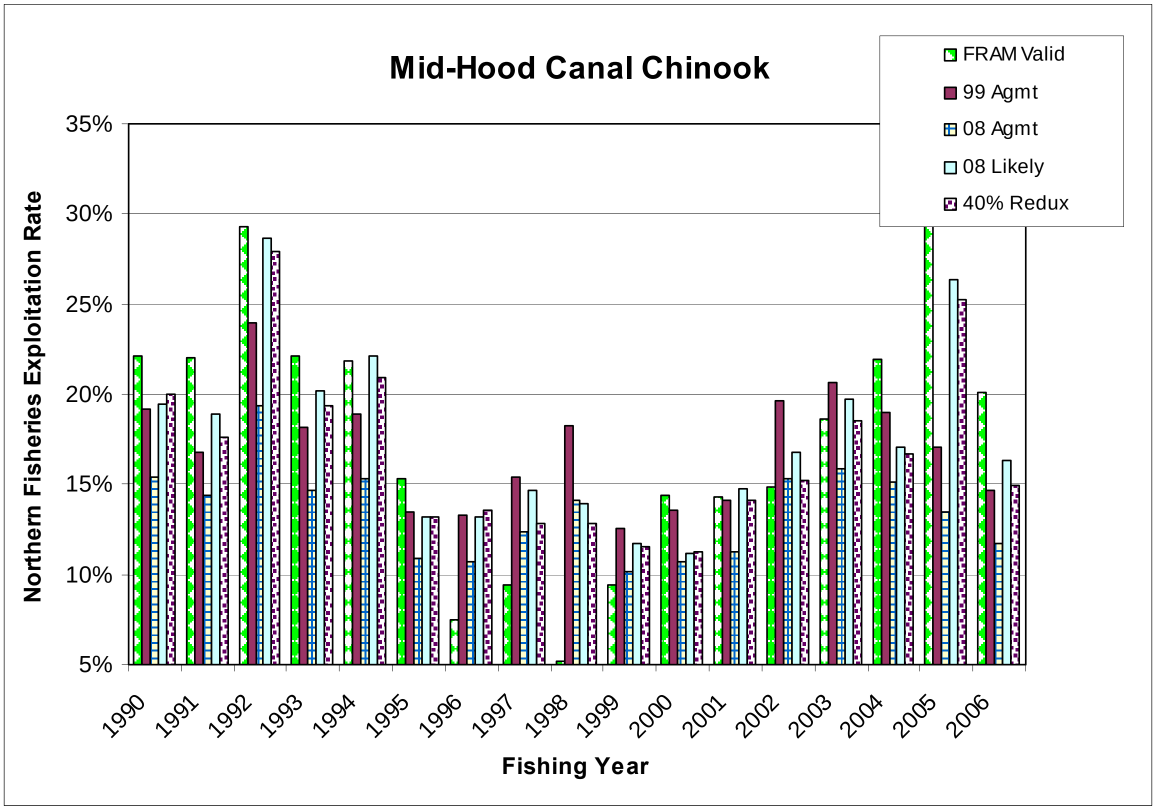


Figure 7.4.4.4-2 Continued.



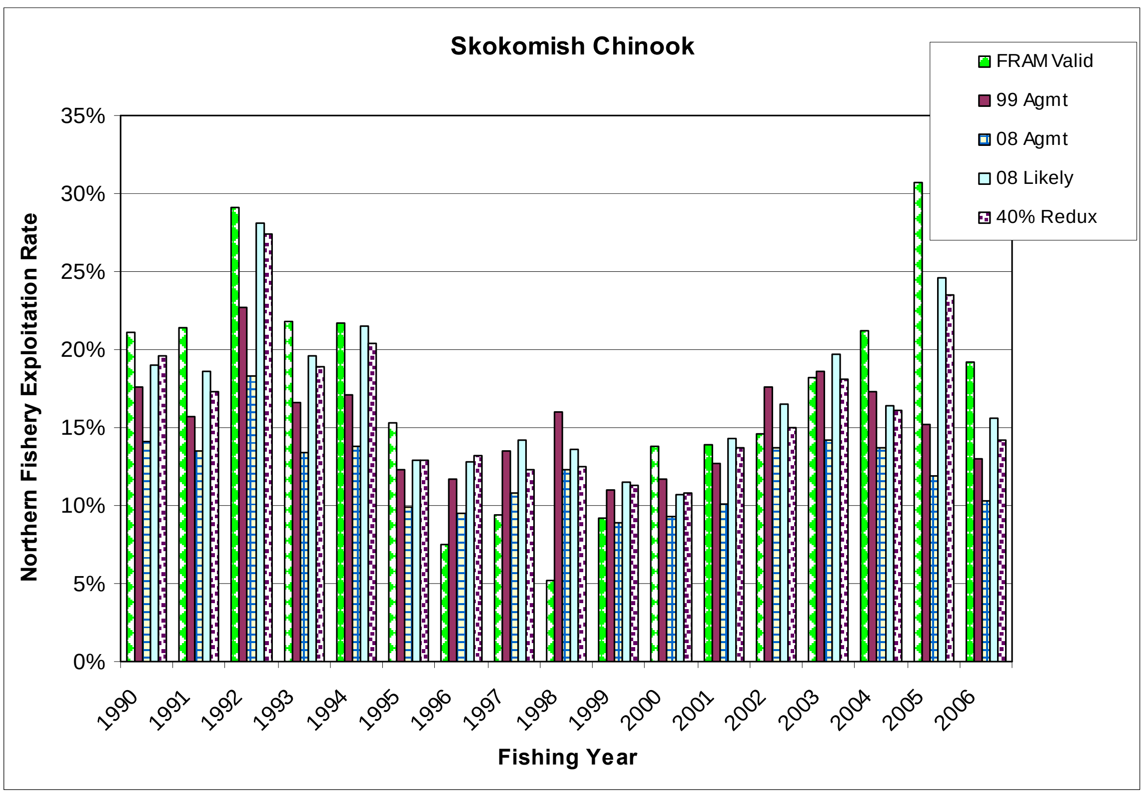
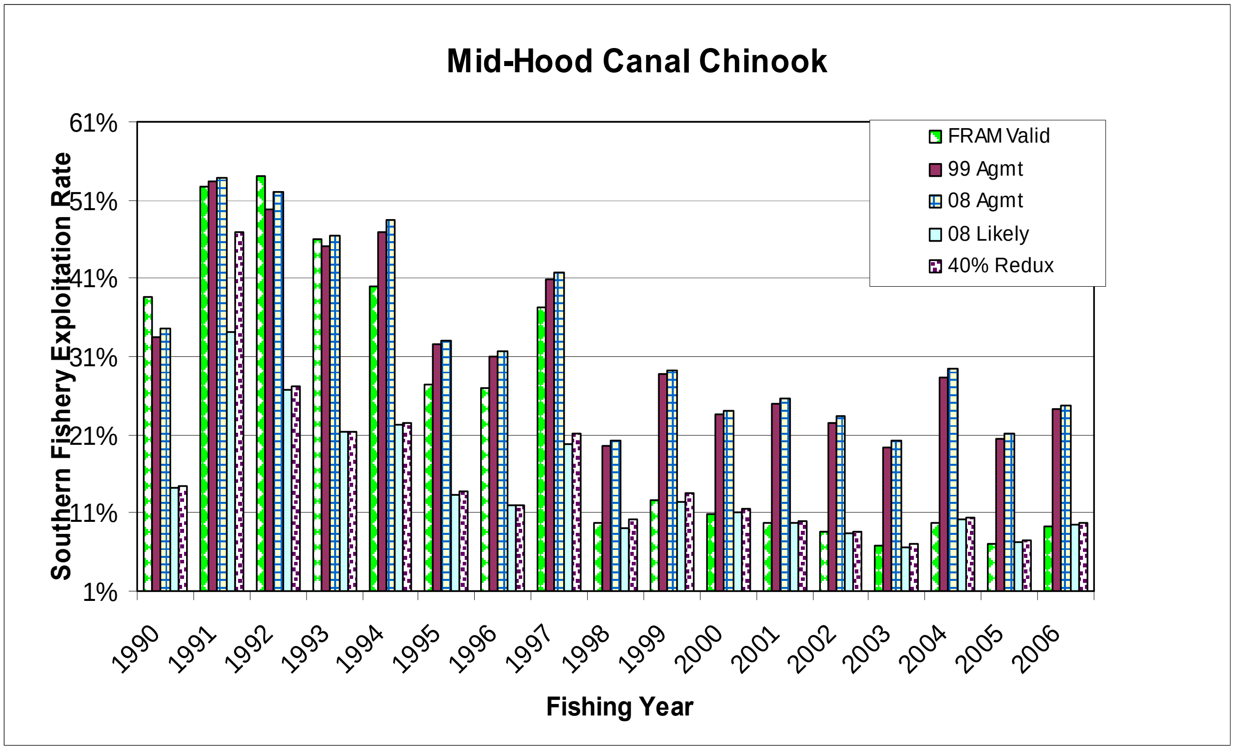
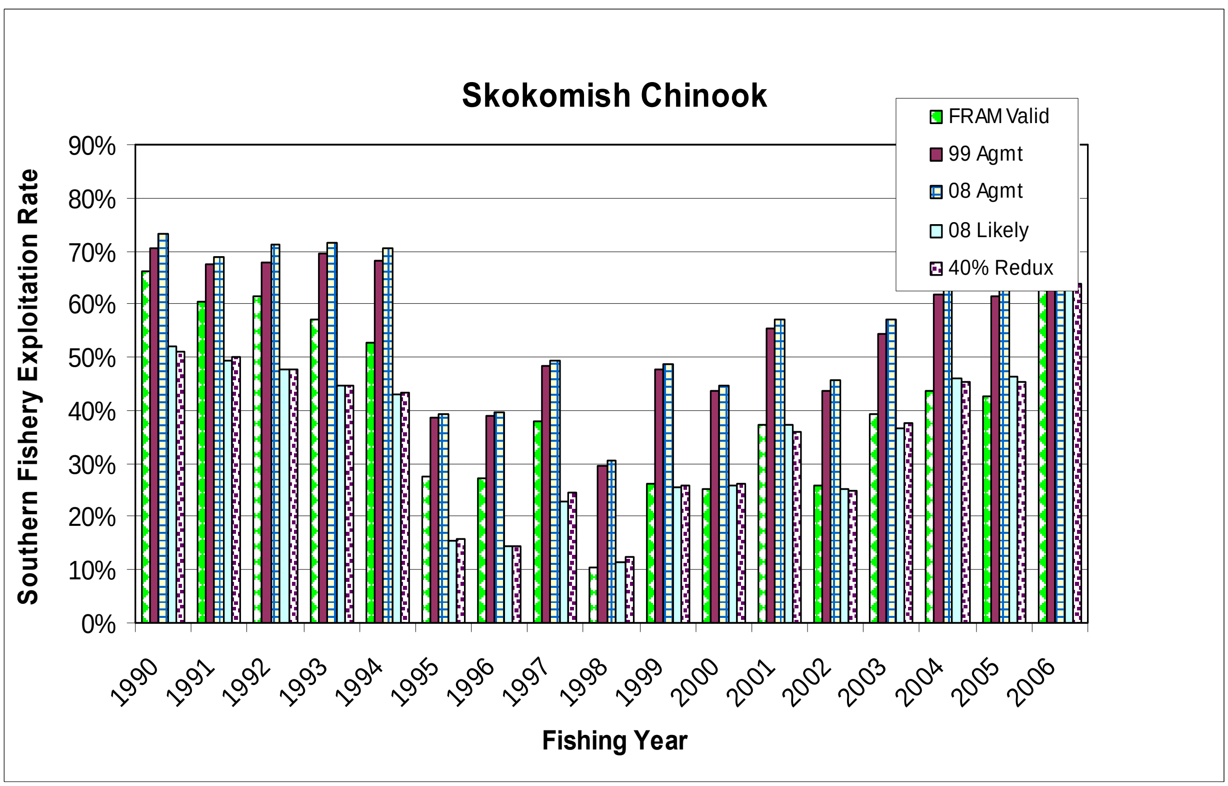


Figure 7.4.4.4-2 Continued.



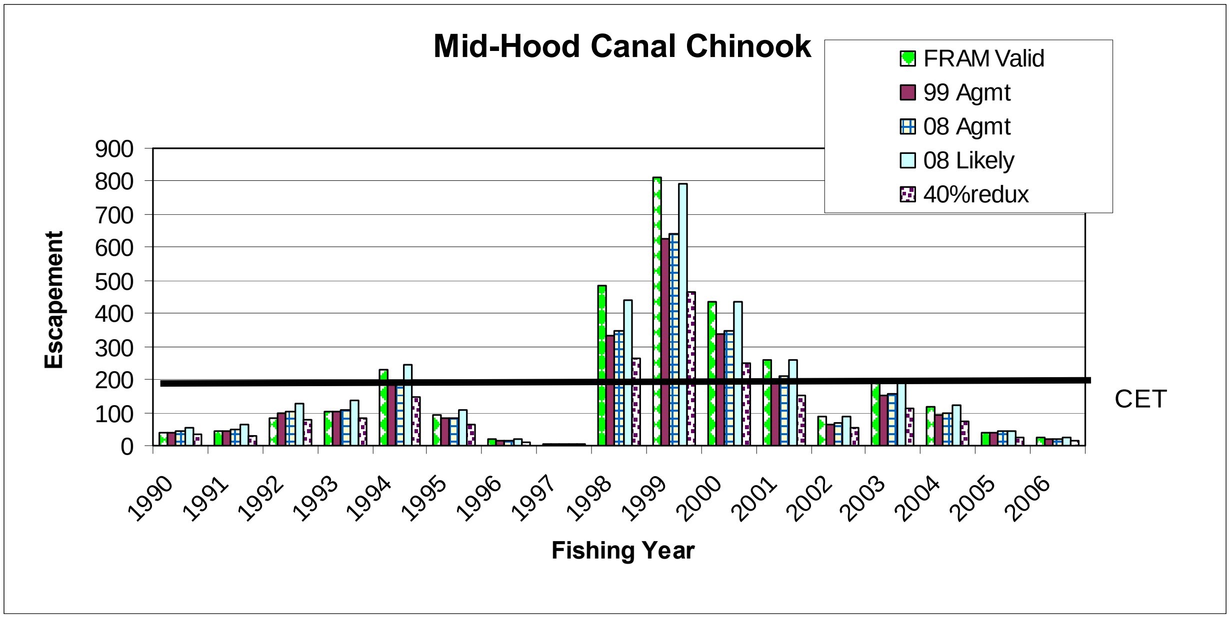


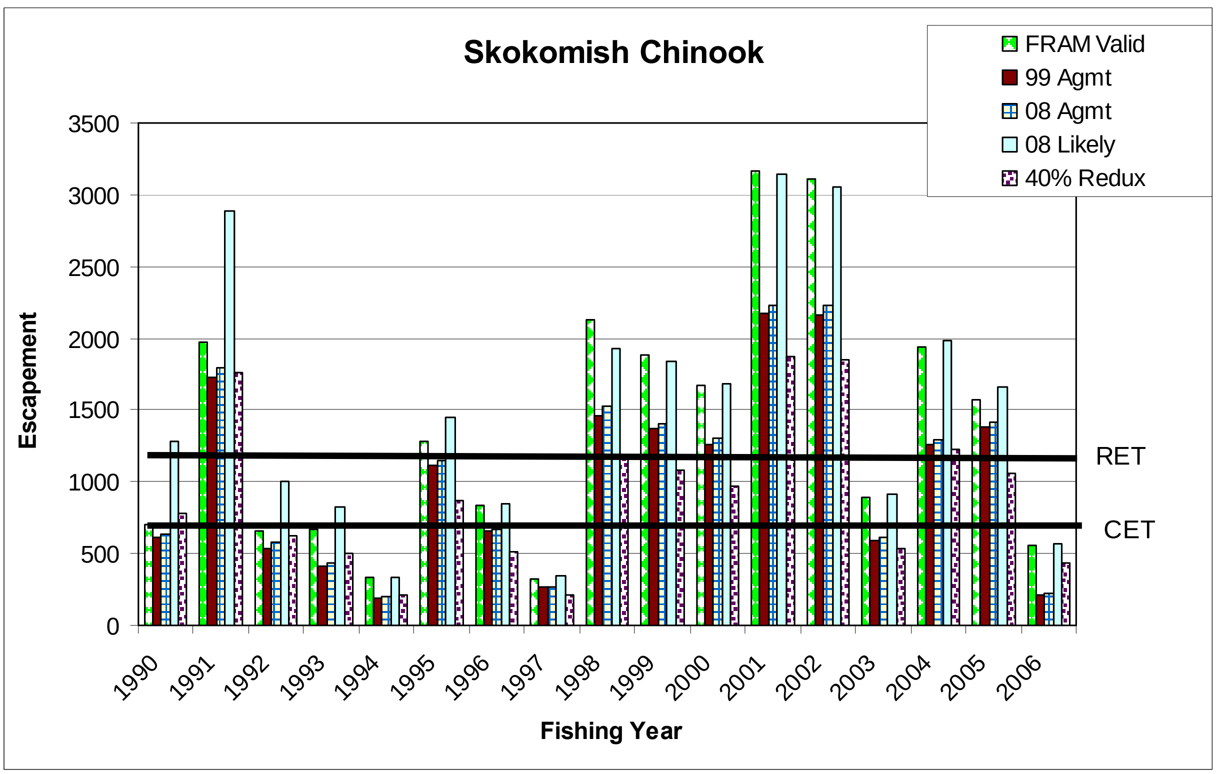
Trends in Escapement

Escapement trends in overall abundance since 1990 are positive for both populations within the region as is the underlying growth rate (Table 5.1.4.1.3). However, the 1997 to 2007 average escapement for the Mid-Hood Canal population is 143 (range = 30-762), below its critical threshold of 200, and escapements since 2002 have been less than 200 (range=30-194). Escapement into the individual systems has varied, with the spawning aggregation in the Hamma Hamma River representing the majority of the total Mid-Hood Canal Rivers population abundance in recent years. Escapements to the Dosewallips and Duckabush Rivers have averaged 11 and 2 fish respectively from 2005-2007 (WDFW and PSTIT 2008; WDFW and PSTIT 2007; WDFW and PSTIT 2006). This escapement pattern in recent years indicates that the short term abundance trend and probably the growth rate are likely negative. Adult returns resulting from the Hamma Hamma River supplementation program, which relies partially on broodstock returning to the river, and possible strays from nearby net pen programs, which have since been terminated, may have contributed substantially to escapements in earlier years. The on-going supplementation program has not been successful in recent years in substantially increasing abundance for even the Hamma Hamma component of the population, primarily because of very low survivals of fish released from the program. The 1999 to 2007 average natural escapement of 1,325 for the Skokomish population exceeds its rebuilding escapement threshold of 1,160 (range = 429-2,398).

The reductions in total exploitation rates under the 2008 Likely scenario result in moderate increases in escapements on average for the Hood Canal populations, when compared with full implementation of the 2008 Agreement (Figure 7.4.4.4-3). The retrospective analysis indicates that escapements for the Mid-Hood Canal population are expected to be below its critical escapement threshold in most years under all scenarios (Figure 7.4.4.4-3). Escapements are expected to increase under implementation of the 2008 Agreement when compared with the 1999 Agreement, but the increases are relatively small. Skokomish escapements are expected to be above its critical threshold in 10 or more of the years in the analysis across all scenarios and above its rebuilding threshold 8 or more years under the 2008 Agreement and the 2008 Likely scenarios. The frequency drops to 5 of the 17 years in the analysis under the 40% Reduction scenario. The 40% reduction scenario did not try to model further reductions in southern fisheries that would likely occur in response to a 40% decline in total abundance.

Figure 7.4.4.4-3. Estimates of natural escapement for the Mid-Hood Canal (top) and Skokomish (bottom) Chinook populations from the retrospective analysis.





7.4.4.5 Strait of Juan de Fuca Region

The Strait of Juan de Fuca Region has two watershed Category 1 populations including an early-timed population on the Dungeness, and a fall-timed population on the Elwha (Ruckelshaus et al.

2006). NOAA Fisheries determined that both populations must be at low risk to recover the ESU. The Dungeness River is located in the rain shadow of the Olympic Mountains and, as a result, receives relatively little rainfall (less than 20 inches per year). Flows in the Dungeness River are therefore particularly dependent on annual precipitation and snow pack, and the river 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 late summer low flow period which coincides with Chinook salmon spawning. Other land use practices have also substantially degraded the system. Much of the Elwha River drainage is still pristine and protected in the Olympic National Park. However, 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. In some years, high temperatures exacerbate problems with the parasite *Dermocystidium* resulting in pre-spawning mortality sometimes as high as 70% (WDF et al. 1993). Recovery of the Elwha population is dependent upon removal of the two dams, and restoration of access to high quality habitat in the upper Elwha River basin. The Elwha Dams are scheduled for removal beginning in 2012 and their removal will take several years to complete. Restoration of upstream access after the dams are removed will greatly enhance the prospects for eventual recovery of a viable Chinook salmon population. During dam removal, natural production will be severely disrupted and may be eliminated entirely for some years because of lethal turbidity and sedimentation levels (Ward et al. 2008). During this time, production will rely on listed fish production from the hatchery program to maintain the population (Ward et al. 2008).

The co-managers, in cooperation with federal agencies and private-sector conservation groups, have implemented a supplementation program to rehabilitate the Dungeness River Chinook population. The primary goal of the supplementation program is to increase the number of fish spawning naturally in the river, while maintaining the genetic characteristics of the existing stock. The fish propagated at WDFW's Dungeness Hatchery for this conservation program are considered part of the listed Puget Sound Chinook ESU. Chinook salmon produced by the hatchery mitigation program in the Elwha River system are also considered part of the listed Elwha Chinook salmon population. Fish produced by both programs are essential to the recovery of the ESU and Chinook production from the Elwha Hatchery will be a key component of watershed rehabilitation and population maintenance as the dams are removed.

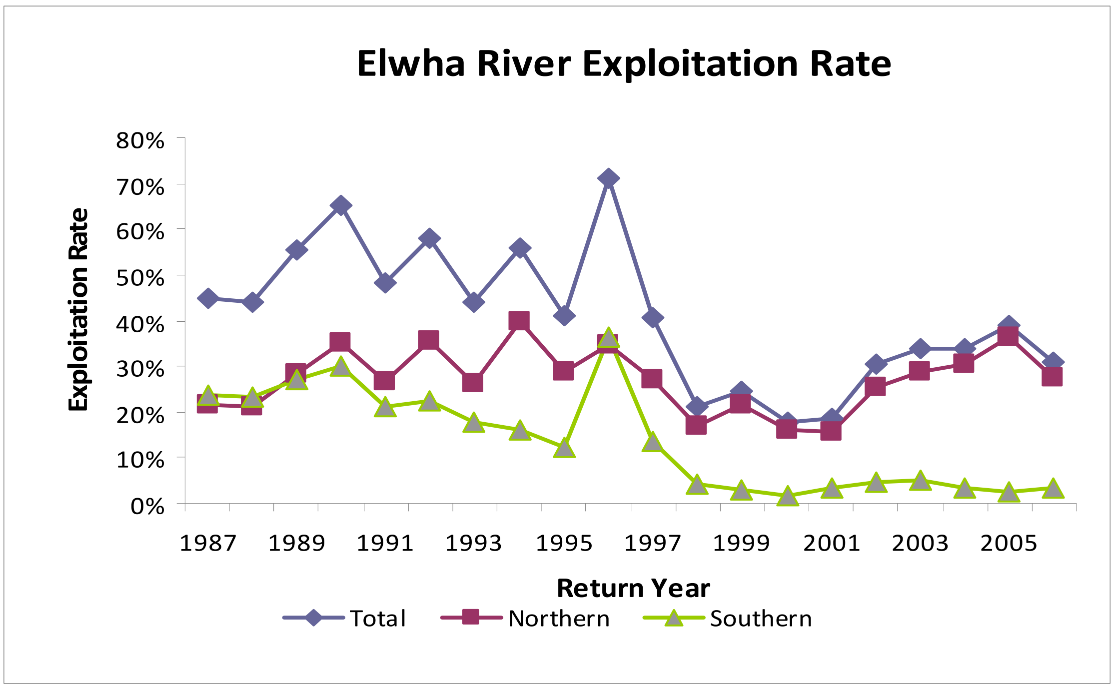
Trends in Harvest Mortality

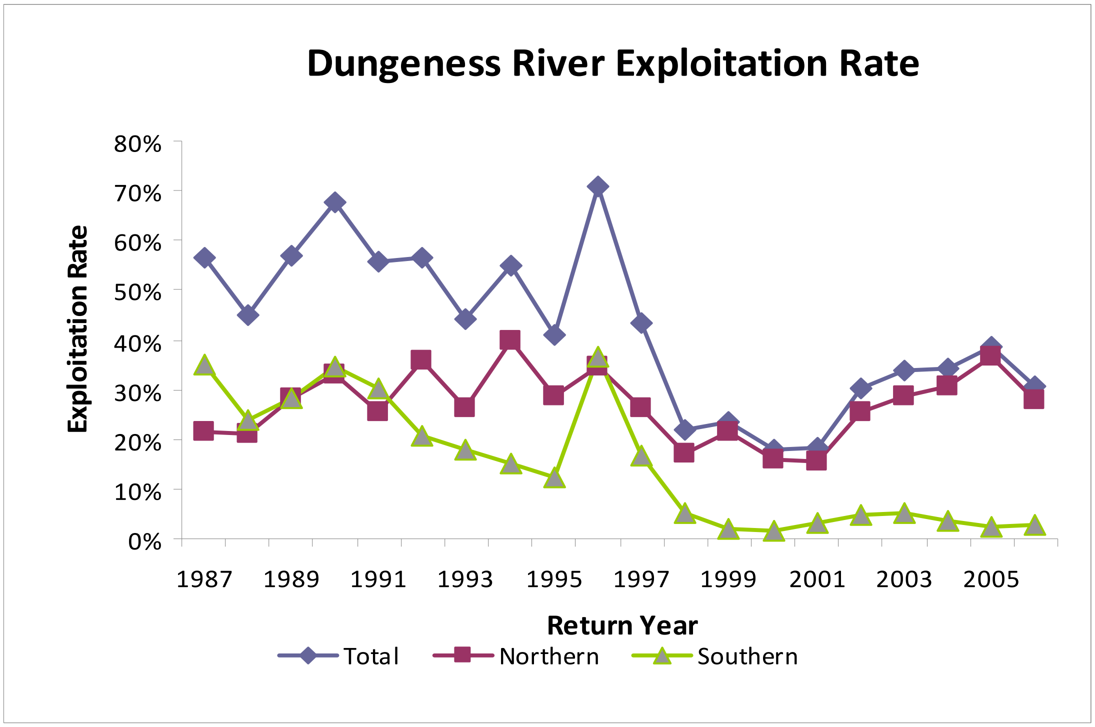
Exploitation rates on the Strait of Juan de Fuca populations have declined overall since the late 1980s, but have increased in recent years due to increases in northern fishery impacts (Figure 7.4.4.5-1). From 1987 to 1997, total exploitation rates averaged 53%. Since 1998, total exploitation rates averaged 28%. Exploitation rates in southern fisheries have averaged 3% since 2000 (Table 7.4.4.5-1). Since 1999, 80% or more of the harvest of the Dungeness and Elwha populations has occurred in northern fisheries (LaVoy 2008).

Table 7.4.4.5-1. Summary of changes in exploitation rates over time for Chinook populations in the Hood Canal Region.

Management Unit	Average Total Exploitation Rate		% Change	Southern U.S. 2000-2006 avg.
	1987-1997	1998-2006		
Dungeness	54%	28%	-48%	3%
Elwha	52%	28%	-46%	3%

Figure 7.4.4.5-1. Trends in exploitation rates for Chinook populations in the Strait of Juan de Fuca Region (LaVoy 2008).





Results from the Retrospective Analysis

Figure 7.4.4.5-2 summarizes information from the retrospective analysis for the Elwha and Dungeness populations. (Results from the retrospective analysis are also shown in tabular form in Appendix 3.) The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. and Canadian ISBM fisheries are managed subject to the limits of ISBM fisheries. The 2008 Agreement scenario would result in a small reduction in the total exploitation rate relative to the 1999 Agreement. The average total exploitation rates are 41% and 39% for the Elwha population**,** and 42% and 40% for the Dungeness population for the 1999 Agreement and 2008 Agreement scenarios, respectively. The average exploitation rate in northern fisheries would be reduced from 27% to 25% for both populations (Figure 7.4.4.5-2). Exploitation rates in southern fisheries would be the same between the two scenarios; 14% for the Elwha and 15% for the Dungeness (Figure 7.4.4.5-2). The 2008 Agreement represents a 1% reduction in average total exploitation rates for both populations from those observed during the analysis period (1990-2006).

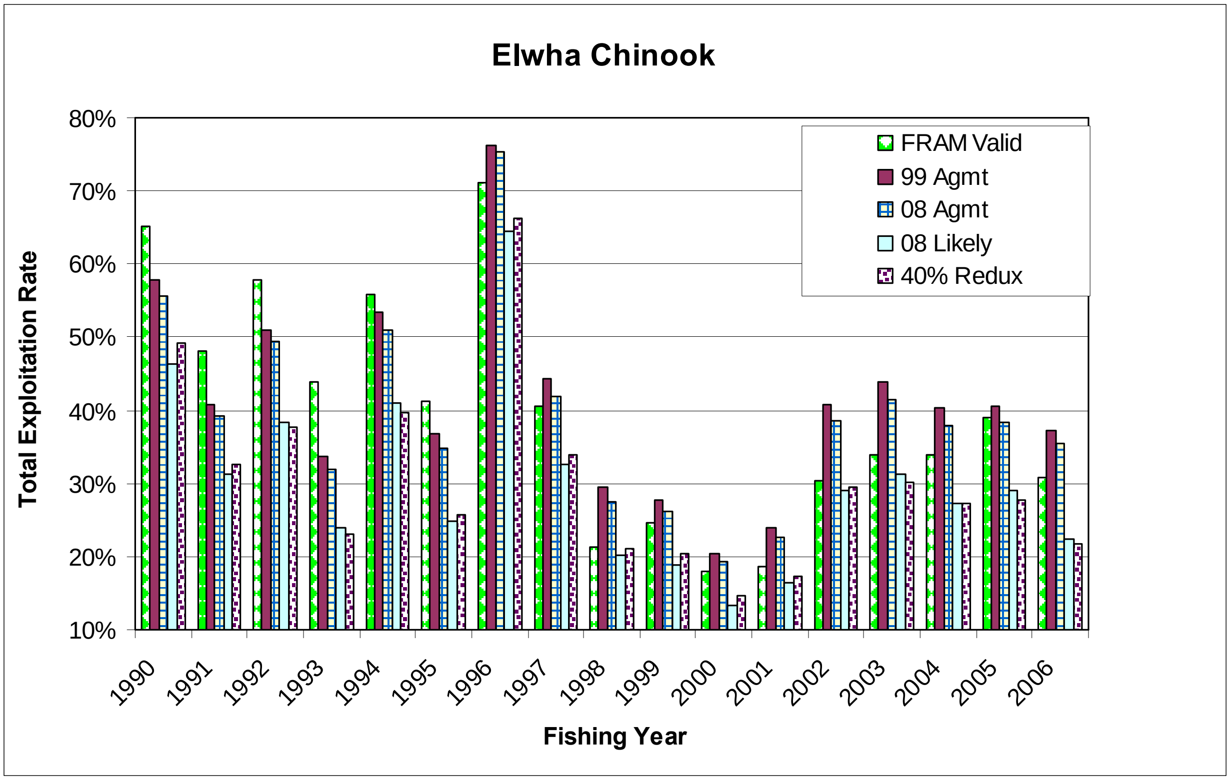
The 2008 Likely Scenario estimates the exploitation rates under the range of fishing levels that are expected over the next ten years based on the current constraints on ISBM fisheries. The average total exploitation rate under the 2008 Agreement scenario would be reduced substantially under the 2008 Likely scenario from 39% to 30% for the Elwha population, and from 40% to 31% for the Dungeness population. In northern fisheries exploitation rates would be reduced by one percentage point for both populations from 25% to 24%. Exploitation rates in southern fisheries would be reduced substantially relative to the 2008 Agreement scenario.

Exploitation rates would be reduced from 14% to 6% for the Elwha population, and from 15% to 7% for the Dungeness population. The differences in exploitation rates the 2008 Agreement and 2008 Likely scenarios are due to additional constraints in ISBM fisheries taken by both countries since the late 1990s or early 2000s to address domestic conservation and allocation concerns, and the shift in the WCVI fishing pattern. The 2008 Likely scenario represents a 24% reduction in average total exploitation rates from those observed during the analysis period (1990-2006).

The 40% Reduction scenario assumes that the overall abundance of Chinook in the ocean is reduced significantly. The average total exploitation rates are basically the same under the 2008 Likely and 40% Reduction scenarios for the two populations. The purpose of the abundance based management regime that characterizes the 2008 Agreement is that harvest should be reduced in response to declining abundance. If abundance is reduced by 40%, catch will have to be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis indicates that the management regime does compensate for reduced abundance as intended by not increasing exploitation rates. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

NOAA Fisheries has not derived RERs for the Strait of Juan de Fuca populations. However, RERs for other populations within the ESU with similar life history and status can be used as reasonable surrogates, i.e., the Nooksack (23%). The total exploitation rate exceeds the surrogate RERs in 12 or more of the 17 years in the analysis across scenarios (Figure 7.4.4.5-2). In most years, the rates in northern fisheries alone exceed the RERs (Figure 7.4.4.5-2).

Figure 7.4.4.5-2. Estimates of exploitation rates for Strait of Juan de Fuca populations from the retrospective analysis for all fisheries combined (Total), for northern and southern fisheries.



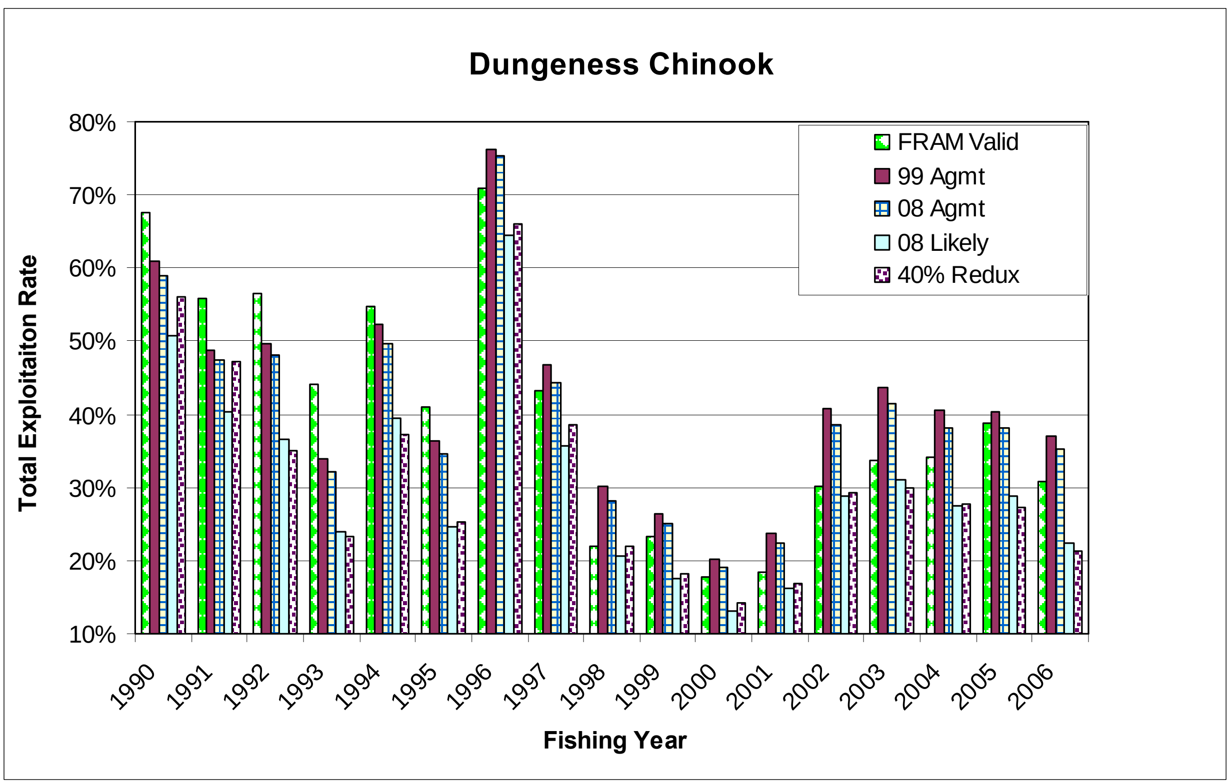
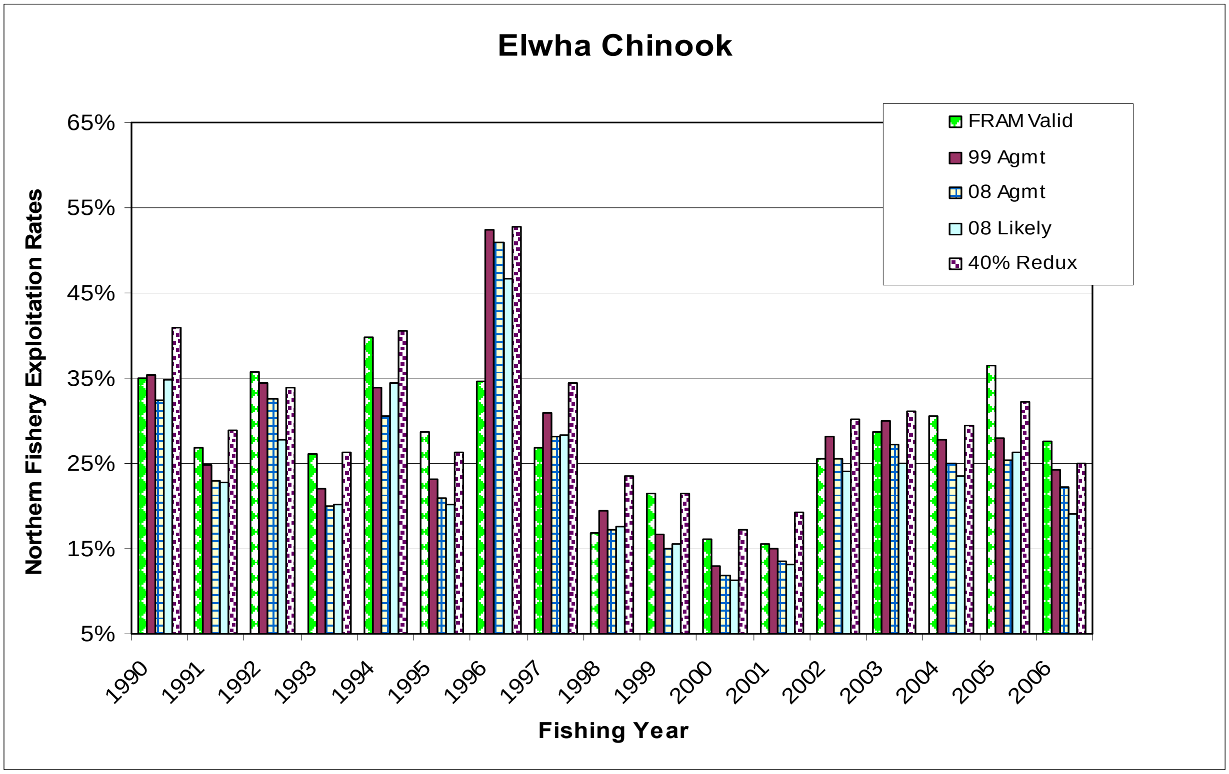


Figure 7.4.4.5-2 (continued).



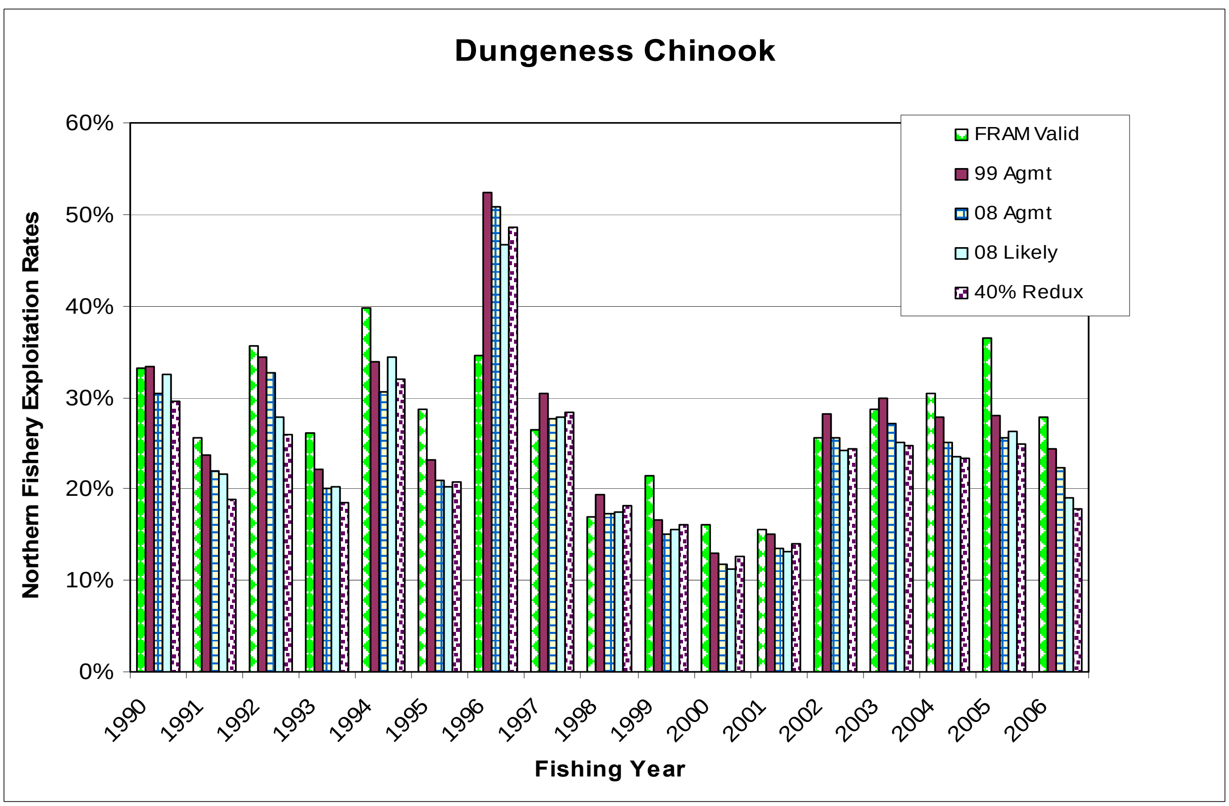
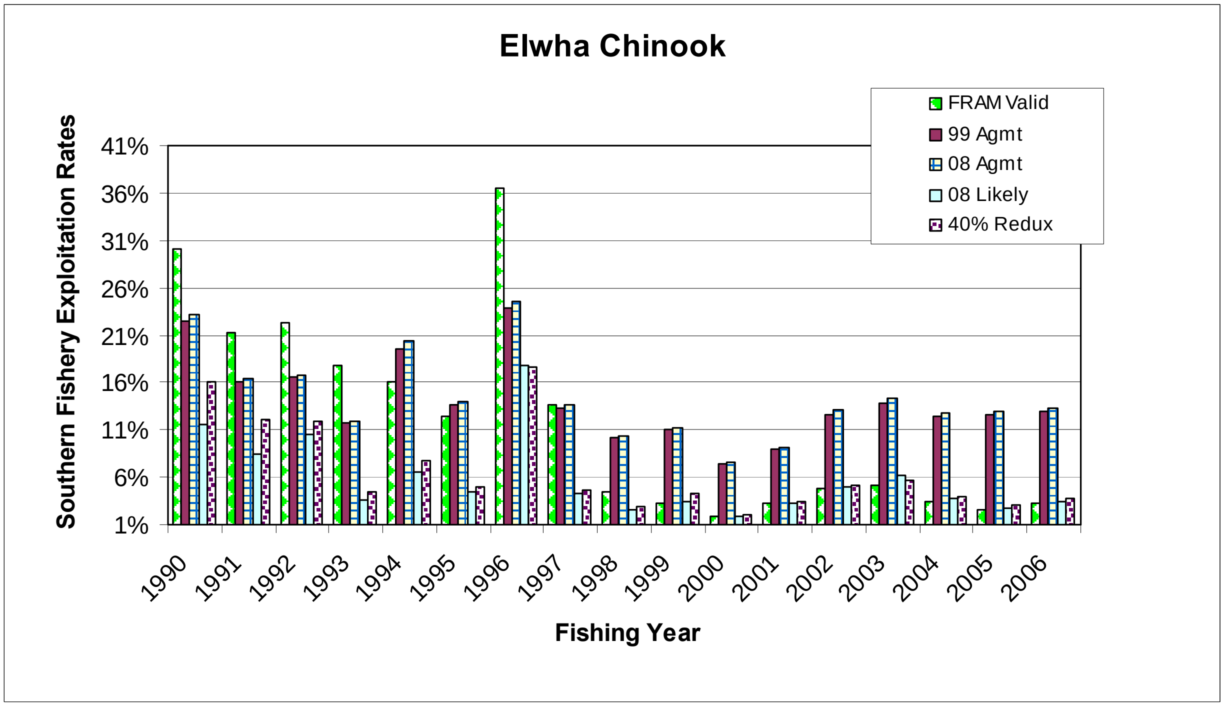
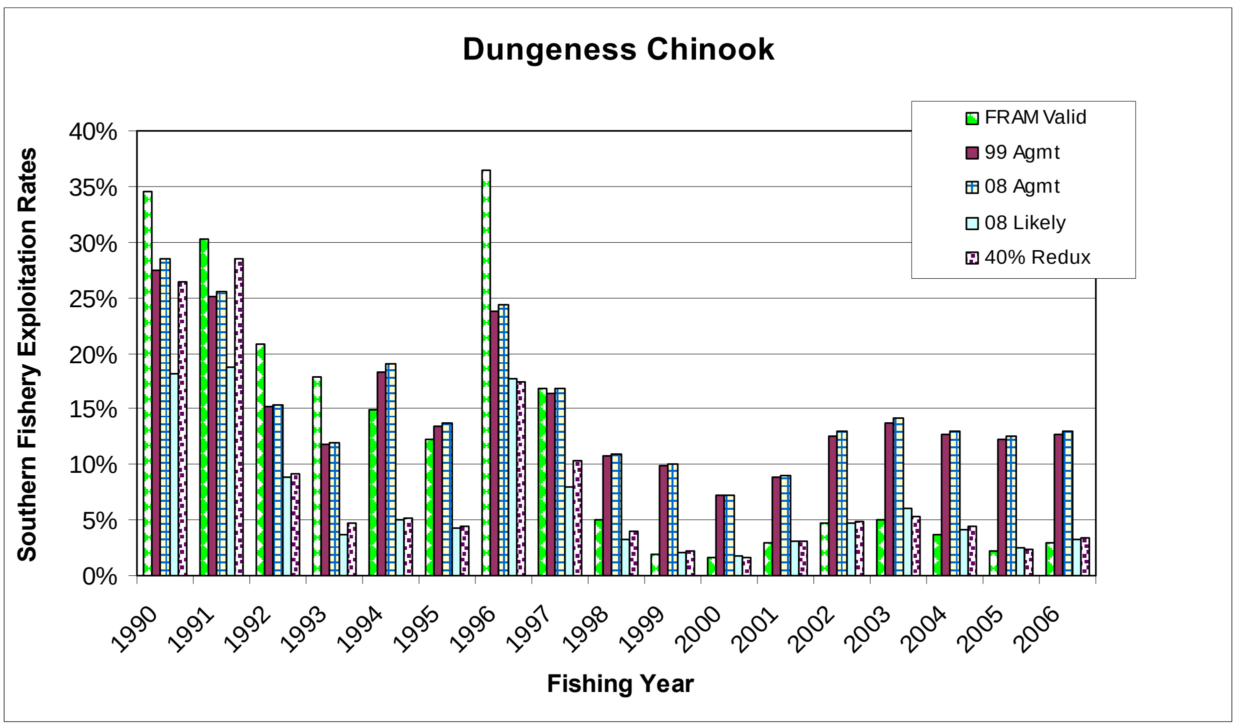


Figure 7.4.4.5-2 (continued).





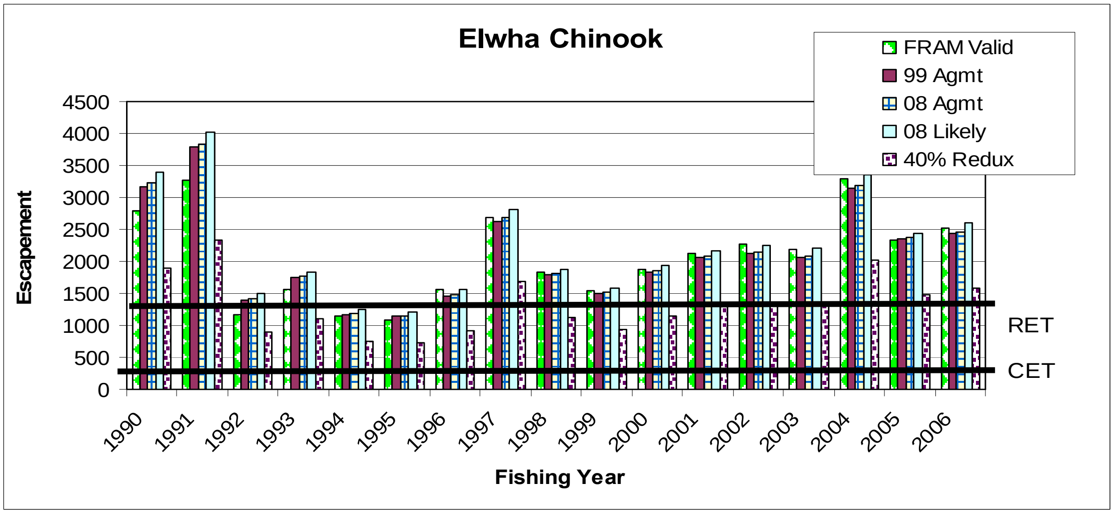
Trends in Escapement

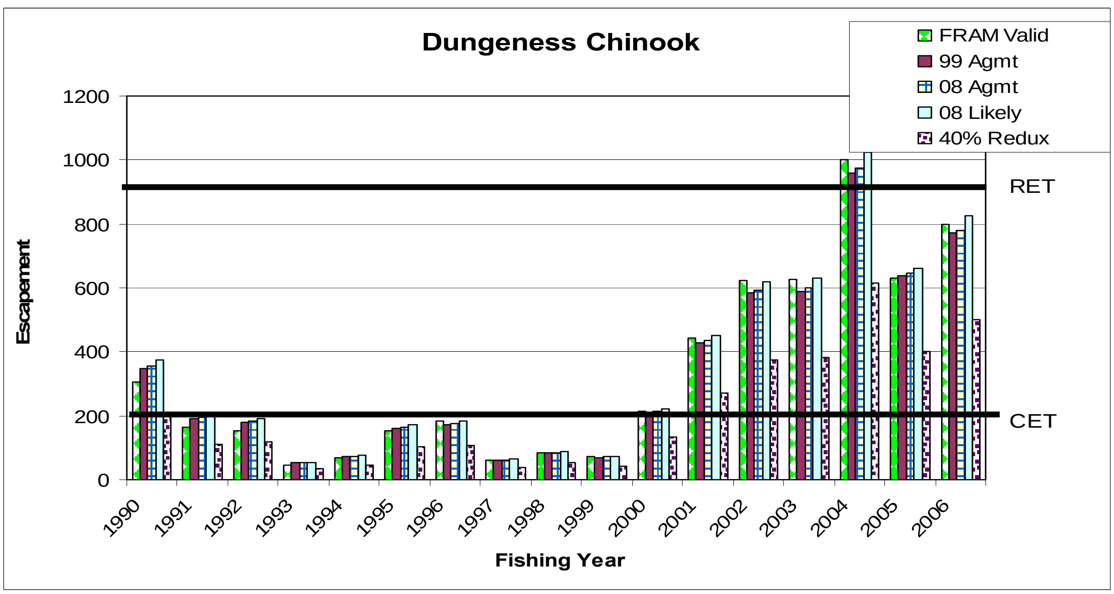
Escapement trends in overall abundance are stable for the Elwha and increasing for the Dungeness although the underlying growth rate is negative for the Elwha population (Table 5.1.4.1.3). The 1997 to 2007 average escapement for the Elwha population is 2,015 fish (range = 1,146-3,404 fish), above both its critical and rebuilding thresholds. Natural escapements have been above the critical threshold in every year during the period and above the rebuilding threshold in all but one. The 1999 to 2007 average natural escapement of 502 fish (range = 75-1,543 fish) for the Dungeness population is also above its critical threshold but below its rebuilding threshold. Natural escapements have been above the critical threshold in every year during the period but 1997. Natural origin escapement has also increased although not at the same rate as total natural escapement (2001-2007 average = 138 fish) and hatchery fish contribution to natural spawning from the conservation program at Dungeness Hatchery remains high. Recall that fish from both hatchery programs are listed and considered essential to recovery of the ESU.

The retrospective analysis indicates that escapements for the Elwha population would be above its critical escapement threshold across all scenarios (Figure 7.4.4.5-3). The retrospective analysis indicates that escapements for the Dungeness population would be above its critical escapement threshold in 7or more of 17 years in the analysis across scenarios and well above the threshold for all years since 2001 (Figure 7.4.4.5-3). As with most of the populations in the other Puget Sound regions, the increase in the escapement under the 2008 Agreement compared with the 1999 Agreement scenario is small (30 fish for Elwha and 5 for Dungeness) (Figure 7.4.4.5-3). Under the 2008 Likely Scenario, escapements increase by 5%. The status and frequency of escapements relative to their thresholds are similar to the results of the 2008 Agreement.

As with the other Puget Sound Chinook populations, the primary effect of the 40% Reduction scenario is on the frequency of achieving rebuilding thresholds. The status of the populations relative to their critical would be generally unchanged. During conditions similar to the most recent years, both populations would remain above their critical escapement thresholds and the Elwha would continue to exceed its rebuilding threshold even with a substantial reduction in abundance. Recall that the 40% reduction scenario did not try to model further reductions in southern fisheries that would likely occur in response to a 40% decline in total abundance.

Figure 7.4.4.5-3. Estimates of natural escapement for the Elwha (top) and Dungeness (bottom) Chinook populations from the retrospective analysis.





Effects on Critical Habitat

Designated critical habitat for Puget Sound Chinook includes estuarine areas and river reaches in specified subbasins. It also includes nearshore areas out to a depth of 30 meters adjacent these subbasins, but does not otherwise include offshore marine areas in Puget Sound or in the ocean. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are part of the proposed action do occur in Puget Sound and its tributaries.

Most of the harvest related activities in Puget Sound occur from boats or along river banks with most of the fishing activity in the marine and nearshore areas. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. The gear that would be used includes hook-and-line, drift and set gillnets, beach seines, and to a limited extent, purse seines. These types of fishing gear in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. Also these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries. Construction activities directly related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats because of the proposed salmon fisheries. The facilities used in association with the fisheries are essentially all in place. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the preceding analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the ESU.

7.4.5 Other Listed Chinook ESUs

In this section we review the effects of the proposed actions on the remaining ESA listed Chinook ESUs, including Snake River spring/summer Chinook, Upper Columbia River Chinook, California Coastal Chinook, Central Valley spring Chinook, and Sacramento River Chinook. The effects of the proposed action on these ESUs are limited and were considered in previous biological opinions that assessed the effects of harvest in the areas where they occur. The review here is therefore brief and generally references these prior consultations.

Snake River spring/summer Chinook and Upper Columbia River spring Chinook are rarely caught in ocean fisheries. The effects of PFMC fisheries on these ESUs were reviewed in biological opinions in 1996 (NMFS 1996) and 2001 (NMFS 2001d). These opinions which still apply concluded that fish from these ESUs are rarely, if ever, caught in ocean fisheries and are not likely to be affected adversely by fisheries managed under the Council's Fishery Management Plan. Although the opinion focused on the Council action area, the analysis considered ocean harvest coast wide. NOAA Fisheries reiterated this conclusion more recently in its biological opinion on the FCRPS where ocean harvest for the two ESUs was assumed to be zero (NMFS 2008c).

Snake River spring/summer Chinook and Upper Columbia River spring Chinook are caught in fisheries in the Columbia Basin. The effects of these fisheries over the next ten years were considered in the biological opinion on the 2008 *U.S. v. Oregon* Agreement (NMFS 2008d). Fisheries in the Columbia Basin are thus part of the baseline for NOAA Fisheries' consideration of the proposed actions in this opinion.

NOAA Fisheries reviewed the effects of fisheries in Alaska and Canada on the three listed California Chinook ESUs in the biological opinion on the 1999 PST Agreement (NMFS 1999b). These stocks reside primarily off California and the southern U.S. and are rarely caught in northern fisheries. The opinion concluded that the ESUs are either not likely to be adversely affected (Sacramento River winter Chinook) or jeopardized (California Coastal Chinook, Central Valley spring Chinook) by the fisheries considered in the 1999 PST Agreement. These ESUs are caught primarily in PFMC fisheries, the effects of which were also considered in prior biological opinions (see Table 6.2.1-1).

Designated critical habitat for these ESUs does not include marine areas beyond their natal estuaries. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed action do occur in the Columbia River and its tributaries. Designated critical habitat in freshwater areas for Snake River spring/summer Chinook and Upper Columbia River spring Chinook may be affected by the proposed actions. The considerations and reasoning regarding the effects of fishing on critical habitat discussed in Section 7.4.1 for Snake River fall Chinook apply for these ESUs as well. NOAA Fisheries' review indicates that there will be minimal effects on the essential habitat features of these ESUs resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

7.5 Chum Salmon

Chapter 6 of Annex IV of the 2008 Agreement pertains to fisheries that affect Southern British Columbia and Washington State chum salmon. Most of the fishery provisions focus on the U.S. chum fishery in northern Puget Sound and the Canadian chum fisheries in Georgia Strait and the Fraser River terminal areas, all of which are directed primarily at the sustainable harvest of chum salmon returning to the Fraser River. There are, however, provisions that require the live release of chum salmon in certain Canadian and U.S. fisheries at times when listed Hood Canal summer chum are likely to be present. Other provisions are designed to prevent the growth in interceptions of chum salmon, and to improve the scientific basis of chum salmon management.

There are two ESA listed chum ESUs including Lower Columbia River chum and Hood Canal summer run chum. The effects of the proposed actions on these ESUs are considered in turn.

7.5.1 Lower Columbia River Chum

The nearest marine area fisheries targeting chum that might affect Lower Columbia River chum occur in terminal areas near Vancouver Island and in the Strait of Juan de Fuca. Chum fisheries in Canada occur inside Barkley Sound, on the west coast of Vancouver Island, and near Nitnat on the south coast of the island. These are terminal fisheries directed at local stocks with little or no impact to stocks from outside areas. Commercial fisheries also occur in the western and eastern parts of the Strait of Juan de Fuca directed at chum returning to Puget Sound and the Fraser River and the end of their spawning migration. These fisheries have been sampled using genetic stock identification techniques. Chum stocks from the Washington coast are present in low abundance in these fisheries, but there are no reports of chum from the Columbia River or their nearest neighbor on the northern Oregon coast (N. Lampsakis, U.S. Section PST Chum Technical Committee Chair, pers. comm., October 14, 2008).

PFMC fisheries are the marine area fisheries closest to Lower Columbia River chum natal streams. However, chum salmon are neither targeted nor caught in PFMC fisheries. The available information suggests that the overall harvest of Columbia River chum is negligible. NOAA Fisheries assumed in their biological opinions on the FCRPS and 2008 *U.S. v. Oregon* Management Agreement that ocean fishing mortality on Columbia River chum salmon is zero (NMFS 2008c, 2008d).

Lower Columbia River chum return to tributaries in the Columbia River estuary and lower river below Bonneville Dam. Retention of chum salmon in the Columbia River recreational fisheries is prohibited. The catch of chum is relatively rare because chum do not actively take sport gear used to target other species. The migration timing of chum salmon is late enough that they are missed by most of the lower river commercial fisheries. There is some incidental catch during fisheries in late September and October directed primarily at coho. Fisheries in the Columbia River are managed to ensure that the incidental take of Lower Columbia River chum does not exceed specified rates. Non-Treaty fisheries in the lower Columbia River are limited to an incidental harvest rate of 5%. Recent harvest rates have averaged about 1.6%. Lower Columbia River chum are not caught in the treaty Indian fisheries above Bonneville Dam. The effects of fishing in the Columbia River to Lower Columbia River chum were considered in the recent biological opinion on the 2008 *U.S. v. Oregon* Management Agreement (NMFS 2008d). In that opinion, NOAA Fisheries concluded that proposed fisheries in the Columbia Basin were not likely to jeopardize Lower Columbia River chum salmon or destroy or adversely modify designated critical habitat.

Effects on Critical Habitat

Designated critical habitat for Lower Columbia River chum includes estuarine areas and river reaches upstream to the confluence with the White Salmon River and specified stream reaches in a number of subbasins. Critical habitat does not include offshore marine areas. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are part of the proposed actions do occur in the lower Columbia River and its tributaries.

Most of the harvest related activities in the Columbia River occur from boats or along river banks with most of the fishing activity in the Columbia River mainstem. The gear that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning and rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of the Lower Columbia River chum ESU from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest may affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for Lower Columbia River chum.

7.5.2 Hood Canal Summer-run Chum

As described in Chapters 5 and 6, Puget Sound salmon fisheries will continue to be managed under fishing regimes consistent with the existing 4(d) determination and section 7 biological opinion for Hood Canal summer chum and therefore will meet ESA requirements for these fisheries (NMFS 2001a). Exploitation rates should remain similar to those in recent years, contributing to strong escapements in both populations. Hood Canal summer-run chum are rarely caught in ocean fisheries. The fishing plan includes an exploitation rate guideline of 6.3% (expected range=2.3% - 8.3%) for listed summer-chum taken in Canadian fisheries although the U.S. has no enforcement mechanism to see the guidelines are met. However, the current Chum Annex requires Canadian fishermen to release chum caught in purse seine gear in Area 20 from July 1 through September 15 when Hood Canal summer chum are thought to be present. The proposed action continues this requirement. In addition, Canadian coho fisheries that historically occurred through the latter part of September and likely intercepted some late returning Hood Canal summer chum have been closed since 1994 and are expected to remain closed due to Canadian domestic management concerns. Exploitation rates in Canadian fisheries since 2000 on listed Hood Canal summer chum have been consistently below 0.5%, well below the guideline of 6.3% (Johnson et al. 2007, 2006; WDFW and PNPTC 2007). A significant factor in the low exploitation rate has also been the severe constraint on Canadian sockeye and pink fisheries in recent years due to concerns about weak sockeye stocks and changes in the allocation of sockeye and pink salmon in Canadian fisheries. These constraints also are expected to continue throughout the duration of the proposed action. It is therefore reasonable to expect that exploitation rates in Canadian fisheries under the proposed action will remain low and will not exceed the management plan guideline.

Effects on Critical Habitat

Designated critical habitat for the Hood Canal Summer-run Chum Salmon ESU includes estuarine areas and specific river reaches associated with the following subbasins: Skokomish, Hood Canal, Kitsap, Dungeness/Elwha (NMFS 2005b). The designation also includes some nearshore areas from extreme high water out to a depth of 30 meters and adjacent to watersheds occupied by the ESU because of their importance to rearing and migration for chum salmon and their prey, but does not otherwise include offshore marine areas. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed actions do occur in the rivers and nearshore areas of the Strait of Juan de Fuca and Hood Canal.

Most of the harvest related activities in Hood Canal and the Strait of Juan de Fuca occur from boats or along river banks with most of the fishing activity in the marine and nearshore areas of Hood Canal and the Strait of Juan de Fuca. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. The gear that would be used includes hook-and-line, and drift and set gillnets, and beach seines. These types of fishing gear in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. Also these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries. Construction activities directly related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats because of the proposed salmon fisheries. The facilities used in association with the fisheries are essentially all in place. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the ESU. Exploitation rate objectives are very low and escapements have been consistently well above their goals (Johnson et al. 2006, 2007; WDFW/PNPTT 2007) which should minimize the effects of salmon carcass removal on critical habitat. Finally, trampling of redds during fishing has the potential to cause high mortality of salmonids. Boat operation can result in stranding and mortality related to pressure changes in juveniles (PFMC 1999). Salmon fisheries are closed or fishing activities do not occur in freshwater areas in Hood Canal, North Puget Sound and the Strait of Juan de Fuca during peak spawning, rearing and out-migration periods (S. Theisfeld, WDFW and T. Johnson, WDFW, per. comm. with S. Bishop, NMFS, May 12, 2004). Notices are posted near fishing access areas by WDFW and the Washington Parks Department, and news releases are distributed by WDFW before each fishing season explaining responsible fishing behavior, including avoidance of spawning areas and damage to riparian areas (T. Johnson, WDFW per, comm. with S. Bishop, NMFS, May 12, 2004). These management measures should minimize redd or juvenile fish disturbance due to conduct of the proposed Puget Sound salmon fisheries.

7.6 Coho Salmon

Chapter 5 of Annex IV of the 2008 Agreement, the Coho Salmon chapter, contains a Southern Coho Management Plan with provisions that limit the impact of Canadian and U.S. fisheries on natural coho stocks originating in southern British Columbia, Puget Sound, and along the northern and central Washington coast. ESA listed stocks are not among the “driver” stocks that affect the fisheries. The substantive provisions of the Southern Coho Management Plan limit the impact of U.S. and Canadian fisheries on the subject coho stocks to specified exploitation rate limits that vary as a function of the annual status forecast of those runs.

There are four ESA listed coho ESUs including Central California Coast coho, Southern Oregon/Northern California coho, Oregon Coast coho, and Lower Columbia River coho (Table 5.1). Harvest of listed coho occurs primarily in the west coast fisheries managed by the PFMC. Lower Columbia River coho are also caught in fisheries in the Columbia River primarily below Bonneville Dam. As discussed in Chapter 6, the effects of harvest in PFMC and lower Columbia River fisheries are the subject of prior consultations which are thus part of the environmental baseline.

ESA listed coho are distributed off the west coast and rarely migrate as far north as Canada. As a consequence, harvest impacts in Canadian fisheries are quite low. The PFMC estimates the effect of harvest on ESA listed coho each year as part of their preseason management process. The exploitation rate in Canadian fisheries on Lower Columbia River coho and Rogue/Klamath coho (the indicator stock for the Southern Oregon/Northern California ESA) have ranged from 0.1% to 0.2% over the last two years. The exploitation rate on Oregon Coast coho ranged from 0.2% to 0.4% (PFMC 2007b, 2008c). Central California Coast coho have an even more southern distribution and are likely subject to little or no harvest in northern fisheries.

The current biological opinion for Oregon Coast coho and Southern Oregon/Northern California coho set total exploitation rate limits that include whatever harvest may occur in northern fisheries (NMFS 1999d). Part of the preseason planning process includes estimating the harvest that will occur to the north. Southern fisheries are then managed to meet the overall exploitation rate limit. Because impacts in Canadian fisheries are low, they have generally not been a significant constraint on southern U.S. fisheries. NOAA Fisheries recently completed a biological opinion regarding the effects of harvest on Lower Columbia River coho (NMFS 2008d). The opinion requires use of a variable harvest schedule that depends on brood year escapement and indicators of marine survival. The allowable exploitation rate for a given year applies to all ocean fisheries in the U.S. and harvest in the Columbia River. As indicated above the additional harvest that may occur in Canada is quite limited and is considered insignificant relative to the limits placed on U.S. fisheries.

Effects on Critical Habitat

Designated critical habitat for Central California Coast coho, Southern Oregon/Northern California coho, and Oregon Coast coho, salmon includes specified river reaches within the boundaries of each ESU, and consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches in specified hydrological units and counties. Critical habitat for Lower Columbia River coho has not yet been designated. Critical habitat does not include offshore marine areas. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat.

7.7 Sockeye Salmon

Chapter 4 of Annex IV pertains to the management of Fraser Sockeye and Pink Salmon. Chapter 4 is not included in the new agreement because the existing regime does not expire until after

2010. Nonetheless, the harvest of listed species taken incidentally in the fisheries directed at Fraser sockeye and pink salmon, particularly listed Chinook salmon, are accounted for and will be considered in the analysis of the Chinook provisions of Chapter 3. We also consider the effect to ESA listed sockeye that may occur as a consequence of the incidental catch of sockeye in fisheries directed at other species and fisheries in the southern U.S. that are in the action area and part of the overall baseline.

There are two ESA listed sockeye ESUs including Snake River sockeye and Lake Ozette sockeye. Although the ocean distribution and migration patterns of Snake River sockeye and Lake Ozette sockeye are not well understood, timing considerations and other information suggest that they are unlikely to be caught in proposed ocean fisheries.

NOAA Fisheries found no information to suggest that Snake River sockeye salmon were subject to significant harvest in ocean fisheries (NMFS 1991). Mature sockeye salmon from the Snake River are not likely to be taken in Alaska or Canada because they exit the ocean prior to the onset of intercepting sockeye fisheries. The average of the peak passage timing for sockeye at Bonneville Dam is July 1. Some fisheries in Alaska and Northern British Columbia may open as early as mid-June, but have not started until early July in recent years with peak catches in early August. Fraser Panel fisheries conducted inside Puget Sound also do not generally begin until at least late July. These timing considerations suggest that it is unlikely that Snake River sockeye are encountered in the Alaskan or Canadian fisheries because the adults will have largely exited the ocean prior to the start of the proposed summer fisheries (July-September). Sockeye salmon are not targeted and are rarely, if ever, caught in PFMC area fisheries. NOAA Fisheries confirmed these conclusions more recently in their Supplemental Comprehensive Analysis for the FCRPS biological opinion (NMFS 2008e) where ocean harvest was assumed to be zero.

Similar information was used to analyze the likely effect of ocean harvest on Lake Ozette sockeye. Timing considerations indicate that Lake Ozette sockeye are gone from fishing areas or largely out of the ocean before the onset of intercepting fisheries where they might be caught (Haggerty 2008). NOAA Fisheries concluded in their draft recovery plan that ocean fisheries were not a factor limiting the species survival and recovery (NMFS 2008j).

Effects on Critical Habitat

Designated critical habitat for Snake River sockeye includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake rivers and specified areas in the Snake River basin. Designated critical habitat for Lake Ozette sockeye salmon includes specified areas within the Hoh/Quillayute subbasin including Lake Ozette and the Lake Ozette watershed. Critical habitat does not include offshore marine areas. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat for sockeye salmon. Fisheries that are consistent with the proposed actions do occur in the Columbia River and its tributaries, and therefore may affect the critical habitat of Snake River sockeye salmon.

Most of the harvest related activities in the Columbia River occur from boats or along river banks with most of the fishing activity in the Columbia River mainstem. The gear that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of the Snake River sockeye salmon ESU from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas. The effects of fisheries on the critical habitat of Snake River sockeye salmon were considered in the recent biological opinion on the 2008 *U.S. v. Oregon* Management Agreement (NMFS 2008d). NOAA Fisheries concluded in that opinion that fisheries management pursuant to the agreement is not likely to result in the destruction or adverse modification of its designated critical habitat.

7.8 Steelhead

There are currently eleven DPSs of steelhead from California, the Columbia River basin, and Puget Sound that are listed under the ESA (Table 5.1). The California and Columbia River DPSs have been listed for some time. The Puget Sound DPS was listed as threatened in 2007. The following discussion considers that likely effects of harvest on listed steelhead. Steelhead is not targeted in marine area fisheries, and is caught rarely and only incidentally in fisheries targeting other species. Retention of steelhead in marine fisheries is generally prohibited. As a consequence, there is relatively little information on the harvest of steelhead in ocean and marine fisheries. We first review what is known about the ocean distribution of California, Columbia River, and Puget Sound origin steelhead. We then review the catch of steelhead in fisheries in Alaska, Canada, PFMC, Puget Sound and the Columbia River.

California Steelhead DPSs

Very little is known about the marine distribution patterns of California steelhead. However, the likelihood of its presence as far north as British Columbia 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 coded-wire tag (CWT) data suggests that winter-run stocks tend to migrate further offshore but not as far north into the Gulf of Alaska 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 were 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 DPSs also would have a southerly distribution and would not be present in Alaskan or Canadian waters.

Columbia River Steelhead DPSs

Lower Columbia River and Upper Willamette River steelhead DPSs 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 DPS. Upper Columbia River, Snake River, and Middle Columbia River steelhead DPSs include inland stocks generally comprised of summer-run fish (Busby et al. 1996).

Summer-run steelhead generally enters freshwater from May through October (Busby et al. 1996) with peak entry occurring in July based on timing at Bonneville dam (*U.S. v. Oregon*, TAC 1997). Mark recoveries indicate that immature Columbia River steelhead is 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 is 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) (*U.S. v. Oregon*, TAC 1997).

Puget Sound Steelhead DPS

As with the California and Columbia River DPSs, little is known about the ocean distribution of Puget Sound steelhead. Puget Sound hatchery steelhead are adipose clipped, but not coded wire tagged. Without coded wire tag data our understanding of their distribution in ocean and inside marine waters is limited. High seas tagging studies indicate Puget Sound steelhead do occur offshore in areas beyond the limits of nearshore ocean fisheries (Nancy Davis, University of Washington, School of Fisheries and Ocean Sciences). There are no data indicating that Puget Sound steelhead are caught in commercial or recreational in the North Pacific.

Southeast Alaskan Fisheries

The ocean distributions for listed steelhead are not known in detail, but steelhead are caught rarely in ocean salmon fisheries and are, therefore, not likely to be caught in Alaskan fisheries (ODFW and WDFW 1998; PSMFC 1999). During 1982-1993, when the SEAK seine landings were sampled for CWTed steelhead, only one tag was recovered, although tag releases of southern U.S. steelhead were quite high.

Canadian Fisheries

The available coded-wire tag data indicates that Canadian fisheries account for 0.9% of the total recoveries of hatchery steelhead from the listed Columbia River ESUs during the 1980-1997 period, an average of 1-8 tags per year depending on the ESU. The percentages range from 0.27% for the Mid-Columbia ESU to 5.4% for the Upper Columbia River ESU.[18] Chapman et al. (1994) found similar results, estimating impacts from Canadian fisheries on type-A steelhead from the Mid-Columbia to be approximately 0.4%. Although there is some concern about non-reporting of steelhead in Canadian fisheries in more recent years, the percentage of total recoveries in Canadian fisheries has remained low over a 17 year period (1980-1997) that was the subject of the analysis. The adult freshwater timing, the ocean distribution patterns, and the greater relative abundance of Puget Sound and Canadian-origin steelhead compared with the listed Lower Columbia River and Upper Willamette winter steelhead stocks, make it unlikely that Canadian fisheries would encounter more than a few steelhead per year from any of the listed Columbia River ESUs.

Steelhead catch in southern British Columbia (Johnstone Strait, Juan de Fuca (Area 20), Nitinat and Fraser River fisheries where most Columbia River steelhead tags are recovered averaged several thousand per year in the 1970s (Oguss and Evans 1978; Andrews and McSheffrey 1976). Parkinson (1984) estimated the catch of Columbia River steelhead (as represented by stocks above Bonneville Dam) in these fisheries to be 102-337 in 1978-80, or less than 1% of the total return of steelhead. This is consistent with the CWT estimates. Given a wild/hatchery ratio of 20%, this would result in a catch of 20-60 wild Columbia River steelhead. However, since that time, the duration of fishing and amount of effort in these fisheries have decreased significantly and the catch of steelhead has declined to several hundred in the late 1980s and 1990s (MELP/DFO 1998; Bison 1992, 1990). Therefore, the catch of steelhead from the Columbia River in recent years is probably 25-50 per year with the catch of natural origin steelhead on the order of 4-10 per year spread across the five DPSs. The catch of Puget Sound steelhead in Canadian fisheries is unknown, but is presumed to be low based on the low number of steelhead caught in the fisheries.

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[18] This average is influenced by 1989 when 44% (4 tags/9 tags) of the Upper Columbia River steelhead tags were recovered in Canadian fisheries. Excluding 1989 brings the average percent recovered in Canadian fisheries to 1.1%.

PFMC Fisheries

NOAA Fisheries reviewed the information related to the catch of steelhead in PFMC fisheries in 2000 (NMFS 2000b). Based on that review, NOAA Fisheries concluded that the total catch of steelhead in the Council area fisheries probably averages something on the order of a few tens but not likely more than 100 fish per year. Not all fish caught would be killed. Those caught in the commercial troll fishery would be released, but only a portion, probably on the order of 26%, would die as a result of hooking. Most of the steelhead caught would be hatchery fish. Most hatchery origin steelhead are marked by removing their adipose fin to facilitate implementation of mark selective fisheries in freshwater. Marked hatchery fish generally are not subject to ESA section 4(d) take prohibitions. The relative abundance of hatchery steelhead and natural fish in the ocean is unknown. However, approximately 80% of steelhead from the upper Columbia River (above Bonneville Dam) are hatchery origin. The number of natural-origin steelhead that are caught and killed is probably less than 10 fish per year. This includes all of the listed steelhead ESUs.

Based on their review, NOAA Fisheries concluded that it would be impossible to measure or detect potential effects of the PFMC area fisheries on these species (which, according to the Interagency Section 7 Handbook, is considered an “insignificant effect”) and concluded that the PFMC fisheries were not likely to adversely affect any of the ten then listed steelhead DPSs (NMFS 2000b). Puget Sound steelhead was listed later, but NOAA Fisheries came to a similar conclusion for that DPS in a more recent opinion (NMFS 2008l).

Puget Sound Fisheries

The catch of steelhead in marine fisheries inside Puget Sound is limited. The Washington Department of Fish and Wildlife conducted a study to estimate the incidental catch rate of steelhead in non-Treaty commercial fisheries. Their biologists observed 4,675 net sets and observed 17 steelhead, indicating that the catch rate of steelhead was low. The retention of steelhead in non-Treaty commercial fisheries is prohibited. Recreational catch since 2001 has averaged 14,477 winter and summer-run steelhead annually; less than 4% of which are wild (Leland, pers. comm. 2008).Washington also prohibits the retention of natural-origin steelhead in recreational fisheries.

Tribal harvest in all marine and freshwater areas of winter and summer hatchery and wild steelhead has averaged 1,412 annually since 2001 (NWIFC unpublished data). The fish caught are a combination of listed natural origin and unlisted hatchery origin steelhead. However, the fisheries are generally timed to focus on returning hatchery origin steelhead. As a consequence, most of the steelhead caught are likely non-listed, hatchery origin steelhead.

NOAA Fisheries currently is reviewing a comprehensive fishery resource management plan for state and tribal fisheries that are directed at steelhead in Puget Sound. Preliminary information from the management plan indicates that the harvest rate on steelhead in Puget Sound is approximately 6% per year. NOAA Fisheries expects to complete a review of the resource management plan by the end of 2009.

Columbia River Fisheries

ESA listed steelhead from the Columbia River basin is caught in fisheries in the Columbia River and its tributaries. However, the effects of harvest on the listed DPS have been considered in recent biological opinions on the FCRPS and 2008 *U.S. v. Oregon* Management Agreement, both of which pertain to activities over the next ten years (NMFS 2008c, 2008d). Fisheries in the Columbia River basin are therefore part of the baseline for the actions considered in this opinion. The biological opinions on actions taken in the Columbia River confirm the general point made above that the effects of ocean harvest are limited. These opinions concluded that few steelhead are caught in ocean fisheries. For practical purposes, ocean fishing mortality on listed steelhead from the Columbia River was assumed to be zero.

Effects on Critical Habitat

Designated critical habitat for ten of the eleven listed DPSs includes specified freshwater areas and the adjacent estuaries. Critical habitat for Puget Sound steelhead has not yet been designated. Ocean fisheries that occur consistent the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed actions do occur in the lower Columbia River and its tributaries.

Most of the harvest related activities in the Columbia River occur from boats or along river banks with most of the fishing activity in the Columbia River mainstem. The gear that would be used include hook-and-line, drift and set gillnets, and hoop nets. These types of gear do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. Thus, there will be minimal effects on the essential habitat features of listed steelhead DPSs from the actions discussed in this biological opinion, certainly not enough to contribute to a decline in the values of the habitat. While harvest activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the following analyses regarding harvest related mortality. By removing adults that would otherwise return to spawning areas, harvest may affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for listed steelhead.

7.9 Southern Resident Killer Whales

The proposed 2008 Agreement may affect listed Southern Residents through direct effects of vessel operation and indirect effects from reduction of prey availability. This section evaluates the direct and indirect effects of the proposed actions on the ESA listed Southern Resident DPS, effects of other activities that are interrelated or interdependent with that action, and determines how the effects of the proposed actions interact with the environmental baseline (50 CFR 402.02).

7.9.1 Effects of Vessel Operation

There is potential for direct interaction between whales and fishing vessels/gear because of overlap in time and space. Some of the fisheries occur outside the Southern Residents' range, with no potential for interaction (i.e., Southeast Alaskan fisheries and some Canadian fisheries). Interactions with vessels could occur while vessels are fishing or while they are transiting to and from the fishing grounds. The most likely vessel interaction is disruption of the whales' behavior. Vessel strikes or any potential for entanglement are rare and have not been observed in association with Pacific Salmon Treaty fisheries. As described previously (Environmental Baseline, Section 6.5.2.1, Entrapment and Entanglement in Fishing Gear), commercial fishers in all categories participating in U.S. fisheries are required to report incidental marine mammal injuries and mortalities. Although unlikely, NOAA Fisheries will evaluate the need for observers to cover the U.S. fisheries of the Pacific Salmon Treaty if fishery interactions with Southern Residents are reported (in accordance with provisions of the MMPA, 50 CFR 229.7).

As described in the Environmental Baseline, behavioral responses to vessels could include faster swimming, less predictable travel paths, shorter or longer dive times, moving into open water, and altering normal behavior patterns at the surface (Kruse 1991; Williams et al. 2002a; Bain et al. 2006; Noren, In Review). Research suggests that Southern Residents may expend 10 to 15 percent more energy when vessels are present than they would without vessels present (Bain et al. 2006; Williams et al. 2002a). Sounds from vessels also have the potential to affect foraging by masking the echolocation signals of the whales (Foote et al. 2004; Holt 2008; Holt et al. in press).

Although vessels generally are a concern for killer whales, fishing vessels operate at slow speeds or in idle when actively fishing, which does not appear to disrupt the whales' behavior (Krahn et al. 2004). When in transit, vessels would likely travel at faster speeds with potential to affect the whales' behavior; however, there are very few past reports of commercial fishing vessels within ½ mile of the whales (Koski 2004, 2005, 2007), probably because fishing vessels do not target whales. Based on this and the low potential for temporal and spatial overlap (i.e., SEAK fisheries and some Canadian fisheries outside their range, and review NMFS 2008o, 2008z), there is a low potential for direct interaction between the Pacific Salmon Treaty fisheries and Southern Resident killer whales.

Nevertheless, there remains potential for the vessels to be close enough to the whales, either while fishing or transiting, to cause behavioral changes. If such interactions were to occur, they would likely result in short-term changes to the whales' behavior or avoidance (as described above). It is unlikely that the few behavioral disruptions that might occur would have more than a minor effect on the fitness of individual whales (and thus on reproduction or numbers) or the distribution of whales.

7.9.2 Effects of Prey Reduction

We compared the environmental baseline to the 2008 Agreement and found that the 2008 Agreement will reduce prey available to Southern Residents. This analysis considers whether effects of that prey reduction may reduce the reproduction, numbers, or distribution of Southern Resident killer whales. We evaluated the potential effects of the 2008 Agreement on Southern Resident killer whales based on the best scientific information regarding metabolic needs of the whales, prey availability, and reductions in prey resulting from the 2008 Agreement.

The analysis focuses on effects to Chinook availability, because the best available information indicates that Southern Residents prefer Chinook (as described in Status of the Species, and discussed further below). By focusing on Chinook, NOAA Fisheries uses a conservative approach to evaluate prey reduction, because the availability of all salmon and other potential prey species within the range of Southern Residents is orders of magnitude larger than Chinook.

NOAA Fisheries evaluated potential short-term or annual effects as well as long-term effects of prey reduction from the 2008 Agreement. Short-term or annual effects of the 2008 Agreement on prey availability were evaluated by: 1) the percent reduction in Chinook available with the 2008 Agreement (percent reduction), and 2) the remaining prey base of Chinook with the 2008 Agreement compared to the metabolic needs of the Southern Resident DPS (prey available : needs). Prey available without the 2008 Agreement relative to the metabolic needs of the Southern Resident DPS was evaluated for comparative purposes.

$$\% \text{ reduction} = (\text{prey available}_{\text{w/ agreement}} - \text{prey available}_{\text{w/o agreement}}) / \text{prey available}_{\text{w/ agreement}}$$

$$\text{Prey available: needs} = \text{prey available}_{\text{w/ agreement}} / \text{prey needs}$$

This analysis highlights our level of confidence in the available data, identifies where there is uncertainty in light of data gaps, and where we made conservative assumptions. We evaluated the potential for long-term effects on prey availability based on conclusions of the salmon analysis and review of conservation objectives for individual stock groups.

NOAA Fisheries evaluated effects of the actions by comparing the 2008 Agreement to the environmental baseline (without the 2008 Agreement). The 2008 Agreement was evaluated with the 2008 Likely fishing scenario, as described in Section 7.3, Retrospective Analysis. The environmental baseline was evaluated by modeling the U.S. fisheries as closed (other than those covered under *U.S. v. Oregon*, as described in the environmental baseline), based on the assumption that U.S. fisheries would not proceed in the absence of a section 7 consultation for Southern Resident killer whales.

Because Canadian fisheries are not governed by the ESA, it is necessary to make informed assumptions about the level of Canadian fishing that would occur in the absence of an agreement. NOAA Fisheries modeled Canadian fisheries for the environmental baseline to reflect its best estimation of how Canadian management would respond in the absence of an agreement. Canadian ISBM fisheries are included in the environmental baseline at recent observed fishing rates based on the assumption that Canada would continue to constrain its ISBM fisheries to protect Canadian-origin stocks. Canadian AABM fisheries are included in the environmental baseline at levels associated with the AI and TAC levels in the 2008 Agreement, but without the negotiated 30 percent reduction in the WCVI fishery, based on the assumption that Canada would not implement reductions in its WCVI fishery in the absence of an agreement. The absence of the 30 percent reduction is based on the assumption that the United States likely would not provide mitigation funding for WCVI reductions in the absence of an agreement (L. Rutter, PSC Commissioner, pers. comm.).

By comparing fishing levels under the 2008 Agreement and the environmental baseline, it is clear that the 2008 Agreement constrains Canadian catch (including Fraser and other Chinook stocks) to a lower level than would occur in the absence of an agreement (30% reduction in WCVI fishery). However, the proposed actions affect both U.S. and Canadian fisheries. When comparing the 2008 Agreement with the environmental baseline for both U.S. and Canadian fisheries, it is clear that overall the 2008 Agreement includes more catch than the environmental baseline for Southern Residents, thereby reducing prey available to Southern Residents.

In order to evaluate how the prey reduction affects Southern Residents, we needed to consider prey reduction specific to the whales' needs, which are dependent on when the whales occur in particular areas of their range. Therefore, the prey reduction was evaluated by time and area, among other factors, based on the available information to stratify the analysis. Available data on whales as well as Chinook stocks limited fine scale stratification temporally and spatially; however, for this analysis we were able to incorporate new information on when the whales are in inland waters compared to coastal waters.

In past consultations, NOAA Fisheries estimated the number of Chinook needed by the whale population by incorporating information on the metabolic needs and diet composition of the population and the average caloric content of Chinook. Previously, NOAA Fisheries was not able to assess differences in biomass of individual Chinook available to Southern Residents, and relied on abundance estimates as a proxy measure (i.e., past consultations NMFS 2008o, 2008p). For this consultation, methods were developed to estimate the food energy of Chinook available, taking into consideration stock- and age-specific variability in size. Food energy was estimated by converting stock- and age-specific Chinook abundance estimates into kilocalories. Abundance was converted to kilocalories with intermediate steps, using a regression based on individual Chinook length and caloric content (described in more detail below). The prey available: needs parameter was estimated by directly comparing available Chinook food energy (in kilocalories) to the metabolic needs of the whale population (in kilocalories). The percent reduction parameter was likewise evaluated by comparing available food energy with and without the agreement.

In addition, a reasonable range of prey size selectivity for Southern Resident killer whales was considered. Our improved ability to estimate food energy available, combined with new modeling produced by the NWFSC (described in detail below) provides a range in size selectivity with reasonable bounds on the food energy available to the whales, dependent on their probability of pursuit.

7.9.2.1 Chinook Availability

Information on Chinook availability was based on FRAM model runs (review description of the FRAM model in Section7.3, Retrospective Analysis). FRAM provides year-specific ocean abundance estimates based on fishery data from central California to Southeast Alaska (including inland waters of Washington and British Columbia), but the model does not include any Alaskan stocks. All Chinook stocks in the FRAM model travel through the range of Southern Resident killer whales. FRAM includes all listed and non-listed Chinook stocks within the whales' range. FRAM is a single-pool model that does not provide abundance estimates of Chinook within sub regions. However, by using catch distribution patterns from the FRAM base period (1979-1982) when fisheries were broadly distributed across time and area, a method was derived to estimate abundance at a regional scale for inland waters (Strait of Juan de Fuca, east to Georgia Strait in the north, and Puget Sound in the south), and coastal waters (all FRAM fishery regions except inland waters). Regional abundance estimates were derived for two retrospective years that represent a range in high (2002) and low (1994) Chinook abundance (PSC 2008). For both years, the estimates were specific to time periods in the FRAM model for an annual cycle: October to April, May to June, and July to September.

The method used to depict regional abundance incorporated fisheries catch distribution during the model base period in waters outside the Southern Residents' range (Southeast Alaska and northern BC) and within the range of Southern Residents (Central to South Coast BC, BC Strait of Juan de Fuca and Georgia Strait, south U.S coastal waters and south U.S. Strait of Juan de Fuca and Puget Sound). The proportion of the catch outside and within the range of Southern Residents was added to the proportion returning to freshwater areas (terminal). In total, these added up to the distribution of each stock.

Depending on whether the origin of the stock was coastal or inland waters, the freshwater portion (escapement plus freshwater catch) was placed in its corresponding regional group. The proportions were treated as annual values and applied to each stock specific cohort in each model run and time period. This method assumes that ocean and inland distributions are the same across time periods, which is not the case in reality (i.e., spawning migration vs. ocean rearing). However, on a crude annual basis this method can show regional differences. Therefore, each stock has a designated distribution of regional occurrence (in inland and coastal waters) according to its annual fishery catch proportion by region and its region of origin (river of origin in inland or coastal waters). Although not a perfect method, this is the best way to show regional stratification for Chinook abundance and availability to Southern Resident killer whales, given the limitations of FRAM. Note that only pre-terminal fisheries catch data were adjusted to compare action and no action alternatives.

Chinook Food Energy

Using the FRAM model, four steps were taken to estimate Chinook food energy (in kilocalories) available for each scenario:

1) Estimate the number of Chinook within each SRKW region and time period,
2) Estimate the average length by stock, age, and time period,
3) Apply a length-to-kilocalorie regression (O'Neil et al. in prep) to the average length data to produce kilocalories per stock, age, and time period; and
4) Multiply the number of Chinook within each SRKW strata to the kilocalories derived in (3).

For each FRAM time period, the model produced stock and age specific cohort abundance for several stages: initial, after natural mortality, after pre-terminal fishing and mature run. For this analysis, the cohort abundance after natural mortality and pre-terminal fisheries were used during each FRAM time period. Using the cohort abundance at this stage excluded Chinook alive at the start of a time period that either died from natural mortality (including from SRKW) or were caught in pre-terminal fisheries during that time period. Hence, these cohort abundances theoretically represent abundance at the end of the time period rather than the beginning. This stage of the model was used even though it excluded some fish available during a portion of each time period, because the purpose of the consultation is to compare the effects of fishing. The effects of fishing within a time period are only shown using cohort abundances after fishing rather than before.

The catch and escapement proportions described above were applied to these cohorts to produce an estimate of the number of Chinook classified as within inland and coastal SRKW ranges. Mean fork-lengths for each stock and age were estimated by time period using the Von Bertallanfy growth functions in FRAM (PFMC, MEW 2008). FRAM contains two growth functions per stock; one represents growth during the ocean rearing phase and applies during pre-terminal type fisheries, and the other is for maturing fish. The rearing-type, maturing-type or an average of the two was used to derive an overall average fork length by age for each stock, depending on the age and time period. For the majority of stocks (i.e. those that mature during July through September), the average length from the rearing-type growth function was used for the Oct-Apr and May-Jun time periods. For the Jul-Sep time period, the rearing-type average length was used for age two, an average of rearing and mature types for ages three and four, and mature type only for age five fish. A converse system was used for spring-run Chinook that mature during the Oct-Apr time frame.

Length to Kilocalorie Regression

The NWFSC developed a regression for Chinook fork-length to kilocalories (Figure 7.9.2.1-1, O'Neill et al. in prep). NOAA Fisheries applied the regression to the abundance distributions by age at the sub regional scale (Appendix 4). The regression is based on data available on proximate composition of individual Chinook. Proximate composition (i.e., moisture, protein and lipid content) was determined for composite samples of males or females, each with 2-3 fish per composite (mostly 3 fish per composite). A 100-g subsample of each fish in the composite sample was dried at 105°C until a constant weight was obtained. To create the Chinook composite sample, equal weights of dried tissue (1.5 g) from each fish in the composite were combined. The dried composite tissue sample was then analyzed for protein and nitrogen (N x 6.25) using a LECO nitrogen/protein analyzer whereas total lipid content of the samples was gravimetrically determined on Soxhlet extracted tissues (AOAC 1975). Carbohydrate was not determined, because only small amounts occur in fish. Wet weight composition of % protein and % lipid for composite samples was calculated from the average % dry weight for that composite sample. From these data, the caloric content of the samples were determined using the following formula: caloric content (in Kcal) = [mass of lipid (g) x 9 Kcal/g] + [mass of protein (g) x 4 Kcal/g].

The regression included the following: 13 composite samples of blackmouth from Apple Cove Point, 9 composite Chinook sample from central coast of California (Sacramento/San Joaquin), 7 composite samples of Columbia River Spring Chinook, 10 composite samples of Columbia River Fall Chinook, 10 composite samples of Fraser River Chinook, 10 composite samples of Skeena River Chinook and 11 composite samples of Puget Sound Chinook. The stock identity of individual animals is unknown, as the genetics have not been done on the samples.

The location specific differences are not shown by the regression. For example, Puget Sound Chinook contain, on average, lower lipid content than Skeena Chinook so a Puget Sound Chinook of a specific size would have lower Kcal content than a comparable size fish from the Skeena. In general, populations will differ in their lipid content depending upon the length and elevation of their upriver migration. However within a population, lipid content will vary with maturation condition among individuals. Additionally, each data point on the regression represents a composite of 3 fish. Therefore, the fork-length to Kcal relationship for each population may be more variable than is shown in the regression (i.e., more representative of an average value).

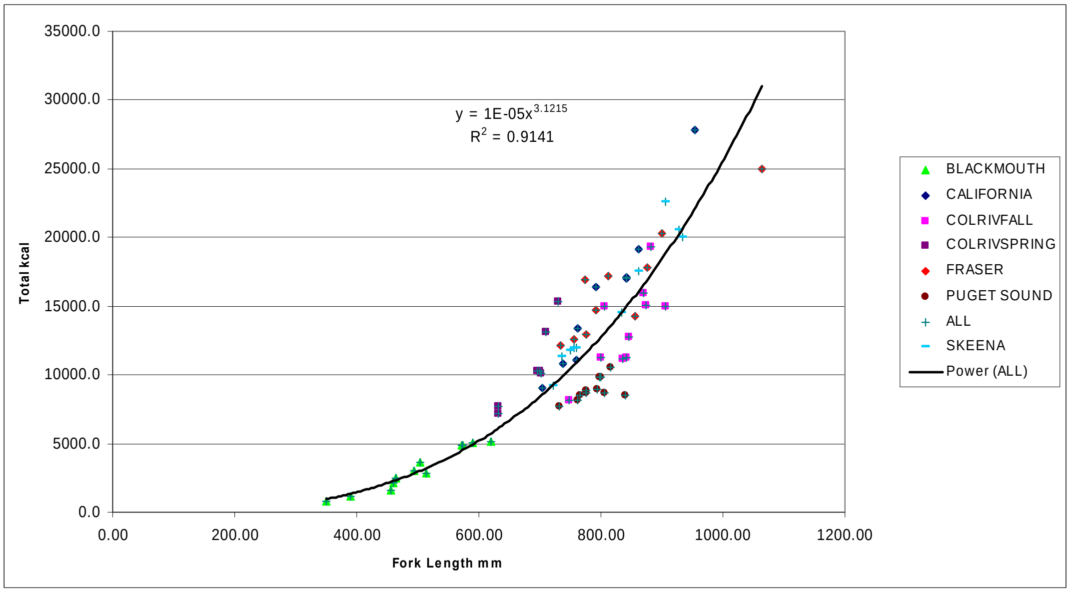

Figure 7.9.2.1-1. Regression of Chinook fork-length to kilocalories (O'Neil et al. in prep.).

Selectivity Analysis

NOAA Fisheries used a reasonable range of size selective prey preferences, based on recommendations of the NWFSC and the best available data (Ward et al. unpubl. report). A size-selective logistic model was used to depict selectivity of killer whale predation. The model is identical to many selectivity models in fisheries stock assessments (Hilborn and Walters 1992).

$$\left\{ f(x) = s_{min} + (s_{min} - s_{max})\left(\frac{1}{1+\exp(-s_a \cdot [x - s_{50}])}\right) \right.,$$

Where $s_{\min}$ and $s_{\max}$ control the minimum and maximum selectivities, s_a is steepness, s_{50} is the point at which 50 percent are selected. The logistic model is appropriate for killer whale consumption of salmon, because it allows for a range of scenarios. The relative preferences of Chinook salmon of different sizes and ages can be evaluated as $f(x_1)/f(x_2)$, where the baseline for these comparisons were 5-year old Chinook salmon (whose selectivity is 1.0). This assumption turns the relative comparison into $1/f(x_2)$, where x_2 is the length of 2, 3, or 4 year old fish.

NWFSC recommended a reasonable range of size selectivity after evaluating strictly data-based scenarios and scenarios informed by data (Ward et al. unpubl. report, Table 1, Figure 2). Data sources evaluated included, age-specific whale predation, or kill, data from Ford and Ellis (2006) and NWFSC (unpubl. data), and data depicting the age distribution of prey available from FRAM, catch data from a PSC test fishery (used in Ford and Ellis 2006, see Figure 5 of their paper), and CWT recovery data from PSMFC (Ward et al. unpubl. report). To fit data sources to the selectivity curve, observed relative preferences were compared to predicted relative preferences, using 5-year olds as a baseline, and a normal likelihood (equivalent to the sum of squares) (Ward et al. unpubl. report).

Table 7.9.2.1-1. Selectivity parameters for two models that represent a reasonable range (low and high) of prey size selectivity, given the available data.

Parameters	Selectivity Range	
	Low Selectivity[1]	High Selectivity[2]
s_a	0.01	0.023
s_{50}	465	774
Age 5 : Age 3	1.4	159

[1] Model representing low selectivity by the whales was informed by the available data, but was not strictly based on a data set (Ward et al. unpubl. report). For example, the slope s_a is equivalent to the slope using Ford and Ellis (2006) data, and the inflection point s_{50} is roughly equivalent to a 3 year old Chinook. The available kill data show 3-year old Chinook and older are taken in greater proportion than 2 year olds (Ford and Ellis 2006, and NWFSC unpubl. data).

[2] Model representing high selectivity by the whales was based on Chinook kill data from Ford and Ellis (2006), and average age distribution of Chinook available from the FRAM model (Ford-FRAM in Ward et al. unpubl. report).

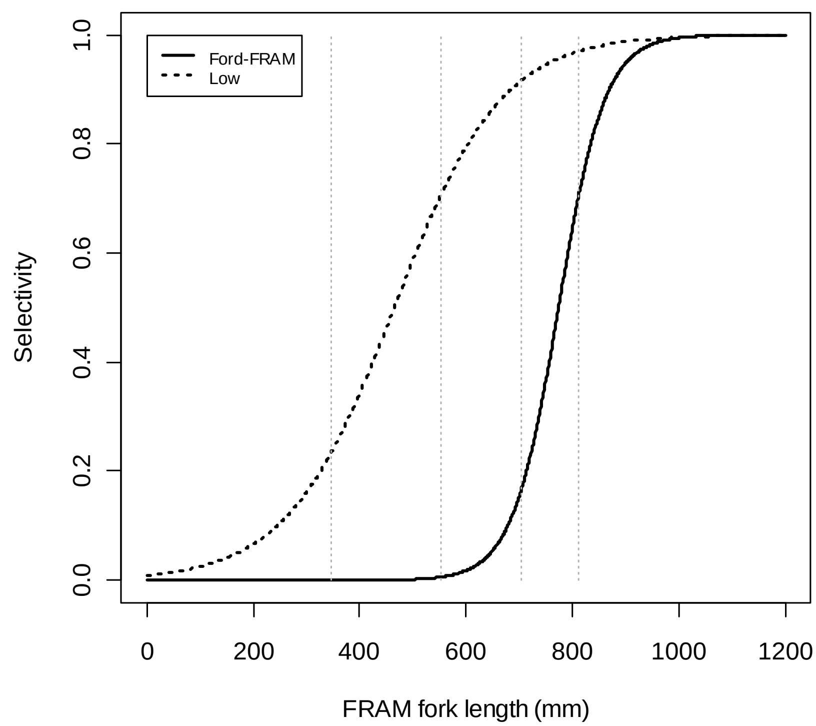

Figure 7.9.2.1-2. Length-based selectivities for 2 models of Chinook consumption by killer whales: Low selectivity and high selectivity (also called Ford-FRAM). The high selectivity model represents data from Ford & Ellis (2006) combined with average lengths from the FRAM model. Vertical grey lines represent average lengths for Chinook aged 2-5. FRAM lengths vary considerably by stock, with mean lengths of 5-year old Chinook in July-Sept ranging from 727-962mm (Ward et al. unpubl. report).

There are potential biases or other issues associated with the different data sources. Issues and biases associated with the whale predation data sources include relatively small sample sizes, particularly when evaluated by age of kills (n= 127, Ford and Ellis 2006; n= 57, NWFSC unpubl. data). The NWFSC data set does not include kills of 2-year old Chinook, which may reflect small sample size as opposed to avoidance of 2-year olds by Southern Residents. Additionally, the two data sets could not be combined to increase sample size, because the studies were conducted in different areas. Depending on the data source used to depict the age distribution of prey available, relative preferences of size and age would be skewed, because of potential difference in the size at age and age distribution per area.

Sampling methods to collect scales from prey remains could also be biased. It is possible that the probability of obtaining scale samples from predation events may improve as the size or age of the Chinook kill increases. For example, if smaller fish tend to be swallowed whole and larger fish tend to be eaten in multiple bites, prey age distribution obtained from sampled scales could be biased toward older (larger) fish. Ford and Ellis (2006) discussed this issue, and concluded that any bias was likely to be small. They did not find behavioral evidence to indicate that the whales consume smaller fish below the surface and larger fish at the surface. In addition, analysis of fecal samples (NWFSC, unpubl. data) is largely consistent with the predominance of Chinook salmon in the whale's diet. Since Chinook salmon are the largest available salmonid, the similarity between the fecal samples and the surface prey remains suggests that the surface remains are not a seriously biased sample of the prey consumed.

The estimates of age composition of available prey are likely to be biased. The data sources from fisheries catch are biased in a different way than data from the FRAM model. The FRAM model estimates are based on the total population available for each FRAM stock. Methods used to develop sub regional abundance estimates are likely less accurate for non-maturing fish than for mature fish, because catch and escapement data that inform FRAM are best represented for mature fish. For inland waters in particular, this likely means that some non-maturing fish that are likely still in the outer ocean are being counted as available to the whales. The CWT data are all based on fishery recoveries, and therefore under represent non-maturing fish, since nearly all fisheries are selective for larger (older) fish. Using the FRAM numbers may therefore tend to overestimate selectivity, while using the CWT data will likely underestimate selectivity, all else being equal.

Despite these caveats, the whales are targeting larger (older) fish in preference over smaller (younger) fish, based on the age composition of the prey taken by the whales (Ford and Ellis 2006; NWFSC unpubl. data). The range of selectivity described in Table 7.9.2.1-1 and Figure 7.9.2.1-2 is realistic, given the available data (Ward et al. unpubl. Report).

7.9.2.2 Prey Requirements

We assessed the prey requirements of killer whales by assuming Chinook comprise 86 percent of the killer whales' diet (discussed in Status of the Species) using and estimates of the whales' metabolic needs (informed by Noren, in review), stratified at the same spatial and temporal scale used to depict available Chinook food energy.

Diet Composition

After considering the available information (discussed in Status of the Species) and for purposes of this analysis, we assumed that the entire diet of the Southern Residents consisted of salmon in both inland and coastal waters. This assumption is supported by chemical analyses, which confirm the year-round importance of salmon in the whales' diet (Krahn 2002, 2007). The assumption is conservative, because there are data indicating that the whales consume other fish and squid as prey items in small amounts.

Further, we focused the analysis on Chinook, based on diet sampling that indicates Southern Resident killer whales prefer Chinook from May to September in inland waters (Ford and Ellis 2006; Hanson et al. 2007a; and NWFSC unpubl. data). Considering this information, it is reasonable to expect they also prefer Chinook when available in coastal waters and at other times of the year (although at least a portion of the population may switch to chum salmon during the fall, based on limited sampling in inland waters). We evaluated scenarios for diet composition, where the percent of Chinook is a range of fixed percents, based on the range of possibilities represented in past studies (~70% Chinook, Ford and Ellis 2006), preliminary data from ongoing research (86% Chinook, NWFSC unpubl. data), and a lower value to represent uncertainty about diet composition in coastal waters (60%).

Metabolic Needs

NWFSC developed a model to estimate the potential range of daily energy expenditure for Southern Resident killer whales for all ages and both sexes (Noren, in review). This information was combined with the population census data to estimate daily energetic requirement for all the members of the Southern Resident DPS based on the sex, age, and estimated body mass of the 85 whales in the population at the end of 2008. Although the model provides a range in daily energy expenditure, the range is meant to represent uncertainty in the calculations. Therefore, 'maximum' should not be interpreted as the maximum needs of the population, but representative of the high end of a typical range in energy requirements. Although based on the best science available, energy requirements depicted from this model may underestimate actual needs of the population.

We further stratified metabolic needs of Southern Residents by region (inland vs. coastal waters). NWFSC provided a compilation of Southern Resident killer whale sightings specific to each pod in inland waters (sighting data from January, 2003 to December, 2007; Hanson and Emmons unpubl. report). The data are based on confirmed sightings made to Orca Network. For the purposes of this analysis, we assumed that Southern Residents occurred west of the Strait of Juan de Fuca (in coastal waters) on days they were not confirmed in inland waters, primarily because the population is highly visible in inland waters. We computed the daily energy requirements by pod based on the age and sex structure of all individuals in each pod, and multiplied the daily energy requirements of each pod by the number of days in a time period that the pod was in inland or coastal waters. Energy requirements were summed across pods by time period, region and for each of three diet composition scenarios (Table 7.9.2.2-1).

Table 7.9.2.2-1. Range in energy requirements for Southern Resident killer whales by region (inland and coastal waters), time period, and for three diet composition scenarios. Minimum and maximum levels represent a typical range in energy requirements, as informed by a metabolic model (Noren, in review).

Time period	Diet Composition (% Chinook)	Inland		Coastal	
		Minimum Needs (kcal)	Maximum Needs (kcal)	Minimum Needs (kcal)	Maximum Needs (kcal)
Oct-April	86	273,080,348	327,155,665	1,919,261,209	2,299,312,934
	70	222,274,702	266,289,495	1,562,189,356	1,871,533,783
	60	190,521,173	228,248,138	1,339,019,448	1,604,171,814
May-June	86	287,605,061	344,556,559	343,210,198	411,172,613
	70	234,097,143	280,453,013	279,357,138	334,675,383
	60	200,654,694	240,388,297	239,448,975	286,864,614
July-Sept	86	530,333,782	635,350,373	421,059,724	504,437,887
	70	431,667,032	517,145,652	342,723,031	410,588,978
	60	370,000,313	443,267,702	293,762,598	351,933,410

7.9.2.3 Short-Term or Annual Effects

As described in Chapter 3, Proposed Actions, the proposed 2008 Agreement modifies an existing fishing regime and requires the U.S. and Canada to manage fisheries so as not to exceed mortality levels specified by the regime. The Parties are not required to harvest up to the allowable limit; either Party may harvest at levels less than the limits allowed by the regime. U.S. fisheries may be constrained to a greater degree than required by the bilateral agreement when, for example, more stringent constraints are necessitated by the ESA. This is reflected in NOAA Fisheries characterization of harvest under the proposed actions at 2008 Likely fishing levels, which incorporates more stringent constraints than are required by the PST agreement, a circumstance that occurs frequently for many U.S. fisheries due to ESA listings. Because currently-listed salmon ESUs are unlikely to be recovered and de-listed in the next ten years, fishery constraints currently in place are unlikely to be relaxed for the duration of the proposed agreement. However, there is some likelihood that fisheries may have to be constrained to an even greater degree as a result of new information and future consultations involving listed salmon or killer whales. Therefore, NOAA Fisheries' use of the 2008 Likely scenario in this opinion to evaluate the short-term or annual effects of prey reduction is a conservative approach because it assumes the maximum extent of prey reduction that is likely to occur for the duration of the proposed agreement.

Percent Reduction

Prey reduction attributed to the proposed actions is measured as the percent reduction with the actions (at 2008 Likely levels) compared to the baseline. For example, in 1994 during the May-June time period, in the Coastal area and assuming the low selectivity model, the analysis suggests that available prey is reduced by 5.2% as a result of fishing (Table 7.9.2.3-1). The range in percent reduction reflects annual and seasonal variability in Chinook abundance, differences by region, and the range in size selectivity of the whales' (Table 7.9.2.3-1). Generally, the percent reduction by region is greater in good Chinook abundance years than in poor abundance years. Per each time period, the prey reduction in coastal waters is greater than in inland waters. The level of size selectivity also affects the prey reduction attributed to the actions, where the percent reduction is reduced as the whales' size selectivity increases (i.e., as the whales become more size selective than the fisheries). Additionally, the proposed actions cause minimal prey reduction during the October to April time period, regardless of year or region (range from 0.1 percent to 0.8 percent reduction; Table 7.9.2.3-1). The proposed actions cause incrementally larger prey reductions during May to June (range from 1.5 percent to 6.0 percent) and July to September (range from 2.8 percent to 13.6 percent) (Table 7.9.2.3-1) when most fisheries occur.

Remaining Prey-Base Compared to Whales' Needs

NOAA Fisheries compared the food energy of prey available to the whales with the proposed actions to the estimated metabolic needs of the whales (Table 7.9.2.3-1; Appendix 5). To be conservative, we relied on scenarios that assume the whales' diet consists of mostly Chinook. Considering a range of conditions, Southern Residents could need as many kilocalories as their estimated maximum needs (based on the high-end of a typical range in daily needs, Noren, in review) and a diet composed of 86 percent Chinook (Table 7.9.2.2-1). Ratios indicate prey available is greater than the whales' needs by the magnitude of the value. For example, a ratio of 47 indicates that prey availability is 47 times energy needs of the whales.

In all cases where a sizeable percent reduction is attributed to the proposed actions (i.e., 13.6 % reduction in a good year, July-Sept, coastal), the ratios of prey available to the whales' needs without the agreement are greater than ratios with the agreement (Table 7.9.2.3-1). However, small percent reductions result in minimal to no detectable change between the ratios with and without the agreement. The ratios are generally greater in good Chinook abundance years than in poor abundance years, with and without the agreement. Similarly, the ratios are greater in coastal waters than in inland waters. Size selectivity of the whales also affects the ratio values, where the ratios are reduced as the whales' size selectivity increases (i.e., as the whales become more size selective, they are less likely to pursue smaller fish and fewer kilocalories are available to the whales).

The ratios are lowest during the October to April time period in inland and coastal waters, regardless of year. In particular, the ratios during October to April in a poor Chinook abundance year within inland waters are the lowest range of ratios evaluated, where prey available is as low as 14.3 to 2.5 times the whales' needs, depending on the whales' size selectivity. However, there is minimal to no detectable difference between the ratios with and without the agreement regardless of year, region, or selectivity of the whales during October to April. For this specific case, 14.3 to 2.5 times prey needs with the agreement are compared to 14.4 to 2.5 times prey needs without the agreement (Table 7.9.2.3-1).

The ratios are greater during May to June and July to September than observed during October to April, regardless of year (lower in inland waters but greater in coastal waters during May to June than during July to September). During May to June, prey available is as low as 20.6 to 4.5 times the whales' prey needs in inland waters, and during July to September as low as 24.2 to 7.0 times needs in inland waters, depending on the whales' size selectivity. For these specific cases, 20.6 to 4.5 times prey needs with the actions are compared to 20.9 to 4.6 times prey needs without the actions, and 24.2 to 7.0 times prey needs with the actions are compared to 25.0 and 7.3 times prey needs without the actions (Table 7.9.2.3-1). Overall, greatest difference in ratios with and without the action, and where the ratios are low, occurs during July to September in inland waters (24.2 to 7.0 times prey needs with the actions compared to 25.0 to 7.3 times prey needs without the actions).

Table 7.9.2.3-1. Range in Poor Chinook year (1994), whales' highly size-selective, high % Chinook in the whales' diet, and underestimate of Chinook stocks available (after natural mortality).

Year	Time Period	Area	Percent Reduction		Ratio Prey Available : Needs (w Agreement)		Ratio Prey Available : Needs (w/o Agreement)	
			Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity
Poor Chinook year (1994)	Oct-April	Coastal	-0.4%	-0.1%	47.1	17.0	47.3	17.0
		Inland	-0.7%	-0.2%	14.3	**2.5**	14.4	2.5
	May-June	Coastal	-5.2%	-5.0%	59.9	26.4	63.2	27.8
		Inland	-1.5%	-1.7%	20.6	4.5	20.9	4.6
	July-Sept	Coastal	-11.0%	-9.2%	54.2	18.3	60.9	20.1
		Inland	-3.6%	**-4.6%**	24.2	**7.0**	25.0	**7.3**
Good Chinook year (2002)	Oct-April	Coastal	-0.8%	-0.4%	72.7	14.9	73.3	15.0
		Inland	-0.5%	-0.2%	21.5	3.7	21.6	3.7
	May-June	Coastal	-6.0%	-4.7%	98.5	26.4	104.7	27.7
		Inland	-1.2%	-1.4%	30.3	6.6	30.7	6.7
	July-Sept	Coastal	**-13.6%**	-10.5%	97.4	23.6	112.8	26.4
		Inland	-2.8%	-4.1%	38.1	11.0	39.2	11.5

In addition to reducing prey abundance, fisheries can cause fish to disaggregate, or cause dense schools of fish to scatter (i.e., Brock and Riffenburgh 1960; Dayton et al. 1995). This phenomenon can affect the foraging behavior of marine mammals that target the aggregated prey. With respect to salmon, the effects of disaggregating prey are likely to be short-term and site-specific, with the fish able to re-aggregate again in the same or different location. While we do not have quantitative information on what effects the fishery may have on salmon aggregations or whether there is any prey density threshold that affects foraging efficiency of killer whales, there is potential for some short-term reduction in the ability of whales to efficiently catch salmon after fishing has occurred in an area.

Data Confidence, Uncertainties, and Assumptions

Section 7 of the ESA requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of threatened and endangered species or destroy or adversely modify their critical habitat, relying on the best scientific data available. Accordingly we highlight our level of confidence in the available data, identify where there is uncertainty in light of data gaps, and identify where we made conservative assumptions in the analysis to estimate effects on prey available to Southern Resident killer whales.

Data Confidence

A variety of data sources and models are used to evaluate the effects of prey reduction, including estimates of the energy requirements of the whales in certain locations at certain times, estimates of the energy available in the form of prey in certain locations at certain times, and estimates of the change in available energy in the form of prey with and without the proposed actions. These estimates are based on the best data available, but we have varying levels of confidence in the data and modeling underlying each estimate.

We are highly confident in the age, sex, and lineage of all Southern Residents, informed by a long-term data set of direct observation. Additionally, we are fairly confident in the regional and temporal characterization of the whales' presence in or absence from inland waters, because the population is highly visible and closely observed in inland waters. We are less confident about the metabolic requirements of the population, informed by modeling that uses values not directly based on the Southern Resident population (i.e., literature-based energy relationships, and whale sizes based on captive animals and other killer whale populations).

We are moderately confident of the predominance of salmon in the whales' diet year-round, and the predominance of Chinook in the whales' diet while in inland waters. We are less confident about the proportion of Chinook in the whales' diet in coastal waters, but conclude it is reasonable to assume a preference for Chinook when available.

To estimate Chinook abundance and distribution in marine waters we relied primarily on FRAM, a single pool model that uses catch and escapement data. The model was not designed to be used to estimate regional and seasonal Chinook abundance, as described previously, so several additional assumptions were required to obtain these results. Regarding the FRAM model results, we are moderately confident in the estimates of total adult Chinook abundance in marine areas, but less confident in regional distribution and abundance estimates, particularly related to the distribution of non-mature fish (2-year-olds).

Finally, we have low confidence in the data sources that informed our assumptions about the whales' selectivity of older larger Chinook. The small sample sizes, and potential biases in Chinook age composition estimates, are described in more detail above following Figure 7.9.2.1-2.

Uncertainty

In addition to variable confidence in the available data, there are data gaps which create uncertainty in the analysis. At this time, we do not have data with sufficient detail regarding whale and Chinook distribution in smaller areas or over shorter time frames than in inland or coastal waters at a seasonal level. The action could reduce prey available to the whales in specific places at specific times by a larger percent than is currently estimated by our analysis of broader areas and time frames. Additionally, we do not have any data on the foraging efficiency of Southern Residents. Without this information, we must rely on professional judgment to evaluate whether the ratio of prey available compared to the whales' needs is small or large.

Conservative Assumptions

In light of variable data confidence and uncertainty, we used conservative assumptions to focus our analysis on the most precautionary data scenarios. We conservatively assumed an all salmon diet composed mainly of Chinook in both inland and coastal waters. We also treated small fish as unavailable to the whales. This assumption reduces the food energy available to Southern Residents by as much as an order of magnitude. Additionally, we focused on the high end of metabolic requirements modeled for the population to represent the whales' needs. Further, the estimated available food energy from Chinook salmon is an underestimate, because natural mortality was already accounted for before estimating the energy available to the whales. In fact, natural mortality includes predation by killer whales. These conservative assumptions aid in meeting our obligation to ensure the proposed actions do not appreciably reduce the species ability to survive and recover.

7.9.2.4 Long-Term Effects

We rely on the salmon determinations to ensure that the proposed actions do not appreciably reduce the survival and recovery of the Southern Residents in the long-term. For the salmon analysis, NOAA Fisheries reviewed the status, environmental baseline, effects of the proposed actions, and cumulative effects for each listed Chinook ESU -- prey of Southern Residents -- and concluded that the actions are not likely to appreciably reduce the survival and recovery of Chinook (Section 9.1) and all other salmon species ESUs affected by the action (Sections 9.2 to 9.5). Additionally, NOAA Fisheries found that the actions are not likely to destroy or adversely modify designated critical habitat of any salmon ESUs (Sections 9.1 to 9.5).

These conclusions on Chinook, other salmon ESUs, and critical habitat were informed by recovery plans, objectives for priority stocks, and/or other considerations specific to individual ESUs, as discussed at length in Sections 7.4, Chinook Salmon; 7.5, Chum Salmon; 7.6, Coho Salmon; 7.7, Sockeye Salmon; and 7.8, Steelhead. The salmon analysis also considered the potential for an overall 40% reduction of Chinook in the ocean and AABM fisheries AI's from ocean conditions or climate effects (described in sections 6.6, Large-scale Environmental Variation, and 7.3, Retrospective Analysis), and found that the regime was resilient to widespread reduction, such that harvest levels were reduced and exploitation rates maintained at or below 2008 Likely levels for AABM fisheries. Additionally, many U.S. fisheries have been, and are likely to continue to be constrained more by domestic fishery management plans or actions which will undergo subsequent consultations. Therefore, as a practical matter the incidental take of ESA listed Chinook salmon in U.S. fisheries will be limited by management measures or take limits defined in U.S. fishery plans and considered in the applicable biological opinions thus providing an opportunity for ongoing review of the effects of harvest on salmon and the indirect effects of harvest on Southern Resident killer whales.

While the harvest is managed to meet objectives to promote recovery of salmon, we are not currently able to evaluate if recovery levels identified for salmon ESUs are consistent with the prey needs and recovery objectives for Southern Resident killer whales. We have no information that suggests identified salmon ESU recovery levels would be insufficient for Southern Resident survival and recovery.

7.9.3 Effects of Critical Habitat

In addition to the direct and indirect effects discussed above, the actions may have effects on critical habitat designated for Southern Resident killer whales. Based on the natural history of the Southern Residents and their habitat needs, NOAA Fisheries identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging. NOAA Fisheries evaluated effects to these features.

NOAA Fisheries did not use the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02 in this Opinion. Instead, this analysis relies on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation", in section 4 that describe the designation process, and in section 7 that set forth the substantive protections and procedural aspects of consultations, and on agency guidance for application of the "destruction or adverse modification" standard (NMFS 2005g).

Pacific Salmon Treaty fisheries are not expected to have an impact on water quality. Discharges from fishing vessels can affect water quality; however, given that fisheries occur seasonally, the small footprint from vessels across the expansive action area, and the low potential for direct interaction with the whales, we expect that any effects to water quality would be insignificant for Southern Residents.

The previous discussion of the effects on whales as a result of prey reduction is also relevant to effects on the prey feature (sufficient quantity, quality and availability of prey) of critical habitat. Effects of the fishery include a potential reduction in short- and long-term prey availability in critical habitat resulting from the harvest of adult salmon. As described previously, the proposed actions are expected to result in prey removal that represents short-term or annual reductions of Chinook in designated critical habitat of 3.6 to 4.6 percent or less (based on inland waters values in a poor Chinook year; Table 7.9.2.3-1). Additionally, NOAA Fisheries concluded that the proposed actions are not likely to jeopardize the continued existence of listed salmon or destroy or adversely modify their critical habitat.

Pacific Salmon Treaty fisheries are not expected to have a significant impact on whales' passage. The whales could have short-term behavioral responses if in close proximity to vessels. However, as discussed previously NOAA Fisheries expect limited potential for direct interaction between the Pacific Salmon Treaty fisheries and Southern Resident killer whales, because of limited temporal and spatial overlap of vessels and Southern Residents. There is substantial room for whales to maneuver around the vessels in the fleets, and we expect any short-term avoidance of fishing vessels would be insignificant.

7.10 Southern DPS of Green Sturgeon

The Southern DPS of North American green sturgeon was listed as threatened under the ESA on April 7, 2006 (NMFS 2006b). NOAA Fisheries considered the effects of salmon fisheries managed by the PFMC on green sturgeon in 2007 (NMFS 2007d). NOAA Fisheries reviewed catch records and consulted experts knowledgeable with the details of ocean salmon fishery management. All indicated that there was no record and that they had no personal knowledge of any green sturgeon being taken in the salmon fishery (NMFS 2007d). The absence of catch in the fishery is consistent with our understanding of the feeding habitats of sturgeon and the fishing methods used to catch salmon. Subadult and adult green sturgeon primarily feed on benthic prey species including shrimp, clams, and benthic fishes. Burrowing ghost shrimp comprise approximately 50 percent of the stomach contents of green sturgeon sampled in one study (NMFS 2008b). Salmon are surface or mid-water feeders that focus on pelagic prey. Salmon fishing methods are such that sturgeon encounters are unexpected. Based on the review, NOAA Fisheries concluded that Council area salmon fisheries likely had no effect on the listed Southern DPS of green sturgeon.

Salmon fisheries in Alaska and Canada, managed subject to the proposed actions, are similar in nature to those in the southern U.S. Most marine area fisheries use hook-and-line gear to target pelagic feeding salmon near the surface and in mid-water areas. Net gear that is used in terminal and nearshore areas, including in the Strait of Juan de Fuca, is fished at the surface. Green sturgeon are bottom oriented, benthic feeders. Given their separation in space and differences in feed habitats, NOAA Fisheries would not expect to catch sturgeon in the proposed salmon fisheries. As was the case with PFMC fisheries, NOAA Fisheries is not aware of any records or reports of green sturgeon being caught in the subject fisheries.

ESA listed green surgeon are caught in fisheries in the lower Columbia River. Green sturgeon are caught occasionally in recreational and commercial fisheries in the lower Columbia River directed at salmon stocks and white sturgeon which are not ESA listed or otherwise considered at risk. Retention of green sturgeon in Columbia River fisheries is prohibited, but there is some mortality associated with catch and release and misidentification in the recreational fishery. The *U.S. v. Oregon* TAC estimated that the mortality of Southern DPS green Sturgeon was approximately 14 fish per year. The effects of harvest on the listed DPS were considered in the recent biological opinion on the 2008 *U.S. v. Oregon* Management Agreement which considered proposed harvest activities over the next ten years (TAC 2008). NOAA Fisheries concluded in that opinion that the proposed fisheries were not likely to jeopardize Southern DPS green sturgeon.

Critical Habitat

Critical habitat for South DPS green sturgeon was recently proposed for designation (NMFS 2008b). The proposed critical habitat includes areas presently known to be occupied by the listed species, including U.S. marine waters within 110 meters depth from Monterey Bay, California north to Cape Flattery, Washington, and the U.S. portion of the Strait of Juan de Fuca, Washington. Also included are specified rivers in California, the lower Columbia River estuary, and other coastal bays and estuaries in California, Oregon, and Washington.

The proposed rule identifies Primary Constituent Elements (PCE) that are considered essential to the conservation of green sturgeon. The PCEs for estuarine areas include food resources, water flow, water quality, migratory corridor, water depth, and sediment quality. The PCEs for marine areas include food resources, migratory corridor, and water quality. Ocean salmon fisheries use hook-and-line gear. Salmon fisheries in estuaries rely primarily on hook-and-line gear, but gillnets and purse seines are used in some limited applications. In all cases, the gear is fished near the surface or in mid water areas. Any contact of the gear with the bottom would be rare and inadvertent. Given the nature and location of the salmon fisheries it is unlikely that they have any effect on the PCEs of the proposed critical habitat for Southern DPS green sturgeon.

7.11 Eastern DPS Steller Sea Lions

The action area includes all marine and freshwater fishing areas in SEAK, BC, and the Pacific Northwest subject to provisions of Annex IV of the Pacific Salmon Treaty. For SEAK, the area extends between the longitude of Cape Suckling (143 53’ 36” W.) and the International Boundary in Dixon Entrance, including waters of the EEZ (Section 4, Action Area). The stock boundary for Steller sea lions is Cape Suckling (NMFS 2007e). The western DPS includes animals west of the boundary, and the eastern DPS includes animals east of the boundary. Therefore, the proposed actions do not have the potential to affect the western DPS of Steller sea lions, but may affect the eastern DPS of Steller sea lions.

Steller sea lions were listed as threatened under the ESA on November 26, 1990 (NMFS 1990) across their entire range. Continued declines in the western portion of the population led to listing the western stock as endangered on May 5, 1997 (NMFS 1997b, 62 FR 24345), however the eastern stock remained listed as threatened. For the past 25 to 30 years, the eastern DPS has grown steadily at about 3 percent per year (NMFS 2008k). The final revised recovery plan (73 FR 11872) found a lack of threats to the recovery of the eastern DPS (NMFS 2008k). Nevertheless, NOAA Fisheries evaluates whether the proposed actions have the potential to incidentally take individual eastern DPS sea lions or reduce prey availability for the eastern DPS.

The eastern DPS of Steller sea lions breeds on rookeries located in southeast Alaska, British Columbia, Oregon, and California; there are no rookeries located in Washington (NMFS 2007e). Haul outs are located throughout the eastern DPS range (NMFS 2007e, 2008k). There is no indication that fisheries subject to management under the proposed actions cause disturbance to rookeries or haul outs, and NOAA Fisheries does not anticipate any effects to either.

PST fisheries of the proposed actions have not been implicated in the taking of Steller sea lions from the eastern DPS by serious injury or mortality incidental to the fisheries in the last decade (NMFS 2007e). From 1988 to 1998, the Northern Washington marine set gillnet fishery had high fishery observer coverage to detect potential interactions between the fishery and marine mammals. The Northern Washington marine set gillnet fishery has incidentally taken one Steller sea lions in the past (in 1996) (NMFS 2001b). Since 1998, observer coverage has been intermittent. In the absence of observer coverage, fishers are responsible for self reporting incidental takes. There have not been observed or self reported takes of Steller sea lions in this fishery since 1996 (Gearin 2008). Additionally, effort in the fishery has declined since the 1990's. The Southeast Alaska drift gillnet fishery has also incidentally taken Steller sea lions in the past (5 animals from 1991 to 1993) (NMFS 2001b). These past incidental takes are known from self reports, as the fishery has not been part of an observer program. There have not been self reported takes of Steller sea lions in this fishery since 1993.

NOAA Fisheries does not anticipate incidental taking of Steller sea lions from U.S. PST fisheries, based on a lack of observed or self reported incidental take in the past decade. Although unlikely, NOAA Fisheries will evaluate the need for observers to cover the U.S. fisheries of the Pacific Salmon Treaty or consider takes under 101(a)(5) and 118 of the MMPA if fishery interactions with Steller sea lions from the eastern DPS are reported (in accordance with provisions of the MMPA, 50 CFR 229.7).

Steller sea lions are generalist predators, able to respond to changes in prey abundance. Their primary prey includes a variety of fishes and cephalopods. Some prey species are eaten seasonally when locally available or abundant, and other species are available and eaten year-round (review in NMFS 2008k). Pacific hake appears to be a primary prey item across the eastern DPS range (review in NMFS 2008k). Other prey items include Pacific cod, walleye pollock, salmon, and herring, among other species. Unlike the western DPS, available evidence suggests that Steller sea lions in the eastern DPS are not nutritionally limited, since their population has increased an annual average of 3 percent over the past 25 to 30 years (NMFS 2008k). Harvest rates that would occur consistent with the proposed actions are lower than those in place during the period of time the eastern Steller sea lion DPS experienced this population increase.

Critical Habitat

NOAA Fisheries designated critical habitat for the Steller sea lion in certain areas and waters of Alaska, Oregon and California, August 27, 1993 (NMFS 1993d). Certain rookeries, haulouts and associated areas, as well as three special foraging areas were designated as critical habitat. Critical habitat east of 144 W includes air zones extending 3,000 feet above the terrestrial and aquatic zones, and aquatic zones extending 3,000 feet seaward from the major rookeries and haulouts. All three special foraging areas are west of 144 W, and therefore outside the action area. In total, there are nine Steller sea lion rookery sites, and 11 major haulout sites designated as critical habitat within the action area, from Southeast Alaska to California. As referenced above, there is no indication that fisheries subject to the PST cause disturbance to rookeries or haul outs, and NOAA Fisheries does not anticipate any effects to either. Further, prey reductions caused in critical habitat (i.e., aquatic zone) will be discountable, as described above.

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8 ▪ Cumulative Effects

Cumulative effects are those effects of future tribal, state, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. For the purpose of this analysis, the action area includes all marine and freshwater fishing areas in SEAK, BC, and the Pacific Northwest subject to provisions of Annex IV of the PST (Figure 4.1).

Cumulative effects within the Columbia River system were considered recently through the FCRPS biological opinion (NMFS 2008c). Through that opinion the states of Oregon, Washington, and Idaho provided information on various ongoing and future or expected projects that NOAA Fisheries determined are reasonably certain to occur and will affect recovery efforts in the Interior Columbia Basin (see lists of projects in Chapter 17 in Corps et al. 2007a). All of these actions are either completed or ongoing and are thus part of the environmental baseline, or are reasonably certain to occur. Examples of these projects specific to each species are given in the section on Cumulative Effects in each species chapter of the FCRPS biological opinion. They address protection and/or restoration of existing or degraded fish habitat, instream flows, water quality, fish passage and access, and watershed or floodplain conditions that affect stream habitat. Significant actions and programs include growth management programs (planning and regulation), a variety of stream and riparian habitat projects, watershed planning and implementation, acquisition of water rights and sensitive areas, instream flow rules, stormwater and discharge regulation, Total Maximum Daily Load (TMDL) implementation, and hydraulic project permitting. Responsible entities include cities, counties, and various state agencies. Many of these actions will have positive effects on the viability (abundance, productivity, spatial structure, and/or diversity) of listed salmon and steelhead populations and the functioning of PCEs in designated critical habitat. Therefore these activities are likely to have cumulative effects that will significantly improve conditions for the species considered in this consultation. These effects can only be considered qualitatively, however.

Other activities taken in the Puget Sound area were considered in the discussion of cumulative effects in the biological opinion on the Puget Sound Harvest Resource Management Plan (NMFS 2004f). That opinion discussed the types of activities taken to protect listed species through habitat restoration, hatchery and harvest reforms, and water resource management actions. A Final Recovery Plan for Southern Resident killer whales was published January 24, 2008 (NMFS 2008n). An Advanced Notice of Proposed Rulemaking regarding vessel effects on Southern Residents to gather information on the potential need for further regulations was published on March 22, 2007 (72 FR 13464). Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA listed salmon, and the listed Southern Residents, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them "reasonably certain to occur" in its analysis of cumulative effects.

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and PCEs, many of which are activities that have occurred in the recent past and had an effect of the environmental baseline. These can be considered reasonably certain to occur in the future because they occurred frequently in the recent past, especially if authorizations or permits have not yet expired. Within the freshwater portion of the action area, non-Federal actions are likely to include human population growth, water withdrawals (i.e., those pursuant to senior state water rights) and land use practices. In coastal waters within the action area, state, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives, and fishing permits. Private activities are likely to be continuing commercial and sport fisheries and resource extraction, all of which can contaminate local or larger areas of the coastal ocean with hydrocarbon-based materials. Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of a continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, although NOAA Fisheries finds it likely that the cumulative effects of these activities will have adverse effects commensurate to those of similar past activities, it is not possible to quantify these effects.

9 ▪ Conclusions

9.1 Chinook Salmon

9.1.1 Snake River Fall Chinook

Snake River fall Chinook is composed of one extant population in one MPG. Two historical populations have been extirpated. Estimates of extinction risk for Snake River fall Chinook vary depending on the time period used and other assumptions used in the analysis. The ICTRT characterizes extinction risk using data from the 1977 to 1999, and 1990 to 1999 brood years as high and moderate, respectively (ICTRT 2007c). The extinction risk analyses assume that all hatchery supplementation ceases immediately. As described in the SCA (NMFS 2008e), this assumption is not representative of the anticipated hatchery management. A more realistic assessment of short-term extinction risk would take hatchery programs into consideration, either qualitatively or quantitatively. If hatchery supplementation is assumed to continue at current levels for Snake River fall Chinook, short-term extinction risk is 0%.

Limiting factors for Snake River fall Chinook include mainstem hydroelectric projects in the Columbia and Snake rivers, predation, harvest, hatcheries, the estuary, and tributary habitat. Ocean conditions have also affected the status of this ESU. Generally, ocean conditions have been poor for this ESU over the past 20 years, improving only recently (NMFS 2008e).

Recovery planning for Snake River fall Chinook and the other listed species from the Snake River currently is in progress. NOAA Fisheries expects to propose a plan by early 2009.

The return of Snake River fall Chinook has increased significantly over the last ten years. The return of natural origin fish averaged 2,358 over the last ten years and 2,788 over the last five (Figure 5.1-1). This compares to an average abundance threshold of 3,000 natural spawners that the ICTRT identifies as a minimum for low risk. The total return of Snake River fall Chinook past Lower Granite Dam averaged 7,905 over the last ten years (through 2007) and 10,758 over the last five (Figure 5.1.2). The return in 2008 is not yet complete, but is expected to exceed 20,000. There is a concern that proportion of natural origin fish relative to the total is declining. The median proportion of natural-origin has been approximately 32% over the past two brood cycles.

The total harvest of Snake River fall Chinook was reduced substantially after they were first listed under the ESA in 1992. From 1986 to 1991, the total exploitation in ocean and inriver fisheries averaged 75%. Since 1992 the total exploitation rate for all fisheries averaged 48% (Figure 7.4.1-1). The combined effect of these overall reductions in harvest in both ocean and inriver fisheries has been to improve the baseline condition and help alleviate the effect of harvest as a limiting factor.

The prospects for the survival and recovery of Snake River fall Chinook were reviewed recently (May 2008) and in more detail in the concurrent biological opinions on the 2008 *U.S. v. Oregon*

Management Agreement, FCRPS, and Upper Snake River projects. The opinions considered a suite of Prospective Actions. The opinions concluded that it is likely that Snake River fall Chinook will have a low short-term risk of extinction, and will ensure a level of improvement that result in the ESU being on a trend toward recovery.

The no jeopardy conclusion in the FCRPS and other biological opinions is reinforced by the proposed 2008 PST agreement. The underlying analysis described in the SCA included ocean harvest as part of the baseline condition. The analysis assumed implicitly that harvest levels observed in the past would continue in the future. As indicated above, the 2008 Agreement will reduce harvest from that allowed in the 1999 PST agreement and in earlier years. We have not tried to quantify the benefits of the reduction through a revision of the SCA, but it is clear that conclusions of the FCRPS and other opinions are reinforced by the anticipated reductions in ocean harvest associated with the 2008 PST agreement.

The retrospective analysis provides insight into the likely effect of the proposed actions on Snake River fall Chinook. In that analysis NOAA Fisheries concluded that there would be a significant reduction in the harvest of Snake River fall Chinook as a consequence of implementing the 2008 Agreement. The scenarios suggest an average reduction in the Snake River fall Chinook index under the 2008 Agreement of about nine percentage points relative to the 1999 Agreement from about 0.57 to 0.48. The averages of the SRFI estimates under the 2008 Likely and 40% Reduction scenarios from 1990 to 2006 are 0.55 and 0.38. Exploitation rates in the northern AABM fisheries were reduced by half. The proposed actions will therefore further improve the baseline condition and reinforce the findings of the earlier biological opinions.

The 40% reduction scenario indicates that the management framework will be responsive to a substantial and sustained reduction in abundance that might occur as a consequence of changes in ocean conditions or climate change. Catch in the northern fisheries will be reduced substantially in order to compensate for the reduced abundance. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Designated critical habitat for Snake River fall Chinook does not include marine areas beyond the Columbia River estuary. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed action do occur in the Columbia River and its tributaries. Our review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

After reviewing the current status of Snake River fall Chinook, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Snake

River fall Chinook salmon. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for Snake River fall Chinook.

9.1.2 Upper Willamette River Chinook

There are seven populations of Chinook in the ESU; all are considered part of the same stratum or MPG. Oregon's recovery planners have tentatively prioritized all of the core populations including the McKenzie, Clackamas, North Fork Santiam, and Middle Fork Willamette for high viability, and indicated that the status of all populations needs to improve from current conditions. The extinction risk of the Upper Willamette River Chinook ESU is classified as high. The extinction risk for the component populations varies. For the Clackamas and McKenzie populations the extinction risks are listed as low and moderate, respectively. The extinction risk levels for the other five populations are all very high.

The factors that have caused the decline of this ESU to its threatened status and that are limiting the ESU's ability to recover include multipurpose dams, hatcheries, harvest, habitat degradation (tributary, mainstem, and estuarine), predation, and ocean and climate conditions. These factors are reviewed in the biological opinion on the Willamette River Project (NMFS 2008g). Of these factors, harvest is believed to have been reduced to a point where it is no longer limiting recovery, based on assessments by the ODFW as part of its recovery planning process (ODFW 2007a). Habitat degradation has been pervasive in the Willamette mainstem and the lower reaches of its tributaries and both Corps and FERC-licensed hydroelectric projects have blocked some spawning areas. Habitat loss due to blockages has been especially severe in the North Santiam, Calapooia, and Middle Fork Willamette subbasins.

The effects of harvest on Upper Willamette River Chinook were considered recently through review of ODFW's FMEP for freshwater fisheries (Kruzic 2001). Through its FMEP ODFW proposed to revise its harvest management strategy and significantly reduce the harvest of natural origin fish by mass marking all hatchery fish and implementing mark selective fisheries. Mark selective fisheries in the Columbia and Willamette rivers were fully implemented in 2002. NOAA Fisheries' review of the FMEP was based in part on a Population Viability Analysis that focused on the McKenzie River population. The effects of fishing on the Upper Willamette River Chinook were evaluated based on an analysis of extinction risk and recovery potential. The analysis focused on alternative management strategies for the freshwater fisheries, but included explicit assumptions about harvest levels in ocean fisheries. NOAA Fisheries approved the FMEP based in part on the Population Viability Analysis and the conclusions of that analysis with respect to survival and recovery.

The Draft Upper Willamette River Recovery Plan incorporated and approved the mass marking/mark selective fishing strategy described in the FMEP. The draft recovery plan concluded that these actions taken to address harvest were sufficient to address the effects of harvest (ODFW 2007a). The recovery plan concludes unequivocally that harvest is not a key or even secondary limiting factor for any of the populations in the ESU. This conclusion recognizes that the status of the Upper Willamette River Chinook populations is limited by factors other than harvest, and that the survival and recovery of these populations can only be addressed by actions that focus on the proximate cause of the species current status.

The effects of harvest on Upper Willamette River Chinook were also considered recently through the biological opinion on the Willamette River Basin Flood Control Project (NMFS 2008g). The biological opinion on the Willamette Project incorporates the conclusions of the draft recovery plan regarding population status and reiterates that harvest is not a limiting factor. The biological opinion concludes that the proposed Willamette Project is likely to jeopardize Upper Willamette River Chinook. The opinion then follows with a comprehensive RPA that supplements the proposed action to systematically address the limiting factors and threats for each population. The opinion concludes that the RPA and proposed action, when combined with recent improvements in project facilities, are not likely to jeopardize the continued existence of the Upper Willamette River Chinook ESU.

Harvest in ocean and inriver fisheries has declined over recent years. Since 1996, the exploitation rate in all fisheries has been reduced from an average of 51% to 21% (Figure 7.4.2-1). The combined effect of these overall reductions in both ocean and inriver fisheries has been to improve the baseline condition and help alleviate the effect of harvest as a limiting factor.

The retrospective analysis provides insight into the likely effect of the proposed actions on Upper Willamette River Chinook. In that analysis NOAA Fisheries concluded that there would be a small, but measureable reduction in harvest as a consequence of implementing the 2008 Agreement. Comparison of the 1999 Agreement and 2008 Agreement scenarios indicates that the average exploitation rate in northern fisheries will be reduced from 0.18 to 0.16. The proposed actions will therefore further improve the baseline condition and reinforce the findings of the earlier biological opinions.

The 40% reduction scenario indicated that the management framework will be responsive to a substantial and sustained reduction in abundance that might occur as a consequence of changes in ocean conditions or climate change. Catch in the northern fisheries will be reduced substantially in order to compensate for the reduced abundance. Comparison of the 2008 likely and 40% reduction scenarios suggests that the exploitation rate in the northern AABM fisheries will be reduced from 0.19 to 0.17. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

Designated critical habitat for Upper Willamette River Chinook does not include marine areas beyond the Columbia River estuary. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed action do occur in the lower Columbia River and its tributaries. Our review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

After reviewing the current status of Upper Willamette River Chinook, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Upper Willamette River Chinook salmon. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for Upper Willamette River Chinook.

9.1.3 Lower Columbia River Chinook

The Lower Columbia River Chinook ESU has a complex structure consisting of three life history types, each with multiple populations that are distributed across three ecological regions or MPGs (Table 5.1.3.1-2). Consideration of the jeopardy decision requires a review of the components of the ESU which include the various life history types and the six MPGs that result from their distribution across the regions.

Spring Chinook Populations

Spring Chinook populations occur in both the Gorge and Cascade MPGs. The Hood River and White Salmon populations are the only populations in the Gorge MPG. Both are extinct. Recovery of these populations will therefore depend on reintroduction efforts. Condit Dam, located at river mile 3.3 on the White Salmon River, is scheduled for removal in 2008. Plans are to eventually reintroduced spring Chinook into the White Salmon River from an out of basin stock. Spring Chinook from the Deschutes River are being reintroduced into the Hood River. The Deschutes River is the nearest source for brood stock, but the population is from the Middle Columbia River ESU. Given the circumstances, the proposed actions are not likely to further reduce the likelihood of survival and recovery for the Gorge MPG populations. The effects of harvest on these populations may have to be reconsidered if and when the reintroduction programs are initiated and begin to take effect.

There are seven spring Chinook populations in the Cascade MPG. The Upper Cowlitz, Cispus, and Tilton populations (collectively referred to as Cowlitz) are all located above Mayfield Dam which has no juvenile or adult passage. Current production of spring Chinook in the production areas above Mayfiled Dam is maintained through juvenile hatchery plants and an adult trap-and-haul program. Escapement estimates to the Cowlitz refer to fish returning to the area below Mayfield Dam (Table 5.1.3.1-5).

Spring Chinook populations from the Cowlitz, Lewis, and Kalama rivers are considered to be at high or very high risk of extinction. The extinction risk for the Sandy population is classified as moderate. There are many limiting factors for Cowlitz, Lewis, and Kalama that are summarized in LCFRB 2004 and reports related to the PCSRF (PCSRF 2006). For the Cowlitz and Lewis populations in particular, the paramount limiting factor is the dams that block access to their historic spawning and rearing habitat. The current trap-and-haul program is an interim step to reintroduce spring Chinook to areas above the Dam, but is not sufficient by itself to provide for survival and recovery. There are long-term risks associated with hatchery operations in the Cowlitz and Lewis rivers that are being addressed, but it is also true that these populations would have been extirpated had they not been maintained in the hatcheries. Harvest is included along with other limiting factors for the Cowlitz, Lewis, and Kalama populations. Key limiting factors for Sandy River spring Chinook include habitat quality in the estuary, and reduced habitat quality and access in the tributaries. Harvest is considered a secondary limiting factor for the Sandy River population.

Recovery planners have prioritized the Cowlitz (Upper Cowlitz and Cispus), Lewis, and Sandy populations for high viability. Recovery of these populations would provide the necessary diversity for this MPG and the ESU as a whole. Recovery plan recommendations that pertain to harvest and hatcheries rely on a strategy that integrates the use of hatcheries to promote survival and recovery along with harvest reforms, most of which have already been implemented. For the Cowlitz and Lewis river populations, hatcheries are being used to reintroduce fish to the upstream habitat above impassable barriers. For the Kalama and Sandy populations, the recovery plans emphasize the use of hatcheries for supplementation. As a consequence, harvest is managed to meet hatchery escapement goals to support the supplementation and reintroduction programs. Hatchery escapement goals have been met and exceeded by a wide margin in recent years. Escapements to the three populations in Washington have numbered in the thousands per year (Table 5.1.3.1-5). For the Sandy population in Oregon the return of natural origin fish to Marmot Dam has averaged approximately 1,700 in recent years, well above the quasi-extinction threshold. This does not account for the additional spawning of natural-origin fish below the dam. The tentative delisting and broad sense recovery goals for Sandy River spring Chinook are 1,400 and 1,900, respectively, although these goals are subject to further review through Oregon's ongoing recovery planning process. The total return of spring Chinook to the Sandy including hatchery fish has averaged more than 6,000 since 2000 (Table 5.1.3.1-5). Escapements are such that there is little near term risk to the survival of these populations. Recovery will require actions to address other limiting factors. But the prospects for recovery are not appreciably reduced by the proposed actions considered in this opinion because escapement goals will continue to be met thus allowing the reintroduction and supplementation programs to proceed unimpeded until the more substantive habitat limitations are addressed (e.g., adult and juvenile passage to headwater spawning and rearing areas).

In the meantime, consistent with recovery plan recommendations, harvest in Columbia River fisheries is managed using mark-selective techniques for all spring season recreational and commercial fisheries to minimize the effects on natural-origin spring Chinook. Mark-selective fishing is facilitated by the requirement that all hatchery fish be marked for visual identification. The transition to mark-selective spring season fisheries was completed in 2002. The emphasis on mark-selective fisheries also supports the recovery of spring Chinook from the Upper Columbia, Snake River, and Upper Willamette River ESUs. The effects of harvest in ocean fisheries have also been reduced over time. Since 1992, the exploitation rate in all fisheries has been reduced from 51% to 31% (Figure 7.4.3.1-1). The combined effect of these reductions in harvest has been to improve the baseline condition and help alleviate the effect of harvest as a limiting factor.

The effects of harvest to Lower Columbia River spring Chinook in Columbia River and PFMC fisheries were reviewed in recent biological opinions regarding the 2008 *U.S. v. Oregon* Management Agreement (a ten year agreement) and fisheries proposed for 2008 in the Council area. NOAA Fisheries concluded that these actions were not likely to jeopardize the Lower Columbia River ESU including the spring Chinook populations.

NOAA Fisheries also considered the effect of the proposed actions on these populations, in part, through the retrospective analysis. In that analysis NOAA Fisheries concluded that there would be a small, but measureable reduction in harvest as a consequence of implementing the 2008 PST Agreement. Comparison of the 1999 Agreement and 2008 Agreement scenarios indicates that the average exploitation rate in northern fisheries will be reduced from 0.07 to 0.06. The proposed actions will therefore further improve the baseline condition and reinforce the findings of the earlier biological opinions.

The 40% reduction scenario indicated that the management framework will be responsive to a substantial and sustained reduction in abundance that might occur as a consequence of changes in ocean conditions or climate change. The catch in the northern fisheries would be reduced substantially in order to compensate for the reduced abundance. Comparison of the 2008 likely and 40% reduction scenarios suggests that the exploitation rate on Lower Columbia River spring populations in the northern AABM fisheries will be maintained at approximately 0.06. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance. The retrospective analysis thus indicates that the management regime that would be implemented through the proposed actions would respond appropriately even in the unlikely event of a sustained and significant reduction in abundance that might occur as a result of a change in climate or ocean conditions.

Bright Chinook Populations

The North Fork Lewis and Sandy River populations are the only bright populations in the ESU. Both are located in the Cascade MPG and prioritized by recovery planners for high viability. They are also both designated as genetic legacy populations (Table 5.1.3.1-2). The current extinction risk for the North Fork Lewis River and Sandy River bright populations are classified as moderate and low, respectively. Key limiting factors for these bright populations include habitat quality in the estuary, and reduced habitat quality and access in the tributaries among others. There are no in basin hatchery production programs for these populations, so they are not greatly affected by hatchery strays. Competition in the estuary with hatchery fish from other species or populations is noted as a secondary limiting factor for the Sandy River population. Harvest is considered a limiting factor for both populations.

The North Fork Lewis population is the principal indicator stock for harvest management. It is a natural-origin population with little or no hatchery influence. The maximum sustained yield escapement goal is 5,700. The Interim Regional Lower Columbia River Recovery Plan (LCFRB 2004) recommends that the North Fork Lewis population be managed subject to an escapement goal of 5,700. Current management is therefore consistent with the recommendations of recovery planners.

The escapement in the North Fork Lewis was below the escapement goal in 2007 and was expected to be below goal again in 2008. But these lower returns are consistent with a pattern of low escapements for other far north migrating bright populations including Oregon coastal stocks and upriver brights that return to the Hanford Reach area. This pattern of low escapements for a diverse range of stocks suggests that they were all affected by poor ocean conditions. The population has generally been well above its escapement goal with returns in this decade in excess of 10,000 fish per year (Table 5.1.3.1-6). The available information regarding the status of the populations suggests that there is little near term risk to the survival of either of the bright populations and that the prospects for recovery are good.

TAC provided estimates of the escapement of bright Chinook to the Sandy River (Table 5.1.3.1-6) (TAC 2008), but it is apparent that these are estimates for an index area that is surveyed directly. These estimates are expanded to account for spawners in areas that are not surveyed. The geometric mean of the estimate of total spawners is 2,771 (Table 5.1.3.1-4). These estimates have been used by Oregon's recovery planners to assess the status of the population (ODFW 2007b). Oregon has concluded that the Sandy bright population is at low risk and further indicated that the population is viable under current harvest patterns (ODFW 2007b). The tentative delisting and broad sense recovery goals for Sandy River bright Chinook are 4,600 and 5,500, although these goals are subject to further review through Oregon's ongoing recovery planning process.

Harvest in both ocean and in-river fisheries has declined over the years. The exploitation in all fisheries has been reduced from an average of 54% prior to 1993 to 34% since. The combined effect of recent changes in harvest management has been to improve the baseline condition and help alleviate the effect of harvest as a limiting factor.

The effects of harvest in Columbia River and PFMC fisheries on Lower Columbia River bright Chinook were reviewed in recent biological opinions regarding the 2008 *U.S v. Oregon* Management Agreement (a ten year agreement) and fisheries proposed for 2008 in the Council area. The opinion on the *U.S. v. Oregon* Agreement considered that these bright population would continue to be managed using the 5,700 fish escapement goal for the North Fork Lewis population. NOAA Fisheries concluded that these actions were not likely to jeopardize the

Lower Columbia River ESU including the bright Chinook returning to the North Fork Lewis and Sandy rivers.

The retrospective analysis provides insight into the likely effect of the proposed actions on these populations. In that analysis NOAA Fisheries concluded that there would be a small, but measureable reduction in harvest as a consequence of implementing the 2008 PST agreement. Comparison of the 1999 Agreement and 2008 Agreement scenarios indicates that the average exploitation rate in northern fisheries will be reduced from 0.14 to 0.12. The proposed actions will therefore further improve the baseline condition and reinforce the findings of the earlier biological opinions.

The 40% reduction scenario indicated that the management framework will be responsive to a substantial and sustained reduction in abundance that might occur as a consequence of changes in ocean conditions or climate change. Provisions of the agreement would reduce the allowable catch in the northern fisheries to compensate for the any such reduction in abundance. Comparison of the 2008 Likely and 40% Reduction scenarios suggests that the exploitation rate in the northern AABM fisheries will be reduced from 0.11 to 0.10. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance. The retrospective analysis thus indicates that the management regime that would be implemented through the proposed actions would respond appropriately even in the unlikely event of a sustained and significant reduction in abundance that might occur as a result of a change in climate or ocean conditions.

Tule Chinook Populations

As discussed in section 5.1.3-1 consideration of the status of Lower Columbia River tule populations, and ultimately the effects of the proposed actions, requires some understanding of the relationship between hatchery and natural-origin fish. Consideration of the status of Lower Columbia River Chinook and the tule populations in particular is complicated and requires some understanding of the relationship between hatchery and natural-origin fish in addition to information on the VSP parameters and the other common risk metrics used to assess population status. The Lower Columbia River Chinook tule populations have been subject to high harvest rates, degraded habitat conditions, and extensive hatchery influence for decades. It is clear from the record that the hatchery fish have strayed into natural spawning areas and, in most cases, dominated the natural spawning that has occurred in these systems. In some cases, hatchery populations were derived from a single stock and have been maintained through time (e.g., Cowlitz River and Spring Creek Hatchery (which is derived from the White Salmon River population)). Although these hatchery stocks may have diverged from their source populations due to the effects of hatchery domestication, they are at least associated genetically to their source population. In other cases, hatchery brood stocks have been mixed over the years and are thus an amalgam of the contributing stocks (e.g., Washougal, Elochoman, Kalama, Toutle, Big Creek.). Several populations have hatcheries located in basin, but most other populations are also subject to substantial straying from adjacent or nearby hatchery programs (e.g., Mill/Abernathy/Germany, Youngs Bay, Clatskine, Scappoose).

It is therefore pertinent, when considering whether an action is likely to appreciably reduce the survival and recovery of a population, or jeopardize the ESU as a whole, to consider the extent of local adaptation to natural conditions in these populations and whether it has been compromised by past practice to the point where it is no longer distinct. Populations are defined by their relative isolation from each other which presumably allows for their adaptation to unique conditions that exist in specific habitats. If there are populations that still retain their historic genetic legacy, then the appropriate course to insure their survival and recovery is to preserve that genetic legacy and rebuild those populations. Preserving that legacy should be a high priority and, if threatened, requires a sense of urgency and implementation of actions necessary and appropriate to preserve the unique characteristics of those populations. However, if the genetic characteristics of the populations are significantly diminished and we are left with individuals that can no longer be associated with a distinct population, then the appropriate course to recover the population, consistent with the requirements of the ESA, is to use individuals that best approximate the genetic legacy of each population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions. These circumstances will require a deliberate response, but one that may be less urgent in the sense that coordinated progress can and should be made over time to address the limiting factors. For example, if the source of individuals for the rebuilding effort is a hatchery with thousands of returning fish, then recovery will have to occur through a coordinated and deliberate strategy that reduces the effects of hatchery straying and harvest, and improves the habitat to the degree necessary for the population to adapt and rebuild. Retaining some of the hatchery fish may be important for the near term to provide on ongoing source of brood stock during the transition and guard against catastrophic loss. The transition will most often involve allowing time for habitat improvements and for the population to readapt to exiting circumstances. Given the nature of these processes, it is reasonable to expect that rebuilding and recovery will take years and perhaps decades of consistent and steady progress. Our assessment of the effects of the proposed actions takes these considerations into account. In the following discussion, we first summarize information related to the Gorge MPG, and then consider the Cascade and Coastal MPGs under a single heading because of their closely related circumstances.

There are twenty one populations of tule Chinook with some located in each of the three MPGs (Table 5.1.3.1-3). There are four populations in the Gorge MPG, ten in the Cascade MPG, and seven in the Coastal MPG.

The Gorge MPG

There are four tule Chinook populations in the Gorge MPG including the Lower Gorge, Upper Gorge, White Salmon, and Hood. All are considered to be at either high or very high risk of extinction. None are considered genetic legacy populations. Recovery planners propose to maintain or improve the status of all of these populations. But the long term viability goals for the Upper Gorge and Hood populations are for low viability with the expectation that the populations will be maintained at their current levels (Table 5.1.3.1-3). The viability goals for the Lower Gorge and White Salmon populations are for medium viability which will require some improvements in the existing status.

The Lower Gorge population is affected by among other things low flows in the fall which limits access to spawning areas in these small tributaries, and by competition with later spawning bright fall Chinook. The Upper Gorge population is limited by strays from the Spring Creek Hatchery and upriver brights from other areas, and because the pool behind Bonneville Dam inundates a significant portion of their spawning habitat in the Wind River.

The White Salmon population is limited by Condit Dam which is located at river mile 3.3. There is natural spawning in the river below the Dam, but that spawning is almost certainly dominated by strays from the Spring Creek Hatchery. The hatchery, which is located immediately downstream from the river mouth, is the largest tule Chinook production program in the basin releasing 15 million smolts annually. The White Salmon River was the original source for the hatchery brood stock so whatever remains of the genetic heritage of the population is contained in the mix of hatchery and natural spawners. There is little near-term risk to this populations' survival, at least to the extent that it is represented by the Spring Creek Hatchery stock, but recovery of a naturally reproducing population more consistent with the goals of the ESA would require institutional changes that are not contemplated at this time.

Oregon's recovery planners consider the Hood population to be extirpated or nearly so. Habitat in the basin was relatively limited historically. Upstream areas are still accessible, but the lower reaches are inundated by Bonneville Pool.

Populations in the Gorge MPG are at high risk. Recovery planners have proposed that the status of these populations be maintained or improved, but they have not prioritized the recovery of these populations to higher levels of viability as part of the more comprehensive recovery strategy for the ESU. Harvest in ocean and inriver fisheries have been reduced significantly in recent years, and will be further reduced as a result of the proposed actions. These harvest reductions will thus improve the status of the Gorge populations relative to the baseline and contribute to their prospects for their survival and recovery. These populations will nonetheless continue to be at some risk unless and until a more comprehensive strategy for their recovery is implemented. We must account for this deficiency when considering our overall conclusion with respect to the ESU.

The Cascade and Coastal MPGs

There are ten populations in the Cascade MPG. Most of the tule populations in the Cascade MPG are considered to be at high or very high risk of extinction (Table 5.1.3.1-8). The Coweeman and Lewis river populations are considered at moderate risk of extinction. Both are identified as genetic legacy populations. Recovery planners have proposed that the Coweeman, Lewis, Toutle, Washougal, and Sandy be prioritized for high viability. The Washougal and Toutle populations are currently associated with major in basin hatchery programs. The Clackamas is proposed for medium viability. These populations are therefore targeted for recovery and intended to provide the necessary diversity to meet recovery objectives for the Cascade tule MPG. Populations in the Lower Cowlitz and Kalama are to be managed in association with the in basin hatchery programs. The hatcheries are operated as isolated programs meaning there are no out-of-basin brood stock transfers. This helps protect the genetic characteristics of these populations, but there is no intent to manage these populations as naturally spawning and self sustaining populations. Populations in the Upper Cowlitz and Salmon rivers are not targeted for improvements because of more intractable limiting conditions.

There are seven populations in the coastal MPG. All of the tule populations in the Coastal MPG are considered at high or very high risk of extinction (Table 5.1.3.1-8). None are considered genetic legacy populations. Recovery planners from Washington have designated the Grays and Elochoman as priority populations that would be managed for high viability. The Mill/Abernathy/Germany population is proposed for medium viability. Oregon recovery planners have tentatively designated the Clatskanie and Scappoose as priority populations. The Elochoman population is currently associated with a major in basin hatchery program. Oregon's recovery plans for the Youngs Bay and Big Creek populations are also tentative, but they have most recently suggested they be managed for medium viability. The Big Creek and Youngs Bay populations are both proximate to a major net pen rearing and release program that provides for a localized, terminal fishery in Youngs Bay. These populations are therefore subject to considerable straying from the released fish that go uncaught. Oregon is not proposing through their recovery planning process to reduce the net pen programs.

Lower Columbia River tule populations in the Cascade and Coastal MPGs are subject to the full range of limiting factors including tributary and mainstem hydropower development, harvest, and ecological factors related to predation and degradation of the estuary. Tributary habitat has been degraded by extensive development and other types of land use. Fall Chinook spawning and rearing habitat in tributary mainstems has been adversely affected by sedimentation, increased temperatures, and reduced habitat diversity. Many naturally-spawning populations have been subject for many years to the effects of a high incidence of naturally-spawning hatchery fish. Exploitation rates exceeded 0.80 in the 1980s (Figure 7.4.3.3-1). Despite reductions in recent years, harvest is still considered a limiting factor.

The Interim Regional Recovery Plan identifies nine actions to be taken for Lower Columbia River Chinook. NOAA Fisheries reviewed these actions in the recent biological opinion on 2008 PFMC fisheries (NMFS 2008h). Most of these actions either have been or are being implemented (NMFS 2008h). Items 1 and 3, and 8 and 9 are most important for tule populations. Item 1 calls for a continuing review of the exploitation rate limits and inclusion of additional indicator populations in the analysis. Item 3 calls for periodic review of harvest targets for fall

Chinook to assure that harvest objectives are consistent with measures of habitat productivity and capacity. When these recommendations were formulated, the Coweeman was the only indicator and we were relying on an exploitation rate limit RER of 0.49. Since then we have added two additional indicators (East Fork Lewis and Grays), and continue to review and revise harvest objectives. Analysis associated with HSRG and recovery planning is designed to account for the relationship between harvest and other factors that are affecting productivity. Items 8 and 9 from the recovery plan recommend developing a basin wide marking plan for hatchery tule Chinook and associated monitoring program, and resolving technical and policy issues associated with mass marking. The mass marking program has now been fully implemented, and a significant review of hatchery management policy has occurred through the HSRG process. These actions actually exceed the recommendations contained in items 8 and 9. Item 2 in the recovery plan suggests considering the development and use of an abundance base harvest matrix for tule populations. However, abundance based management relies on the use of preseason forecasts of abundance. Information necessary to do a forecast is unavailable at this time, so this recommendation is not currently feasible.

Abundance information is sufficient to analyze trends for about half of the tule populations in these MPGs. Analysis of the data through 2001 for Washington populations and 2004 for Oregon populations indicates that long term trends and median population growth rates are less than 1for most populations (Table 5.1.3.1-4). More recent information for Washington populations indicates that escapements have been higher in recent years than in the past decade (Table 5.1.3.1-10). Escapements to the Coweeman and Lewis rivers have averaged 980 and 360 over the last five years; escapement to the Washougal has averaged almost 5,100. Escapement to the Elochoman in the Coastal MPG has averaged over 4,300. As indicated above, the Coweeman and Lewis populations are subject to relatively little hatchery influence. Escapements to the Washougal and Elochoman are higher because of the associated hatchery programs. Similar information for other priority populations in the Cascade and Coastal MPG is not available.

The effects of harvest have been reduced in recent years. From 1983 to 1993, the total exploitation rate in ocean and inriver fisheries averaged 69%. Since 1994 the total exploitation rate for all fisheries averaged 42%. ESA related harvest limits have become increasing restrictive since the ESU was listed. In 2001 fisheries were subject to a total exploitation rate limit of 65%. From 2002 to 2006 fisheries were managed subject to a limit of 49%. The limit was reduced further to 42% in 2007 and 41% in 2008. The combined effect of recent changes in harvest management has therefore been to improve the baseline condition and help alleviate the effect of harvest as a limiting factor.

The retrospective analysis provides insight into the likely effect of the 2008 Agreement on the harvest of tule populations. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that would be allowed under the respective agreements given the abundance levels observed in each year and assuming that southern U.S. ocean fisheries are managed subject only to the minimum requirements specified in the two scenarios for ISBM fisheries. For Lower

Columbia River tule Chinook the difference between the 1999 Agreement and 2008 Agreement scenarios is significant. The scenarios indicate that the total exploitation rate of Lower Columbia River tule Chinook would be reduced by about three percentage points from an average of 0.476 to 0.444 under the respective scenarios. In these scenarios ISBM fisheries in the south are constrained only by the general obligation for ISBM fisheries and therefore do not reflect what further reductions would be required in the south to meet ESA standards for tule populations or other stocks of concern. These results indicate that Lower Columbia River tule Chinook will benefit from the 30% reductions in catch in the WCVI fishery, and from the redistribution of catch between troll and sport fisheries and seasons.

The 2008 Likely scenario estimates the exploitation rates under a "likely" range of fishing levels during the next ten years given current constraints on ESA listed Chinook stocks. AABM fisheries in the 2008 Likely scenario were modeled using the same abundance levels and quotas as in the 2008 Agreement scenario, although there is some redistribution of the catch between the troll and sport fisheries, and between fishing seasons in the WCVI fishery. The ISBM fisheries were modeled with fishing effort rates observed in recent years. The estimated total exploitation rates under the 2008 Agreement and 2008 Likely scenarios are 0.44 to 0.41, respectively. The 2008 Likely scenario approximates the sort of reductions expected to occur in southern fisheries based on observations from recent years. The results indicate that on average the current 41% limit would be achieved. In fact, this outcome can be assured because southern fisheries will have to be managed every year to achieve the 41% standard or whatever alternative standard NOAA Fisheries eventually articulates through its subsequent guidance and related consultations. More than half of the harvest mortality of tules occurs in southern fisheries. Therefore, NOAA Fisheries retains sufficient jurisdiction, opportunity and discretion to reduce harvest as needed to meet the 41% limit or any other reasonably foreseeable exploitation rate limit.

NOAA Fisheries has used various life cycle modeling approaches to help inform our assessment of the effects of harvest on tule Chinook populations. The VRAP and SPAZ were used to analyze data for the Coweeman, East Fork Lewis and Grays river populations. These were selected as indicator populations because of the availability of the necessary data and because these populations were thought to be subject to relatively little hatchery straying. There was a Chinook hatchery on the Grays River until recently, but that program was closed in 1997. The relative absence of hatchery fish in the Grays is therefore a recent occurrence. Results from these two approaches were similar. Rebuilding exploitation rates (RER) for the Coweeman ranged from 0.34 to 0.58, and for the East Fork Lewis population 0.44 to 0.52 (Table 7.4.3.3-1). Results from the SPAZ analysis are harder to summarize. Results depend on, among other things, the QET value used. For a QET of 150 exploitation rates of 0.50 were consistent with an acceptable probability of viability; for a QET of 50 exploitation rates of 0.25 were consistent with a comparable probability of viability (Table 7.4.3.3-2). The RER for the Grays population ranged from 0.00 to 0.20. Results from the SPAZ analysis were generally comparable suggesting the population would remain at risk even with little or no harvest.

A common characteristic of the VRAP and SPAZ methods is that they assumed that estimates of productivity observed in the past would continue in the future. The HSRG, and Washington and Oregon recovery planning processes took a different approach to their life cycle analyses. They considered estimates of past productivity, but also considered how much productivity would have to improve to satisfy specified risk criteria for the populations. They considered actions taken to date and the feasibility of achieving additional improvements through habitat actions, hatchery reforms, and harvest reductions. The resulting target exploitation rates from the HSRG analysis ranged from 0.32 to 0.34. The target from Washington's Interim Regional Recovery Plan was 0.38. Oregon has not completed their recovery planning yet, but they are currently using a target exploitation rate of 0.35. In all cases, they indicate that these rates will be phased in as mark selective fishing is implemented, but are not specific about the timing for phasing in the harvest reductions. The reduction would presumably be from the most recent exploitation rate limit of 0.41 that was implemented through consultation in 2008. Mark selective fisheries cannot begin until 2010 when most of the returning hatchery fish will be marked, or 2011 when all returning hatchery fish will all be marked.

NOAA Fisheries' indicated in its recent opinion on the PFMC fisheries that fisheries in 2008 should be managed subject to a total exploitation rate limit of 41%. NOAA Fisheries also indicated that it would continue its review of the status of the tule populations and the effects of harvest, and implement changes that are consistent with the evolving information, the expected evolution of the hatchery programs, and the long term goal of recovery articulated in the Interim Regional Recovery Plan. NOAA Fisheries consulted on PFMC fisheries for 2008 while assuming that exploitation rates in 2009 and thereafter would be no greater than 41%, and conveying to the Council their expectation the further reductions in harvest may be required.

The prevailing theme in recent opinions on Lower Columbia River Chinook is one of change and the need to anticipate and consider new information as it becomes available. In the preceding discussion we also highlighted the need to consider the relationship between hatchery and naturally spawning fish, the resulting effects on population status, and the need for a coordinated and deliberate strategy that would allow the populations to readapt to their current circumstances and recover. Areas of ongoing work consistent with these themes include recovery planning, hatchery reform, population risk assessment, and efforts to integrate harvest, hatchery, and habitat related actions that will in combination lead to recovery. Progress has been made recently on all of these fronts. Recovery planners have described recovery scenarios that identify priority populations. Hatchery reform is ongoing, but substantial changes that will contribute to population specific improvements in survival have already been implemented. Habitat actions have been taken though the FCRPS opinion that will improve survival in the estuary; additional actions have been taken such as those described for the Grays River that will improve survival in the tributaries. Population risk assessments have narrowed the range of exploitation rate limits that are likely to be needed to achieve recovery objectives, and further emphasize the need to focus on populations within the coastal MPG in particular. The HSRG and recovery planning processes have developed recovery scenarios that seek to integrate action sectors and thereby provide further guidance on how to manage fisheries in conjunction with other actions to achieve recovery. Although progress has been made, we expect that new information will continue to accumulate over the next several years to better inform future actions. It is therefore necessary to recognize the dynamic nature of the current circumstances as we consider the effects of the proposed actions on Lower Columbia River tule Chinook populations in particular.

The 2008 PST Agreement caps AABM fisheries, which includes the two Canadian fisheries where most of the impact on tules occurs, and thereby removes uncertainties about harvest levels in northern fisheries. The retrospective analysis suggests that the exploitation rate on tule populations in northern fisheries will be on the order of 0.18. The 2008 Agreement will secure significant reductions in harvest on tule Chinook in the AABM fisheries that will be on the order of three percentage points. NOAA Fisheries intends to ensure that these savings are passed through to escapement by reducing the 0.41 exploitation rate limit that applied in 2008. The Agreement includes limits on ISBM fisheries for the benefit of specific stocks identified in the Agreement, but southern fisheries have been, and will continue to be, subject to greater constraint due to domestic ESA considerations, as implemented in the case of tules through our consultation on PFMC fisheries in particular. NOAA Fisheries will consult on PFMC fisheries again in 2009 and thereafter as needed. We will use that consultation and our associated guidance to the Council to set a total exploitation rate that continues to encompass all fisheries, including those to the north and in the Columbia River, and that passes the savings from the reduction in the WCVI fishery through to the escapement. If additional reductions beyond these are required in the future based on our ongoing review, such reductions can be effectuated through NOAA Fisheries continuing jurisdiction over U.S. fisheries that affect these stocks. Our conclusion with respect to the proposed actions is therefore premised on our ability, if necessary, to reduce harvest further through subsequent consultation.

In the preceding discussion we identified the populations that had been prioritized for high viability and recovery through recovery planning including the Coweeman, Lewis, Washougal, Toutle, and Sandy populations from the Cascade MPG, and the Grays, Elochoman, Clatskanie, and Scappoose from the Coastal MPG. NOAA Fisheries concludes that this subset of populations is adequate to represent the diversity of each MPG, and consistent with TRT recommendations regarding recovery goals for an ESU.

The Coweeman and East Fork Lewis were identified as genetic legacy populations. As discussed above it is therefore particularly important that the unique characteristics of these populations be preserved as a foundation for the recovery of the MPG and ESU. Results from the VRAP analysis indicate that exploitation rates ranging from 0.34 to 0.58 for the Coweeman, and 0.44 to 0.52 for the Lewis are consistent the survival and recovery of these populations. Results from the SPAZ analysis were generally consistent. In 2008 all fisheries were managed subject to a total exploitation rate limit of 0.41. As indicated above, we expect that the exploitation rate in the future will be reduced from 0.41 through subsequent consultation and that such reductions can be achieved by regulation of southern U.S. fisheries. The proposed actions considered in this consultation will reduce the exploitation rate on these populations from that of recent years. Given the circumstances we conclude that the proposed actions are not likely to appreciably reduce the survival and recovery of these genetic legacy populations.

The other populations in the Cascade and Coastal MPGs that are prioritized for recovery have been affected by past hatchery practices and other limiting conditions and will require a more comprehensive and deliberate approach to achieve the recovery objectives. Results from the VRAP analysis for the Grays population suggest that an exploitation rate of 0.0 to 0.20 may be required. The SPAZ analysis suggests that the population can sustain little or no harvest. These results are likely conservative in that they do not account for improvements in survival that have occurred from recent actions or those that are reasonably likely to occur from ongoing actions. Results from the Grays may be more representative of populations like the Clatskanie and Scappoose, but are less representative of the Washougal or Toutle in the Cascade MPG that are associated with large hatchery programs. For all of these populations the appropriate course to survival and recovery is through a comprehensive, coordinated and deliberate strategy of reform. Results from HSRG and recovery planning analysis suggest that recovery can be achieved through such a strategy with exploitation rates that range from 0.32 to 0.38.

Reductions in harvest resulting from the proposed actions will contribute to the necessary reductions in harvest. Necessary reductions are assured since half or more of the harvest occurs in U.S. fisheries that are under NOAA Fisheries jurisdiction. Based on these considerations we conclude that the proposed actions are not likely to appreciably reduce the survival and recovery of the populations prioritized for recovery in the Cascade and Coastal MPGs.

Through the above discussion we have reviewed the effects of the proposed actions and prospects for the survival and recovery of Lower Columbia River Chinook and its component populations and MPGs. The spring and tule populations in the Gorge MPG are problematic. The spring populations are extinct; their recovery will depend on future reintroduction and recovery efforts. The four tule populations in the Gorge MPG are also at risk, but have not been prioritized for high viability because of the intractable nature of their limiting conditions. The prospects for survival and recovery of populations in the Cascade spring MPG depend on ongoing reintroduction and supplementation programs. The likelihood of survival and recovery for these populations are not appreciably reduced by the proposed actions. The prospects for survival and recovery of the bright populations are also not appreciable reduced by the proposed actions. For reasons discussed above in some detail, we have also concluded that the proposed actions are not likely to appreciably reduce the survival and recovery of the priority populations in the Cascade and Coastal MPGs.

Designated critical habitat for Lower Columbia River Chinook does not include marine areas beyond the Columbia River estuary. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed action do occur in the lower Columbia River and its tributaries. NOAA

Fisheries review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

After reviewing the current status of Lower Columbia River Chinook, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Lower Columbia River Chinook salmon. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for Lower Columbia River Chinook.

9.1.4 Puget Sound Chinook

All of the populations in the ESU are considered to be at high risk. However, measures of abundance, trends in abundance, productivity (Table 5.1.4.1-3), and other information give an indication of the relative status of populations in the ESU. In general, populations in the Georgia Basin and Hood Canal regions are at greater risk due to critically low abundance of at least one of the two populations in each region and declining growth rates for both populations in the Georgia Basin.

Limiting factors for the Puget Sound Chinook populations include a range of adverse affects associated with land use activities including urbanization, forestry, agriculture, and development. Populations are also limited by the adverse effects of hatchery operations and harvest. The severity and relative contribution of these factors varies by population.

Since 2004, the state and tribal fishery co-managers have managed fisheries affecting Puget Sound Chinook to meet the conservation and allocation objectives described in the jointly-developed Puget Sound Chinook Harvest Resource Management Plan (RMP). The RMP expires April 30, 2010. Harvest objectives specified in the RMP account for fisheries-related mortality of Puget Sound Chinook in Puget Sound and throughout their migratory range – from Oregon and Washington to Southeast Alaska. NOAA Fisheries evaluated the Puget Sound Chinook RMP and found that it met the requirements of Limit 6 of the Endangered Species Act (ESA) 4(d) Rule. A section 7 consultation was also conducted as part of the 4(d) evaluation on the plan and NOAA Fisheries concluded fisheries managed consistent with the terms of the plan would not jeopardize the survival and recovery of the ESU. The RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan which includes the Puget Sound Chinook ESU. The co-managers are working on a new RMP that will take effect in 2010. We expect that the new plan will be similar in structure and concept to the current plan, but will include some modifications to address new information and evolving circumstances.

Exploitation rates for most of the Puget Sound Chinook populations have been reduced substantially since the mid-1990s. The trends in harvest mortality for the populations in each region are discussed in more detail under Effects in section 7.4.4. The effect of these overall reductions in harvest has been to improve the baseline condition and help to alleviate the effect of harvest as a limiting factor.

The retrospective analysis provides estimates of how exploitation rates are likely to change under various scenarios. The 1999 Agreement and 2008 Agreement scenarios represent harvest levels that will be allowed under the respective agreements and assuming that southern U.S. and Canadian fisheries are managed subject to the limits for ISBM fisheries. The results of the retrospective analysis indicate small reductions in fishery harvest impacts and small improvements in escapements for Puget Sound Chinook salmon resulting from full implementation of the 2008 agreement scenario when compared with the 1999 agreement scenario. However, management consistent with the 2008 Agreement scenario is expected to exceed RERs or surrogate RERs for almost all populations in the ESU, increase exploitation rates from recently observed levels, and decrease escapements from recently observed levels for 12 of the 22 populations in the ESU. In three cases, the resulting decreases in escapement could change the status of the population relative to meeting its rebuilding threshold. The differences between the 2008 Agreement and 2008 Likely scenarios are attributable to additional constraints taken by both countries under the 2008 Likely scenario to address domestic conservation and allocation concerns. In southern fisheries the 2008 Likely scenario reflects management of Puget Sound fisheries consistent with the harvest component of the Puget Sound Salmon Recovery Plan (Shared Strategy 2007). These regimes were also found by NOAA Fisheries to be consistent with the ESA in previous consultations (NMFS 2001a, 2004f, 2005d). Management consistent with the 2008 Likely scenario is expected to meet RERs or RER surrogates for 12 of the 22 populations, decrease exploitation rates substantially for most populations compared with those anticipated under the 2008 Agreement scenario, and increase escapements. The U.S. and Canada will continue to manage their fisheries to meet conservation and allocation objectives beyond those specified in the 2008 Agreement. It is reasonable, therefore, to focus our assessment of jeopardy on management as we expect it will occur under the 2008 Likely scenario. The key premise here is that southern U.S. fisheries will continue to be managed more conservatively than they would be under the 2008 Agreement scenario (where southern fisheries are only limited by ISBM requirements). Southern U.S. fisheries, in fact all U.S. fisheries, have been, and will continue to be subject to review through section 7 consultation thus assuring that future fisheries can be managed to meet necessary constraints.

Management consistent with the 2008 Likely scenario appears robust to significant decreases in abundance as reflected under the 40% Reduction scenario. The greatest effect of such a substantial reduction in returning Chinook salmon abundance bears on achievement of the population rebuilding thresholds. Few of the Puget Sound Chinook populations continue to meet their rebuilding thresholds. However, 17 of the 19 populations expected to exceed their critical escapement thresholds will continue to do so in years of reduced abundance and most by large margins, including those essential to recovery of the ESU. All populations meeting their RERs will continue to do so. These findings regarding population responses under the 2008 Likely scenario may be conservative as the retrospective analysis did not model additional reductions in the ISBM fisheries that would likely occur in response to the presumed 40% reduction in abundance.

NOAA Fisheries has determined that an ESU-wide recovery scenario for Puget Sound Chinook should include at least two to four viable Chinook salmon populations in each of five geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region. Three of the five regions within the ESU (Strait of Georgia, Hood Canal and the Strait of Juan de Fuca) contain only two populations. For the remaining two with multiple populations (Whidbey Basin, Central/South Sound), NOAA Fisheries has specified which populations within the region must be at low risk to recover the ESU.

Based on the analysis presented in this Opinion, NOAA Fisheries concludes that likely actions associated with implementation of the 2008 Agreement including continuance of additional domestic constraints provides adequate protection for Chinook salmon originating from the five regions within the Puget Sound ESU. This conclusion is supported by the number and diversity of life history characteristics of populations within each region anticipated to meet their RERs or abundance thresholds over the duration of the agreement, expected increasing escapement trends for key populations and the current status of populations when compared with the ESU recovery criteria. For some key populations (Mid-Hood Canal, Nisqually, Skokomish, Dungeness) NOAA Fisheries identified areas of risk that are addressed more directly in the area-specific subsections. The results of this Opinion also highlight the importance of habitat actions and hatchery conservation programs for the preservation and recovery of these key populations specifically, and to the ESU in general. As was discussed in the Environmental Baseline section, the status of many of these stocks is largely the result of reduced productivity in the wild from habitat loss and degradation and from other sources of human induced mortality. The analysis in this opinion suggests that it is unrealistic to expect to achieve substantive increases in Chinook population abundance and productivity and population recovery through harvest reductions alone without also taking substantive action in other areas to improve the survival and productivity of the populations. Likely implementation of the 2008 Agreement will help ensure that northern Chinook salmon fisheries are managed conservatively and responsibly, but recovery of the Puget Sound Chinook ESU depends on implementation of a broadly based program that addresses the identified major limiting factors of decline. Therefore, NOAA Fisheries concludes that implementation of the 2008 Agreement would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU in the wild. The following analysis summarizes the information that formed the basis for this conclusion.

Strait of Georgia Basin Region

There are two populations within the Strait of Georgia Basin: the North Fork Nooksack River and the South Fork Nooksack River early Chinook salmon populations. Both are classified as Category 1 populations and both are essential to recovery of the Puget Sound Chinook ESU. Abundance trends for both populations are positive. However, natural-origin escapement for both populations remains close to or below their critical escapement thresholds and the median growth rates are negative. If naturally spawning listed hatchery-origin adults from the Kendall Creek Hatchery supplementation program are included, the escapement of Chinook salmon has averaged 1,699 fish in the North Fork Nooksack in recent years, an 800% increase since the ESU was listed. Over the same period, natural-origin Chinook escapement has increased by only 200% (216 adults). The total exploitation rate has declined by 38% since the 1980's, averaging 22% since 1994, which is below the FRAM-equivalent RER of 23%.

Under the 2008 Likely scenario we expect that the average exploitation rate will be reduced significantly (from 26% to 19%) compared with full implementation of the 2008 Agreement, particularly in northern fisheries (from 20% to 14%), and that the FRAM-based RER of 23% will be met. The average total exploitation rate under the 2008 Likely scenario is 19%. Although the exploitation rate will decrease, resulting increases in escapements are expected to be small. The retrospective analysis indicates that natural-origin escapements for both populations are expected to remain at depressed levels; and for the South Fork at critically depressed levels. Despite a substantial reduction in exploitation rates compared with full implementation of the 2008 Agreement, the 2008 Likely scenario is expected to result in only a slight increase in average escapement (10 natural-origin spawners to both populations combined).

Based on the observed data and model results and assuming impacts will be similar to those anticipated under the 2008 Likely scenario over the duration of the Agreement, harvest does not appear to be a limiting factor for the Nooksack populations. Past reductions in harvest and benefits from the supplementation program have contributed to increased escapement of fish into the North and South Fork Nooksack Rivers. However, the relative lack of response in terms of natural-origin production, and the strongly negative underlying growth rates for both populations suggests natural-origin recruitment will not increase much beyond existing levels unless constraints limiting marine, freshwater, and estuary survival for the Nooksack early populations are alleviated. Augmentation of natural-origin spawners on the natural spawning areas of the North Fork Nooksack River, with conservation hatchery-origin spawners, will continue to test the natural production potential of the watershed at higher escapement levels. The escapement of hatchery-origin fish may also benefit natural-origin production by capitalizing on favorable freshwater and marine survival conditions in some years. The broodstock used for the Kendall Creek Hatchery program retains the genetic characteristics of the original, donor, wild population. Therefore, early Chinook produced by the Kendall Creek Hatchery program serves as a reserve that buffers genetic and demographic risks to the natural-origin North Fork Nooksack River population. The newly implemented captive-brood stock program for the South Fork Nooksack early Chinook population is essential to protecting and rebuilding the remaining indigenous component of this population until benefits to natural productivity from habitat improvements are realized.

Whidbey/Main Basin region

The ten Chinook salmon populations in Whidbey/Main Basin region are all Category 1 populations (Table 5.1.4.1-2). NOAA Fisheries Service has determined that the Suiattle and one each of the early (Upper Sauk, North Fork Stillaguamish), moderately early (Upper Skagit, Lower Sauk, Upper Cascade, South Fork Stillaguamish), and late (Lower Skagit, Skykomish, Snoqualmie) run time forms will need to be viable for the Puget Sound Chinook ESU to recover.

Escapement trends are stable or positive for eight of the ten populations within the region. The exceptions are the Suiattle and South Fork Stillaguamish populations. The median growth rates for five of the ten populations are negative (Table 5.1.4.1-3). Seven of the ten populations currently exceed their rebuilding escapement thresholds, and all exceed their critical escapement thresholds by 81 to 1,100%, with the exception of the South Fork Stillaguamish population (Table 5.1.4.1-5). Exploitation rates on populations in the Whidbey/Main Basin Region have decreased 30 to 52% since the late 1980s. Fifty percent or more of all harvest of the populations from this region has occurred in Alaskan and Canadian fisheries, primarily in the WCVI sport and troll and Georgia Strait sport fisheries.

Management under the 2008 Likely scenario would contribute to rebuilding 9 of the 10 populations in the region. The analysis indicates that 7 of the 10 RERs or RER surrogates would be met under the 2008 Likely scenario. The average exploitation rate in northern fisheries approaches or exceeds the RER for the Skykomish and Snoqualmie populations. However, although RERs would not be met for the Skykomish, Snoqualmie and South Fork Stillaguamish populations, both the Skykomish and Snoqualmie populations have increasing escapement trends and natural escapements are currently above their rebuilding thresholds. Seven of the 10 populations are expected to exceed their rebuilding thresholds and all except the South Fork Stillaguamish are expected to remain well above their critical thresholds even with a substantial reduction in abundance. Average escapement for the South Fork Stillaguamish is expected to remain close to its critical threshold. The 2008 Likely scenario represents a 15-32% reduction in exploitation rates from those observed over the same period. The analysis indicates this reduction in exploitation rate would reduce the risk to the South Fork Stillaguamish population by a small increase in escapements. The South Fork Stillaguamish conservation hatchery program using native broodstock will further reduce risks to the South Fork Stillaguamish population. Although a few populations in the region will remain at higher risk, the overall risk in the region would be consistent with the recovery plan guidance for the number of populations and diversity of life history characteristics within the region.

Central/South Sound Region

There are six populations within the Central/South Sound Region (Table 5.1.4.1-2). Most are genetically similar, likely reflecting the extensive influence of transplanted hatchery releases, primarily from the Green River population. The Cedar and Duwamish-Green River fall Chinook salmon populations and White River spring Chinook salmon population are Category 1 populations. The Sammamish, Puyallup and Nisqually River Chinook are Category 2 populations. NOAA Fisheries determined the Nisqually and White River populations were essential to recovery of the ESU. Unlike populations in the Strait of Georgia and Whidbey/Main Basin regions, most of the harvest of the Central/South Sound populations occurs in southern U.S. fisheries. The exceptions are the populations in Lake Washington where approximately 60% of the harvest is taken in northern fisheries, primarily due to significant constraints in southern U.S. fisheries including closures of fisheries in the terminal area. Abundance trends are stable or positive for five of the six populations and median growth rates are positive for three of the six populations (Table 5.1.4.1-3). Exploitation rates on populations in the Central/South Sound Region have declined by 6-54% since the mid-1980s.

Management under the 2008 Likely scenario would adequately protect three (White, Cedar, Duwamish/Green) of the six populations and increase protection for all six populations. All six populations are anticipated to exceed their critical escapement thresholds under the 2008 Likely scenario. The status of the populations relative to their rebuilding thresholds is not anticipated to change, although escapements are expected to increase as a result of the anticipated decreases in exploitation rates. However, the Sammamish population could experience very low abundance in the next several years, possibly below its critical threshold. Identifying this population as a concern is considered precautionary, as information suggests that the escapement estimated for this system is likely conservative since they are based on surveys in index areas and do not include all areas where spawning is known to occur. There is a substantial contribution of stray, listed hatchery-origin fish to the natural escapement in the Sammamish River tributaries that will buffer demographic risks. The Sammamish River population is not genetically distinct from these stray hatchery-origin fish.

Management under the 2008 Likely scenario is expected to result in reductions in exploitation rates of 4-32% from the observed 1990-2006 average. Three and possibly four of the six populations[19] are expected to meet their RERs or RER surrogates. Exploitation rates are anticipated to exceed the RER surrogates for the Puyallup and Nisqually populations. However, these are Category 2 populations where the indigenous stock has been extirpated. For the Nisqually population which is considered essential to recovery of the Puget Sound Chinook ESU, the focus of recovery is on re-introduction and transition to a Category 1 type designation over time as the existing Green River lineage population adapts to the watershed, and as habitat conditions improve to support natural production. The total exploitation rates anticipated to result from the 2008 Agreement are likely too high for such a transitional strategy, but since 80% of the harvest of this population occurs in southern fisheries, it is appropriate to look to southern fisheries to achieve the additional reductions likely to be required. As discussed in section 6 under the Environmental Baseline, the current management plan for Puget Sound expires after the 2009 fishing season. NOAA Fisheries will reconsider management provisions for southern fisheries in 2009 as part of our review of the new Puget Sound fishery plan.

[19] Rates are between the two surrogate RERs for the Lake Washington populations.

Hood Canal Region

There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal Rivers populations. Both the Skokomish and Mid-Hood Canal Rivers populations are considered Category 2 populations with adult returns that are a composite of natural- and hatchery-origin fish. The two extant populations likely reflect the extensive influence of inter-basin hatchery stock transfers and releases in the region, mostly from the Green River broodstock (Ruckelshaus et al. 2006) and the extirpation of the original indigenous population. Both populations will need to transition to Category 1 management over time as both are considered essential to recovery of the ESU. Escapement trends are positive for both populations as is their underlying growth rate (Table 5.1.4.1-3). However, very low escapements in recent years for the Mid-Hood Canal population as a whole and to its component rivers raise concerns about the abundance, productivity and spatial integrity of that population. Average natural spawning escapement for the Skokomish population is above its rebuilding threshold; exceeding that threshold in five of the last eight years. Exploitation rates on the Mid-Hood Canal and Skokomish populations have declined significantly since the early 1990s, but have increased in recent years offsetting some of the prior reductions, particularly for the Skokomish population.

Total exploitation rates under the 2008 Likely scenario would be reduced substantially relative to those under alternative scenarios and moderately from rates observed during the 1990-2006 period. Nonetheless, both populations are still expected to substantially exceed their RER or RER surrogate. Exploitation rates in northern fisheries alone approach or exceed the surrogate RER for the Mid-Hood Canal population. The reductions in exploitation rates are expected to result in small increases in escapement compared with observed levels. Under the 2008 Likely scenario, the Skokomish Chinook escapement is expected to exceed its rebuilding threshold abundance in 10 of the 17 years in the analysis period. Escapements to Mid-Hood Canal are expected to be below its critical threshold in most years under all scenarios.

It is important to note that both are Category 2 populations where the indigenous populations have been extirpated. The two extant populations in the Hood Canal Region are both essential to recovery of the Puget Sound Chinook ESU. The focus of recovery, therefore, in is on re-introduction of localized natural populations and transition of both populations to a Category 1 type designation over time as the populations adapt to the watershed and habitat conditions improve to support natural production. The total exploitation rates anticipated under the 2008 Likely scenario are probably too high for such a transitional strategy, particularly for the Skokomish population. However, since the majority of the fishery-related mortality on the Skokomish population occurs in southern fisheries, it is appropriate to look to southern fisheries to achieve the additional reductions likely to be required. As discussed in section 6 under the Environmental Baseline, the current management plan for Puget Sound expires after the 2009 fishing season. NOAA Fisheries will reconsider management provisions for southern fisheries in 2009 as part of our review of the new Puget Sound fishery plan. In addition, the timing and magnitude of changes in harvest that occur in these watersheds must be coordinated with corresponding habitat and hatchery actions and take into account the Category 2 status of the population. For the Mid-Hood Canal population, northern fisheries account for the majority of harvest, and the resultant exploitation rate would approach or exceed the surrogate RER, which is a concern for a population at such low abundance. However, further reductions in northern fisheries would have little substantive effect on the persistence of the spawning aggregations within the Mid-Hood Canal population; it is therefore unreasonable to expect to achieve those reductions from Canada.

The general characteristics of the Mid-Hood Canal Rivers population, including genetic lineage, life history, and run timing, are also found in the Skokomish River population. Genetically similar stocks are also sustained by two hatchery facilities in the Hood Canal area and in hatcheries in the South Puget Sound Region where Green River-lineage fall-run Chinook salmon are naturally or artificially sustained. These populations and programs serve as reserves that could be used to support further supplementation and recovery programs for the Mid-Hood Canal population.

Strait of Juan de Fuca

The Strait of Juan de Fuca Region has two watershed Category 1 populations including an early-timed population on the Dungeness, and a fall-timed population on the Elwha (Ruckelshaus et al. 2006). NOAA Fisheries determined that both populations must be at low extinction risk to recover the ESU. The status of both populations is constrained by significant habitat-related limiting factors that are in the process of being addressed. Survival and productivity of the Dungeness population are adversely affected by low flows from agricultural water withdrawals and by other land use practices. A captive brood stock program for the Dungeness population has been successful in increasing natural spawning escapement, contributing 80% of the total annual natural spawners on average in recent years. All but the lower 5 miles of the Elwha River is blocked to anadromous fish migration by two dams and the remaining habitat in the lower river is severely degraded. An ambitious plan to remove the dams and restore natural habitat in the watershed have been completed, with dam removal scheduled to begin in 2012. Listed, native-origin Chinook salmon maintained and produced by the hatchery mitigation program in the Elwha River system will be a key component of watershed rehabilitation and population preservation and restoration before, during and after dam removal. Given the condition of the salmon habitat in the watersheds, the prospects for the survival and recovery of the Elwha population depend on maintaining the hatchery program in the short term, and using it for reintroduction into pristine areas in the Olympic National Park once the dams are removed. Both the Dungeness and Elwha conservation hatchery programs will be key to restoring the Chinook populations in the Strait of Juan de Fuca Region.

Escapement trends are stable for the Elwha population and increasing for the Dungeness population, although the underlying growth rate for the Elwha population is negative. Both populations are well above their critical thresholds. The Elwha population is above its rebuilding threshold in terms of natural escapement and escapement for the Dungeness population has exceeded its rebuilding threshold in three of the last eight years. Hatchery origin fish contribute heavily to escapements for both populations, but for the Dungeness in particular the increase primarily reflects the success of the supplementation program which is design to help rebuild the population.

Exploitation rates on the Strait of Juan de Fuca populations have declined from an average of 53% prior to 1998 to 28% in recent years. Exploitation rates in southern fisheries have been very low since 1998 ranging from two to five percent. Eighty percent or more of the harvest of the Dungeness and Elwha populations currently occurs in northern fisheries. Escapement has benefited from the decreased exploitation rates.

Management under the 2008 Likely scenario is expected to result in a 24% reduction in total exploitation rates for the Strait of Juan de Fuca populations relative to those observed in past years. The anticipated reductions are due primarily to continuing constraints in southern fisheries. Both populations are expected to exceed their RER surrogate of 23% by 7 to 9 percentage points. The average exploitation rate in northern fisheries under the 2008 Likely scenario is 24% and thus exceeds the RER. Additional reductions in northern fisheries to achieve the RER could result in escapement of 48-85 additional spawners on average to the Dungeness based on the average escapements and northern fishery rates. However, current fishing levels do not appear to be impeding the ability of the population to rebuild considering the observed increasing abundance and growth trends for the Dungeness population. Further reductions in exploitation rates, anticipated based on the 2008 Likely scenario, are expected to provide additional increases in escapement and will result in a minor improvement in the status of both populations relative to their critical and rebuilding thresholds.

The conservation hatchery program operating in the Dungeness River will continue to help rebuild the population and mitigate the demographic and genetic risks to the Dungeness River population. However, because the exploitation rates anticipated under the 2008 Likely scenario are higher than the surrogate RER, there is the potential for additional risk to the Dungeness population. If the trends in escapement or growth rate decline, NOAA Fisheries should reassess the effect of all fisheries on that population. Because virtually all of the harvest of Dungeness Chinook occurs in Canadian fisheries, our reassessment may require that the U.S. consider provisions of paragraph 13 of Annex IV Chapter 3 of the PST Agreement that relates to our mutual consideration of extraordinary circumstances. Given the current constrained and degraded condition of habitat available for natural Chinook salmon production in the Elwha River, and the severe disruption to the system caused by the scheduled dam removals, the population will rely on the hatchery production to sustain the population and restore natural production for the foreseeable future.

Designated critical habitat for Puget Sound Chinook includes estuarine areas and river reaches in specified subbasins. It also includes nearshore areas out to a depth of 30 meters adjacent these subbasins, but does not otherwise include offshore marine areas in Puget Sound or in the ocean. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are part of the proposed action do occur in Puget Sound and its tributaries. NOAA Fisheries' review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

After reviewing the current status of Puget Sound Chinook, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Puget Sound Chinook salmon. NOAA Fisheries also concludes that the actions considered in this consultation are not likely to destroy or adversely modify designated critical habitat for Puget Sound Chinook.

9.1.5 Other Listed Chinook ESUs

In section 7.4.5 we briefly reviewed the effects of the proposed actions on the remaining ESA listed Chinook ESUs including Snake River spring/summer Chinook, Upper Columbia River Chinook, California Coastal Chinook, Central Valley spring Chinook, and Sacramento River Chinook. Snake River spring/summer Chinook and Upper Columbia River Chinook are rarely caught in ocean fisheries. Harvest that may occur on occasion is insignificant and for practical purposes is treated as zero in life-cycle modeling efforts designed to assess extinction risk or options for recovery NMFS 2008e).

California Coastal Chinook, Central Valley spring Chinook, and Sacramento River Chinook are caught in ocean fisheries, but are rarely found as far north as Canada. The effects of ocean harvest on these ESUs south of the U.S. border have been considered through consultations related to the PFMC's Fishery Management Plan (Table 6.2.1-1). The effects of the proposed actions on these ESUs are thus limited and were considered in previous biological opinions that assessed the effects of harvest in the areas where they occur.

Designated critical habitat for these ESUs does not include marine areas beyond their natal estuaries. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are consistent with the proposed action do occur in the Columbia River and its tributaries. This review indicates there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Snake River spring/summer Chinook, Upper Columbia River Chinook, California Coastal Chinook, Central Valley spring Chinook, and Sacramento River Chinook. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for these ESUs.

9.2 Chum Salmon

There are two ESA listed chum ESUs including Lower Columbia River chum and Hood Canal summer run chum. The nearest marine area fisheries that are directed at chum and may affect Lower Columbia River chum occur in terminal areas near Vancouver Island and in the Strait of Juan de Fuca. Lower Columbia River chum is not caught in these fisheries. Ocean fisheries off the Washington coast are managed by the PFMC, but chum salmon is not targeted or caught in PFMC fisheries. Chum salmon are not targeted in commercial or recreational fisheries in the Columbia River, but are caught incidentally in late season commercial fisheries directed at coho. Columbia River fisheries are managed subject to an incidental harvest rate take limit of 5%, but the actual harvest rate has been on the order of 1.6% in recent years. This small level of harvest is not considered a limiting factor for the species.

The proposed fisheries' impacts on Hood Canal summer-run chum are expected to be similar to those that have occurred since 2001 and are consistent with the harvest strategies in the Hood Canal Salmon Recovery Plan and existing biological opinions. Exploitation rates in these fisheries have been reduced from an average of 50% in the 1980s to less than 1% and 17% for the Strait of Juan de Fuca and Hood Canal populations, respectively. The co-managers have taken steps to further reduce bycatch in terminal fisheries targeting hatchery coho. Requirements to release chum during the time that Hood Canal summer-run chum are present in Canadian fisheries will continue under the proposed agreement. It is therefore reasonable to expect that exploitation rates in Canadian fisheries under the proposed action will remain low and will not exceed the management plan guideline

Under such fishing regimes, extinction risk has decreased; abundance trends, productivity, spatial structure and diversity have increased. Supplementation programs have been successful in increasing escapements and reintroducing summer chum to areas where they had been extirpated. High percentages of natural-origin fish in many of the subpopulations indicate growth in these areas will be sustained. The strong responses of the populations, coincident with the implementation of a fishing regime consistent with the proposed action, suggest that harvest is no longer a factor limiting survival and recovery of the ESU.

Designated critical habitat for Lower Columbia River chum does not include marine areas beyond their natal estuaries. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat for Lower Columbia River chum. Fisheries that are consistent with the proposed action do occur in the lower Columbia River and its tributaries. Our review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of its designated habitat.

Designated critical habitat for Hood Canal summer-run chum includes the major watersheds and nearshore areas in Hood Canal and the Strait of Juan de Fuca. For the reasons discussed in the

Effects section, the proposed action should result in minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality. The fisheries as proposed, therefore, would have a negligible impact on critical habitat for the Hood Canal Summer-run Chum Salmon ESU.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Lower Columbia River chum or Hood Canal summer-run chum. NOAA Fisheries also concludes that actions considered in this consultation are not likely to destroy or adversely modify designated critical habitat for these ESUs.

9.3 Coho Salmon

There are four ESA listed coho ESUs including Central California Coast coho, Southern Oregon/Northern California coho, Oregon Coast coho, and Lower Columbia River coho. ESA listed coho are distributed off the west coast and rarely migrate as far north as Canada. As a consequence, harvest impacts in Canadian fisheries are quite low. The exploitation rate in Canadian fisheries on Lower Columbia River coho and Rogue/Klamath coho (the indicator stock for the Southern Oregon/Northern California ESA) have ranged from 0.1% to 0.2% over the last two years. The exploitation rate on Oregon Coast coho ranged from 0.2% to 0.4% (PFMC 2007c, PFMC 2008c). Central California Coast coho has an even more southern distribution and is likely subject to little or no harvest in northern fisheries.

Current biological opinion for Oregon Coast coho and Southern Oregon/Northern California coho set total exploitation rate limits that include whatever harvest may occur in northern fisheries (NMFS 1999b). The recent biological opinion for Lower Columbia River coho requires use of a variable harvest schedule that depends on brood year escapement and indicators of marine survival (NMFS 2008d). The allowable exploitation rate for a given year applies to all ocean fisheries in the U.S. and harvest in the Columbia River. As indicated above, the additional harvest that may occur in Canada is quite limited and is considered insignificant relative to the limits placed on U.S. fisheries.

Designated critical habitat for Central California Coast coho, Southern Oregon/Northern California coho, and Oregon Coast coho does not include marine areas beyond their natal estuaries. Ocean fisheries that occur consistent with the proposed actions are therefore outside the limits of designated critical habitat. Critical habitat for Lower Columbia River coho has not yet been designated.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Central California Coast coho, Southern Oregon/Northern California coho, Oregon Coast coho, and Lower Columbia River coho. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for these ESUs.

9.4 Sockeye Salmon

Chapter 4 of Annex IV pertains to the management of Fraser Sockeye and Pink Salmon. Chapter 4 is not included in the new agreement because the existing regime does not expire until after 2010. Nonetheless, the harvest of listed species taken incidentally in the fisheries directed at Fraser sockeye and pink salmon, particularly listed Chinook salmon, are accounted for and will be considered in the analysis of the Chinook provisions of Chapter 3. We also considered the effect to ESA listed sockeye that may occur as a consequence of the incidental catch of sockeye in fisheries directed at other species and fisheries in the southern U.S. that are in the action area and part of the overall baseline.

There are two ESA listed sockeye ESUs including Snake River sockeye and Lake Ozette sockeye. Although the ocean distribution and migration patterns of Snake River sockeye and Lake Ozette sockeye are not well understood, timing considerations and other information suggest that they are unlikely to be caught in proposed ocean fisheries.

These timing considerations suggest that it is unlikely that Snake River sockeye is encountered in the Alaskan or Canadian fisheries since the adults will have largely exited the ocean prior to the start of the proposed summer fisheries (July-September). Sockeye salmon is not targeted and is rarely if ever caught in PFMC area fisheries. NOAA Fisheries confirmed these conclusions more recently in their FCRPS Biological Opinion (NMFS 2008c) where ocean harvest was assumed to be zero.

Similar information was used to analyze the likely effect of ocean harvest on Lake Ozette sockeye. Timing considerations indicate that Lake Ozette sockeye is gone from fishing areas or largely out of the ocean before the onset of intercepting fisheries where it might be caught (Haggerty 2008). NOAA Fisheries concluded in their draft recovery plan that ocean fisheries are not a factor limiting the species survival and recovery (NMFS 2008j).

Designated critical habitat for Snake River sockeye includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake rivers and specified areas in the Snake River basin. Designated critical habitat for Lake Ozette sockeye salmon includes specified areas within the Hoh/Quillayute subbasin including Lake Ozette and the Lake Ozette watershed. Critical habitat does not include offshore marine areas. Ocean fisheries that occur as a result of the proposed actions are therefore outside the limits of designated critical habitat for sockeye salmon. Fisheries that are part of the proposed action do occur in the Columbia River and its tributaries. This review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of Snake River sockeye and Lake Ozette sockeye. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for these ESUs.

9.5 Steelhead

Through this consultation NOAA Fisheries reviewed available information related to the distribution of steelhead from the listed DPSs from California, the Columbia River basin, and Puget Sound. We then reviewed information related to the catch of steelhead in Alaska, Canada, PFMC areas, Puget Sound, and the Columbia River. Steelhead is not targeted in ocean fisheries and is caught rarely. Regulations often prohibit the retention of steelhead in marine area fisheries. As a consequence, information that could be used to quantify species specific harvest is quite limited. Harvest of steelhead in ocean fisheries does occur. However, it is apparent that the catch of steelhead is a rare event and that the overall impact is low. For example, a review of available coded-wire tag data indicates that Canadian fisheries account for 0.9% of hatchery recoveries from steelhead originating in the Columbia River. NOAA Fisheries concluded that the catch of steelhead in PFMC area fisheries was on the order of a few tens of fish, but not likely more than a hundred fish per year. Recreational catch since 2001 has averaged 14,477 winter and summer-run steelhead annually. Retention of listed, wild steelhead in recreational and non-treaty commercial fisheries is generally prohibited. Tribal harvest in all marine and freshwater areas of winter and summer hatchery and wild steelhead has averaged 1,412 annually since 2001. The fish caught are a combination of listed natural origin and unlisted hatchery origin steelhead. However, the fisheries are generally timed to focus on returning hatchery origin steelhead. As a consequence, most of the steelhead caught are likely non-listed hatchery origin-steelhead. Listed steelhead are caught in Columbia River fisheries, but the associated harvest that is expected to occur over the next ten years as a result of these actions was considered in biological opinions on the FCRPS and 2008 *U.S. v. Oregon* Management Agreement (NMFS 2008c, 2008d). Those opinions confirmed the earlier findings that few steelhead are caught in ocean fisheries. For practical purposes, ocean fishing mortality on listed steelhead from the Columbia River was assumed to be zero in those opinions.

Designated critical habitat for ten of the eleven listed DPSs includes specified freshwater areas and the adjacent estuaries. Critical Habitat for Puget Sound steelhead has not yet been designated. Ocean fisheries that occur as a result of the proposed actions are therefore outside the limits of designated critical habitat. Fisheries that are part of the proposed action do occur in the lower Columbia River and its tributaries. This review indicates that there will be minimal effects on the essential habitat features of the ESU resulting from the proposed actions, and certainly not enough to contribute to a decline in the values of their designated habitat.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of any of the eleven ESA listed steelhead DPSs. NOAA Fisheries is currently conducting a consultation on the effects of a joint co-managers' harvest plan for Puget Sound salmon and steelhead on listed Puget Sound steelhead. NOAA Fisheries expects to complete its review by the end of 2010. Any additional action required in Puget Sound salmon fisheries under the ESA to conserve listed Puget Sound steelhead in Puget Sound salmon fisheries will be addressed in that consultation. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify designated critical habitat for these DPSs.

9.6 Southern Resident Killer Whales

The Southern Resident killer whale DPS has fewer than 90 members and a variable productivity rate. The loss of a single individual, or the decrease in reproductive capacity of a single individual, can reduce the likelihood of survival and recovery of the DPS. Thus the section 7 analysis must scrutinize even small effects on the fitness of individuals that increase the risk of mortality or decrease the chances of successful reproduction.

NOAA Fisheries' conclusions are informed by both the effects of vessel operations, and prey reduction on the Southern Resident population. As described in section 7.9.1, Effects of Vessel Operation, the proposed actions will result in an increase in vessel activity across the range of Southern Residents. Any effects on killer whales are likely to be small, however, considering the limited potential for temporal and spatial overlap of vessels and Southern Residents. Any direct interaction between the Pacific Salmon Treaty fisheries and Southern Resident killer whales would likely result in short-term behavioral avoidance, with insignificant effects.

For the reasons described in section 7.9.2, Effects of Prey Reduction, our effects analysis focused primarily on the likely percent reduction in Chinook prey available to whales as a result of the proposed harvest. To put that reduction in context, the analysis also reported the ratio of Chinook prey available to prey needed by the whales. We discussed the need to make conservative assumptions that focus our conclusions on the most precautionary data scenarios to mitigate for variable data confidence and uncertainty.

It is currently uncertain whether a lack of adequate prey at particular times in particular locations is limiting the ability of the Southern Resident killer whale DPS to survive and recover. There is anecdotal evidence that some individual whales in some years may be undernourished, although it is unknown whether their condition is a result of insufficient prey or some other cause. Researchers have correlated reductions in Chinook abundance with decreased survival of resident whales and decreased fecundity of Southern Residents. Information developed for the analysis in this opinion also provides some evidence that under some conditions, in some locations and seasons, the ratio of prey needed to prey available is low (for example, in a poor

Chinook year, from July to September in inland waters, the ratio of prey available to the whales' needs is as low as 7.0 times needs).

In the short-term, the proposed harvest reduces the prey available to the whales in most locations and time periods. For some periods and locations, the proposed harvest makes a negligible difference in the availability of prey. For example, in inland waters during October to April, although the ratio of prey available compared to prey needed is very small (about 2.5), there is no detectable difference between the ratio with and without the proposed harvest. For other periods and locations, the proposed harvest makes a measurable difference in the availability of prey (13.6 percent reduction), but the ratio of prey available compared to prey needed is relatively large (close to 100). To arrive at conclusions in a section 7 consultation, we focused on those periods and locations where the reduction in available prey would be measurable and the ratio of prey available compared to prey needed appears to be relatively small. We emphasize that without knowing the foraging efficiency of the whales, whether a ratio is small or large is qualitative and based on best professional judgment.

The scenarios we focused on are the July to September time period, across years in both inland and coastal waters, assuming the whales are highly size-selective. In inland waters during this time period, annual variability in the ratio of prey available to the whales' needs ranges from 11.0 to 7.0 times prey needs, corresponding to a 4.1 to 4.6 percent reduction in prey attributed to the proposed harvest. In coastal waters, the ratio ranges from 18.3 to 23.6 times prey needs, corresponding to a 9.2 to 10.5 percent reduction. These scenarios demonstrate the greatest measureable prey reductions attributed to the actions, where the reductions are accompanied by low ratios of prey available to the whales' needs.

As the ratios of prey available to the needs of the whales get smaller, the foraging efficiency required by the whales to meet their needs gets increasingly larger. We expect that the whales need greater ratios of prey available to needs in coastal waters than in inland waters, because prey is likely more dense and predictably congregated in inland waters. In coastal waters, features that may congregate prey are likely spread out geographically, potentially less predictable, and generally we would expect the whales' are less efficient foragers under such circumstances. The ratios during July to September are twice as large in coastal waters as ratios estimated in inland waters, but considering the probable difference in Southern Residents' ability to foraging efficiently in coastal versus inland waters, both sets of ratios are relatively low.

In the case of inland waters, only a portion of the 4.1 to 4.6 percent reduction is attributed to Fraser Chinook stocks (about half of the reduction is Fraser stocks), which the whales are most likely to intercept in their core foraging area (recall from Status of the Species that genetic analysis from kills confirms Fraser Chinook are taken by Southern Residents in high proportion). A proportion of the reduction in Fraser stocks is attributed to U.S. fisheries, which are subject to future consultation. Additionally, catch of Fraser and other stocks in Canadian fisheries are constrained by the agreement.

Although these July to September scenarios present relatively low ratios of prey available to the whales' needs in both inland and coastal waters across years, we have made conservative assumptions by focusing on the most precautionary data scenarios. These scenarios focus on an all salmon diet composed mainly of Chinook, assume the whales are highly size-selective, and underestimate the prey available to the whales.

We conclude that while the proposed actions have the potential to adversely affect Southern Resident killer whales and their critical habitat by reducing prey in their range and critical habitat, the factors listed above reduce the severity of the impacts or mitigate our concerns, so that the proposed actions are not likely to appreciably diminish the likelihood of the Southern Resident's survival and recovery nor significantly change the conservation value of essential features of its critical habitat. In summary, these conclusions were based on the following factors:

- The lowest ratio observed (2.5 times prey needs) is not a reduction from the baseline.
- The greatest differences in the ratio with and without the action where the ratio is relatively small in inland waters (7.0 to 11.0 times prey needs) is accompanied by prey reductions (4.1 to 4.6 percent) only partially attributed to the stocks of primary importance to the whales (about half of the reduction attributed to Fraser stocks) per the time period and region of inference.
- The agreement constrains Canadian catch of Fraser and other stocks to a lower level than would occur in the absence of the agreement (due to the 30% reduction in the WCVI fishery).
- A portion of the prey reductions under consideration are subject to future consultation (U.S. fisheries), and in the interim harvest will be at or below 2008 Likely levels.
- There are several factors that reduce the likely severity of effects from the proposed actions, which we considered in making our conclusion:

1. The amount of spatial and temporal overlap between Southern Residents (or their critical habitat) and the Pacific Salmon Treaty fisheries is relatively small and direct interactions between the whales and vessels, gear or noise associated with the fishery are likely to be minimal.

2. Our estimate of the Chinook food energy required to sustain the Southern Resident killer whale population may be an overestimate, because we based decisions on the conservative assumptions that the population relies on a mostly-Chinook diet and is highly size-selective.

3. Our estimate of the total Chinook food energy available is likely an underestimate, because our estimates are after natural mortality (which includes predation by killer whales).

It is, therefore, NOAA Fisheries determination the proposed actions are not likely to jeopardize the continued existence of the species or adversely modify its critical habitat.

9.7 Southern DPS Green Sturgeon

NOAA Fisheries considered the likely effect of the proposed ocean and marine area salmon fisheries on Southern DPS green sturgeon. The absence of catch in fisheries directed at salmon is consistent with our understanding of the feeding habitats of sturgeon and the fishing methods used to catch salmon. Subadult and adult green sturgeon feed primarily on benthic prey species including shrimp, clams, and benthic fishes. NOAA Fisheries reviewed catch records and consulted experts knowledgeable with the details of ocean salmon fishery management. All indicated that there was no record, and that they had no personal knowledge, of any green sturgeon being taken in the salmon fisheries.

Green sturgeon are caught occasionally in recreational and commercial fisheries in the lower Columbia River directed at salmon stocks and white sturgeon which are not ESA listed or otherwise considered at risk. Retention of green sturgeon in Columbia River fisheries is prohibited, but there is some mortality associated with catch and release and misidentification in the recreational fishery. The *U.S. v. Oregon* TAC estimated that the mortality of Southern DPS green Sturgeon was approximately 14 fish per year. The effects of harvest on the listed DPS were considered in the recent biological opinion on the 2008 *U.S. v. Oregon* Management Agreement which considered proposed harvest activities over the next ten years (TAC 2008). NOAA Fisheries concluded in that opinion that the proposed fisheries were not likely to jeopardize Southern DPS green sturgeon.

Critical habitat for South DPS green sturgeon was recently proposed for designation (NMFS 2008b). The proposed rule identifies Primary Constituent Elements (PCE) that are considered essential to the conservation of green sturgeon. Given the nature and location of the salmon fisheries and salmon fishing gear in relation to these PCEs, it is unlikely that the proposed fisheries have any effect on the critical habitat that has been proposed for Southern DPS green sturgeon.

Based on the considerations summarized here and discussed in more detail elsewhere in this opinion and in prior biological opinions that are incorporated by reference, NOAA Fisheries concludes that the proposed actions are not likely to jeopardize the continued existence of any of Southern DPS green Sturgeon. NOAA Fisheries also concludes that activities considered in this consultation are not likely to destroy or adversely modify the critical habitat of Southern DPS green sturgeon that has been proposed for designation.

9.8 Eastern DPS Steller Sea Lion

NOAA Fisheries concludes that prey reductions caused by the proposed actions will be discountable or insignificant to the eastern DPS of Steller sea lions, as supported by their ability to adapt to changing prey abundance as generalist predators, combined with the lack of threats to recovery and increasing population trend. Therefore, NOAA Fisheries finds that the proposed actions are not likely to adversely affect Steller sea lions, or their critical habitat.

10 ▪ Incidental Take Statement

Section 9 of the ESA and Federal regulations 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. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. 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 (ITS).

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary or appropriate to minimize impacts and sets forth terms and conditions in order to implement the reasonable and prudent measures.

10.1 Amount or Extent of Incidental Take

For purposes of this consultation NOAA Fisheries assumed that fisheries in SEAK and Canada will be managed up to the limits of allowable catch specified in the PST Agreement. As indicated in the description of the proposed action, the State Department's approval of the 2008 Agreement establishes upper limits on allowable catch that may be authorized by U.S. domestic management authorities, but does not itself authorize the conduct of any fishery. Fisheries in SEAK occur as a consequence of NOAA Fisheries' deferral to the State of Alaska and regulations issued by the ADFG conforming with the Treaty agreement. The expected take in the SEAK fishery is therefore described in the following incidental take statement. Fisheries in the southern U.S. including those in Puget Sound, the PFMC management area, and Columbia River basin are subject to ESA consultation by NOAA Fisheries through our consideration of fishery management actions in each of these respective areas. Details related to these other actions are described in the environmental baseline section of this opinion. The PST Agreement obligates southern managers to manage the aggregate impact of their fisheries so as to achieve agreed spawning escapement goals or so as not to exceed exploitation rate objectives for specified stocks. However, southern U.S. fisheries have been, and are likely to continue to be constrained more by domestic fishery management plans or actions that previously have undergone consultations or, when those expire, subsequent consultations. Therefore, as a practical matter the incidental take of ESA listed Chinook salmon in southern U.S. fisheries will be limited by management measures or take limits defined in southern U.S. fishery plans that are described in the applicable biological opinions. The expected take associated with the southern U.S. fisheries is therefore not described in this incidental take statement.

10.1.1 Chinook Salmon

The incidental take of listed Chinook salmon from the various ESUs in the SEAK and Canadian fisheries will vary from year to year depending on the stock abundances, annual variation in migratory patterns, and fishery management measures used to set and implement fishing levels in the PST Agreement. The incidental take of listed Chinook salmon in SEAK and Canadian fisheries will be limited on an annual basis by the provisions of Chapter 3, Annex IV of the PST Agreement that define the limits of catch or total mortality for each fishery.

10.1.2 Chum Salmon

No take of Hood Canal summer chum or Lower Columbia River chum is expected in the proposed SEAK fisheries. Canadian fisheries are managed under the agreement subject to an exploitation rate guideline for Hood Canal summer chum of 6.3% with an upper bound of 8.3%. The upper bound of 8.3% therefore defines the limit of expected take. However, actual exploitation rates have been consistently below 0.5% in recent years and are likely to remain low. The available information suggests that Lower Columbia River chum may be taken on occasion in the proposed fisheries in Canada, but that individual takings will be a rare event. In this case rare event is taken to mean a maximum of ten fish in any one year.

10.1.3 Coho Salmon

NOAA Fisheries does not anticipate that the fisheries in SEAK or Canada will take any coho from the Central California Coast ESU. Southern Oregon/Northern California Coast coho and Lower Columbia River coho are taken occasionally in Canadian fisheries. Exploitation rates in Canadian fisheries for the two ESUs have ranged from 0.1% to 0.2% in recent years. The exploitation rate on Oregon Coast coho in Canadian fisheries has ranged from 0.2% to 0.4% in recent years. NOAA Fisheries expects that exploitation rates on ESA listed coho in northern fisheries managed subject to the 2008 Agreement will continue to be similar to those observed in recent years.

10.1.4 Sockeye Salmon

NOAA Fisheries does not anticipate that the fisheries in SEAK or Canada will take any Snake River or Lake Ozette sockeye salmon.

10.1.5 Steelhead

Steelhead are caught rarely in ocean fisheries. Some of the steelhead that are caught may be from ESUs that are not listed. Others may be hatchery-origin fish that are not subject to section 4(d) take prohibitions. NOAA Fisheries does not anticipate that the fisheries in SEAK or Canada will take any steelhead from the four California DPSs. NOAA Fisheries estimated that the catch of listed steelhead from the five Columbia River DPSs is up to 10 per year. The take of Puget

Sound steelhead in SEAK and Canadian fisheries is unknown, but presumed to be low. In this case low is taken to mean a maximum of ten fish in any one year.

10.1.6 Southern Resident Killer Whales

The harvest of salmon that may occur under the proposed action could result in some level of harm to Southern Resident killer whales by reducing prey availability, which may cause animals to forage for longer periods, travel to alternate locations, or abandon foraging efforts. All individuals of the Southern Resident killer whale DPS have the potential to be adversely affected across their range. However, the extent of take arising from this adverse impact is limited by management measures that define catch or total mortality limits on Chinook in the PST Agreement, as described above in Section 10.1.1. The extent of take is also limited by the seasonal nature of fishing effort. As discussed above for salmonids, this authorization applies only to Southeast Alaska fisheries.

10.1.7 Southern DPS Green Sturgeon

NOAA Fisheries does not anticipate that the fisheries in SEAK or Canada will take any Southern DPS green sturgeon. The incidental take of ESA listed green sturgeon in southern U.S. fisheries will be limited by management measures or take limits defined in southern U.S. fishery plans that are defined in the applicable biological opinions.

10.2 Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined that the level of anticipated take of the nine Chinook ESUs, two chum ESUs, four coho ESUs, two sockeye ESUs, eleven steelhead DPSs, and Southern Resident killer whales and Southern DPS green sturgeon listed Table 1 is not likely to result in jeopardy to the species.

10.3 Reasonable and Prudent Measures

In order to minimize and reduce the anticipated level of incidental take of listed species, NOAA Fisheries believes that it is essential: 1) that management objectives established preseason be consistent with the terms of the agreement, 2) that inseason management actions taken during the course of the fisheries are also consistent with the agreement, 3) that catch and other management measures used to control fisheries be monitored adequately to ensure compliance with management objectives, and 4) that the fisheries be sampled for stock composition and other biological information.

10.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, compliance with the following terms and conditions is required. These terms and conditions are non-discretionary.

1. NOAA Fisheries Administrator for the Alaska Region shall ensure that management objectives established by ADFG preseason for the SEAK fisheries are consistent with all applicable provisions of Annex IV of the Treaty.

2. NOAA Fisheries Administrator for the Alaska Region shall ensure that all in-season management actions taken by ADFG during the course of and following the SEAK fisheries are consistent with all applicable provisions of Annex IV of the Treaty.

3. NOAA Fisheries shall review preseason management objectives, post-season reports produced annually and exchanged by the parties for U.S. fisheries and Canadian fisheries and review other reports and work products produced by the PST technical committees for consistency with applicable provisions of Annex IV of the Treaty.

4. NOAA Fisheries shall review sampling programs for stock composition and other biological information in Canadian and US fisheries to evaluate whether sufficient information is being collected to provide for a thorough post-season analysis of fishery impacts on listed species.

11 ▪ Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NOAA Fisheries believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by NOAA Fisheries.

1. NOAA Fisheries should continue to evaluate the ability of each listed ESU and DPS affected by fisheries managed subject to the PST Treaty to survive and recover, given the totality of impacts affecting each ESU and DPS during all phases of the species life cycle, including freshwater, estuarine and ocean life stages. For this effort, NOAA Fisheries should evaluate available life cycle models or initiate the development of life cycle models where needed. As this information becomes available, it should be reviewed by the appropriate technical committees and incorporated into the assessment and development of PST management objectives, in order to ensure use of the best available science.

2. The agreement provides that the Parties may implement domestic policies that restrict their respective fisheries to a greater degree than is required by the specific provisions of the agreement (Annex IV, Chapter 3, Paragraph 8(b), Koenings and Sprout 2008). It also provides that either Party may recommend, for conservation purposes, that the PSC develop and recommend harvest responses in the relevant fisheries that are more restrictive than those provided for in the agreement to address extraordinary circumstances (Annex IV, Chapter 3, Paragraph 13, Koenings and Sprout 2008). Although the overall objective of the agreement is to rebuild wild stocks, the agreement was not intended to provide all the protection nor do so at the scale of detail that may be necessary for the component runs of listed salmon ESUs. It is reasonable to expect that additional management actions will be required in some years that are targeted to the needs of particular species or stocks. For example, the analysis associated with the opinion highlighted concerns related to some of the stocks in the Puget Sound Chinook and Lower Columbia River Chinook ESUs that are affected in Canadian fisheries. In response to such circumstances, the Parties to the agreement and the co-managers should use the discretionary provisions of the agreement to the maximum extent possible to achieve necessary reductions in the mortality of the stocks of concern and should do so by focusing on the fisheries that have the greatest impact and thus provide the greatest opportunity to provide the necessary savings.

3. The Parties recognized during the course of completing the agreement that certain Chinook stocks in Puget Sound were more depressed and that immediate actions beyond the proposed harvest reductions could and should be taken to address their particular circumstances. These actions were identified by the state and tribal managers and are included in the Puget Sound

Recovery Plan, and are generally in the form of hatchery supplementation programs or habitat actions that would have relatively immediate conservation benefits. These programs generally require additional funding. NOAA Fisheries and the state and tribal entities involved in the agreement should use their authorities as appropriate to seek the necessary funding and implement these critical stock programs as quickly as possible.

4. Similar analysis associated with this opinion indicated that certain Lower Columbia River tule populations were more depressed, and that immediate action beyond the proposed harvest reductions should be taken to address the particularly challenging circumstances for these stocks. The coastal and gorge MPGs are of particular concern. In response to such circumstances, NOAA Fisheries and the co-managers should carefully monitor the status of these stocks and ensure that the actual exploitation rates do not exceed allowable levels for these stocks.

   In addition, NOAA Fisheries should work with co-managers to:

   a. Improve the monitoring of spawning and rearing habitat in key watersheds in order to better understand the implications for RERs, PNI, and other indicators of progress towards recovery;

   b. Develop, test and when appropriate implement improved methodologies for harvest management of tule Chinook, including:
      - Use of a harvest management matrix for tule Chinook similar to the one used by co-managers for coho as recommended in the Interim Regional Recovery Plan (LCFRB 2004).
      - Use of the NOAA Fisheries Science Center's Ocean Index Tool for harvest management.

   c. Develop additional "indicator stocks" for managing Lower Columbia River Chinook to provide greater representation of the diversity of status of the affected stocks;

   d. Continue the adaptive management (reform) of hatchery programs to comply with best management practices, considering recommendations of the HSRG and other appropriate sources. Due to the importance of hatchery reforms to the recovery of these stocks, NOAA Fisheries and the co-managers should establish a schedule for such reforms with prescribed consequences if the reforms are not implemented in a timely manner.

7. NOAA Fisheries should continue to evaluate through research and further analysis the effects of prey availability on the ability of Southern Resident killer whales to survive and recover, given the totality of impacts that affect prey availability. To this end, NOAA Fisheries will engage the appropriate technical committees of the PSC to provide technical expertise, data, and cooperation on analysis to assess the overall effects of fishing on Southern Residents. Analysis should assess the potential for local depletion effects. Where a significant potential is

identified, the Parties to the agreement and the co-managers should use the discretionary provisions of the agreement to the maximum extent possible to achieve necessary reductions in the impacts of fisheries that are concentrated in time and space.

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12 ▪ 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.

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13 ▪ Magnuson-Stevens Act Essential Fish Habitat Consultation

The Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the Magnuson-Stevens Act:

Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2)); NOAA Fisheries must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A)); and Federal agencies must provide a detailed response in writing to NOAA Fisheries within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NOAA Fisheries EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

EFH consultation with NOAA Fisheries is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as upstream and upslope activities that may adversely affect EFH.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

13.1 Identification of Essential Fish Habitat

Pacific Fishery Management Council, Puget Sound and Columbia River Basin
Pursuant to the Magnuson-Stevens Act, the Pacific Fishery Management Council (PFMC) has designated EFH for five coastal pelagic species (Casillas et al. 1998; PFMC 1998), over 80 species of groundfish (PFMC 2005) and three species of federally-managed Pacific salmon: Chinook (*O. tshawytscha*); coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). The PFMC has not identified EFH for chum salmon (*O. keta*), or steelhead (*O. mykiss*), but the areas used by chum and steelhead for "spawning, breeding, feeding, or growth to maturity" overlap with those identified for coho and Chinook salmon as encompassed by the actions considered in this biological opinion.

EFH for groundfish includes all waters, substrates and associated biological communities from the mean higher high water line, the upward extent of saltwater intrusion in river mouths, seaward to the 3500 m depth contour plus specified areas of interest such as seamounts. EFH for coastal pelagic species includes all waters, substrates and associated biological communities from the mean higher high water line, the upriver extent of saltwater intrusion in river mouths, and along the coast extending westward to the boundary of the EEZ. Marine EFH for Chinook and coho in Washington, Oregon, and California includes all estuarine, nearshore and marine waters within the western boundary of the EEZ, 200 miles offshore. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH are found for groundfish in the Final Environmental Assessment/Regulatory Impact Review for Amendment 19 to the Pacific Coast Groundfish Management Plan (PFMC 2005); for coastal pelagic species in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PFMC 1998); and for salmon in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

13.1.1 North Pacific Fishery Management Council

The North Pacific Fishery Management Council (NPFMC) amended its five FMPs (Bering Sea/Aleutian Islands [BSAI] Groundfish FMP, Gulf of Alaska [GOA] Groundfish FMP, BSAI Crab FMP, Scallop FMP, and Salmon FMP) in 1998 to address the new EFH requirements. The Secretary of Commerce, acting through NOAA Fisheries, approved the Council's EFH FMP amendments in January 1999. In September 2000, the court upheld NOAA Fisheries' approval of the EFH amendments under the Magnuson-Stevens Act.

Marine EFH for salmon in Alaska includes all estuarine and marine areas utilized by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. EEZ (NMFS 2005i). This habitat includes waters of the Continental Shelf, which extends to about 30 to 100 km offshore from Dixon Entrance to Kodiak Island, then becomes more narrow along the Pacific Ocean side of the Alaska Peninsula and AI chain. In BS areas of southwest and western Alaska and in Chukchi and Beaufort Seas areas of northwest and northern Alaska, the Continental Shelf becomes much wider. In oceanic waters beyond the Continental Shelf, the documented range of Alaska salmon extends from lat. 42° N north to the Arctic Ocean and to long. 160° E. In the deeper waters of the Continental Slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m. Chinook and chum salmon, however, use deeper layers, generally to about 300 m, but on occasion to 500 m. The range of EFH for salmon is the subset of this habitat that occurs within the 320 km EEZ boundary of the United States. Foreign waters (i.e., off British Columbia in the GOA and off Russia in the BS) and international waters are not included in salmon EFH because they are outside United States jurisdiction. The marine EFH for Alaska salmon described above is also EFH for the Pacific coast salmon for those salmon stocks of Pacific Northwest origin that migrate through Canadian waters into the Alaska EFH zone.

13.2 Proposed Action and Action Area

For this EFH consultation, the proposed actions and action area are as described in detail in section 3 of the preceding biological opinion. The proposed actions are (1) Formal approval by the Secretary of State on behalf of the United States of the new fishing regimes that have been recommended by the PST and, (2) NOAA Fisheries' decision to approve the NPFMC decision to continue to defer its management authority over salmon fisheries in southeast Alaska to the State of Alaska. The action area includes all marine and freshwater fishing areas in SEAK, BC, and the Pacific Northwest subject to provisions of Annex IV of the PST. For BC this includes in particular all marine and freshwater Chinook fishing areas located between the International Boundary in Dixon Entrance and the International Boundary separating BC from the State of Washington. For SEAK this includes in particular all marine and freshwater Chinook fishing areas, including waters of the EEZ, between the longitude of Cape Suckling (143 53' 36" W) and the International Boundary in Dixon Entrance. In the southern U.S. the action area includes marine and freshwater fishing areas in the Strait of Juan de Fuca, Puget Sound, and the Washington and Oregon coast, and fishing areas in the Columbia River and Snake River Basin in Idaho.

13.3 Effects of the Proposed Action

13.3.1 Pacific Fishery Management Council

PFMC concluded fishing activities of the type included in the proposed actions considered in this opinion are likely to adversely affect EFH and it provided recommended conservation measures (Casillas et al. 1998; PFMC 1998; PFMC 1999). The PFMC adopted these conservation measures for fishing activities under its jurisdiction at the June 2000 Council meeting, and they were approved by the Secretary of Commerce as part of the package on Amendment 14 on September 27, 2000. These conservation measures remain in effect for the PFMC Fisheries.

13.3.2 Puget Sound Fisheries

The harvest-related activities of the proposed actions considered in this consultation involve boats using hook-and-line gear and commercial net gear. The use of these gears affects the water column and the shallower estuarine and freshwater substrates, rather than the deeper water, offshore habitats. The PFMC assessed the effects of fishing on salmon EFH and provided recommended conservation measures in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). NMFS (2005f) concluded that fisheries in Puget Sound Managed consistent with the approved RMP would have a negligible impact on the physical environment and would not adversely affect designated EFH for Chinook salmon or for other fish species for which EFH has been designated.

13.3.3 North Pacific Fishery Management Council

An analysis prepared by the Council indicated that groundfish fisheries represent all but a small fraction of the potential fishing effects on habitat and that salmon fisheries have a negligible effect on EFH (Witherell 2002). For the salmon fisheries, the analysis found that the effects of EFH are almost non-existent because troll and purse seine gear, which are predominant in the fisheries, generally never touches benthic habitat. Thus, the effects on EFH of the Alaska salmon fisheries are considered minimal and temporary in nature (NPFMC 2006).

13.3.4 Columbia River Fisheries

Most of the harvest related activities occur from boats or along river banks. Gears that are used include primarily hook-and-line, drift and set gillnets, and hoop nets that do not substantially affect the habitat. There will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, or to water quantity and water quality, particularly since most of the fishing activity occurs in Zones 1-6 on the Lower mainstem Columbia River. Thus, there will be minimal effects on the essential habitat features of the affected species from the action discussed in this Biological Opinion, certainly not enough to contribute to a decline in the values of the habitat.

13.4 Conclusion

For the reason discussed above, NOAA Fisheries concludes that EFH has been adequately addressed for the fishing regimes that have been recommended by the PST.

13.5 EFH Conservation Recommendation

Pursuant to Section 305(b)(4)(A) of the Magnuson-Stevens Act, NOAA Fisheries is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. Since NEAK and Columbia River Fisheries would not adversely affect designated EFH, NOAA Fisheries will not issue additional specific conservation recommendations. Because NOAA Fisheries concluded that conservation recommendations have been made and adopted by the PFMC for the fishing regimes that have been recommended by the PST, no additional conservation recommendations beyond those identified and already adopted are needed.

13.6 Statutory Response Requirement

Because there are no conservation recommendations, there are no statutory response requirements.

13.7 Consultation Renewal

Reinitiation of EFH consultation is required if the fishing regimes that have been recommended by the PST are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

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14 ▪ Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) ("Data Quality Act") specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion addresses these Data Quality Act components, documents compliance with the Data Quality Act, and certifies that this Biological Opinion has undergone pre-dissemination review.

Utility: This ESA section 7 biological opinion on the formal approval by the Secretary of State on behalf of the United States of the new fishing regimes that have been recommended by the PSC and NOAA Fisheries' decision to approve the NPFMC decision to continue to defer its management authority over salmon fisheries in southeast Alaska to the State of Alaska will not jeopardize any of the ESA-listed ESUs in the action area. NOAA Fisheries can therefore write a no-jeopardy Biological Opinion for the incidental take of ESA-listed species for all fishing regimes that have been recommended by the PSC. The intended users are Canadian citizens between the International Boundary in Dixon Entrance and the International Boundary separating BC from the State of Washington, and U.S. citizens in SEAK (including all marine and freshwater Chinook fishing areas between the longitude of Cape Suckling -143 53' 36" W- and the International Boundary in Dixon Entrance), Strait of Juan de Fuca, Puget Sound, and the Washington and Oregon coast, and fishing areas in the Columbia River and Snake River Basin in Idaho. Tribal members, recreational fishers and associated businesses, commercial fishers, fish buyers and related food service industries, and the general public benefit from the consultation.

Copies of the Biological Opinion will be provided to the chairs of the Department of State, represented by the Secretary of State and The North Pacific Fishery Management Council. This biological opinion will be posted on the NOAA Fisheries NW Region web site (www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

Integrity: This biological opinion was completed on a computer system managed by NOAA Fisheries in accordance with relevant information technology security policies and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

Objectivity

Information Product Category: Natural Resource Plan.

Standards: This opinion and supporting documents are clear, concise, complete, and unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NOAA Fisheries ESA Consultation Handbook, ESA

Regulations (50 CFR 402.01 et seq.), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) implementing regulations regarding Essential Fish Habitat (50 CFR 600.920(j)).

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the literature cited section. The analyses in this Biological Opinion/EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data, and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NOAA Fisheries staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

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Pacific Salmon Treaty Biological Opinion

Appendix 1

Viability Risk Assessment Procedure

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Viability Risk Assessment Procedure

NMFS analyzes the effects of harvest actions on populations using quantitative analyses where possible and more qualitative considerations where necessary. The Viable Risk Assessment Procedure (VRAP) is an example of a quantitative risk assessment method that was developed by NMFS, and applied so far primarily for analyzing harvest impacts on Puget Sound and Lower Columbia River tule Chinook. VRAP provides estimates of population-specific exploitation rates (called Rebuilding Exploitation Rates or RERs) that are designed to be consistent with ESA-related survival and recovery requirements. Proposed fisheries are then evaluated, in part, by comparing the RERs to rates that can be anticipated as a result of the proposed harvest plan. Where impacts of the proposed plan are less than or equal to the RERs, NMFS considers the harvest plan to present a low risk to that population. (The context and basis of NMFS' conclusions related to RERs is discussed in more detail below.) The results of this comparison, together with more qualitative considerations for populations where RERs cannot be calculated, are then used in making the jeopardy determination for the ESU as a whole. A brief summary of VRAP and how it is used to estimate an RER is provided below. For a more detailed explanation see NMFS (2000a) and NMFS (2004c).

The Viable Risk Assessment Procedure:

- quantifies the risk to survival and recovery of individual populations,
- accounts for total fishing mortality throughout the migratory range of the ESU,
- explicitly incorporates management, data, and environmental uncertainty, and
- isolates the effect of harvest from mortality that occurs in the habitat and hatchery sectors.

The result of applying the VRAP to an individual population is an RER which is the highest allowable ("ceiling") exploitation rate that satisfies specified risk criteria related to survival and recovery. Calculation of RERs depend on the selection of two abundance-related reference points (referred to as critical and upper escapement thresholds (CET and UET)), and two risk criteria that define the probability that a population will fall below the CET and exceed the UET. Considerations for selecting the risk criteria and thresholds are discussed briefly here and in more detail in NMFS 2000a.

The selection of risk criteria for analytical purposes is essentially a policy decision. For jeopardy determinations, the standard is to not "…reduce appreciably the likelihood of survival and recovery …" (50 CFR section 402.2). In this context, NMFS used guidance from earlier biological opinions to guide the selection of risk criteria for VRAP. NMFS' 1995 biological opinion on the operation of the Columbia River hydropower system (NMFS 1995b) considered the biological requirements for Snake River spring/summer Chinook to be met if there was a high likelihood, relative to the historic likelihood, that a majority of populations were above lower threshold levels[1] and a moderate to high likelihood that a majority of populations would achieve their recovery levels in a specified amount of time. High likelihood was considered to be a 70% or greater probability, and a moderate-to-high likelihood was considered to be a 50% or greater probability (NMFS 1995b). The Cumulative Risk Initiative (CRI) has used a standard of 5% probability of absolute extinction in evaluating the risks of management actions to Columbia River ESUs. The different standards of risk, i.e., 50% vs. 5%, were based primarily on the thresholds that the standard was measured against. The CRI threshold is one of absolute extinction, i.e., 1 spawning adult in a brood cycle. The Biological Requirements Work Group (BRWG 1994) threshold is based on a point of potential population destabilization, i.e., 150-300 adult spawners, but well above what would be considered extinction. In fact, several of the populations considered by the BWRG had fallen below their thresholds at some point and rebounded, or persisted at lower levels. Since the consequences to a species of the CRI threshold are much greater than the consequences of the BWRG thresholds, the CRI standard of risk should be much higher (5%). Scientists commonly define high likelihood to be ≥95%. For example, tests of significance typically set the acceptable probability of making a Type I error at 5%. The basis of the VRAP critical threshold is more similar to the BWRG lower threshold in that it represents a point of potential population destabilization. However, given the uncertainties in the data, especially when projected over a long period of time, and the different risk to populations represented by the two thresholds, we chose a conservative approach both for falling below the critical threshold, i.e., 5%, and exceeding the recovery threshold, i.e., 80%.

The risk criteria were chosen within the context of the jeopardy standard. They measure the effect of the proposed action against the baseline condition, and require that the proposed action not result in a significant negative effect on the status of the species over the conditions that already exist. We determined that the risk criteria consistent with the jeopardy standard would be that 1) the percentage of escapements below the critical threshold differs no more than 5% from that under baseline conditions; <u>and</u>, 2) the viable threshold must be met 80% of the time, <u>or</u> the percentage of escapements less than the viable threshold differs no more than 10% from that under baseline conditions. Said another way, these criteria seek to identify an exploitation rate that will not appreciably increase the number of times a population will fall below the critical threshold and also not appreciably reduce the prospects of achieving recovery. For example, if under baseline conditions, the population never fell below the critical threshold, escapements must meet or exceed the critical threshold 95% of the time under the proposed harvest regime.

As described above, VRAP uses critical escapement and upper escapement thresholds as benchmarks for calculating the RERs. The CET represents a boundary below which uncertainties about population dynamics increase substantially. In cases where sufficient stock-specific information is available, we can use the population dynamics relationship to define this point. Otherwise, we use alternative population-specific data, or general literature-based

[1] The Biological Requirements Work Group defined these as levels below which uncertainties about processes or population enumerations are likely to become significant, and below which qualitative changes in processes are likely to occur (BRWG 1994). They accounted for genetic risk, and some sources of demographic and environmental risk.

guidance. NMFS has provided some guidance on the range of critical thresholds in its document, *Viable Salmonid Populations* (McElhaney et al. 2000). The VSP guidance suggests that effective population sizes of less than 500 to 5,000 per generation, or 125 to 1,250 per annual escapement, are at increased risk. For the Lower Columbia River tule analyses, we generally used CETs corresponding to the WLC TRT's quasi-extinction thresholds (QET): 50/year for four years for 'small' populations, 150/year for four years for medium populations, and 250/year for four years for large populations (McElhany et al., 2006).

The UET may represent a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required. The UET could also be an estimate of the spawners needed to achieve maximum sustainable yield or for maximum recruits, or some other designation. It is important to recognize, though, that the UET is not an escapement goal but rather a threshold level that is expected to be exceeded most of the time (≥ 80%). It should also be noted that, should the productivity and/or capacity conditions for the population improve, the UET should be changed to reflect the change in conditions.

There is often some confusion about the relationship between upper escapement thresholds used in the VRAP analysis, and abundance related recovery goals. The UET is sometimes less than recovery goals that are specified in recovery plans. VRAP seeks to analyze a population in its existing habitat given current conditions. As the productivity and capacity of the habitat improves, the VRAP analysis will be adjusted to reflect those changes. Thus the UET serves as a step in the progression to recovery, which will occur as the contributions from recovery action across all sectors are realized. In this application of the VRAP for Lower Columbia Chinook populations, we explored a variety of UETs, including the spawner escapement that would produce maximum sustained yield (MSY) associated with the spawner/recruit function used in the VRAP analysis, the mean of natural-origin spawner escapement, and the mean of natural spawner escapement (mean calculated over the available time series).

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

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

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

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

The data are fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1975), Beverton-Holt (Ricker 1975), and Hockey stick (Barrowman and Meyers 2000). The simple forms of these models can be augmented by the inclusion of environmental variables correlated with brood year survival. The VRAP is therefore flexible in that it facilitates comparison of results depending on assumptions between production functions and any of a wide range of possible environmental co-variates.

Equations for the three models are as follows:

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

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

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

In the above, M is the index of marine survival and F is the freshwater correlate.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to project the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the

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

environmental correlates. Also, since fishing-related mortality is modeled in the projection phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed “management error” and its distribution, as well as the others are estimated from available recent data.

For each trial RER the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the critical escapement threshold and the fraction of runs for which the final year’s escapement is greater than the upper escapement threshold. Trial RERs for which the first fraction is less than 5% and the second fraction is greater than 80% (or 10% from baseline) satisfy the identified risk criteria are thus used to define the population specific ceiling exploitation rates for harvest management.

Finally, the population-specific RERs must be made compatible with the exploitation rates generated from the FRAM model for use in fishery management planning. The VRAP and the FRAM model were developed for different purposes and are therefore based on different data sources and use different approaches to estimate exploitation rates. The VRAP uses long-term population intensive data to derive a RER for a single population. The FRAM uses fishery intensive data to estimate the effects of southern U.S. West Coast fishing regimes across the management units (populations or groups of populations) present in those fisheries. Because the FRAM model is used for preseason planning and to manage fisheries, it is necessary to ensure that the RERs derived from VRAP are consistent with the management unit exploitation rates that we estimated by the FRAM model. To make them compatible, the RERs derived from VRAP are converted to FRAM-based RERs using linear or log-transform regressions between the exploitation rate estimates from the population specific data and post season exploitation rate estimates derived from FRAM.

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Pacific Salmon Treaty Biological Opinion

Appendix 2

Salmon Population Analyzer

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Salmon Population Analyzer

The Salmon Population AnalyZer (SPAZ) is a program designed for analyzing salmon population data and is used for fitting population growth models to data, and assessing population viability or extinction risk. Although the SPAZ was not designed specifically to assess the effects of harvest on population viability, it can be used to estimate how various levels of harvest affect the related metrics. The SPAZ has not been used previously for analyzing the effects of harvest in a section 7 consultation for other populations or ESUs. The relationship between VRAP and SPAZ and resulting outputs is still an area of active research. The concepts and methods underlying SPAZ are described in detail in the most recent WLC TRT viability report (McElhany et al. 2006), which builds on the basic framework in the NOAA Technical Memorandum on Viable Salmonid Populations (VSP) (McElhany et al. 2000). A brief summary of the program and its applications is provided below.

The abundance and productivity evaluation conducted by the SPAZ model is predicated on two basic observations: 1) all else being equal, a larger population is less likely to go extinct than a small one, and 2) all else being equal, a more productive population is less likely to become extinct than a less productive population. Productivity in this context refers to “intrinsic” productivity, and is an indication of a populations “resilience” or tendency to return to high abundance if perturbed to low abundance. Intrinsic productivity is broadly defined as the number of offspring per parent when there are few parents. The quantity and quality of data available to evaluate the abundance and productivity varies among WLC populations. We can divide the populations into two basic groups; those with sufficient time series of abundance and related parameters for a quantitative evaluation and those without sufficient time series. For those with a sufficient time series, we conducted a viability assessment under several alternative harvest rates as described below.

The primary approach the WLC TRT applied to the analysis of populations with an adequate time series is viability curve analysis. A viability curve describes a relationship between population abundance, productivity and extinction risk (WLCTRT, 2003). Extinction risk is defined as the probability that the population will fall below the critical escapement threshold, based on a four year average, any time during a 100 year forward projection. All of abundance and productivity combinations defined by the curve indicate the same level of risk. Populations with productivity and abundance combinations above and to the right of the viability curve have a lower extinction risk than those that fall on the curve, while those below and to the left have a higher risk than those that fall on the curve.

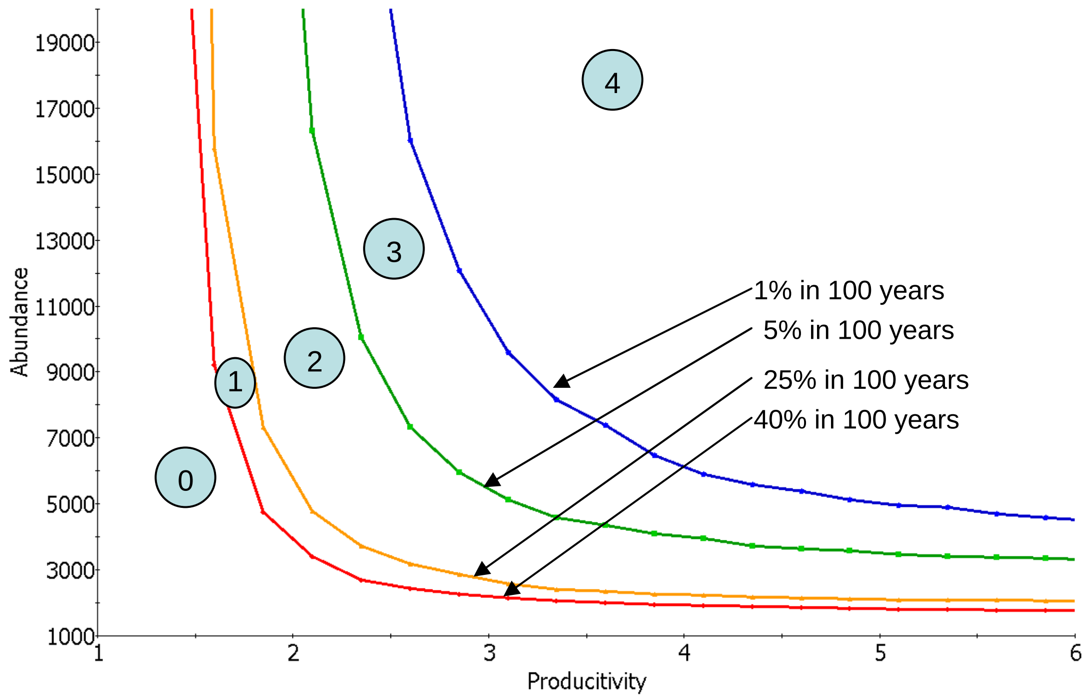

Figure 16 - Viability curves showing relationship between risk levels and population persistence categories (example based on Chinook curve). Each of the curves indicates a different risk level. The numbers in circles are the persistence categories associated with each region of the chart (i.e. the area between the curves). A population with a risk category 0 is described as a population that is nearly extinct and population with a risk category of 3 is described as "viable" (McElhany et al. 2006)

The mathematical models used to construct the viability curve (Hockey-stick with autocorrelation) and to assess the status of a population relative to the curve (Mean RS Method) are described in the TRT's viability reports (McElhany et al. 2004, 2006). A key issue in the analysis is how we incorporate uncertainty in the estimation of a population's current abundance and productivity. We can not precisely estimate abundance and productivity so we present probability contours for these parameters (Figure 17). See McElhany et al. 2006 for a detailed description of the methods (see especially pp. 12-39 for a description of how current population status is assessed relative to the viability curves).

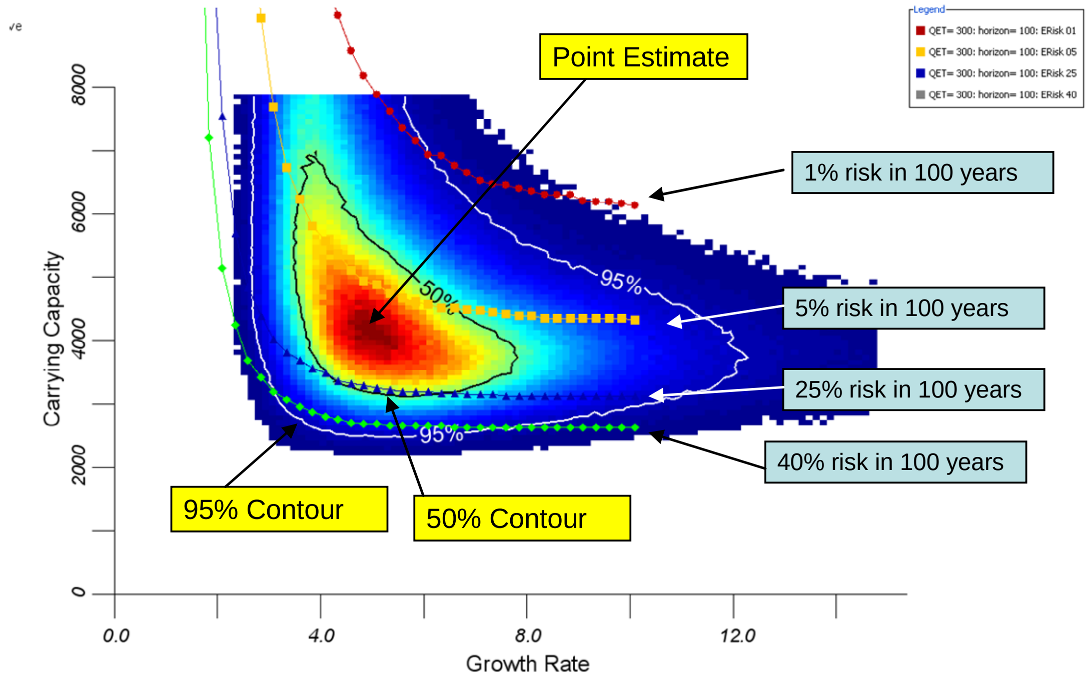

Figure 17 - Example of current status contours combined with viability curves. In this example, the point estimate of the population indicates a persistence category of 2 (i.e. between 25% and 5% viability curves). To ensure at least a 50% chance that the population exceeds a given viability curve we would examine the 50% contour, which in this example suggests the population is in persistence category 1 (the bottom of the 50% contour is between the 40% and 25% viability curves). To ensure at least a 95% chance that the population exceeds a given viability curve we would examine the 95% contour (McElhany et al. 2006)

If a population has a high intrinsic productivity, the viability curve analysis may indicate that the population is expected to be viable even if at relative low abundance level. If average abundance is too low, however, the population may be at risk from phenomena that are not incorporated into the SPAZ analyses. For example, very small populations are more likely to suffer from inbreeding depression or may not be able to maintain sufficient genetic variability for long-term survival (reviewed by McElhany et al. 2000). The results of the SPAZ analyses should therefore be interpreted carefully, and in some cases it may be appropriate to specify a viability floor higher than the viability curve alone would indicate.

The VRAP and SPAZ analysis procedures are similar in that they use available data to estimate the production dynamics of a population based on a time series of abundance data. Both models incorporate uncertainty and are used to project future outcomes. VRAP is designed to identify an exploitation rate (RER) that is associated with a small increase (5%) in the frequency of escapements that are below the critical escapement threshold relative to no harvest, and a high probability (80%) that the upper escapement threshold will be met by the end of a 25 year projected time series. SPAZ on the other hand focuses on extinction risk where extinction is defined as the probability that the population will fall below the critical escapement threshold, based on a four year average, any time during a 100 year forward projection. SPAZ can be used to assess the effects of harvest by estimating how the extinction risk changes for various levels of assumed harvest (e.g., 0%, 25%, 50%). SPAZ does not directly address the prospect of recovery.

Pacific Salmon Treaty Biological Opinion

Appendix 3

Analysis Columbia River & Puget Sound

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Snake River Fall Chinook

Snake River Fall Chinook Index for ocean fisheries from the Retrospective Analysis (LaVoy 2008)

	SRFI - All Ocean Fisheries					SFRI - Northern Ocean Fisheries					SRFI - Southern Ocean Fisheries				
	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
1990	1.17	0.73	0.61	0.64	0.41	1.07	0.85	0.66	0.66	0.33	1.40	0.48	0.48	0.59	0.59
1991	0.83	0.71	0.59	0.62	0.38	0.92	0.81	0.63	0.63	0.28	0.63	0.48	0.48	0.59	0.61
1992	1.00	0.59	0.50	0.54	0.35	1.02	0.64	0.51	0.51	0.23	0.97	0.48	0.48	0.59	0.61
1993	1.07	0.64	0.53	0.57	0.36	1.11	0.70	0.56	0.56	0.24	0.99	0.48	0.48	0.59	0.61
1994	0.73	0.68	0.57	0.60	0.37	0.98	0.77	0.60	0.60	0.26	0.15	0.48	0.48	0.59	0.61
1995	0.60	0.59	0.49	0.52	0.37	0.70	0.63	0.49	0.49	0.26	0.38	0.48	0.48	0.59	0.61
1996	0.26	0.79	0.63	0.66	0.52	0.17	0.93	0.70	0.70	0.48	0.45	0.48	0.48	0.59	0.61
1997	0.48	0.64	0.53	0.56	0.37	0.45	0.71	0.55	0.55	0.26	0.56	0.48	0.48	0.59	0.61
1998	0.36	0.40	0.36	0.39	0.28	0.23	0.36	0.30	0.30	0.13	0.64	0.48	0.48	0.59	0.61
1999	0.33	0.29	0.27	0.34	0.27	0.16	0.21	0.18	0.18	0.09	0.69	0.48	0.48	0.69	0.69
2000	0.39	0.40	0.34	0.35	0.26	0.34	0.37	0.28	0.28	0.14	0.50	0.48	0.48	0.51	0.51
2001	0.37	0.40	0.34	0.38	0.29	0.26	0.37	0.28	0.28	0.14	0.61	0.48	0.48	0.62	0.62
2002	0.48	0.56	0.47	0.53	0.36	0.40	0.60	0.47	0.47	0.22	0.65	0.48	0.48	0.66	0.66
2003	0.56	0.62	0.51	0.61	0.43	0.46	0.69	0.53	0.53	0.26	0.78	0.45	0.45	0.77	0.79
2004	0.67	0.52	0.44	0.59	0.44	0.56	0.55	0.44	0.44	0.23	0.94	0.45	0.45	0.93	0.93
2005	0.96	0.58	0.48	0.80	0.61	0.72	0.63	0.49	0.49	0.22	1.49	0.45	0.45	1.48	1.48
2006	0.68	0.51	0.42	0.56	0.39	0.61	0.56	0.43	0.43	0.19	0.84	0.39	0.39	0.84	0.84
1990 - 2006 Avg.	**0.64**	**0.57**	**0.47**	**0.54**	**0.38**	**0.60**	**0.61**	**0.48**	**0.48**	**0.23**	**0.75**	**0.47**	**0.47**	**0.70**	**0.71**

Willamette River Spring Chinook

Total AEQ exploitation rates for Willamette Spring Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rates					Northern Ocean Fisheries Exploitation Rates					Southern Ocean Fisheries Exploitation Rates				
	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
1990	0.63	0.57	0.56	0.58	0.56	0.27	0.20	0.18	0.22	0.19	0.36	0.37	0.38	0.36	0.37
1991	0.71	0.65	0.63	0.65	0.63	0.34	0.22	0.19	0.25	0.20	0.37	0.43	0.44	0.41	0.43
1992	0.64	0.54	0.52	0.54	0.52	0.35	0.21	0.19	0.24	0.20	0.30	0.33	0.33	0.31	0.32
1993	0.72	0.65	0.64	0.65	0.63	0.38	0.25	0.23	0.27	0.23	0.34	0.40	0.41	0.38	0.40
1994	0.56	0.52	0.51	0.52	0.51	0.26	0.17	0.15	0.18	0.15	0.31	0.35	0.36	0.34	0.35
1995	0.59	0.55	0.54	0.54	0.54	0.32	0.23	0.21	0.23	0.23	0.27	0.32	0.33	0.31	0.31
1996	0.43	0.47	0.46	0.46	0.46	0.17	0.20	0.19	0.21	0.20	0.26	0.26	0.27	0.25	0.25
1997	0.31	0.29	0.27	0.29	0.26	0.22	0.20	0.17	0.21	0.17	0.09	0.09	0.10	0.09	0.09
1998	0.36	0.31	0.29	0.31	0.31	0.29	0.22	0.20	0.23	0.22	0.07	0.09	0.10	0.08	0.08
1999	0.33	0.32	0.31	0.32	0.31	0.23	0.20	0.18	0.21	0.20	0.11	0.12	0.13	0.11	0.11
2000	0.44	0.38	0.36	0.38	0.38	0.31	0.22	0.20	0.24	0.24	0.13	0.16	0.16	0.14	0.14
2001	0.24	0.23	0.22	0.24	0.23	0.15	0.14	0.12	0.15	0.14	0.09	0.09	0.09	0.09	0.09
2002	0.28	0.24	0.23	0.26	0.24	0.20	0.17	0.16	0.18	0.15	0.08	0.07	0.07	0.08	0.08
2003	0.23	0.22	0.21	0.21	0.21	0.12	0.11	0.10	0.10	0.09	0.11	0.11	0.11	0.11	0.12
2004	0.26	0.26	0.23	0.25	0.24	0.15	0.16	0.12	0.14	0.13	0.11	0.10	0.10	0.11	0.12
2005	0.22	0.20	0.19	0.20	0.18	0.12	0.11	0.10	0.10	0.08	0.10	0.09	0.09	0.10	0.10
2006	0.27	0.25	0.24	0.25	0.23	0.12	0.11	0.09	0.09	0.08	0.15	0.15	0.15	0.15	0.16
1990 -2006 aver	**0.43**	**0.39**	**0.38**	**0.39**	**0.38**	**0.23**	**0.18**	**0.16**	**0.19**	**0.17**	**0.19**	**0.21**	**0.21**	**0.20**	**0.21**

Lower Columbia River Spring Chinook

Total AEQ exploitation rates for Lower Columbia Spring Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rates					Northern Ocean Fisheries Exploitation Rates					Southern Ocean Fisheries Exploitation Rates				
	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
1990	0.67	0.62	0.62	0.61	0.61	0.07	0.09	0.08	0.09	0.08	0.60	0.53	0.53	0.53	0.53
1991	0.65	0.65	0.65	0.64	0.63	0.08	0.08	0.07	0.07	0.06	0.56	0.57	0.58	0.57	0.57
1992	0.58	0.54	0.53	0.53	0.52	0.08	0.08	0.07	0.07	0.05	0.50	0.46	0.47	0.46	0.47
1993	0.62	0.60	0.59	0.59	0.59	0.08	0.08	0.07	0.07	0.05	0.53	0.52	0.53	0.53	0.53
1994	0.45	0.49	0.49	0.48	0.48	0.10	0.10	0.09	0.09	0.08	0.35	0.39	0.40	0.40	0.40
1995	0.34	0.35	0.34	0.33	0.33	0.10	0.09	0.08	0.08	0.08	0.23	0.25	0.26	0.25	0.25
1996	0.28	0.32	0.32	0.31	0.31	0.04	0.06	0.05	0.05	0.05	0.24	0.26	0.26	0.26	0.26
1997	0.24	0.28	0.27	0.27	0.26	0.05	0.07	0.06	0.06	0.05	0.19	0.21	0.21	0.21	0.21
1998	0.17	0.23	0.23	0.21	0.21	0.07	0.08	0.07	0.07	0.08	0.10	0.16	0.16	0.14	0.14
1999	0.34	0.34	0.34	0.32	0.31	0.08	0.05	0.05	0.05	0.05	0.26	0.29	0.29	0.27	0.27
2000	0.45	0.45	0.45	0.45	0.45	0.06	0.06	0.05	0.05	0.05	0.39	0.40	0.40	0.39	0.39
2001	0.39	0.40	0.40	0.38	0.38	0.07	0.07	0.06	0.06	0.06	0.32	0.33	0.33	0.32	0.32
2002	0.29	0.29	0.28	0.29	0.28	0.05	0.06	0.05	0.05	0.05	0.23	0.22	0.23	0.23	0.23
2003	0.24	0.23	0.22	0.24	0.23	0.06	0.07	0.06	0.06	0.05	0.18	0.16	0.16	0.18	0.18
2004	0.27	0.25	0.24	0.28	0.27	0.05	0.07	0.06	0.06	0.06	0.22	0.18	0.18	0.22	0.22
2005	0.48	0.42	0.41	0.46	0.46	0.08	0.07	0.06	0.06	0.05	0.40	0.35	0.35	0.41	0.41
2006	0.39	0.38	0.37	0.38	0.38	0.06	0.05	0.05	0.04	0.04	0.34	0.33	0.33	0.34	0.34
1990 - 2006 avg	**0.40**	**0.40**	**0.40**	**0.40**	**0.39**	**0.07**	**0.07**	**0.06**	**0.06**	**0.06**	**0.33**	**0.33**	**0.33**	**0.33**	**0.34**

Lower Columbia River Bright Chinook

Total AEQ exploitation rates for Lower Columbia Bright Chinook from Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rates					Northern Ocean Fisheries Exploitation Rates					Southern Ocean Fisheries Exploitation Rates				
	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
1990	0.34	0.32	0.30	0.28	0.27	0.15	0.15	0.13	0.12	0.10	0.19	0.17	0.17	0.16	0.17
1991	0.55	0.55	0.54	0.52	0.51	0.16	0.14	0.11	0.12	0.10	0.39	0.41	0.42	0.41	0.41
1992	0.57	0.55	0.53	0.51	0.49	0.25	0.22	0.20	0.18	0.16	0.33	0.32	0.33	0.33	0.34
1993	0.49	0.47	0.46	0.43	0.42	0.17	0.14	0.13	0.12	0.10	0.32	0.33	0.33	0.32	0.32
1994	0.30	0.32	0.30	0.27	0.25	0.21	0.18	0.16	0.14	0.13	0.09	0.14	0.14	0.12	0.13
1995	0.37	0.38	0.37	0.35	0.35	0.14	0.12	0.11	0.09	0.09	0.23	0.26	0.26	0.25	0.25
1996	0.15	0.20	0.18	0.16	0.16	0.08	0.12	0.10	0.09	0.10	0.06	0.08	0.08	0.07	0.07
1997	0.25	0.25	0.24	0.22	0.20	0.15	0.14	0.12	0.11	0.10	0.10	0.11	0.12	0.10	0.11
1998	0.22	0.22	0.21	0.19	0.19	0.13	0.11	0.09	0.09	0.08	0.10	0.11	0.11	0.10	0.10
1999	0.18	0.19	0.18	0.14	0.14	0.14	0.12	0.11	0.10	0.10	0.04	0.07	0.07	0.04	0.04
2000	0.35	0.34	0.31	0.28	0.29	0.20	0.15	0.12	0.12	0.13	0.15	0.19	0.19	0.16	0.16
2001	0.29	0.29	0.28	0.26	0.26	0.13	0.12	0.11	0.10	0.10	0.16	0.17	0.17	0.16	0.16
2002	0.35	0.36	0.34	0.33	0.32	0.14	0.14	0.12	0.11	0.09	0.22	0.22	0.22	0.22	0.23
2003	0.46	0.46	0.45	0.44	0.44	0.14	0.16	0.14	0.13	0.12	0.31	0.30	0.31	0.32	0.32
2004	0.40	0.40	0.37	0.38	0.37	0.14	0.14	0.10	0.11	0.10	0.26	0.26	0.27	0.27	0.27
2005	0.51	0.43	0.42	0.46	0.45	0.19	0.15	0.13	0.12	0.11	0.32	0.28	0.29	0.34	0.35
2006	0.27	0.26	0.25	0.24	0.23	0.12	0.10	0.09	0.08	0.06	0.16	0.16	0.17	0.16	0.16
1990 - 2006 avg.	**0.35**	**0.35**	**0.34**	**0.322**	**0.315**	**0.15**	**0.14**	**0.12**	**0.113**	**0.104**	**0.20**	**0.21**	**0.22**	**0.21**	**0.21**

Lower Columbia River Tule Chinook

Total AEQ exploitation rates for Lower Columbia Natural Tule Chinook from Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rates					Northern Ocean Fisheries Exploitation Rates					Southern Ocean Fisheries Exploitation Rates				
	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction	FRAM Validation	1999 Agreement	2008 Agreement	2008 Likely	40% Reduction
1990	0.59	0.46	0.42	0.38	0.51	0.29	0.25	0.21	0.19	0.18	0.29	0.20	0.21	0.19	0.33
1991	0.66	0.62	0.60	0.56	0.54	0.35	0.28	0.24	0.24	0.22	0.31	0.34	0.35	0.32	0.32
1992	0.68	0.54	0.51	0.47	0.46	0.35	0.26	0.22	0.21	0.19	0.33	0.28	0.30	0.26	0.27
1993	0.63	0.52	0.49	0.46	0.45	0.31	0.23	0.19	0.19	0.17	0.32	0.29	0.30	0.27	0.27
1994	0.38	0.43	0.39	0.35	0.34	0.31	0.23	0.19	0.19	0.17	0.06	0.20	0.21	0.17	0.17
1995	0.41	0.46	0.43	0.37	0.37	0.28	0.22	0.18	0.17	0.17	0.14	0.24	0.25	0.20	0.20
1996	0.28	0.47	0.45	0.40	0.41	0.09	0.20	0.17	0.16	0.17	0.19	0.27	0.28	0.24	0.23
1997	0.38	0.45	0.42	0.39	0.37	0.17	0.22	0.18	0.17	0.15	0.21	0.23	0.24	0.22	0.22
1998	0.33	0.50	0.46	0.40	0.39	0.14	0.30	0.24	0.20	0.18	0.19	0.21	0.22	0.20	0.21
1999	0.44	0.50	0.48	0.44	0.44	0.15	0.20	0.17	0.16	0.16	0.29	0.30	0.31	0.28	0.28
2000	0.45	0.48	0.42	0.41	0.41	0.25	0.24	0.19	0.20	0.20	0.20	0.24	0.24	0.21	0.21
2001	0.48	0.57	0.54	0.46	0.44	0.26	0.30	0.24	0.22	0.20	0.22	0.27	0.29	0.24	0.24
2002	0.46	0.50	0.47	0.45	0.44	0.20	0.25	0.20	0.18	0.16	0.26	0.25	0.26	0.27	0.27
2003	0.35	0.40	0.36	0.35	0.33	0.18	0.24	0.19	0.17	0.15	0.18	0.16	0.17	0.18	0.18
2004	0.38	0.37	0.33	0.34	0.34	0.20	0.20	0.15	0.15	0.15	0.18	0.17	0.18	0.19	0.19
2005	0.45	0.39	0.37	0.39	0.37	0.23	0.19	0.16	0.14	0.13	0.22	0.20	0.20	0.24	0.24
2006	0.45	0.43	0.41	0.40	0.39	0.21	0.19	0.17	0.14	0.13	0.24	0.23	0.24	0.26	0.26
1990 - 2006 aver	**0.46**	**0.48**	**0.44**	**0.412**	**0.412**	**0.23**	**0.24**	**0.19**	**0.181**	**0.171**	**0.22**	**0.24**	**0.25**	**0.23**	**0.24**

Nooksack River

Total AEQ exploitation rates and escapements[1] for Nooksack River early Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.28	0.27	0.27	0.21	0.20
1991	0.35	0.29	0.28	0.23	0.22
1992	0.34	0.28	0.27	0.21	0.21
1993	0.36	0.29	0.28	0.23	0.23
1994	0.26	0.26	0.25	0.20	0.19
1995	0.24	0.25	0.24	0.19	0.18
1996	0.22	0.25	0.24	0.19	0.19
1997	0.26	0.27	0.27	0.21	0.20
1998	0.21	0.26	0.25	0.20	0.20
1999	0.27	0.26	0.25	0.21	0.21
2000	0.25	0.26	0.25	0.18	0.19
2001	0.22	0.25	0.24	0.18	0.18
2002	0.19	0.25	0.24	0.15	0.14
2003	0.19	0.27	0.26	0.16	0.15
2004	0.20	0.27	0.26	0.16	0.16
2005	0.22	0.26	0.26	0.17	0.16
2006	0.17	0.24	0.24	0.13	0.13
90-06 average	0.25	0.26	0.26	0.19	0.18
Change from Validation (1990-2006 average)		0.05	0.02	-0.25	-0.26

Northern Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.23	0.22	0.22	0.16	0.15
1991	0.29	0.24	0.23	0.18	0.17
1992	0.27	0.23	0.22	0.16	0.15
1993	0.28	0.22	0.21	0.16	0.15
1994	0.20	0.21	0.20	0.14	0.14
1995	0.17	0.20	0.19	0.13	0.13
1996	0.14	0.20	0.19	0.13	0.14
1997	0.18	0.22	0.21	0.15	0.15
1998	0.16	0.21	0.20	0.14	0.14
1999	0.22	0.21	0.20	0.15	0.15
2000	0.20	0.21	0.20	0.13	0.13
2001	0.18	0.20	0.19	0.13	0.13
2002	0.18	0.21	0.20	0.14	0.13
2003	0.15	0.21	0.20	0.12	0.11
2004	0.16	0.21	0.20	0.12	0.12
2005	0.18	0.21	0.20	0.13	0.12
2006	0.13	0.19	0.18	0.09	0.08
90-06 average	0.20	0.21	0.20	0.14	0.13

Southern Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.05	0.05	0.05	0.05	0.05
1991	0.06	0.05	0.05	0.05	0.05
1992	0.07	0.05	0.05	0.05	0.05
1993	0.08	0.06	0.06	0.07	0.08
1994	0.06	0.05	0.05	0.05	0.05
1995	0.07	0.05	0.05	0.05	0.05
1996	0.07	0.05	0.05	0.05	0.05
1997	0.09	0.05	0.05	0.05	0.05
1998	0.05	0.05	0.05	0.05	0.06
1999	0.05	0.05	0.05	0.05	0.05
2000	0.05	0.05	0.05	0.06	0.06
2001	0.04	0.05	0.05	0.05	0.05
2002	0.02	0.04	0.04	0.02	0.02
2003	0.03	0.05	0.05	0.04	0.03
2004	0.04	0.06	0.06	0.04	0.04
2005	0.04	0.05	0.05	0.04	0.04
2006	0.04	0.05	0.05	0.04	0.05
90-06 average	0.05	0.05	0.05	0.05	0.05

Escapement

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	120	128	129	132	79
1991	374	420	422	431	260
1992	396	435	439	450	272
1993	434	494	498	508	302
1994	91	94	94	96	58
1995	423	424	426	436	261
1996	350	350	352	359	215
1997	183	179	180	184	111
1998	112	108	108	110	66
1999	227	227	228	231	138
2000	388	384	386	399	239
2001	444	437	439	450	270
2002	449	433	436	454	274
2003	365	345	348	367	221
2004	383	364	367	388	233
2005	269	264	266	277	167
2006	560	539	542	572	343
90-06 average	327	331	333	344	206

[1] The escapements shown here include returns to both the North Fork and South Fork Nooksack populations.

Skagit Summer/Fall

Total AEQ exploitation rates and escapements[2] for Skagit River Summer/Fall Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.51	0.57	0.56	0.45	0.44
1991	0.62	0.62	0.61	0.52	0.52
1992	0.59	0.55	0.54	0.43	0.43
1993	0.67	0.61	0.60	0.49	0.50
1994	0.48	0.51	0.49	0.38	0.38
1995	0.55	0.60	0.59	0.48	0.49
1996	0.36	0.52	0.50	0.37	0.38
1997	0.53	0.58	0.56	0.46	0.47
1998	0.30	0.39	0.37	0.27	0.27
1999	0.40	0.51	0.50	0.35	0.36
2000	0.42	0.48	0.47	0.34	0.34
2001	0.31	0.42	0.40	0.29	0.28
2002	0.46	0.57	0.55	0.44	0.42
2003	0.43	0.59	0.56	0.40	0.38
2004	0.43	0.60	0.58	0.37	0.36
2005	0.47	0.57	0.56	0.40	0.39
2006	0.40	0.52	0.51	0.33	0.32
90-06 average	**0.47**	**0.54**	**0.53**	**0.40**	**0.40**
Change from Validation (1990-2006 average)		**0.16**	**0.13**	**-0.15**	**-0.15**

Northern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.34	0.38	0.36	0.30	0.28
1991	0.33	0.36	0.34	0.28	0.26
1992	0.39	0.37	0.35	0.29	0.28
1993	0.38	0.38	0.37	0.28	0.28
1994	0.36	0.40	0.38	0.29	0.29
1995	0.30	0.38	0.36	0.27	0.27
1996	0.20	0.39	0.38	0.30	0.30
1997	0.29	0.38	0.35	0.29	0.28
1998	0.25	0.25	0.24	0.22	0.22
1999	0.33	0.37	0.35	0.28	0.27
2000	0.37	0.37	0.35	0.29	0.29
2001	0.23	0.28	0.26	0.21	0.20
2002	0.33	0.41	0.38	0.31	0.28
2003	0.35	0.46	0.43	0.32	0.29
2004	0.34	0.41	0.39	0.28	0.27
2005	0.33	0.33	0.32	0.26	0.24
2006	0.29	0.33	0.31	0.22	0.20
90-06 average	**0.32**	**0.37**	**0.35**	**0.27**	**0.27**

Southern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.17	0.19	0.19	0.15	0.16
1991	0.29	0.26	0.27	0.24	0.26
1992	0.21	0.18	0.18	0.14	0.15
1993	0.29	0.22	0.23	0.21	0.22
1994	0.12	0.11	0.12	0.09	0.09
1995	0.25	0.22	0.22	0.21	0.21
1996	0.16	0.12	0.13	0.08	0.08
1997	0.24	0.20	0.21	0.17	0.18
1998	0.05	0.13	0.14	0.05	0.05
1999	0.08	0.14	0.14	0.08	0.08
2000	0.05	0.11	0.12	0.05	0.05
2001	0.08	0.14	0.14	0.08	0.08
2002	0.13	0.16	0.17	0.13	0.13
2003	0.08	0.13	0.13	0.08	0.09
2004	0.09	0.19	0.20	0.09	0.09
2005	0.13	0.24	0.24	0.14	0.15
2006	0.11	0.19	0.20	0.11	0.12
90-06 average	**0.15**	**0.17**	**0.18**	**0.12**	**0.13**

Escapement					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	18,318	17,054	17,447	20,240	12,205
1991	6,697	6,795	6,952	7,961	4,764
1992	9,694	10,646	10,920	12,731	7,584
1993	6,387	7,526	7,702	8,927	5,239
1994	11,027	10,739	10,942	12,334	7,411
1995	8,561	8,214	8,362	9,532	5,683
1996	13,012	11,248	11,409	12,953	7,748
1997	4,577	4,355	4,456	5,098	3,043
1998	13,216	11,529	11,771	13,638	8,159
1999	5,720	5,171	5,262	6,065	3,620
2000	17,635	15,680	16,052	18,510	11,073
2001	14,362	12,753	12,986	14,653	8,849
2002	17,857	15,717	16,123	18,115	11,100
2003	11,515	9,536	9,861	11,594	7,077
2004	24,910	20,802	21,293	26,071	15,725
2005	22,244	19,744	20,043	23,554	14,254
2006	22,240	19,606	19,919	23,645	14,248
90-06 average	**13,410**	**12,183**	**12,441**	**14,448**	**8,693**

[2] The escapements shown here include returns to the Upper Skagit, Lower Skagit and Lower Sauk River populations.

Skagit Spring

Total AEQ exploitation rates and escapements[3] for Skagit River Spring Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.46	0.44	0.43	0.29	0.28
1991	0.61	0.51	0.50	0.34	0.33
1992	0.61	0.52	0.50	0.35	0.35
1993	0.56	0.47	0.46	0.32	0.31
1994	0.56	0.53	0.52	0.35	0.35
1995	0.48	0.47	0.46	0.29	0.29
1996	0.30	0.34	0.33	0.20	0.20
1997	0.53	0.50	0.49	0.32	0.31
1998	0.25	0.37	0.37	0.24	0.25
1999	0.20	0.34	0.34	0.20	0.21
2000	0.28	0.40	0.39	0.26	0.27
2001	0.34	0.49	0.48	0.33	0.34
2002	0.28	0.48	0.47	0.28	0.28
2003	0.22	0.45	0.44	0.23	0.22
2004	0.24	0.48	0.48	0.22	0.22
2005	0.30	0.57	0.56	0.27	0.27
2006	0.23	0.47	0.46	0.22	0.21
90-06 average	**0.38**	**0.46**	**0.45**	**0.28**	**0.28**
Change from Validation (1990-2006 average)		**0.22**	**0.19**	**-0.27**	**-0.27**

Northern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.23	0.21	0.19	0.13	0.12
1991	0.26	0.23	0.22	0.13	0.12
1992	0.24	0.23	0.21	0.13	0.12
1993	0.24	0.21	0.19	0.13	0.11
1994	0.15	0.22	0.21	0.12	0.11
1995	0.12	0.21	0.20	0.11	0.11
1996	0.08	0.16	0.15	0.10	0.10
1997	0.10	0.22	0.21	0.12	0.11
1998	0.06	0.16	0.15	0.10	0.11
1999	0.09	0.14	0.13	0.10	0.10
2000	0.09	0.16	0.15	0.08	0.08
2001	0.10	0.20	0.20	0.10	0.10
2002	0.11	0.20	0.19	0.11	0.10
2003	0.10	0.21	0.20	0.10	0.10
2004	0.12	0.21	0.20	0.11	0.11
2005	0.15	0.23	0.22	0.13	0.12
2006	0.10	0.20	0.19	0.08	0.08
90-06 average	**0.14**	**0.20**	**0.19**	**0.11**	**0.11**

Southern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.23	0.23	0.24	0.16	0.16
1991	0.35	0.28	0.28	0.20	0.21
1992	0.37	0.29	0.29	0.22	0.23
1993	0.32	0.26	0.27	0.19	0.20
1994	0.41	0.31	0.31	0.23	0.24
1995	0.36	0.26	0.26	0.18	0.19
1996	0.23	0.18	0.18	0.10	0.10
1997	0.43	0.27	0.28	0.19	0.20
1998	0.19	0.21	0.21	0.13	0.14
1999	0.11	0.21	0.21	0.11	0.11
2000	0.18	0.24	0.24	0.18	0.18
2001	0.24	0.29	0.29	0.23	0.23
2002	0.17	0.28	0.28	0.17	0.17
2003	0.12	0.24	0.24	0.12	0.12
2004	0.11	0.27	0.27	0.11	0.11
2005	0.15	0.34	0.34	0.15	0.15
2006	0.13	0.27	0.28	0.13	0.13
90-06 average	**0.24**	**0.26**	**0.26**	**0.17**	**0.17**

Escapement					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	1,822	2,215	2,260	2,590	1,557
1991	1,788	2,228	2,255	2,604	1,576
1992	1,024	1,363	1,391	1,604	966
1993	835	1,047	1,069	1,224	736
1994	1,089	1,131	1,151	1,335	803
1995	2,283	2,379	2,414	2,801	1,677
1996	1,801	1,793	1,822	2,075	1,247
1997	823	893	909	1,050	636
1998	957	870	879	990	590
1999	280	244	246	278	166
2000	602	527	531	610	365
2001	1,905	1,679	1,694	1,919	1,149
2002	843	732	740	845	508
2003	1,599	1,300	1,324	1,586	956
2004	2,108	1,716	1,736	2,131	1,276
2005	1,361	1,146	1,157	1,389	835
2006	2,013	1,669	1,683	2,035	1,226
90-06 average	**1,361**	**1,349**	**1,368**	**1,592**	**957**

[3] The escapements shown here include returns to the Suiattle, Upper Sauk and Upper Cascade River populations.

Stillaguamish Summer/Fall

Total AEQ exploitation rates and escapements[4] for Stillaguamish Summer/Fall Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.54	0.49	0.48	0.35	0.38
1991	0.47	0.35	0.34	0.22	0.22
1992	0.40	0.27	0.26	0.18	0.18
1993	0.40	0.32	0.31	0.18	0.19
1994	0.34	0.30	0.29	0.19	0.19
1995	0.47	0.41	0.40	0.29	0.35
1996	0.38	0.33	0.33	0.21	0.21
1997	0.39	0.36	0.35	0.25	0.26
1998	0.22	0.33	0.32	0.22	0.23
1999	0.28	0.44	0.43	0.27	0.28
2000	0.25	0.32	0.31	0.22	0.22
2001	0.25	0.34	0.33	0.23	0.23
2002	0.22	0.36	0.34	0.20	0.20
2003	0.18	0.32	0.30	0.16	0.17
2004	0.21	0.35	0.33	0.17	0.17
2005	0.27	0.38	0.36	0.21	0.22
2006	0.18	0.34	0.33	0.15	0.15
90-06 average	0.32	0.35	0.34	0.22	0.23
Change from Validation (1990-2006 average)		0.10	0.07	-0.32	-0.29

Northern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.19	0.17	0.16	0.13	0.13
1991	0.12	0.10	0.10	0.08	0.07
1992	0.13	0.09	0.08	0.07	0.07
1993	0.14	0.10	0.09	0.07	0.08
1994	0.12	0.09	0.08	0.08	0.08
1995	0.09	0.09	0.08	0.07	0.07
1996	0.05	0.09	0.08	0.07	0.07
1997	0.07	0.12	0.10	0.09	0.10
1998	0.05	0.11	0.10	0.08	0.08
1999	0.10	0.11	0.10	0.09	0.09
2000	0.10	0.09	0.08	0.06	0.06
2001	0.09	0.11	0.10	0.08	0.07
2002	0.11	0.13	0.11	0.09	0.08
2003	0.09	0.12	0.10	0.08	0.08
2004	0.13	0.13	0.11	0.09	0.09
2005	0.17	0.13	0.12	0.11	0.10
2006	0.11	0.11	0.10	0.07	0.06
90-06 average	0.11	0.11	0.10	0.08	0.08

Southern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.34	0.32	0.32	0.22	0.24
1991	0.35	0.25	0.25	0.15	0.15
1992	0.27	0.18	0.18	0.11	0.11
1993	0.26	0.22	0.22	0.11	0.11
1994	0.22	0.21	0.21	0.11	0.11
1995	0.38	0.31	0.32	0.22	0.27
1996	0.34	0.24	0.25	0.14	0.14
1997	0.31	0.25	0.25	0.16	0.17
1998	0.18	0.21	0.22	0.14	0.15
1999	0.19	0.33	0.33	0.18	0.20
2000	0.16	0.23	0.23	0.15	0.16
2001	0.16	0.23	0.24	0.15	0.16
2002	0.12	0.23	0.24	0.11	0.12
2003	0.09	0.20	0.20	0.08	0.09
2004	0.08	0.22	0.22	0.08	0.08
2005	0.10	0.24	0.25	0.10	0.12
2006	0.08	0.23	0.23	0.08	0.08
90-06 average	0.21	0.24	0.24	0.14	0.15

Escapement					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	603	697	704	745	432
1991	1,301	1,502	1,510	1,603	960
1992	985	1,198	1,209	1,250	749
1993	839	984	993	1,074	644
1994	1,003	1,030	1,038	1,096	658
1995	623	680	685	732	410
1996	1,423	1,518	1,528	1,606	962
1997	1,037	1,135	1,145	1,215	727
1998	1,599	1,520	1,536	1,644	982
1999	977	926	932	979	584
2000	1,565	1,459	1,473	1,592	953
2001	1,233	1,172	1,182	1,245	747
2002	1,424	1,321	1,335	1,439	866
2003	1,385	1,245	1,258	1,390	830
2004	888	804	812	904	542
2005	787	761	768	812	476
2006	1,093	998	1,005	1,112	664
90-06 average	1,104	1,115	1,124	1,202	717

[4] The escapements shown here include returns to the both the North Fork and South Fork Stillaguamish River populations.

Snohomish Summer/Fall

Total AEQ exploitation rates and escapements[5] on Snohomish River Summer/Fall Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rate					Northern Exploitation Rate					Southern Exploitation Rate					Escapement				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.49	0.55	0.54	0.31	0.31	0.20	0.19	0.17	0.14	0.13	0.29	0.36	0.37	0.17	0.18	3,747	3,633	3,695	5,286	3,146
1991	0.54	0.55	0.54	0.34	0.34	0.25	0.20	0.19	0.15	0.14	0.29	0.35	0.35	0.19	0.20	2,624	2,591	2,618	3,539	2,115
1992	0.62	0.59	0.58	0.37	0.37	0.25	0.22	0.20	0.17	0.15	0.38	0.37	0.37	0.20	0.21	2,275	2,435	2,480	3,428	2,052
1993	0.65	0.65	0.64	0.42	0.42	0.25	0.25	0.23	0.18	0.16	0.40	0.40	0.41	0.24	0.25	3,026	2,964	3,025	4,264	2,563
1994	0.53	0.61	0.60	0.38	0.38	0.20	0.21	0.19	0.15	0.14	0.33	0.40	0.40	0.23	0.23	3,209	2,559	2,589	3,441	2,071
1995	0.70	0.74	0.73	0.52	0.52	0.15	0.27	0.26	0.18	0.18	0.54	0.46	0.47	0.34	0.35	2,397	1,969	2,002	2,866	1,715
1996	0.49	0.61	0.60	0.34	0.34	0.10	0.22	0.21	0.15	0.15	0.39	0.39	0.39	0.19	0.20	4,356	3,382	3,436	5,052	3,030
1997	0.29	0.44	0.43	0.23	0.22	0.07	0.12	0.10	0.10	0.08	0.22	0.32	0.33	0.13	0.14	8,765	7,321	7,415	10,080	6,109
1998	0.28	0.54	0.53	0.31	0.32	0.07	0.18	0.17	0.13	0.12	0.21	0.36	0.36	0.18	0.19	5,512	3,836	3,888	5,488	3,281
1999	0.41	0.63	0.62	0.40	0.39	0.17	0.26	0.25	0.18	0.17	0.24	0.37	0.38	0.22	0.22	3,732	2,819	2,845	3,837	2,305
2000	0.29	0.50	0.50	0.22	0.22	0.12	0.16	0.14	0.10	0.10	0.17	0.35	0.35	0.12	0.13	3,675	2,525	2,562	3,905	2,342
2001	0.30	0.48	0.46	0.26	0.24	0.13	0.19	0.16	0.14	0.12	0.17	0.29	0.30	0.12	0.13	5,231	4,047	4,105	5,508	3,326
2002	0.33	0.58	0.57	0.31	0.31	0.13	0.20	0.18	0.16	0.13	0.20	0.38	0.39	0.15	0.18	3,861	2,545	2,592	4,021	2,335
2003	0.26	0.58	0.57	0.28	0.27	0.13	0.22	0.20	0.15	0.14	0.13	0.36	0.37	0.13	0.14	4,514	2,886	2,942	4,417	2,662
2004	0.25	0.56	0.55	0.24	0.24	0.16	0.21	0.19	0.15	0.14	0.09	0.35	0.36	0.09	0.10	9,349	5,985	6,081	9,405	5,647
2005	0.36	0.62	0.61	0.32	0.31	0.24	0.25	0.23	0.20	0.17	0.12	0.37	0.38	0.12	0.13	4,684	3,205	3,259	4,806	2,908
2006	0.27	0.58	0.57	0.25	0.23	0.16	0.21	0.20	0.14	0.11	0.11	0.36	0.37	0.11	0.12	6,242	4,071	4,125	6,325	3,836
90-06 average	**0.41**	**0.58**	**0.57**	**0.32**	**0.32**	**0.16**	**0.21**	**0.19**	**0.15**	**0.14**	**0.25**	**0.37**	**0.37**	**0.17**	**0.18**	**4,541**	**3,457**	**3,509**	**5,039**	**3,026**
Change from Validation (1990-2006 average)		0.39	0.37	-0.22	-0.23															

[5] The escapements shown here include returns to the both the Skykomish and Snoqualmie River populations.

Lake Washington

Total AEQ exploitation rates and escapements[6] for Lake Washington Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rate					Northern Exploitation Rate					Southern Exploitation Rate					Escapement				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.65	0.54	0.52	0.38	0.42	0.24	0.19	0.16	0.17	0.17	0.41	0.35	0.36	0.21	0.26	298	404	418	492	275
1991	0.71	0.60	0.58	0.45	0.52	0.23	0.18	0.16	0.17	0.16	0.48	0.42	0.42	0.28	0.36	319	437	449	534	283
1992	0.76	0.57	0.55	0.41	0.49	0.24	0.17	0.14	0.15	0.12	0.52	0.40	0.41	0.26	0.37	306	536	560	661	338
1993	0.58	0.48	0.46	0.34	0.37	0.21	0.16	0.14	0.15	0.14	0.37	0.32	0.32	0.19	0.23	105	128	132	151	86
1994	0.39	0.38	0.35	0.24	0.23	0.16	0.15	0.12	0.13	0.12	0.23	0.23	0.23	0.11	0.11	336	337	347	399	242
1995	0.32	0.30	0.29	0.18	0.18	0.12	0.11	0.09	0.09	0.09	0.20	0.19	0.19	0.09	0.09	610	623	635	735	440
1996	0.29	0.33	0.31	0.21	0.24	0.05	0.10	0.09	0.09	0.09	0.24	0.22	0.23	0.13	0.15	301	284	290	338	197
1997	0.32	0.35	0.33	0.23	0.22	0.08	0.14	0.11	0.12	0.10	0.23	0.21	0.21	0.11	0.11	192	193	199	224	136
1998	0.16	0.30	0.29	0.20	0.21	0.05	0.12	0.10	0.11	0.11	0.11	0.19	0.19	0.09	0.10	390	328	335	380	225
1999	0.18	0.29	0.28	0.19	0.19	0.08	0.10	0.09	0.10	0.10	0.09	0.19	0.19	0.09	0.10	217	193	196	213	128
2000	0.23	0.32	0.31	0.21	0.21	0.13	0.13	0.11	0.10	0.10	0.11	0.20	0.20	0.11	0.11	104	90	92	105	63
2001	0.22	0.34	0.33	0.22	0.22	0.10	0.12	0.11	0.11	0.10	0.12	0.22	0.22	0.12	0.12	688	587	599	686	414
2002	0.20	0.36	0.34	0.21	0.20	0.11	0.15	0.12	0.13	0.11	0.09	0.21	0.21	0.09	0.09	328	270	277	323	196
2003	0.27	0.47	0.44	0.29	0.27	0.15	0.21	0.17	0.17	0.15	0.11	0.25	0.26	0.12	0.11	536	418	433	532	319
2004	0.31	0.46	0.43	0.28	0.28	0.20	0.20	0.16	0.16	0.16	0.11	0.26	0.27	0.12	0.12	443	360	368	450	270
2005	0.44	0.60	0.58	0.36	0.35	0.31	0.22	0.19	0.23	0.20	0.12	0.37	0.39	0.13	0.14	399	359	367	414	249
2006	0.35	0.52	0.50	0.30	0.28	0.23	0.20	0.17	0.18	0.15	0.12	0.32	0.33	0.13	0.13	863	748	760	878	531
90-06 average	**0.37**	**0.42**	**0.40**	**0.28**	**0.29**	**0.16**	**0.16**	**0.13**	**0.14**	**0.13**	**0.22**	**0.27**	**0.27**	**0.14**	**0.16**	**379**	**370**	**380**	**442**	**258**
Change from Validation (1990-2006 average)		**0.13**	**0.08**	**-0.26**	**-0.24**															

[6] The escapements shown here include returns to the both the Cedar and Sammamish River populations.

Green River

Total AEQ exploitation rates and escapements for Duwamish-Green River Chinook from the Retrospective Analysis (LaVoy 2008)

Year	Total Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.75	0.65	0.63	0.51	0.51
1991	0.69	0.62	0.61	0.49	0.49
1992	0.78	0.64	0.62	0.49	0.48
1993	0.72	0.65	0.64	0.53	0.54
1994	0.65	0.58	0.56	0.45	0.44
1995	0.39	0.37	0.36	0.24	0.24
1996	0.40	0.43	0.42	0.31	0.31
1997	0.34	0.41	0.39	0.27	0.28
1998	0.30	0.45	0.44	0.33	0.36
1999	0.25	0.40	0.39	0.26	0.26
2000	0.42	0.48	0.47	0.40	0.41
2001	0.33	0.44	0.43	0.33	0.33
2002	0.46	0.60	0.59	0.47	0.46
2003	0.42	0.60	0.58	0.48	0.42
2004	0.49	0.60	0.58	0.46	0.46
2005	0.50	0.67	0.65	0.44	0.42
2006	0.51	0.65	0.64	0.48	0.46
90-06 average	**0.49**	**0.54**	**0.53**	**0.41**	**0.40**
Change from Validation (1990-2006 average)		**0.10**	**0.07**	**-0.17**	**-0.18**

Year	Northern Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.24	0.19	0.16	0.17	0.17
1991	0.23	0.18	0.16	0.17	0.16
1992	0.24	0.17	0.14	0.15	0.12
1993	0.21	0.16	0.14	0.15	0.14
1994	0.16	0.15	0.12	0.13	0.12
1995	0.12	0.11	0.09	0.09	0.09
1996	0.05	0.10	0.09	0.09	0.09
1997	0.08	0.14	0.11	0.12	0.10
1998	0.05	0.12	0.10	0.11	0.11
1999	0.08	0.10	0.09	0.10	0.10
2000	0.13	0.13	0.11	0.10	0.10
2001	0.10	0.12	0.11	0.11	0.10
2002	0.11	0.15	0.12	0.13	0.11
2003	0.15	0.21	0.17	0.17	0.15
2004	0.20	0.20	0.16	0.16	0.16
2005	0.31	0.22	0.19	0.23	0.20
2006	0.23	0.20	0.17	0.18	0.15
90-06 average	**0.16**	**0.16**	**0.13**	**0.14**	**0.13**

Year	Southern Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.51	0.46	0.47	0.34	0.35
1991	0.46	0.45	0.45	0.32	0.33
1992	0.53	0.47	0.48	0.34	0.35
1993	0.51	0.49	0.50	0.39	0.40
1994	0.49	0.43	0.44	0.32	0.33
1995	0.27	0.26	0.27	0.15	0.15
1996	0.34	0.32	0.33	0.22	0.22
1997	0.25	0.27	0.28	0.15	0.17
1998	0.25	0.33	0.34	0.23	0.26
1999	0.17	0.30	0.30	0.16	0.17
2000	0.29	0.36	0.36	0.30	0.30
2001	0.23	0.32	0.32	0.23	0.23
2002	0.35	0.45	0.47	0.35	0.35
2003	0.27	0.39	0.41	0.31	0.27
2004	0.29	0.40	0.42	0.30	0.30
2005	0.19	0.44	0.46	0.21	0.22
2006	0.28	0.45	0.47	0.30	0.31
90-06 average	**0.33**	**0.39**	**0.40**	**0.27**	**0.28**

Year	Escapement Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	6,989	10,110	10,427	12,630	7,539
1991	7,933	9,518	9,707	11,594	6,957
1992	5,480	8,694	9,008	10,903	6,617
1993	2,347	2,876	2,947	3,551	2,091
1994	3,533	4,206	4,332	5,267	3,199
1995	8,001	8,138	8,296	9,930	5,957
1996	7,004	6,586	6,713	8,096	4,855
1997	10,328	9,676	9,969	11,749	6,976
1998	8,528	6,754	6,918	8,267	4,722
1999	12,054	10,003	10,158	11,870	7,082
2000	9,133	7,925	8,106	9,185	5,452
2001	19,832	16,823	17,133	19,769	11,939
2002	12,184	9,217	9,471	12,002	7,277
2003	8,408	6,206	6,425	7,695	5,005
2004	14,503	11,801	12,070	14,802	8,851
2005	4,040	3,410	3,483	4,201	2,539
2006	10,103	8,383	8,520	10,264	6,222
90-06 average	**8,847**	**8,254**	**8,452**	**10,104**	**6,075**

White River

Total AEQ exploitation rates and escapements for White River Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.26	0.22	0.22	0.13	0.16
1991	0.41	0.39	0.39	0.20	0.20
1992	0.30	0.22	0.22	0.12	0.12
1993	0.23	0.21	0.21	0.12	0.11
1994	0.41	0.35	0.35	0.18	0.19
1995	0.37	0.33	0.33	0.18	0.19
1996	0.31	0.27	0.27	0.14	0.14
1997	0.26	0.31	0.31	0.17	0.17
1998	0.23	0.30	0.30	0.18	0.19
1999	0.41	0.66	0.66	0.41	0.43
2000	0.14	0.22	0.22	0.14	0.14
2001	0.17	0.26	0.26	0.17	0.18
2002	0.13	0.28	0.28	0.13	0.13
2003	0.12	0.26	0.26	0.12	0.12
2004	0.16	0.47	0.47	0.16	0.17
2005	0.09	0.30	0.30	0.09	0.09
2006	0.22	0.59	0.59	0.22	0.23
90-06 average	**0.25**	**0.33**	**0.33**	**0.17**	**0.17**
Change from Validation (1990-2006 average)		-0.19	-0.19	-0.85	-0.83

	Northern Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.06	0.05	0.05	0.03	0.03
1991	0.07	0.05	0.05	0.03	0.03
1992	0.11	0.05	0.05	0.03	0.03
1993	0.06	0.05	0.05	0.03	0.03
1994	0.03	0.05	0.05	0.03	0.03
1995	0.02	0.05	0.05	0.03	0.03
1996	0.01	0.05	0.05	0.03	0.03
1997	0.01	0.05	0.05	0.03	0.03
1998	0.02	0.05	0.05	0.03	0.03
1999	0.03	0.05	0.05	0.03	0.03
2000	0.03	0.05	0.05	0.03	0.03
2001	0.04	0.05	0.05	0.04	0.04
2002	0.03	0.05	0.05	0.03	0.02
2003	0.03	0.05	0.05	0.03	0.03
2004	0.04	0.05	0.05	0.04	0.04
2005	0.01	0.05	0.05	0.01	0.01
2006	0.02	0.05	0.05	0.02	0.02
90-06 average	**0.04**	**0.05**	**0.05**	**0.03**	**0.03**

	Southern Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.19	0.17	0.17	0.10	0.12
1991	0.34	0.35	0.35	0.17	0.17
1992	0.19	0.17	0.17	0.09	0.09
1993	0.17	0.16	0.16	0.08	0.08
1994	0.38	0.30	0.30	0.15	0.15
1995	0.35	0.29	0.29	0.15	0.16
1996	0.30	0.22	0.22	0.11	0.11
1997	0.25	0.26	0.26	0.13	0.14
1998	0.21	0.25	0.25	0.15	0.16
1999	0.38	0.61	0.61	0.38	0.40
2000	0.11	0.17	0.17	0.11	0.11
2001	0.13	0.21	0.21	0.13	0.13
2002	0.10	0.23	0.23	0.10	0.11
2003	0.09	0.22	0.22	0.09	0.09
2004	0.12	0.42	0.42	0.12	0.13
2005	0.08	0.25	0.25	0.08	0.08
2006	0.21	0.54	0.54	0.21	0.21
90-06 average	**0.21**	**0.28**	**0.28**	**0.14**	**0.14**

	Escapement				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	324	375	375	412	241
1991	233	277	277	302	182
1992	472	574	574	630	377
1993	518	567	568	622	373
1994	761	771	771	844	507
1995	1,131	1,211	1,211	1,327	795
1996	1,331	1,361	1,361	1,491	895
1997	849	863	864	946	568
1998	486	458	458	501	300
1999	666	608	608	666	400
2000	1,921	1,737	1,737	1,922	1,154
2001	3,629	3,392	3,393	3,629	2,176
2002	1,470	1,340	1,340	1,470	881
2003	2,933	2,592	2,593	2,925	1,757
2004	2,948	2,600	2,600	2,949	1,769
2005	3,302	2,888	2,889	3,305	1,983
2006	3,398	2,964	2,965	3,399	2,038
90-06 average	**1,551**	**1,446**	**1,446**	**1,608**	**964**

Puyallup River

Total AEQ exploitation rates and escapements for Puyallup River Chinook from the Retrospective Analysis (LaVoy 2008)

Year	Total Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.73	0.67	0.66	0.57	0.56
1991	0.71	0.63	0.63	0.52	0.51
1992	0.70	0.55	0.53	0.39	0.37
1993	0.73	0.68	0.66	0.58	0.60
1994	0.71	0.72	0.71	0.64	0.67
1995	0.69	0.69	0.69	0.63	0.63
1996	0.59	0.62	0.61	0.55	0.55
1997	0.61	0.63	0.62	0.54	0.54
1998	0.34	0.46	0.45	0.37	0.37
1999	0.53	0.60	0.60	0.54	0.54
2000	0.70	0.75	0.74	0.69	0.69
2001	0.77	0.82	0.81	0.78	0.77
2002	0.70	0.77	0.76	0.71	0.70
2003	0.64	0.74	0.73	0.64	0.64
2004	0.71	0.78	0.77	0.70	0.70
2005	0.70	0.79	0.78	0.66	0.65
2006	0.55	0.67	0.65	0.52	0.50
90-06 average	**0.65**	**0.68**	**0.67**	**0.59**	**0.59**
Change from Validation (1990-2006 average)		**0.04**	**0.02**	**-0.10**	**-0.10**

Year	Northern Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.24	0.19	0.16	0.17	0.17
1991	0.23	0.18	0.16	0.17	0.16
1992	0.24	0.17	0.14	0.15	0.12
1993	0.21	0.16	0.14	0.15	0.14
1994	0.16	0.15	0.12	0.13	0.12
1995	0.12	0.11	0.09	0.09	0.09
1996	0.05	0.10	0.09	0.09	0.09
1997	0.08	0.14	0.11	0.12	0.10
1998	0.05	0.12	0.10	0.11	0.11
1999	0.08	0.10	0.09	0.10	0.10
2000	0.13	0.13	0.11	0.10	0.10
2001	0.10	0.12	0.11	0.11	0.10
2002	0.11	0.15	0.12	0.13	0.11
2003	0.15	0.21	0.17	0.17	0.15
2004	0.20	0.20	0.16	0.16	0.16
2005	0.31	0.22	0.19	0.23	0.20
2006	0.23	0.20	0.17	0.18	0.15
90-06 average	**0.16**	**0.16**	**0.13**	**0.14**	**0.13**

Year	Southern Exploitation Rate Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.48	0.48	0.50	0.40	0.40
1991	0.47	0.46	0.47	0.35	0.36
1992	0.46	0.38	0.39	0.24	0.25
1993	0.52	0.51	0.52	0.43	0.47
1994	0.55	0.57	0.58	0.51	0.55
1995	0.58	0.58	0.59	0.54	0.54
1996	0.54	0.51	0.52	0.46	0.46
1997	0.52	0.49	0.50	0.43	0.44
1998	0.29	0.34	0.35	0.26	0.26
1999	0.45	0.50	0.51	0.44	0.44
2000	0.57	0.62	0.64	0.59	0.59
2001	0.67	0.69	0.71	0.67	0.67
2002	0.60	0.62	0.64	0.58	0.59
2003	0.49	0.53	0.55	0.48	0.48
2004	0.51	0.58	0.60	0.53	0.54
2005	0.39	0.56	0.59	0.43	0.45
2006	0.32	0.46	0.48	0.34	0.35
90-06 average	**0.49**	**0.52**	**0.54**	**0.45**	**0.46**

Year	Escapement Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	2,610	3,239	3,340	3,888	2,339
1991	1,154	1,417	1,445	1,668	1,015
1992	2,673	3,963	4,105	4,770	2,906
1993	1,390	1,634	1,680	1,970	1,106
1994	1,650	1,592	1,649	1,965	1,088
1995	2,427	2,404	2,454	2,892	1,729
1996	2,651	2,459	2,510	2,982	1,777
1997	1,231	1,233	1,272	1,474	886
1998	4,476	3,723	3,810	4,382	2,616
1999	1,639	1,441	1,466	1,611	970
2000	796	644	662	799	478
2001	1,354	1,118	1,141	1,348	814
2002	1,285	1,029	1,061	1,264	768
2003	1,301	997	1,035	1,302	778
2004	946	758	775	962	577
2005	784	701	716	814	492
2006	1,706	1,474	1,498	1,730	1,050
90-06 average	**1,769**	**1,754**	**1,801**	**2,107**	**1,258**

Nisqually River

Total AEQ exploitation rates and escapements for Nisqually River Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.94	0.94	0.94	0.90	0.90
1991	0.84	0.83	0.82	0.66	0.65
1992	0.84	0.82	0.81	0.75	0.75
1993	0.88	0.89	0.89	0.81	0.81
1994	0.96	0.96	0.96	0.95	0.95
1995	0.83	0.88	0.88	0.81	0.81
1996	0.56	0.67	0.67	0.54	0.54
1997	0.72	0.83	0.82	0.72	0.72
1998	0.79	0.86	0.85	0.79	0.80
1999	0.81	0.87	0.87	0.82	0.82
2000	0.72	0.84	0.83	0.72	0.72
2001	0.74	0.83	0.82	0.75	0.74
2002	0.77	0.87	0.86	0.77	0.77
2003	0.84	0.91	0.91	0.85	0.84
2004	0.79	0.88	0.88	0.78	0.78
2005	0.67	0.79	0.78	0.63	0.63
2006	0.83	0.91	0.91	0.82	0.82
90-06 average	0.80	0.86	0.85	0.77	0.77
Change from Validation (1990-2006 average)		0.08	0.07	-0.04	-0.04

Northern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.22	0.19	0.16	0.13	0.12
1991	0.24	0.22	0.21	0.16	0.16
1992	0.18	0.17	0.14	0.11	0.09
1993	0.15	0.15	0.13	0.10	0.09
1994	0.14	0.16	0.13	0.10	0.09
1995	0.07	0.09	0.08	0.06	0.06
1996	0.04	0.12	0.10	0.07	0.07
1997	0.06	0.15	0.13	0.10	0.10
1998	0.04	0.12	0.10	0.08	0.08
1999	0.05	0.09	0.07	0.06	0.06
2000	0.10	0.12	0.11	0.08	0.08
2001	0.08	0.12	0.10	0.08	0.08
2002	0.10	0.16	0.13	0.10	0.09
2003	0.15	0.18	0.16	0.15	0.14
2004	0.22	0.19	0.16	0.18	0.18
2005	0.25	0.17	0.15	0.19	0.17
2006	0.17	0.15	0.14	0.14	0.12
90-06 average	0.13	0.15	0.13	0.11	0.10

Southern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.72	0.75	0.78	0.77	0.77
1991	0.61	0.60	0.62	0.49	0.49
1992	0.66	0.65	0.67	0.64	0.65
1993	0.73	0.74	0.76	0.71	0.72
1994	0.82	0.81	0.83	0.84	0.86
1995	0.76	0.80	0.80	0.75	0.75
1996	0.53	0.55	0.56	0.47	0.47
1997	0.66	0.67	0.69	0.62	0.62
1998	0.75	0.74	0.75	0.72	0.72
1999	0.76	0.79	0.80	0.76	0.76
2000	0.62	0.72	0.73	0.64	0.64
2001	0.67	0.71	0.72	0.67	0.67
2002	0.68	0.71	0.73	0.67	0.68
2003	0.68	0.73	0.75	0.70	0.69
2004	0.57	0.69	0.71	0.59	0.60
2005	0.42	0.62	0.63	0.45	0.46
2006	0.66	0.76	0.77	0.68	0.70
90-06 average	0.66	0.71	0.72	0.66	0.66

Escapement					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	491	635	654	959	576
1991	640	647	668	1,198	733
1992	52	73	75	111	67
1993	795	708	724	1,245	749
1994	244	202	208	316	187
1995	460	305	308	539	323
1996	1,623	1,068	1,092	1,691	1,013
1997	292	173	176	290	175
1998	442	262	267	416	248
1999	477	303	306	467	280
2000	982	645	660	966	577
2001	759	479	486	755	454
2002	1,146	680	696	1,136	688
2003	523	367	377	502	312
2004	2,345	1,803	1,836	2,384	1,430
2005	2,149	2,084	2,126	2,220	1,340
2006	1,642	1,376	1,397	1,692	1,007
90-06 average	886	695	709	993	598

Mid-Hood Canal

Total AEQ exploitation rates and escapements for Mid-Hood Canal Rivers Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.61	0.53	0.50	0.34	0.34
1991	0.75	0.70	0.68	0.53	0.64
1992	0.83	0.74	0.72	0.55	0.55
1993	0.68	0.63	0.61	0.42	0.41
1994	0.62	0.66	0.64	0.44	0.44
1995	0.43	0.46	0.44	0.27	0.27
1996	0.34	0.44	0.42	0.25	0.26
1997	0.47	0.56	0.54	0.35	0.34
1998	0.15	0.38	0.34	0.23	0.23
1999	0.22	0.41	0.39	0.24	0.25
2000	0.25	0.37	0.35	0.22	0.23
2001	0.24	0.39	0.37	0.24	0.24
2002	0.24	0.42	0.39	0.25	0.24
2003	0.25	0.40	0.36	0.26	0.26
2004	0.32	0.47	0.44	0.27	0.27
2005	0.40	0.38	0.35	0.34	0.33
2006	0.29	0.39	0.37	0.26	0.25
90-06 average	**0.42**	**0.49**	**0.47**	**0.32**	**0.33**
Change from Validation (1990-2006 average)		**0.18**	**0.12**	**-0.23**	**-0.22**

Northern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.22	0.19	0.15	0.19	0.20
1991	0.22	0.17	0.14	0.19	0.18
1992	0.29	0.24	0.19	0.29	0.28
1993	0.22	0.18	0.15	0.20	0.19
1994	0.22	0.19	0.15	0.22	0.21
1995	0.15	0.13	0.11	0.13	0.13
1996	0.07	0.13	0.11	0.13	0.14
1997	0.09	0.15	0.12	0.15	0.13
1998	0.05	0.18	0.14	0.14	0.13
1999	0.09	0.13	0.10	0.12	0.11
2000	0.14	0.14	0.11	0.11	0.11
2001	0.14	0.14	0.11	0.15	0.14
2002	0.15	0.20	0.15	0.17	0.15
2003	0.19	0.21	0.16	0.20	0.19
2004	0.22	0.19	0.15	0.17	0.17
2005	0.33	0.17	0.13	0.26	0.25
2006	0.20	0.15	0.12	0.16	0.15
90-06 average	**0.18**	**0.17**	**0.14**	**0.18**	**0.17**

Southern Exploitation Rate					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.39	0.33	0.35	0.14	0.14
1991	0.53	0.53	0.54	0.34	0.47
1992	0.54	0.50	0.52	0.27	0.27
1993	0.46	0.45	0.46	0.21	0.21
1994	0.40	0.47	0.49	0.22	0.23
1995	0.27	0.32	0.33	0.13	0.14
1996	0.27	0.31	0.32	0.12	0.12
1997	0.37	0.41	0.42	0.20	0.21
1998	0.10	0.20	0.20	0.09	0.10
1999	0.13	0.29	0.29	0.13	0.14
2000	0.11	0.24	0.24	0.11	0.12
2001	0.10	0.25	0.26	0.10	0.10
2002	0.09	0.22	0.23	0.08	0.09
2003	0.07	0.19	0.20	0.07	0.07
2004	0.10	0.28	0.29	0.10	0.10
2005	0.07	0.21	0.21	0.07	0.08
2006	0.09	0.24	0.25	0.09	0.10
90-06 average	**0.24**	**0.32**	**0.33**	**0.15**	**0.16**

Escapement					
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	39	41	43	54	32
1991	42	46	48	66	30
1992	81	98	103	127	77
1993	102	104	108	135	82
1994	231	189	195	244	148
1995	93	81	84	106	64
1996	20	16	16	20	12
1997	4	3	4	5	3
1998	486	335	348	441	265
1999	814	627	640	793	474
2000	433	339	348	435	260
2001	261	203	209	259	156
2002	90	66	69	88	53
2003	199	151	158	198	118
2004	117	94	96	121	72
2005	41	40	42	44	26
2006	25	22	22	26	16
90-06 average	**181**	**144**	**149**	**186**	**111**

Skokomish River

Total AEQ exploitation rates and escapements on Skokomish River Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rate					Northern Exploitation Rate					Southern Exploitation Rate					Escapement				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.87	0.88	0.87	0.71	0.71	0.21	0.18	0.14	0.19	0.20	0.66	0.70	0.73	0.52	0.51	704	610	635	1,278	784
1991	0.82	0.83	0.82	0.68	0.67	0.21	0.16	0.14	0.19	0.17	0.60	0.67	0.69	0.49	0.50	1,973	1,731	1,797	2,890	1,766
1992	0.91	0.91	0.90	0.76	0.75	0.29	0.23	0.18	0.28	0.27	0.62	0.68	0.71	0.48	0.48	657	540	576	1,008	624
1993	0.79	0.86	0.85	0.64	0.63	0.22	0.17	0.13	0.20	0.19	0.57	0.69	0.72	0.45	0.45	666	417	440	825	506
1994	0.74	0.85	0.84	0.64	0.64	0.22	0.17	0.14	0.21	0.20	0.53	0.68	0.71	0.43	0.43	330	188	196	340	207
1995	0.43	0.51	0.49	0.28	0.29	0.15	0.12	0.10	0.13	0.13	0.28	0.38	0.39	0.15	0.16	1,279	1,116	1,146	1,454	872
1996	0.35	0.51	0.49	0.27	0.28	0.07	0.12	0.09	0.13	0.13	0.27	0.39	0.40	0.15	0.15	836	656	673	851	510
1997	0.47	0.62	0.60	0.37	0.37	0.09	0.13	0.11	0.14	0.12	0.38	0.48	0.49	0.23	0.24	319	264	273	343	208
1998	0.15	0.45	0.43	0.25	0.25	0.05	0.16	0.12	0.14	0.13	0.10	0.29	0.31	0.11	0.12	2,128	1,464	1,524	1,929	1,161
1999	0.35	0.59	0.57	0.37	0.37	0.09	0.11	0.09	0.11	0.11	0.26	0.48	0.49	0.26	0.26	1,888	1,370	1,399	1,839	1,108
2000	0.39	0.55	0.54	0.37	0.37	0.14	0.12	0.09	0.11	0.11	0.25	0.44	0.45	0.26	0.26	1,675	1,263	1,300	1,682	1,008
2001	0.51	0.68	0.67	0.51	0.50	0.14	0.13	0.10	0.14	0.14	0.37	0.55	0.57	0.37	0.36	3,167	2,169	2,226	3,143	1,954
2002	0.41	0.61	0.59	0.42	0.40	0.15	0.18	0.14	0.17	0.15	0.26	0.44	0.46	0.25	0.25	3,105	2,157	2,230	3,053	1,879
2003	0.57	0.73	0.71	0.56	0.56	0.18	0.19	0.14	0.20	0.18	0.39	0.54	0.57	0.36	0.38	894	586	615	913	553
2004	0.65	0.79	0.78	0.63	0.61	0.21	0.17	0.14	0.16	0.16	0.44	0.62	0.64	0.46	0.45	1,938	1,260	1,292	1,988	1,226
2005	0.73	0.77	0.76	0.71	0.69	0.31	0.15	0.12	0.25	0.24	0.43	0.61	0.64	0.46	0.45	1,576	1,384	1,420	1,657	1,053
2006	0.84	0.94	0.94	0.83	0.78	0.19	0.13	0.10	0.16	0.14	0.64	0.81	0.83	0.67	0.64	553	216	219	571	431
90-06 average	0.59	0.71	0.70	0.53	0.52	0.17	0.15	0.12	0.17	0.16	0.41	0.56	0.58	0.36	0.36	1,393	1,023	1,057	1,516	932
Change from Validation (1990-2006 average)		0.21	0.19	-0.10	-0.11															

Elwha River

Total AEQ exploitation rates and escapements for Elwha River Chinook from the Retrospective Analysis (LaVoy 2008)

Total Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.65	0.58	0.56	0.46	0.49
1991	0.48	0.41	0.39	0.31	0.32
1992	0.58	0.51	0.49	0.38	0.38
1993	0.44	0.34	0.32	0.24	0.23
1994	0.56	0.53	0.51	0.41	0.40
1995	0.41	0.37	0.35	0.25	0.26
1996	0.71	0.76	0.75	0.65	0.66
1997	0.41	0.44	0.42	0.33	0.34
1998	0.21	0.30	0.28	0.20	0.21
1999	0.25	0.28	0.26	0.19	0.20
2000	0.18	0.21	0.19	0.13	0.15
2001	0.19	0.24	0.23	0.16	0.17
2002	0.30	0.41	0.39	0.29	0.30
2003	0.34	0.44	0.41	0.31	0.30
2004	0.34	0.40	0.38	0.27	0.27
2005	0.39	0.41	0.38	0.29	0.28
2006	0.31	0.37	0.35	0.22	0.22
90-06 average	**0.40**	**0.41**	**0.39**	**0.30**	**0.30**
Change from Validation (1990-2006 average)		**0.04**	**-0.01**	**-0.24**	**-0.23**

Northern Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.35	0.35	0.32	0.35	0.33
1991	0.27	0.25	0.23	0.23	0.20
1992	0.36	0.34	0.33	0.28	0.26
1993	0.26	0.22	0.20	0.20	0.19
1994	0.40	0.34	0.31	0.34	0.32
1995	0.29	0.23	0.21	0.20	0.21
1996	0.35	0.52	0.51	0.47	0.49
1997	0.27	0.31	0.28	0.28	0.29
1998	0.17	0.19	0.17	0.18	0.18
1999	0.21	0.17	0.15	0.16	0.16
2000	0.16	0.13	0.12	0.11	0.13
2001	0.15	0.15	0.14	0.13	0.14
2002	0.26	0.28	0.26	0.24	0.24
2003	0.29	0.30	0.27	0.25	0.25
2004	0.31	0.28	0.25	0.23	0.23
2005	0.36	0.28	0.25	0.26	0.25
2006	0.28	0.24	0.22	0.19	0.18
90-06 average	**0.28**	**0.27**	**0.25**	**0.24**	**0.24**

Southern Exploitation Rate

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.30	0.22	0.23	0.11	0.16
1991	0.21	0.16	0.16	0.09	0.12
1992	0.22	0.17	0.17	0.10	0.12
1993	0.18	0.12	0.12	0.04	0.05
1994	0.16	0.20	0.20	0.07	0.08
1995	0.12	0.14	0.14	0.05	0.05
1996	0.37	0.24	0.25	0.18	0.18
1997	0.14	0.13	0.14	0.04	0.05
1998	0.04	0.10	0.10	0.03	0.03
1999	0.03	0.11	0.11	0.03	0.04
2000	0.02	0.07	0.08	0.02	0.02
2001	0.03	0.09	0.09	0.03	0.03
2002	0.05	0.13	0.13	0.05	0.05
2003	0.05	0.14	0.14	0.06	0.06
2004	0.03	0.12	0.13	0.04	0.04
2005	0.03	0.13	0.13	0.03	0.03
2006	0.03	0.13	0.13	0.03	0.04
90-06 average	**0.12**	**0.14**	**0.14**	**0.06**	**0.07**

Escapement

Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	2,783	3,163	3,220	3,388	1,892
1991	3,265	3,785	3,839	4,016	2,333
1992	1,173	1,398	1,423	1,494	892
1993	1,560	1,744	1,773	1,843	1,114
1994	1,143	1,176	1,193	1,254	747
1995	1,083	1,138	1,152	1,211	723
1996	1,553	1,466	1,484	1,557	925
1997	2,687	2,631	2,681	2,806	1,697
1998	1,826	1,786	1,803	1,878	1,120
1999	1,552	1,501	1,517	1,578	936
2000	1,872	1,839	1,859	1,945	1,156
2001	2,134	2,055	2,078	2,158	1,293
2002	2,263	2,119	2,151	2,253	1,361
2003	2,186	2,055	2,086	2,203	1,326
2004	3,286	3,152	3,196	3,363	2,019
2005	2,326	2,350	2,382	2,439	1,475
2006	2,518	2,441	2,466	2,614	1,578
90-06 average	**2,071**	**2,106**	**2,135**	**2,235**	**1,329**

Dungeness River

Total AEQ exploitation rates and escapements for Dungeness River Chinook from the Retrospective Analysis (LaVoy 2008)

	Total Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.68	0.61	0.59	0.51	0.56
1991	0.56	0.49	0.47	0.40	0.47
1992	0.57	0.50	0.48	0.37	0.35
1993	0.44	0.34	0.32	0.24	0.23
1994	0.55	0.52	0.50	0.40	0.37
1995	0.41	0.36	0.35	0.25	0.25
1996	0.71	0.76	0.75	0.64	0.66
1997	0.43	0.47	0.44	0.36	0.39
1998	0.22	0.30	0.28	0.21	0.22
1999	0.23	0.26	0.25	0.18	0.18
2000	0.18	0.20	0.19	0.13	0.14
2001	0.19	0.24	0.23	0.16	0.17
2002	0.30	0.41	0.39	0.29	0.29
2003	0.34	0.44	0.41	0.31	0.30
2004	0.34	0.40	0.38	0.28	0.28
2005	0.39	0.40	0.38	0.29	0.27
2006	0.31	0.37	0.35	0.22	0.21
90-06 average	0.40	0.42	0.40	0.31	0.32
Change from Validation (1990-2006 average)		0.04	-0.01	-0.24	-0.22

	Northern Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.33	0.33	0.30	0.33	0.30
1991	0.26	0.24	0.22	0.22	0.19
1992	0.36	0.34	0.33	0.28	0.26
1993	0.26	0.22	0.20	0.20	0.19
1994	0.40	0.34	0.31	0.34	0.32
1995	0.29	0.23	0.21	0.20	0.21
1996	0.35	0.52	0.51	0.47	0.49
1997	0.26	0.30	0.28	0.28	0.28
1998	0.17	0.19	0.17	0.18	0.18
1999	0.21	0.17	0.15	0.16	0.16
2000	0.16	0.13	0.12	0.11	0.13
2001	0.15	0.15	0.14	0.13	0.14
2002	0.26	0.28	0.26	0.24	0.24
2003	0.29	0.30	0.27	0.25	0.25
2004	0.30	0.28	0.25	0.23	0.23
2005	0.37	0.28	0.26	0.26	0.25
2006	0.28	0.24	0.22	0.19	0.18
90-06 average	0.28	0.27	0.25	0.24	0.23

	Southern Exploitation Rate				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	0.35	0.28	0.28	0.18	0.26
1991	0.30	0.25	0.25	0.19	0.28
1992	0.21	0.15	0.15	0.09	0.09
1993	0.18	0.12	0.12	0.04	0.05
1994	0.15	0.18	0.19	0.05	0.05
1995	0.12	0.13	0.14	0.04	0.04
1996	0.36	0.24	0.24	0.18	0.17
1997	0.17	0.16	0.17	0.08	0.10
1998	0.05	0.11	0.11	0.03	0.04
1999	0.02	0.10	0.10	0.02	0.02
2000	0.02	0.07	0.07	0.02	0.02
2001	0.03	0.09	0.09	0.03	0.03
2002	0.05	0.13	0.13	0.05	0.05
2003	0.05	0.14	0.14	0.06	0.05
2004	0.04	0.13	0.13	0.04	0.04
2005	0.02	0.12	0.13	0.03	0.02
2006	0.03	0.13	0.13	0.03	0.03
90-06 average	0.13	0.15	0.15	0.07	0.08

	Escapement				
Year	Valid	1999 Agreement	2008 Agreement	08 RctYr ISBM	40% Reduction
1990	306	349	355	374	206
1991	164	193	196	206	111
1992	152	180	183	192	117
1993	46	52	52	55	33
1994	69	71	72	76	46
1995	154	162	164	173	103
1996	182	172	174	183	109
1997	61	60	61	64	38
1998	86	84	85	88	52
1999	73	70	71	74	44
2000	215	211	214	223	133
2001	445	429	434	450	270
2002	622	583	592	619	375
2003	627	590	599	632	381
2004	1,002	961	974	1,025	614
2005	630	637	646	661	400
2006	797	773	781	827	500
90-06 average	331	328	333	348	208

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Pacific Salmon Treaty Biological Opinion

Appendix 4

Alternative Estimates of Harvest Mortality for Upper Willamette River Chinook

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Alternative Estimates of Harvest Mortality for Upper Willamette River Chinook

There are two principle sources of information that provide different estimates of the ocean harvest for Upper Willamette River Chinook. The PSC CTC model is used primarily for managing fisheries to the north of the U.S. border; the PFMC FRAM model is used primarily for managing fisheries to the south. The CTC and FRAM models are related and overlap with respect to purpose and areas of emphasis, but are not identical. Estimates of exploitation rate from the CTC model are on the order of 10 to 15%. FRAM model estimates are roughly twice as high. Estimates of ocean harvest in past assessments have been derived from the CTC model and associated sources. For example, ocean harvest estimates for the biological opinion on the PFMC's Salmon FMP (NMFS 2001d), the Fishery Management and Evaluation plan for inriver fisheries (ODFW 2001), and the recent biological opinion on the Willamette River Flood Control Project (NMFS 2008g) are consistent with those derived from the CTC model. The FRAM model has not been used to estimate ocean harvest impacts on Upper Willamette River Chinook largely because such estimates were not needed for the management of southern fisheries. As noted above, the harvest of Upper Willamette River Chinook in PFMC fisheries is low (on the order of 1 or 2% per year) and NOAA Fisheries has not set annual ESA related stock standards for use during the annual preseason management cycle (see, for example, NOAA Fisheries' Guidance letter to the Council for 2008 (Lohn and McInnis 2008)).

Because we need to characterize the magnitude of ocean harvest for the effects analysis in this biological opinion it is necessary to consider why the models provide different estimates and whether there is reason to prefer one over the other. The apparent source of the difference in harvest is that the models rely on overlapping, but nonetheless different sets of coded wire tags (CWTs). The CTC model uses tag groups with a yearling outmigration life history. The FRAM model uses a larger set of tag codes that include both yearling and sub-yearling types. It is therefore appropriate to consider which life history type best represents natural-origin Upper Willamette River Chinook.

Upper Willamette River Chinook salmon display both ocean- and stream-type life histories characteristics. Smolt outmigration occur both as subyearlings, consistent with ocean-type life histories, and as yearlings, consistent with stream-type life histories (Schroeder and Kenaston 2004). However, it is apparent that natural origin Upper Willamette River Chinook leave freshwater primarily as yearlings when in their native habitat. Recent research provides estimates of outmigration timing for several Upper Willamette River Chinook populations. Fish in the McKenzie, Clackamas, and Sandy rivers still have access to native headwater spawning and rearing areas (the spring Chinook population in the Sandy River is part of the Lower Columbia River Chinook ESU, but has similar life history characteristics). The percent of returning adults with sub-yearling life histories in these rivers averaged 16%, 17%, and 10%, respectively, over four brood years (Figure 1). The percent of returning adults with sub-yearling life histories in the

North and South Santiam rivers averaged 60% and 35%, respectively Schroeder, Kenaston, and McLaughlin 2007).

Spring Chinook in the North and South Santiam rivers spawn lower in the watershed than they did historically because access to the upper watersheds is blocked by dams. Emergence timing and growth of juvenile fish would be affected by water temperature, which is higher in the lower watershed than in the upper watershed during incubation, emergence, and early rearing. Release of water from the dams also elevates water temperature which again accelerates growth. As a consequence, spring Chinook emerge earlier in the North and South Santiam rivers than in rivers where access to the upper watershed remains, and a greater percentage of those that survive reach a threshold size to trigger outmigration as a sub-yearling.

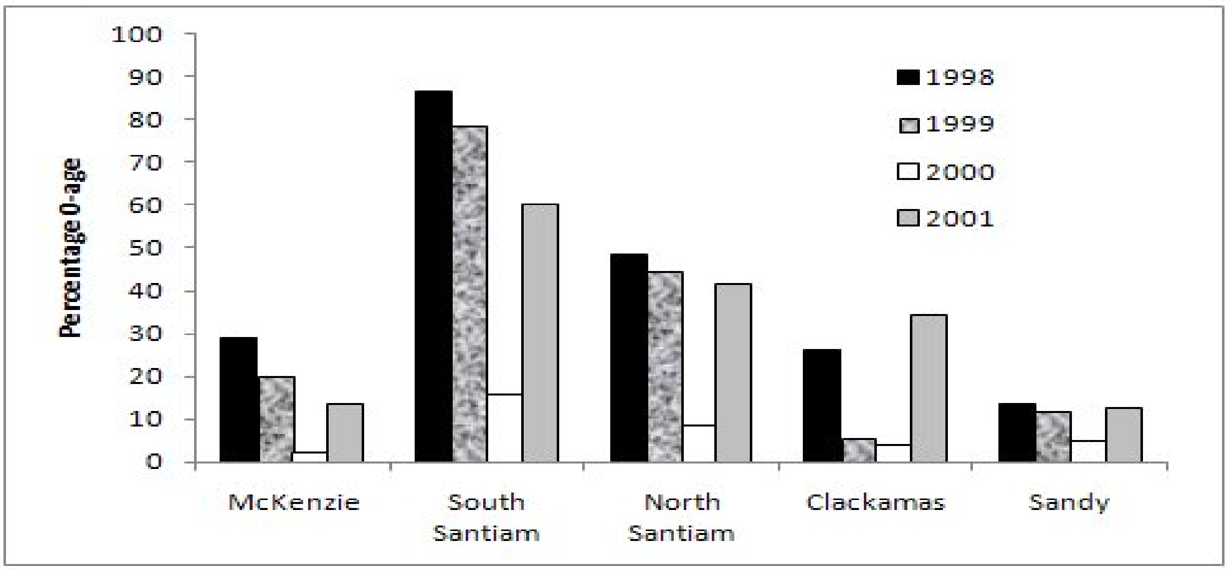

Figure 1. Percentage of wild adult spring Chinook recovered in spawning areas of the Willamette and Sandy basins that had an age-0 life history, 1998–2001 brood years. The 2001 brood year does not include age 6 returns. Wild origin of fish was determined by absence of induced thermal marks in otoliths.

We conclude from these results that ocean harvest estimates from the CTC model that are based on yearling tag codes better represent the distribution and ocean harvest of native fish. Information developed from the FRAM model was used for the retrospective analysis. There was insufficient time to revise the base CWT data in the FRAM model for this consultation. Nonetheless, the retrospective analysis still provides useful information for Upper Willamette River Chinook regarding the relative change in ocean harvest that is characterized by the various modeling scenarios.

It would be useful to review the importance of the sub-yearling life history to the survival recovery of the ESU, and depending on those results, whether the ocean management models need to be revised to better represent harvest impacts on the different life history types. In the meantime, the CTC model and associated tag codes provide the best available information regarding the magnitude and distribution of ocean harvest while the FRAM model provides the best available information regarding the relative change in harvest that can be expected from the various scenarios used in the retrospective analysis

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Pacific Salmon Treaty Biological Opinion

Appendix 5

Chinook Food Energy Available

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Chinook Energy Food Available

Chinook food energy available with and without the actions by cohort, region, time period, and depending on a range in size selectivity of the whales (LaVoy 2008).

Year	Time Period	Kilocalories available (with Agreement)				Kilocalories available (without Agreement)			
		Coastal		Inland		Coastal		Inland	
		Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity
2002	Oct-April	23,798,521,768	4,877,069,780	7,042,527,870	1,222,317,511	23,982,321,255	4,897,379,693	7,079,371,575	1,225,026,018
	May-June	32,214,661,257	8,622,057,108	9,911,388,423	2,150,168,782	34,266,029,439	9,046,885,892	10,032,122,809	2,181,114,709
	July-Sept	31,874,224,489	7,724,459,993	12,451,816,659	3,602,309,738	36,900,458,728	8,627,728,140	12,813,776,064	3,755,006,198
1994	Oct-April	15,424,119,772	5,553,251,740	4,689,412,060	830,997,482	15,486,567,015	5,559,440,185	4,721,356,301	832,384,946
	May-June	19,587,334,884	8,647,058,619	6,743,476,990	1,464,357,690	20,668,578,744	9,105,859,037	6,849,278,253	1,489,900,756
	July-Sept	17,723,534,838	5,992,108,386	7,902,023,064	2,275,526,048	19,921,251,441	6,592,108,765	8,194,645,307	2,386,027,480

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Pacific Salmon Treaty Biological Opinion

Appendix 6

Range in the Ratio of Prey Available

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Range in the Ratio of Prey Available

Range in the ratio of prey available to the whales' needs with and without the actions, depending on the year, time period, region, range in energy requirements of the whales (min and max, based on Noren in review), range in percent Chinook in the whales' diet, and range in size selectivity of the whales (LaVoy 2008).

Selectivity	Diet %	Time Period	Years	Prey available : prey needs							
				With Agreement				Without Agreement			
				Inland		Coastal		Inland		Coastal	
				Min	Max	Min	Max	Min	Max	Min	Max
Low Selectivity	86% Chinook	Oct- April	2002	25.8	21.5	87.1	72.7	25.9	21.6	87.8	73.3
			1994	17.2	14.3	56.5	47.1	17.3	14.4	56.7	47.3
		May-June	2002	36.3	30.3	118.0	98.5	36.7	30.7	125.5	104.7
			1994	24.7	20.6	71.7	59.9	25.1	20.9	75.7	63.2
		July-Sept	2002	45.6	38.1	116.7	97.4	46.9	39.2	135.1	112.8
			1994	28.9	24.2	64.9	54.2	30.0	25.0	73.0	60.9
	70% Chinook	Oct – April	2002	31.7	26.4	107.1	89.4	31.8	26.6	107.9	90.1
			1994	21.1	17.6	69.4	57.9	21.2	17.7	69.7	58.2
		May-June	2002	44.6	37.2	144.9	121.0	45.1	37.7	154.2	128.7
			1994	30.3	25.3	88.1	73.6	30.8	25.7	93.0	77.6
		July-Sept	2002	56.0	46.8	143.4	119.7	57.6	48.1	166.0	138.6
			1994	35.6	29.7	79.7	66.6	36.9	30.8	89.6	74.8
	60% Chinook	Oct – April	2002	36.3	30.9	124.9	104.3	37.2	31.0	125.9	105.1
			1994	24.6	20.5	81.0	67.6	24.8	20.7	81.3	67.8
		May-June	2002	52.0	40.7	169.1	141.1	52.7	44.0	179.9	150.1
			1994	35.4	29.5	102.8	85.8	36.0	30.0	108.5	90.6

Selectivity	Diet %	Time Period	Years	Prey available : prey needs							
				With Agreement				Without Agreement			
				Inland		Coastal		Inland		Coastal	
				Min	Max	Min	Max	Min	Max	Min	Max
		July-Sept	2002	65.4	54.6	167.3	139.6	67.3	56.1	193.7	161.7
			1994	41.5	34.6	93.0	77.7	43.0	35.9	104.6	87.3
High Selectivity	86% Chinook	Oct – April	2002	4.5	3.7	17.9	14.9	4.5	3.7	17.9	15.0
			1994	3.0	2.5	20.3	17.0	3.0	2.5	20.4	17.0
		May-June	2002	7.9	6.6	31.6	26.4	8.0	6.7	33.1	27.7
			1994	5.4	4.5	31.7	26.4	5.5	4.6	33.3	27.8
		July-Sept	2002	13.2	11.0	28.3	23.6	13.8	11.5	31.6	26.4
			1994	8.3	7.0	21.9	18.3	8.7	7.3	24.1	20.1
	70% Chinook	Oct - April	2002	5.5	4.6	21.9	18.3	5.5	4.6	22.0	18.4
			1994	3.7	3.1	25.0	20.9	3.7	3.1	25.0	20.9
		May-June	2002	9.7	8.1	38.8	32.4	9.8	8.2	40.7	34.0
			1994	6.6	5.5	38.9	32.5	6.7	5.6	41.0	34.2
		July-Sept	2002	16.2	13.5	34.8	29.0	16.9	14.1	38.8	32.4
			1994	10.2	8.5	27.0	22.5	10.7	9.0	29.7	24.8
	60% Chinook	Oct - April	2002	6.4	5.4	25.6	21.4	6.4	5.4	25.7	21.5
			1994	4.4	3.6	29.1	24.3	4.4	3.6	29.2	24.4
		May-June	2002	11.3	9.4	45.3	37.8	11.4	9.6	47.5	39.6
			1994	7.7	6.4	45.4	37.9	7.8	6.5	47.8	39.9
		July-Sept	2002	18.9	15.8	40.5	33.8	19.7	16.5	45.3	37.8
			1994	11.9	10.0	31.5	26.3	12.5	10.5	34.6	28.9