Biological Opinion on the Effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel Fisheries in 2010 and 2011 on the Lower Columbia River Chinook Evolutionarily Significant Unit and Puget Sound/Georgia Basin Rockfish Distinct Populations Segments Listed Under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation.

Action Agency: National Marine Fisheries Service (NMFS)

Species/Evolutionarily Significant Units Affected:

Species	Evolutionarily Significant Unit/ Distinct Population Segment	Status	Federal Register Notice	
Chinook Salmon (O. tshawytscha)	Lower Columbia River	Threatened	70 FR 37160	6/28/05
Puget Sound Rockfish (Sebastes spp.)	Canary/Yelloweye Bocaccio	Threatened Endangered	75 FR 22276	4/28/10

Activities considered: To promulgate ocean salmon fishing regulations in 2010 and 2011 in waters off of the Washington, Oregon and California coasts under the jurisdiction of the Pacific Fisheries Management Council and in the Strait of Juan de Fuca and San Juan salmon fisheries under the jurisdiction of the U.S. Fraser Panel pursuant to the Pacific Salmon Treaty.

Consultation conducted by: NMFS, Sustainable Fisheries Division, Northwest Region.
Consultation number: F/NWR/2010/01714

NOAA's National Marine Fisheries Service (NMFS) proposes to promulgate ocean salmon fishing regulations within the Exclusive Economic Zone of the Pacific Ocean and to regulate U.S. Fraser Panel Fisheries in northern Puget Sound under the Pacific Salmon Treaty in 2010 and 2011. Federal agencies proposing activities that may affect species listed under the Endangered Species Act (ESA) may request a formal consultation under Section 7(a)(2) of the ESA. In this biological opinion, NMFS reviews information regarding the impacts on listed Lower Columbia River Chinook salmon and Puget Sound/Georgia Basin rockfish associated with the proposed fisheries. This biological opinion has been prepared in accordance with section 7 of the ESA, as amended (16 U.S.C. 1531 et seq.). A complete administrative record of this biological opinion is on file with NMFS, Sustainable Fisheries Division in Seattle, Washington.

For Approved by: Frank Lockhart
Barry A. Thom, Acting Regional Administrator

Date: 4/30/2010

Corrected: After completing this biological opinion an error was found in one sentence at the bottom of page 7 that incorrectly characterized the proposed action. That sentence has been replaced.

Peter Dygert
Branch Chief, SFD
May 21, 2010

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1 Introduction

The NOAA's National Marine Fisheries Service (NMFS) promulgates ocean fishing regulations within the Exclusive Economic Zone (EEZ) of the Pacific Ocean and regulates U.S. Fraser Panel fisheries in northern Puget Sound under the Pacific Salmon Treaty (PST). There are 28 listed salmonid species in the action area that are potentially affected by the actions considered in this biological opinion (Table 1). The take of 27 ESA listed salmon Evolutionarily Significant Units (ESU) and steelhead Distinct Population Segments (DPS) associated with the proposed fisheries is addressed in existing biological opinions (Table 2). This biological opinion considers the effects of proposed Pacific coast ocean salmon fisheries conducted under the Pacific Coast Salmon Plan (hereafter 'PFMC Fisheries') and U.S. Fraser Panel fisheries managed under the PST (hereafter 'Fraser Panel Fisheries') in 2010 and 2011 on the Lower Columbia River Chinook Salmon ESU and three recently listed Puget Sound/Georgia Basin rockfish DPS'.

This Biological Opinion and incidental take statement were prepared by NMFS in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402.

NMFS is also conducting an essential fish habitat (EFH) consultation in conjunction with the biological opinion. The EFH consultation is prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 USC 1801, et seq.) and implementing regulation at 50 CFR 600.

2 Background & Consultation History

2.1 Background

Since 1991, 28 salmon ESUs and steelhead DPSs have been listed under the ESA on the west coast of the U.S. (Table 1). Beginning in 1991 NMFS considered the effects resulting from 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, NMFS considered the impacts on all salmon species then listed under the ESA resulting from implementation of the Pacific Coast Salmon Fishery Management Plan (FMP) including spring/summer Chinook, fall Chinook, and sockeye salmon from the Snake River and Sacramento River winter Chinook (NMFS 1996a). Subsequent biological opinions beginning in 1997 considered the effects of PFMC fisheries on the growing catalogue of listed species (e.g. NMFS 1997a, NMFS 1998a, NMFS 1999a, NMFS 2000a, NMFS 2000b). NMFS has reinitiated consultation when new information became available on the status of the ESUs or the impacts of the FMP on the ESUs, or when new ESUs were listed. For the last several years, NMFS combined its consultation on Pacific coast salmon fisheries with those that occurred in Puget Sound under the jurisdiction of the U.S. Fraser Panel Fisheries for reasons of efficiency, because of the interrelated nature of the preseason planning processes, and to provide a more inclusive assessment of harvest-related impacts on the listed species. Southern Resident killer whales and the southern DPS of green sturgeon were listed in 2005 and 2006, respectively. The effects of the proposed actions on these species have also been considered in recent opinions. Table 2 lists the current biological opinions that considered the effects of the PFMC fisheries off the West Coast of the United States on ESA-listed ESUs and DPSs.

NMFS recently made a final determination to list the southern Distinct Population Segment (DPS) of Pacific eulachon (*Thaleichthys pacificus*) as a threatened species under the ESA (NMFS 2010a). Eulachon is a marine, pelagic species that ranges up to ten inches in length. They feed mainly on euphasids, a small shrimp-like crustacean sometimes called krill. Eulachon are caught in targeted commercial fisheries in the Columbia River basin using small-mesh gillnets (i.e., <2 inches) and small mesh dipnets (although small trawl gear is legal, it is rarely used). Eulachon have been taken as bycatch in pink shrimp trawl gear off of the coast of Oregon, Washington and California (Hannah and Jones 2007). Salmon fisheries in northern Puget Sound use nets with large mesh sizes (i.e., >4 inches); fisheries in the ocean and Puget Sound use also hook and line gear designed to catch the much larger salmon species. Both gear types are deployed to target pelagic feeding salmon near the surface and in mid-water areas. Encounters of eulachon in salmon fisheries would be extremely unlikely given the general differences in spatial distribution and gear characteristics. NMFS is not aware of any record of eulachon caught in either commercial or recreational salmon fisheries associated with the proposed actions. NMFS therefore concludes that proposed actions have no effect to the listed eulachon. Critical habitat for eulachon has not been designated.

NMFS also made a final determination to list three DPS' of Puget Sound/Georgia Basin rockfish (NMFS 2010b). Bocaccio (*S. paucispinis*) were listed as endangered. Yelloweye rockfish (*S. ruberrimus*) and canary rockfish (*S. pinniger*) were listed as threatened. Critical habitat for the rockfish DPSs' has not been designated. NMFS determined that the proposed PFMC and Fraser Panel actions will have no direct affect to any of the ESA-listed rockfish DPS' because no catch of listed rockfish is expected in either of the fisheries. However, Fraser Panel fisheries may have an indirect effect to rockfish as a result of the loss of commercial fishing nets. This derelict fishing gear is identified as one of the significant factors of decline for the species. Yelloweye rockfish, canary rockfish and bocaccio were listed on April 28, 2010, two days before this biological opinion was due to be completed. Because of the limited time, consideration of the effect of the Fraser Panel fishery on ESA-listed rockfish is included as an appendix to this biological opinion. Conclusions regarding rockfish and information required for the Incidental Take Statement are included in the main body of the biological opinion.

Table 1. Status and critical habitat designations for ESA listed species (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 1999b)
Snake River fall-run	T: 6/28/05 (NMFS 2005a)	12/28/93 (NMFS 1993a)
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 1993b)
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 1999c)
Central California Coast	E: 6/28/05 (NMFS 2005a)	05/5/99 (NMFS 1999c)
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 1993a)
Steelhead *(O. mykiss)*		
Puget Sound Steelhead	T: 5/11/07 (NMFS 2007a)	Not yet designated

Upper Columbia River	E: 6/18/2007 (Court Decision)	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)
Eulachon (Thaleichthys pacificus)		
Columbia River Eulachon	T: 03/18/10 (NMFS 2010a)	Not yet designated
Puget Sound/Georgia Basin Rockfish (Sebastes spp.)		
Bocaccio, Yelloweye, Canary	E: Bocaccio T: Yelloweye, Canary 04/28/10 (NMFS 2010b)	Not yet designated

Table 2. NMFS 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/DPS considered
March 8, 1996 (BO)	until reinitiated	NMFS 1996a	Snake River spring/summer and fall Chinook, and sockeye
April 28, 1999 (BO)	until reinitiated	NMFS 1999a	S. Oregon/N. California Coast coho Central California Coast coho Oregon Coast coho
April 28, 2000 (BO)	until reinitiated	NMFS 2000b	Central valley Spring-run Chinook
April 27, 2001 (BO, 4(d) Limit)	until withdrawn	NMFS 2001a	Hood Canal summer-run chum
April 30, 2001 (BO)	until reinitiated	NMFS 2001b	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead ESUs
April 30, 2010 (BO)	until reinitiated	NMFS 2010c	Sacramento River winter-run Chinook
April 29, 2004 (BO)	until reinitiated	NMFS 2004a	Puget Sound Chinook
June 13, 2005 (B0)	until reinitiated	NMFS 2005d	California Coastal Chinook
April 30, 2007 (B0)	until reinitiated	NMFS 2007b	North American Green Sturgeon
April 29, 2008 (B0)	until reinitiated	NMFS 2008c	Lower Columbia River coho Puget Sound Steelhead
May 5, 2009 (B0)	until reinitiated	NMFS 2009a	Southern Resident Killer Whales

As a result of the previous consultation history, the effects of PFMC fisheries on all but one of the 27 listed salmonid ESUs and DPSs have been considered for ESA compliance in long-term biological opinions or 4(d) limit approvals (Table 2). NMFS reviewed the effects of the 2009 PFMC and Fraser Panel fisheries on Lower Columbia River Chinook. But NMFS' review was limited in duration to the 2009 fishing season that extends from May 1, 2009 to April 30, 2010. As a consequence, and as explained in more detail below, this opinion considers the effect of PFMC and U.S. Fraser Panel fisheries on the Lower Columbia River Chinook in 2010 and 2011.

The Lower Columbia River Chinook ESU is comprised of a spring component, a far north-migrating bright component, and a component of north-migrating tules. Prior consultations have considered the effects of the proposed actions on all components of the Lower Columbia River Chinook ESU, but because of related complexities have focused on the tule component in greater detail. That relative emphasis continues in this opinion.

Lower Columbia River Chinook were first listed as threatened under the ESA in 1999 (NMFS 1999e), although the original listing was subsequently reviewed and affirmed in 2005 (NMFS 2005a). In 1999 NMFS wrote a biological opinion for the 1999 PFMC fisheries on the nine newly listed ESUs not covered by an existing opinion, including Lower Columbia River Chinook. NMFS did not set specific harvest constraints in the 1999 biological opinion as it sought to develop the necessary information for the just listed species (NMFS 1999d). In 2000 and 2001 NMFS required that the total brood year exploitation rate for the Coweeman stock [representing the Lower Columbia River tule component of the ESU], in all fisheries combined, not exceed 65% (NMFS 2000c and 2001a). The exploitation rate limit was derived using the recently developed Viability Risk Assessment Procedure (VRAP) that provides an estimate of an associated Rebuilding Exploitation Rate (RER). An RER for a specific population is defined as the maximum exploitation rate that would result in a low probability of the population falling below a specified lower abundance threshold and a high probability that the population would exceed an upper abundance threshold over a specific time period. (For a more detailed discussion of VRAP and the related RER calculations see NMFS 2009b.) The 65% RER was subsequently reviewed and replaced in 2002 with an RER of 49%. The 49% RER was used as the consultation standard for the tule component of the Lower Columbia River Chinook ESU from 2002 to 2006.

In the 2006 Guidance Letter to the Council, NMFS indicated their intention to review the 49% RER (Lohn and McInnis 2006). After five years NMFS concluded that a periodic review was warranted. The Lower Columbia Salmon Recovery Plan also called for a review of the 49% standard and the associated effects of fishing on other Lower Columbia River tule populations. NMFS organized an ad hoc Work Group that included staff from the Northwest Fisheries Science Center and Washington Department of Fish and Wildlife. Initial results from the Work Group were used in 2007 to reduce the exploitation rate limit for tule Chinook from 49% to 42% (NMFS 2007b). The Work Group completed their work and provided a report in October 2007 along with an associated addendum in February 2008 (Ford et. al 2007, LCRTWG 2008). In 2008 the exploitation rate was reduced again to 41% (NMFS 2008c). In both years, NMFS' guidance to the Council, the Work Group analysis, and other related information, provided the basis for NMFS' consultation on Lower Columbia River Chinook which was described in detail in the associated biological opinions.

In 2008, after completing the biological opinion for that year, the U.S. completed a new ten year agreement with Canada pursuant to the Pacific Salmon Treaty. The new agreement resulted in reductions in the Alaskan and Canadian fisheries for the next ten years that reduced impacts to Lower Columbia River tule Chinook (NMFS 2008d). NMFS' guidance to the Council for the 2009 fishing season took advantage of the anticipated savings from the new PST Agreement and required that the exploitation rate on Lower Columbia River tule Chinook be reduced in 2009 to 38% (Thom and McInnis 2009). NMFS further indicated their intention to review the information that had accumulated over the last several years and conduct further analysis that would provide the basis for a biological opinion that would set harvest limits for the next several years. The goal of the multi-year approach was to reduce the uncertainty associated with recovery, and add predictability to recreational, commercial and tribal fisheries. Although NMFS, the co-managers and recovery planners made significant progress over the last year in developing additional information to inform recovery, the effort did not meet the conditions necessary to support a long term harvest regime. Instead, NMFS provided guidance through their letter to the Council that applied to fisheries in 2010 and 2011 only (Thom and McInnis 2010) that is the subject of this consultation.

2.2 Consultation History

The current salmon FMP requires that the PFMC manage fisheries consistent with NMFS' ESA-related consultation standards or recovery plans to meet the immediate needs for conservation and long-term recovery of the species. These standards are provided annually to the PFMC by NMFS at the start of the pre-season planning process (PFMC 2003). Consistent with the requirements of the salmon FMP, NMFS provided guidance to the PFMC prior to the start of the preseason planning process regarding ESA-related management constraints derived from existing opinions and new guidance for the 2010 fisheries for Lower Columbia River Chinook (Thom and McInnis, 2010). NMFS' guidance for Lower Columbia Chinook applied to fisheries in 2010 and 2011 only. The guidance letter also explained the considerations for NMFS' decision, and the conditions necessary to support a long term harvest regime in the future.

The guidance letter which was dated March 2, 2010 initiated the start of the formal consultation process. However, NMFS has been preparing for this consultation for the last several months. As explained above, NMFS indicated in its 2009 guidance letter and biological opinion its intention to develop a multiyear opinion in 2010. NMFS therefore focused over the last several months on developing the necessary information. For example, NMFS' regional office worked with the Northwest Fisheries Science Center to develop a more detailed life-cycle model analysis for Lower Columbia River Chinook populations (NWFSC 2010). NMFS also spent considerable time clarifying the relationship between harvest actions and the all-H recovery strategy that is developing through the recovery planning process. One product of that effort was an internal memo from NMFS' Salmon Recovery Division to their Sustainable Fisheries Division describing key elements of the recovery strategy (Walton 2010). Both the Science Center and recovery coordination efforts were open and included direct involvement by the state management agencies, recovery planners, and members of the Council.

NMFS' guidance letter includes a list of tasks that are relevant to its decision regarding the applicable exploitation rate in 2011. The purpose of those tasks is to reduce the uncertainty related to the recovery strategy. NMFS indicated its intent to refine the task list in cooperation with co-managers, recovery planner and other interested persons prior to completion of this opinion. NMFS held two meetings and a final conference call to refine the list and help inform and engage those that will have help do some the necessary work over the next year.

The Council's preseason process occurs through their March and April meetings. At the end of the process, the Council produces Preseason Report III which contains their final recommendations for harvest specifications and management measures. The report also includes an analysis of the effects of the proposed actions, including the Fraser Panel action, on ESA listed species. In 2010, Preseason Report III was provided on April 23, 2010 (PFMC 2010a).

2.3 Description of the Proposed Action

The proposed action is NMFS' promulgation of annual regulations developed in accordance with Pacific Coast Salmon Plan in 2010 and 2011, and NMFS' issuance of regulations pursuant to the Pacific Salmon Treaty Act of 1985 (16 USC 3631) to implement the in-season orders of the Fraser River Panel in 2010 and 2011 under the Pacific Salmon Treaty.

2.3.1 PFMC Fisheries

This opinion considers the effects on ESA-listed Lower Columbia River Chinook salmon resulting from NMFS' implementation of the PFMC's Pacific Coast Salmon Plan in 2010 and 2011. Because the extent of allowable impacts each year in the PFMC's ocean fishery will be constrained by an exploitation rate limit that includes all fisheries impacting Lower Columbia River Chinook, the PFMC's calculation of specific harvest rates each year is the remainder of the total exploitation rate after taking into account estimated impacts on Lower Columbia River Chinook that have or are expected to occur that year in those other fisheries. Those other fisheries include fisheries in Southeast Alaska, Canada, Puget Sound and the Strait of Juan de Fuca (particularly including the fisheries directed at Fraser River sockeye and pink salmon normally managed by the Fraser River Panel pursuant to the Pacific Salmon Treaty), Buoy 10, and the Lower Columbia River. The ocean salmon fisheries in the EEZ (3-200 nautical miles offshore) off of the states of Washington, Oregon, and California are managed under authority of the Magnuson-Stevens Act (Figure 1). Annual regulations apply to the period from May 1 of the current year through April 30 of the following year. Pursuant to the Magnuson-Stevens Act, NMFS proposes to promulgate ocean salmon fishing regulations developed each year in accordance with the FMP and the FMP's associated amendments. These ocean fisheries include recreational and commercial troll fisheries, and tribal fisheries targeting coho and Chinook. The PFMC provides its management recommendations to the Secretary of Commerce (Secretary), who implements the measures in the EEZ if they are found to be consistent with the Magnuson-Stevens Act and other applicable law such as the ESA. Because the Secretary, acting through NMFS, has the ultimate authority for the FMP and its implementation, NMFS is both the action agency and the consulting agency with respect to PFMC Fisheries.

In developing management recommendations for a particular year, the PFMC analyzes several management options for ocean fisheries occurring in the EEZ. The options considered by the Council include various time and area openings, catch quotas, non-retention requirements related to species and size, and other regulations that are designed to meet all of the conservation and allocation objectives of the FMP. Specifics about the final option recommended by the Council are described in their final planning report for the year referred to as Preseason Report III (PFMC 2010a) The Council's analysis of the options includes assumptions regarding the levels of harvest for Lower Columbia River Chinook and other listed species in fisheries to the north of the U.S. border, and in state marine, estuarine, and freshwater areas.

Fisheries in Southeast Alaska and Canada are managed subject to the terms of the recently completed and approved Pacific Salmon Treaty (PST) Agreement (Pacific Salmon Commission, May, 2008) that commenced on January 1, 2009 and will be in place through 2018. Fisheries in estuarine and freshwater areas of the Columbia River are regulated under authority of the states and tribes, and consistent with the terms of agreements among the U.S v. Oregon parties. 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. NMFS completed biological opinions on the 2008 PST Agreement and 2008 Management Agreement

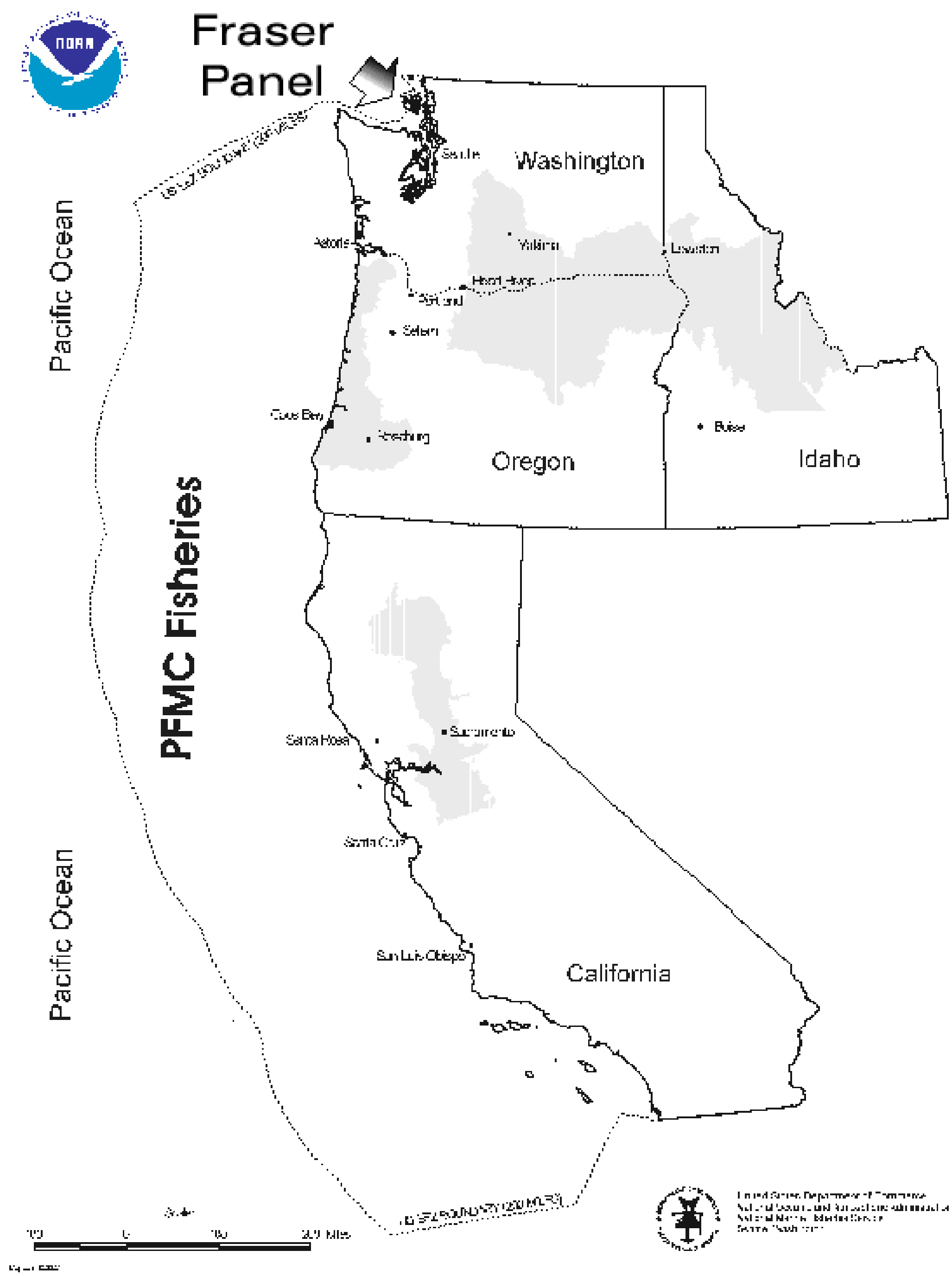
(NMFS 2008d, NMFS 2008e). The biological opinions considered the effects of fisheries covered by those agreements on the listed salmon and steelhead species including Lower Columbia River Chinook. Though the fisheries to the north are covered under the PST biological opinion, their impact on Lower Columbia River Chinook must be included in the total exploitation rate limit established by NMFS for Lower Columbia River Chinook. As a consequence, the PFMC and co-managers must account for the harvest expected to occur in fisheries to the north, and propose how the remaining allowable catch (exploitation rate) will be distributed among southern U.S. ocean and in-river fisheries, including those directed at Fraser River sockeye and pink salmon. The necessary allocation choices are made concurrent with the Council's annual preseason planning process. This close association between fisheries managed subject to the PST Agreement, Council fisheries, and those in the Columbia River is also discussed in the aforementioned biological opinions (NMFS 2008d, NMFS 2008e).

Under the Council's FMP each stock affected by the fishery is managed subject to a specified conservation objective. For ESA listed species the conservation objectives are referred to as consultation standards. The FMP requires that NMFS provide consultation standards for each listed species, which specify levels of take that are not likely to jeopardize the continued existence of the species. NMFS provides these standards in its annual guidance letter to the Council prior to the start of the preseason planning process. The Council is required by the FMP to manage their fisheries to meet or exceed those standards. NMFS provides the necessary review for these consultation standards through an associated biological opinion.

Generally, NMFS strives to provide consultation standards for listed species that are multi-year or long term. Table 2 lists the biological opinions that supported consultation standards for most of the currently listed species. Long term standards provide greater certainty and stability to the management planning process, and allow for a more comprehensive review of the effects of fishing on the species. These longer term standards are subject to periodic review as they expire or through reinitiation of the section 7 consultation. In some case, NMFS provides consultation standards that apply for only one year. NMFS relies on these short term standards when important information is still evolving, as is the case with newly listed species, or when there are substantive and ongoing changes in available information that require further review as is the case with Lower Columbia River Chinook. Information related to Lower Columbia River Chinook has not yet been developed to the point where NMFS believes it can move from the annual consultation standards provided in recent years to a multi-year framework as we have done for other listed species. However, sufficient information has been developed to support consultation standards for two years, 2010 and 2011.

In 2010 NMFS provided its consultation standards as required through its annual guidance letter to the Council (Thom and McInnis 2010). For Lower Columbia River Chinook, which is the subject of this consultation, NMFS recommended a standard that would apply in 2010 and 2011.

Figure 1. PFMC Fisheries and Fraser River Panel Fisheries



The Lower Columbia River Chinook ESU includes populations with spring, bright and tule life history types. For spring Chinook populations, NMFS indicated their expectation that the state management agencies would continue to manage fisheries to meet hatchery escapement goals, but concluded that additional management constraints in Council fisheries were unnecessary. Similarly, NMFS concluded that management constraints for bright populations in Council fisheries, beyond those required for other stocks, were unnecessary. For Lower Columbia River tule Chinook population, NMFS' guidance was that Council fisheries be managed in 2010 subject to a total exploitation rate limit of 0.38 and, in 2011, a total exploitation rate limit of 0.36. The limit may be increased to 0.37 in 2011 if certain tasks are completed that reduce uncertainties surrounding the recovery strategy and improve the environmental baseline. The annual exploitation rate limit includes the impacts from all fisheries. The Council is thus required to develop annual fishing plans in 2010 and 2011 that would not result in exceeding the applicable overall limit on Lower Columbia River tule Chinook.

After completing their preseason planning process in April 2010, the Council proposed fisheries designed to comply with NMFS' guidance. The proposed action in 2010 as it applies to Lower Columbia River Chinook is to promulgate fishing regulations that will affect the spring, bright, and tule components of the Lower Columbia River Chinook ESU. For a description of the proposed PFMC fisheries, refer to the 2010 PFMC Preseason Report III (PFMC 2010a). LaVoy (2010) provides a more detailed analysis of the magnitude and distribution of exploitation rates in the proposed fisheries and in the neighboring fisheries both to the north and in the Columbia River. Exploitation rates in the proposed PFMC fisheries in 2010 for spring, bright, and tule Chinook are 0.16, 0.05, and 0.15, respectively.

In 2011 the Council will go through a similar preseason planning process. The amount of fishing and associated catch allowed in Council area fisheries varies from year to year depending on stock specific run sizes, catches anticipated in other fisheries, and fishery allocation decisions, but proposed Council area fisheries will be consistent with the overall limits and guidance provided by NMFS through its annual guidance letter to the Council.

As indicated above, the total exploitation rate limit for tule Chinook in 2011 is 0.36, but may be increased to 0.37 if certain tasks are completed that reduce uncertainties surrounding the recovery strategy. From recovery planning and other assessments, NMFS has a good understanding of the sorts of survival improvements that must occur to achieve recovery. These tasks are designed to accelerate the recovery process by identifying and promoting actions that will benefit the tule populations. The tasks are also designed to bring greater certainty that these actions will occur as quickly as possible. If these tasks are completed satisfactorily prior to the 2011 season, NMFS would clarify through its 2011 guidance that the exploitation rate limit was 37% rather than 36%. A tentative list of tasks was provided in the 2010 letter to convey NMFS' thinking at the time. NMFS has since consulted with the states, recovery planners, and Northwest Science Center to review and refine the task list which is specified below. NMFS expects that these tasks will be completed by NMFS, or the states, recovery planners, or other interested participants. Prior to development of the guidance letter for 2011, NMFS will review available reports or other information, and evaluate whether they adequately address the following tasks:

a) Describe the primary funding sources for habitat improvement projects, and existing data bases and/or summaries of all past and present projects that benefit LCR tule populations. The report should include an assessment of the feasibility and utility of developing a more coordinated and centralized reporting system. The report will also comment on how to best improve coordination and reporting of all future projects.

b) Identify the amount and distribution of extant marsh type habitats currently inaccessible for juvenile rearing. The report will focus specifically on lower tributary and mainstem Columbia juvenile rearing habitats used by Lower Columbia River tule Chinook populations. The report should also identify ongoing efforts to gather additional data on current and potential juvenile rearing habitat distribution in the Lower Columbia River.

c) Identify milestones or expected trends in improved habitat conditions in high priority tributary and intertidal areas for tule Chinook populations.

d) Describe a recovery plan implementation schedule that identifies specific actions for a 3 to 5 year period, potential implementing entities, costs, location and duration of actions, funding sources, VSP and limiting factors affected, and linkages to milestones for improved habitat conditions.

e) Describe the transition strategy for reducing the proportion of hatchery fish in natural spawning areas for primary tule Chinook populations in a manner that addresses short term demographic risks while promoting progress to recovery objectives.

f) Analyze options for implementing mark selective fisheries. The report should include an analysis of the feasibility of mark selective fisheries, the magnitude of differential harvest impacts to marked and unmarked fish, and the relative benefits of efforts to reduce the harvest mortality to natural origin fish and reduce the proportion of hatchery fish on the spawning grounds. The report should also provide a schedule for assessing selective fishing gear and mortality rates of released fish.

g) Analyze options for incorporating abundance driven management principles into Lower Columbia tule Chinook management.

h) Review and update existing escapement estimate time series for selected primary tule populations with particular attention to estimates of hatchery contribution. The report should also describe current escapement monitoring programs and how they are designed to address key uncertainties.

Successful management of the Council area salmon fisheries requires monitoring to collect information on the fish stocks, the amount of effort for each fishery, the harvests that occurs in each fishery, the timing of harvest, and other biological and fishery statistics. In general, the information can be divided into that needed for in-season management and that needed for annual and long-term management. The data needs and reporting requirements for the fishery are described in the Salmon FMP (PFMC 2003). Results on catch, escapement, and compliance with conservation objectives are reported annually in the Council's preseason documents including, in particular, the annual Review of Ocean Salmon Fisheries (see for example PFMC 2010b).

2.3.2 Fraser Panel Fisheries

Details related to the Fraser Panel fisheries, and the nature of the proposed action, are described below. The effects of Fraser Panel fisheries in 2010 on the spring, bright, and tule components of the ESU were analyzed in conjunction with the PFMC fisheries. The analysis in Preseason Report III, and the associated analysis provided by LaVoy (2010), provide estimates of impacts to the component populations. Anticipated exploitation rates in the proposed Fraser Panel fisheries in 2010 for spring, bright, and tule Chinook are 0.001, 0.001, and 0.003, respectively.

In 2011, the Council and Fraser Panel will go through a similar preseason planning process. The amount of fishing and associated catch allowed in Fraser area fisheries varies from year to year depending on stock specific run sizes, catches anticipated in other fisheries, and fishery allocation decisions. Impacts in Fraser fisheries will be taken into account during the Council's planning process and reported as they are for 2010 to insure that combined impacts are consistent with NMFS' guidance for 2011. Additional details relate the Fraser Panel fisheries follow.

As noted above, the PFMC must (and has) taken into account the impacts on Lower Columbia River Chinook of all fisheries. This includes the fisheries in northern Puget Sound and the Strait of Juan de Fuca that harvest Fraser River sockeye and pink salmon under the terms of the Pacific Salmon Treaty. Under Article VI of the Treaty, preseason fishing plans for harvesting Fraser River sockeye and pink salmon in the Fraser Panel Area are developed annually by the bilateral Fraser River Panel and recommended by the Pacific Salmon Commission for approval by the Parties (Paragraph 5, Article IV). These preseason plans are approved by the U.S. Secretary of State under authority granted in the Treaty's U.S. implementing legislation, the Pacific Salmon Treaty Act (16 USC. 3631 et seq). The preseason plan developed by the Panel, however, is in fact just a forecast of when fishing will occur; it does not actually open any fishing. In fact, the Panel's preseason plan always contains a provision that states that the entire Panel Area is closed to fishing until specifically opened (later) by in-season order of the Panel. Thus, approval of the preseason plan by the Secretary of State does not in itself result in the take of listed species and is thus not the subject of consultation. The actual fishing in the Panel Area occurs pursuant to in-season orders of the Fraser River Panel that are effectuated in U.S. waters by regulations promulgated by NMFS. The in-season orders from the Panel are based on the best available estimates of Fraser sockeye and/or pink run strength, migratory timing, catches to date, and other considerations. They are very specific as to the amount of time for each opening, the areas and the types of allowable gear. Because of the dynamic nature of the runs and the fishery, the Panel meets frequently during the season and issues many in-season orders.

The Fraser River Panel exercises management control over the Panel Area only during that time of the year when Fraser River sockeye and pink salmon are present, which typically includes the period from late June through August or, in odd numbered years, through September. (Pink salmon return to the Fraser River only in odd numbered years, and migrate through the Panel Area somewhat later than sockeye. Thus, the Panel typically retains control for several weeks longer in odd-numbered years.) Most of the fishing targeting Fraser sockeye and pinks in U.S. portions of the Strait of Juan de Fuca and northern Puget Sound generally occurs in July and August (or September in odd years). These fisheries include commercial and subsistence net fisheries using gillnet, reef net and purse seine gear. Though the fisheries are directed specifically at Fraser River sockeye and/or pinks, other species including Chinook salmon, are caught incidentally in these fisheries, and it is this incidental catch of Chinook that must be taken into account by the Council as it develops its fishing plan for Council area fisheries, and which is considered in this opinion to be included in the overall exploitation rate limit set for Lower Columbia River Chinook.

The Fraser River Panel manages fisheries in the Panel Area to achieve specific allocation and conservation objectives prescribed in Chapter 4 of Annex IV of the PST (the Fraser River agreement). Under the current Fraser River agreement, the U.S. shares are 16.5 percent of the total allowable catch of Fraser River sockeye salmon and 25.7 percent of the total allowable catch of Fraser River pink salmon. As noted above, the Panel meets frequently during the season and adjusts the fisheries by issuing in-season orders in an effort to achieve the conservation and allocation objectives set forth in the Fraser River agreement, especially including the prescribed U.S. shares. However, an unusual set of circumstances relating to the Fraser River agreement exists as of the writing of this biological opinion and may continue for the next two or three years, and thus must be described herein. The current Fraser River agreement is set to expire by its own terms at the end of 2010. Anticipating this, the Pacific Salmon Commission and its Fraser River Panel have been engaged in negotiations for a new agreement (i.e., a revised Chapter 4 of Annex IV) for approximately a year. If a new agreement is reached and approved by the two countries, it would be in place starting in 2011, and likely would be of similar duration as the current agreement (i.e., 12 years). However, for the last several years, there has been a significant decline in the survival of Fraser River sockeye, resulting in ever-decreasing available harvest in both countries. The decline reached its worst case in 2009; despite a preseason forecast of a run of well over ten million Fraser sockeye, only about a million fish actually returned. The drop in actual run size was so precipitous in 2009 that all fisheries directed at Fraser sockeye were closed for the entire season in both Canada and the United States. The cause of the decline is unknown at this time, but its effects on fisheries and the Fraser resource are so consequential that the problem has received attention at the highest levels of government in Canada. In late 2009, the Prime Minister of Canada announced an official investigation into the decline of Fraser River sockeye. The investigation would be undertaken pursuant to Canada's Inquiries Act, which grants authority to a Commissioner appointed by the government of Canada to conduct the inquiry. The Commissioner's report on the findings of the Fraser sockeye inquiry is due in May of 2011.

Due to the existence of this official inquiry, Canada's representatives on the Pacific Salmon Commission were obliged to suspend negotiations for a new long-term Fraser River sockeye agreement. Their government did not want them to be negotiating long term arrangements affecting Fraser sockeye while the inquiry was in progress. Thus, bilateral negotiations within the Commission for a new long term Fraser River agreement have been suspended and a new long term Fraser agreement likely will not be in place prior to the 2012 season.

While this does introduce a degree of procedural uncertainty as to how (and by whom) the U.S. fishery directed at Fraser River sockeye and pink salmon will be regulated in 2011 (2010 is included in the current agreement), this uncertainty is unlikely to affect the objectives of the U.S. fishery as they relate to the target share of Fraser River sockeye and pink salmon. This is because the U.S. shares of 16.5% and 25.7% of the Fraser sockeye and pink salmon TACs, respectively, have not been at issue in the negotiations for a longer term agreement prior to the suspension of negotiations. Thus, the amount of fishing directed at Fraser River sockeye and pink salmon, and the incidental harvest of other species including Lower Columbia River

Chinook taken in the fishery should remain unchanged relative to the recent past. As such, these incidental catches should and can be estimated and taken into account when the Council area fisheries are planned.

A more detailed description of actions involved and the structure of Fraser Panel fisheries is included in a recent biological assessment related to the effect of 2008 fisheries on Southern Resident killer whales (NMFS 2008f).

The PFMC and Fraser actions have been grouped into this single biological opinion for efficiency and in compliance with the regulatory language of section 7, which allows NMFS to group similar, individual actions within a given geographic area or segment of a comprehensive plan (50 CFR 402.14(b)(6)).

2.3.3 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. For the purpose of proposed fisheries in 2010 and 2011, NMFS determined that no interrelated or interdependent actions exist. However, there is a relationship between hatchery programs in the Columbia River and fisheries that harvest the hatchery production. Only some of these fisheries are the subject of this biological opinion. The relationship is as described in subsequent sections of this biological opinion. The exact relationship is dependent upon the authorization for each hatchery program in the basin. In this biological opinion, although hatchery programs are not formally treated as interrelated or interdependent actions, we do evaluate effects of hatchery programs on listed species and interactions between relevant hatchery programs and fisheries.

2.4 Description of the Action Area

The action area means "all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action" (50 CFR 402.02(d)). For the PFMC Fisheries the action area is the EEZ, which is directly affected by the federal action, and the coastal and inland marine waters of the states of Washington, Oregon and California, which may be indirectly affected by the federal action because the states of Oregon, Washington, and California generally regulate harvest in state waters to conform with federal fisheries regulations. For the U.S. Fraser Panel Fisheries, the action area includes the U.S. waters of the Strait of Juan de Fuca and the San Juan Islands in northern Puget Sound during the period of Fraser Panel control (Figure 1) (a more detailed description of U.S. panel waters can be found at CFR 300.91, Definitions and NMFS 2008f).

3 Endangered Species Act Biological Opinion

3.1 Introduction to the Biological Opinion

Section 7(a)(2) of the ESA requires Federal agencies to consult with NMFS to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat.

To jeopardize the continued existence of a listed species means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

3.1.1 Jeopardy Analysis Framework

Section 7 of the ESA requires that all Federal agencies consult with NMFS (or the U.S. Fish and Wildlife Service regarding species listed under their jurisdiction) concerning their proposed actions that may affect any species listed as threatened or endangered or its critical habitat. Formal consultation is required if the action is likely to adversely affect a listed species or critical habitat. Through this consultation process Federal agency actions may be exempt from the "take" prohibitions of ESA Section 9, 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.

NMFS 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 2004b). The following section summarizes that information and describes the approach used in this opinion to apply the standards for determining the likelihood that the action will jeopardize listed species or adversely modify 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 Sections 2.3 and 2.4.

- 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, NMFS 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 Section 3.2.

- 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 Section 3.3 of this opinion.

- Analyze the effects of the proposed actions. In this step NMFS 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 Sections 3.4 and 3.5.

- 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 Section 3.6 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, NMFS determines that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or adversely modify designated critical habitat, NMFS 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 2004b).

3.2 Status of the Species and Critical Habitat

In order to describe a species' status, it is first necessary to define what "species" means in this context. Traditionally, one thinks of the ESA listing process as pertaining to entire taxonomic species of animals or plants. While this is generally true, the ESA also recognizes that there are times when the listing unit must necessarily be a subset of the species as a whole. In these instances, the ESA allows a "distinct population segment" (DPS) of a species to be listed as threatened or endangered. Lower Columbia River Chinook salmon constitute an ESU (a salmon DPS) of the taxonomic species *Oncorhynchus tshawytscha*, and as such are considered a "species" under the ESA. The discussion in this opinion is limited to the Lower Columbia River Chinook salmon ESU because completed biological opinions exist for all other affected species, as described in the Consultation History section.

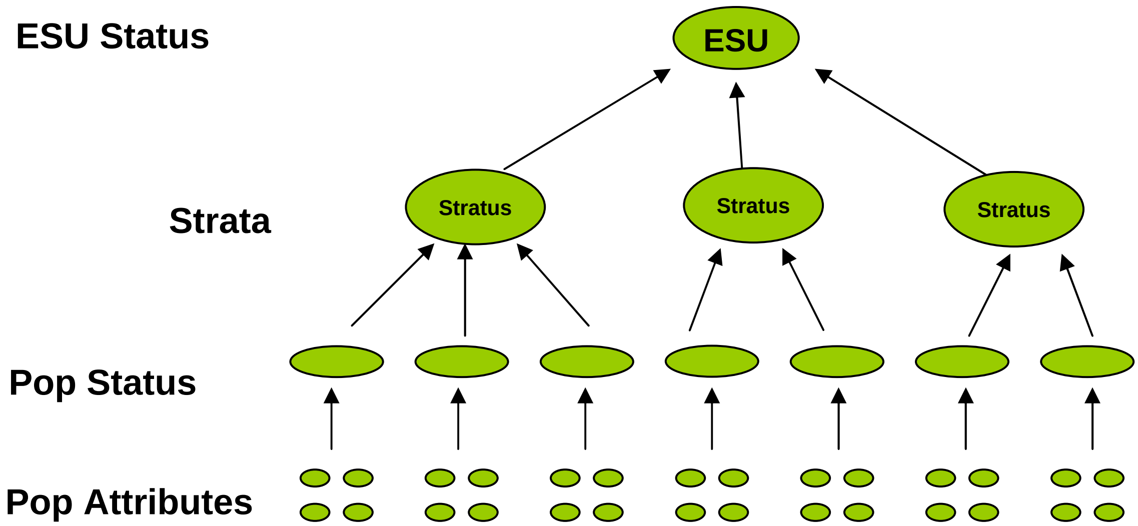
Lower Columbia River Chinook were first listed as threatened under the ESA in 1999 (NMFS 1999e). The original listing was reviewed and affirmed in 2005 (NMFS 2005a). Critical Habitat for Lower Columbia River Chinook was designated on September 2, 2005 (NMFS 2005b). Critical habitat for Lower Columbia River Chinook does not include offshore marine areas of the Pacific Ocean. The bounds of the action area are therefore outside the bounds of critical habitat for Lower Columbia River Chinook.

In this step of the section 7 analyses, NMFS defines the biological requirements and current status of the affected listed species and the conservation role and current function of any designated critical habitat. The WLC TRT has developed a hierarchical approach for determining ESU-level viability criteria (Figure 2). Briefly, an ESU is divided into populations (McElhany et. al. 2000). The risk of extinction of each population is evaluated, taking into account population-specific measures of abundance, productivity, spatial structure and diversity. Populations are then grouped into ecologically and geographically similar strata (referred to as Major Population Groups [MPG] by the WLC TRT), which are evaluated on the basis of population status. In order to be considered viable, a stratum generally must have at least half of its historically present populations meeting their population-level viability criteria (McElhany et al. 2006). At the ESU-level the WLC TRT recommends that each of the ESU's strata also be viable.

In assessing status, NMFS 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. Recent information from recovery plans is often relevant and is used to supplement the overall review of the species' status. This step of the analysis tells NMFS 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 status review starts with a description of the general life history characteristics and the population structure of the ESU including the strata or major population groups (MPG) where they occur. We 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 ESU, and the limiting factors and threats. This section concludes by commenting on the status of critical habitat.

Figure 2. Hierarchical approach to ESU viability criteria



Recovery plans are an important source of information that describe, among other things, the status of the species and its component populations, limiting factors, recovery goals and actions that are recommended to address limiting factors. Recovery plans are not regulatory documents. Consistency of a proposed action with a recovery plan therefore does not by itself provide the basis for a no jeopardy determination. However, recovery plans do provide an all-H perspective that is important when assessing the effects of an action. Information from the recovery plans for Lower Columbia River Chinook are discussed where it applies in various sections of this opinion. It is therefore useful to summarize the status of the recovery planning process before proceeding with the substance of the biological opinion.

Recovery planning for the Lower Columbia River Chinook ESU is well underway. A final recovery plan will result from consolidation of three management unit recovery plans and an Estuary Module:

- Update of the Lower Columbia Fish Recovery Board (LCFRB) plan, which covers most of the Washington portion of the ESU (LCFRB 2010);
- The White Salmon Basin plan, being developed by NMFS with participation from Klickitat County, the Yakama Nation, and other stakeholders (NMFS 2010d);
- The Oregon Lower Columbia plan, being developed by the Oregon Department of Fish and Wildlife (ODFW), with the Oregon Lower Columbia Stakeholder Team (ODFW 2009).
- The Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead, which was prepared for NMFS by the Lower Columbia River Estuary Partnership (NMFS 2007c).

In February 2006, NMFS approved an Interim Regional Recovery Plan for the Washington portions of Lower Columbia Chinook, steelhead, and chum (LCFRB 2004, Lohn 2006). NMFS also issued a supplement to the Interim Plan that provided context related to the use of that Plan (NMFS 2005e). Washington's Lower Columbia Fish Recovery Board (LCFRB) has since updated and modified the Interim Plan to reflect changes in available information. The new Public Review Draft of the LCFRB Plan was released on March 5, 2010 (LCFRB 2010). In this opinion, the Draft LCFRB Plan is the primary source for recovery plan recommendations for the Washington side of the Lower Columbia River ESU.

The management unit recovery plan for the White Salmon River applies to populations of Lower Columbia River spring and fall Chinook salmon, coho salmon, chum salmon, and Middle Columbia River steelhead. The plan was developed by NMFS with the cooperation of the Yakama Nation, Klickitat County, Washington Department of Fish and Wildlife, the Washington State Governor's Salmon Recovery Office, and other Federal and state agencies, local governments, and the public. A Final Draft of the Plan will be completed in April 2010 and made available for public comment with the ESU plan (NMFS 2010d).

Oregon is also engaged in a full-scale recovery planning effort that focuses on the Oregon portion of the Lower Columbia for Chinook, steelhead, chum, and coho. The initial draft of Oregon's recovery plan was released in 2007 (ODFW 2007). NMFS has since provided at least two rounds of comments to Oregon's recovery plan. Oregon's most recent draft is dated December 18, 2009 (ODWF 2009). Oregon's draft plan is the primary source of recovery plan recommendations for the Oregon side of the Lower Columbia River Chinook ESU.

When these management unit plans are complete, NMFS will finalize a "roll-up," ESU-level recovery plan that addresses the entire LCR Chinook ESU (as well as LCR coho, LCR steelhead, and Columbia River chum). Among the functions of this ESU recovery plan are the following: (1) endorse the management unit plans and make any needed additions or qualifications; (2) synthesize and summarize content from management unit plans, along with other relevant information (e.g., NMFS's recent life-cycle modeling effort for tule fall Chinook); (3) describe ESU- and MPG-scale recovery strategies; (4) incorporate the Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NMFS 2007c); and (5) define ESA de-listing criteria for the four LCR ESUs. NMFS has prepared an internal memo that addresses ESU-level recovery criteria and strategies for the tule and spring components of the Lower Columbia River Chinook ESU (referred to in this opinion as the NMFS memo (Walton 2010)). The memo provides a concise and relatively short summary of the overall recovery strategy and considerations that pertain to this opinion. Although the content of the NMFS memo is preliminary, it addresses key points and summarizes NMFS' preliminary conclusions related to the overall recovery strategy. Because these conclusions are relevant to this consultation and represent the best available information on several key points, NMFS' memo is referenced and relied on in this opinion. NMFS expects to have a complete draft ESU recovery plan available for comment by June 2010. A federal register notice of the proposed plan would be published by January 2011; the final plan would be completed by August 2011.

3.2.1 Rangewide Status of the Species

Lower Columbia River Chinook display three life history types including early fall runs ("tules"), late fall run ("brights") and spring-runs (Table 3). 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 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 matured at an older average age than either lower Columbia River spring or fall Chinook salmon, and had a more northerly oceanic distribution. Currently, the abundance of fall Chinook greatly exceeds that of the spring component.

Table 3. Life history and population characteristics of Lower Columbia River Chinook salmon originating in Washington portions of the lower Columbia River.

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 (1999-2000)	37,000 (1991-1995)	NA

Lower Columbia River Chinook salmon 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 4). There are 21 fall populations, two late fall populations, and nine spring populations, some of which are considered extirpated or nearly so. 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.

Table 4. 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 WLC-TRT 2003).[1]

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	(Big) 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), (Big) 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)

Before reviewing the details of the status of each population including consideration of their abundance, productivity, spatial structure, and diversity, it is useful to provide some broader perspective regarding two key points. First, we review ESU level recovery goals and delisting criteria that have been developed through the recovery planning process. We then discuss the relationship between hatchery and natural-origin fish and how it affects our assessment of the status of many of the populations in the ESU.

3.2.1.1 Recovery Goals and Delisting Criteria

Recovery plans provide, among other things, an ESU level recovery scenario with population specific viability targets, and threats criteria for each limiting factor that are designed to ensure that the underlying causes of decline have been addressed. Recovery plan recommendations regarding actions designed to address limiting factors are discussed below as part of the

[1] Core populations are defined as those that, historically, represented a substantial portion of the species abundance. Genetic legacy populations are defined as those that have had minimal influence from nonendemic fish due to artificial propagation activities, or may exhibit important life history characteristics that are no longer found throughout the ESU (WLC-TRT 2003).

Environmental Baseline. Discussion related to the recovery scenario provides perspective pertinent to our consideration and understanding of the status of each population and the ESU as a whole.

A proposed recovery scenario that identifies population specific viability targets for Lower Columbia River Chinook is shown in Table 5. Both the LCFRB Plan and Oregon Plan comment on the uncertainties and practical limits to achieving high viability for the spring and tule populations in the Gorge MPGs. The LCFRB Plan indicates that neither of the spring populations in the White Salmon and Hood rivers were historically very large or productive due to the low habitat suitability of the cold, steep systems. The Plan recognizes that recovery in both cases will depend on successful reintroduction programs, but notes that the prospects for success are uncertain. The Plan also indicates that the prospects for recovery of Gorge tule populations are constrained by current low numbers, limited habitat availability, and inundation of historically productive habitats by Bonneville Dam. The LCFRB Plan proposes to increase the status of Gorge populations to medium viability, but otherwise targets more populations in adjacent strata for higher levels of viability in order to ameliorate the ESU-wide risk.

The Oregon Plan (ODFW 2009) also concludes that meeting high viability objectives for populations in the spring and tule Gorge strata are unlikely for reasons similar to those described by the LCFRB. The populations were relative small compared to other populations in the ESU, and available habitat has been reduced further by anthropogenic factors that are unlikely to change (e.g., roads, dams, reservoirs, water quality, and water quantity). The Oregon Plan also questioned the designation of the Gorge populations by the TRT and suggested that those designations be reevaluated. The Oregon Plan designated the Hood River tule and spring populations for high or very high viability to meet the TRT's recommendations for having high viability populations in each MPG, despite their expectations that these status levels may not be achievable. However, consistent with the intent of the LCFRB Plan, the Oregon Plan indicates that some form of compensation in the adjacent Cascade stratum should be considered as an alternative criterion if the desired statuses are not achieved and the current designation for the Gorge population structure is not revised.

NMFS acknowledged the difficulties related to the Gorge populations in their supplement to the LCFRB Plan (NMFS 2005e), and concurred that recovery opportunities in the Gorge were limited by the small numbers of populations and the high uncertainty related to restoration because of Bonneville Dam. NMFS also recognized the uncertainty regarding the TRT's MPG delineations between the Gorge and Cascade MPG populations, and that several Chinook populations downstream from Bonneville Dam may be quite similar to those upstream of Bonneville Dam. The recovery scenario and recommendations provided by the LCFRB, Oregon, and White Salmon plans identify improvements in more than the minimum number of populations required in the Cascade and Coastal MPGs, to provide a safety factor to offset the anticipated shortcomings for the Gorge MPGs (see Table 5). This was considered a more precautionary approach to recovery than merely assuming that efforts related to the Gorge MPG would be successful. NMFS concluded in its 2005 Supplement that the recommendations in the LCFRB Plan describes a clear rationale for this divergence from the TRT's recommendations for delisting and a clear argument that the ESU scenario proposed by the Plan could result in a delisting of the ESU if the biological criteria described in the Plan are achieved, and the associated threats to the ESU were adequately addressed (NMFS 2005e).

NMFS recently considered and reiterated their prior conclusion related to the ESU level recovery scenario (Walton 2010). NMFS indicated its intention to endorse a recovery scenario for the Lower Columbia River Chinook ESU that is based on the draft 2010 management unit plans and that uses the same approach as the 2005 Supplement for the Gorge spring and tule Chinook MPGs.

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 generally 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 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.

With regard to impacts from past and ongoing hatchery and harvest management, a reasonable interpretation of available information is that many of the populations have been substantially affected by a combination of habitat degradation, high levels of hatchery production using non-local broodstock and high harvest rates that have limited natural-origin spawners to very low levels. As a result of these affects, it is very unlikely that the tule Chinook salmon currently spawning in the coastal stratum rivers in particular represent the genetic diversity and adaptation that was originally present in these populations. The probable lack of locally adapted populations may be a contributing factor to the apparent low productivity of these populations (Walton 2010). Other populations in the ESU may be less affected by these circumstances. Two tule populations in the Cascade stratum, Coweeman and Lewis, have not had direct releases of hatchery fish and have relatively lower fractions of hatchery origin spawners than the other tule populations. These populations are more likely to have retained appreciable local adaptation to natural conditions; however, the level of hatchery fish influence even in these populations may not be trivial from a genetic standpoint. All other Cascade and Gorge stratum tule populations have likely been composed of over 50 percent hatchery origin spawners for decades, and we would expect that this has depressed the fitness of these populations as well.

Populations are defined by their relative isolation from each other which allows for their demographic independence, and generally for their adaptation to unique conditions that exist in specific habitats. If there are populations in the ESU 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 and reestablish their demographic independence. 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 transition 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 WLC TRT 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.

3.2.1.2 Abundance, Productivity and Trends

Recovery plans provide useful summaries of information regarding the status of populations. As discussed above, there are three management unit recovery plans that are nearing completion that are referenced in the following discussion regarding species status. Table 5 summarizes estimates of the baseline viability status of populations at the time of listing, estimates of current viability (shown as Transitional recovery Strategy Category and discussed in more detail below), and target viability status recommendations for each population that would be consistent with delisting. Viability is a measure of the probability of persistence for 100 years that ranges from very low (probability < 40%) to very high (probability >99%).

Table 5. Current status for Lower Columbia River Chinook populations and recommended status under the recovery scenario (LCFRB 2010, ODFW 2009, Walton 2010).

	Status Assessment		Recovery Scenario		
Population	**Baseline Viability[1]**	**Transitional Recovery Strategy Category[2]**	**Contribution[3]**	**Target Viability**	**Abundance Objective[4]**
Coast Fall					
Grays/Chinook	VL	2	Contributing	M+	1,000
Eloch/Skam	VL	3	Primary	H	1,500
Mill/Aber/Germ	VL	2	Primary	H	900
Youngs Bay (OR)	L	--	Stabilizing	L	505
Big Creek (OR)	VL	3	Contributing	L	577
Clatskanie (OR)	VL	3	Primary	H	1,277
Scappoose (OR)	L	3	Primary	H	1,222
Cascade Fall					
Lower Cowlitz	VL	2	Contributing	M+	3,100
Upper Cowlitz	VL	--	Stabilizing	VL	--
Toutle	VL	2	Primary	H+	4,000
Coweeman	VL	1	Primary	H+	900
Kalama	VL	2	Contributing	M	500
Lewis	VL	1	Primary	H+	1,500
Salmon	VL	--	Stabilizing	VL	--
Washougal	VL	2	Primary	H+	1,200
Clackamas (OR)	VL	2	Contributing	M	1,551
Sandy (OR)	VL	--	Contributing	M	1,031
Cascade L Fall					
Lewis NF	VH	--	Primary	VH	7,300
Sandy (OR)	H	--	Primary	VH	3,747
Cascade Spring					
Upper Cowlitz	VL	--	Primary	H+	1,800
Cispus	VL	--	Primary	H+	1,800
Tilton	VL	--	Stabilizing	VL	100
Toutle	VL	--	Contributing	M	1,100
Kalama	VL	--	Contributing	L	300
Lewis NF	VL	--	Primary	H	1,500
Sandy (OR)	M	--	Primary	H	1,230
Gorge Fall					
L. Gorge (WA/OR)	VL	--	Contributing	M	1,200
U. Gorge (WA/OR)	VL	--	Contributing	M	1,200
White Salmon	VL	--	Contributing	M	500
Hood (OR)	VL	2	Primary[5]	H[5]	1,245
Gorge Spring					

White Salmon	VL	--	Contributing	L+	500
Hood (OR)	VL	--	Primary[5]	VH[5]	1,493

[1] The Washington evaluations (LCFRB 2010) used the late 1990s as a baseline period for evaluating status; the Oregon evaluations (ODFW 2009) assume average environmental conditions of the period 1974-2004 and use a reference period of roughly 1994-2004 for harvest exploitation rates.
[2]Based on results from Walton (2010).
[3]Primary, contributing, and stabilizing designations reflect the relative contribution of a population to recovery goals and delisting criteria. Primary populations are targeted for restoration to high or very high viability. Contributing populations are targeted for medium or medium-plus viability. Stabilizing populations are those that will be maintained at current levels (generally low to very low viability), which is likely to require substantive recovery actions to avoid further degradation. The terminology of "primary," "contributing," and "stabilizing" is used in the Washington and White Salmon plans, and not Oregon. Because the terminology is useful in communicating a population's role within the recovery scenario, Oregon populations have been assigned a designation here consistent with their role.
[4]Abundance objectives account for related goals for productivity(from Table 6-1 in LCFRB 2010 and Table 6-36 in ODFW 2009) . Spatial structure and diversity will be evaluated separately based on criteria established by the TRT (McElhany et al. 2006).
[5]Oregon analysis indicates a low probability of meeting the delisting objectives for these populations.

Population status indicators, including measures of abundance and productivity, 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 6). 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 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 the Lewis and White Salmon rivers that depend on headwater spawning and rearing areas are particularly affected by these barriers (Table 6).

The information in Table 7 is from NMFS' most recent status review (Good et al. 2005) that summarizes information on the abundance, productivity, and trends for Lower Columbia River Chinook populations. 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. NMFS has initiated a five year status review for all of the listed salmon and steelhead species and will be updating this information in the near future.

The majority of populations for which data is available have a long-term trend of less than 1, 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 (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, and the Clatskanie. 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 7 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 shown in the following tables.

Table 6. 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
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

Table 7. 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 Fall	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.

Gorge Spring MPG

Spring Chinook populations occur in both the Gorge and Cascade MPGs (Table 4). The Hood River and White Salmon populations are the only populations in the Gorge MPG. The 2005 Biological Review Team described the Hood River spring run as "extirpated or nearly so" and the 2005 ODFW Native Fish Status report describes the population as extinct (ODFW 2005). The delisting viability objective is listed as very high, but as discussed above, the Oregon Plan also indicates that there is a low probability of meeting that objective. 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. Because of the apparent extirpation of the population, Oregon initiated a reintroduction program using spring Chinook from the Deschutes River. The Deschutes River is the nearest source for brood stock, but the population is from the Middle Columbia River ESU. Information on abundance is very limited. Some natural production may occur in the basin (Table 7), but native fish are not considered to be present (McElhany et al. 2007).

The White River population is also considered extinct (LCFRB 2010). 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 2010 or as soon as the permitting process is completed. Once the dam is removed, the White Salmon Recovery Plan calls for monitoring escapement into the basin for four to five years to see if recolonization occurs. At the end of that period a decision will be made about whether to proceed with a reintroduction program. The delisting viability objective for the White Salmon spring populations is low plus (Table 5).

Cascade Spring MPG

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 Mayfield Dam is maintained from juvenile hatchery plants and an adult trap and haul program. Estimates of natural spawners for the Kalama and North Fork Lewis populations are shown in Table 7, but include data only through 2001. The estimate of 1,787 for the Cispus in 2001 is spurious since those fish could only come from fish that were passed above Mayfield Dam. Relatively few fish were passed upstream in 2001 (pers. com. R. Turner, NMFS).

More recent information on abundance is provided in Table 8. The return of combined hatchery-origin and natural-origin spring Chinook to the Cowlitz, Kalama, and Lewis river populations in Washington have all numbered in the thousands in recent years (Table 8). 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 (LCFRB 2010). A supplementation program is now being implemented on the Cowlitz River that that involves trap and haul of adults and juveniles. The reintroduction program is consistent with the general recommendations of the LCFRB Plan (2010) and constitutes the initial steps in a more comprehensive recovery strategy. However, the program is limited for the time being by low collection efficiency of out-migrating juveniles and the lack of facilities that allow for the collection of adults that may return from supplementation efforts. Some unmark adults return voluntarily to the hatchery intake, but for the time being the reintroduction programs rely primarily on use of surplus hatchery adults. (Information on the hatchery program and associated Settlement Agreement with Tacoma Power can be found at: http://www.ci.tacoma.wa.us/power/parksandpower/hydro_licensing/cowlitz/docs/docs_setag.htm The reintroduction program facilitates the use of otherwise vacant habitat, but cannot be self sustaining until the juvenile and adult collection problems are solved, and other limiting factors are addressed. Efforts are underway to improve juvenile and adult collection facilities. Given the circumstances, fisheries are managed to achieve the escapement goal and thereby preserve the genetic heritage of the population, and the option for the reintroduction program and eventual rehabilitation of the Cowlitz population.

A supplementation program is also planned for the Lewis River as described in the Lewis River Hatchery and Supplementation Plan (Jones and Stokes 2009). Outplanting of 2,000 hatchery spring Chinook adults is scheduled to begin in 2011 in anticipation of the completion of downstream passage facilities in 2012. Hereto harvest is managed to ensure that hatchery broodstock needs are met in order to support the needs of the supplementation program.

A hatchery supplementation program is also being implemented on the Kalama with juvenile and adult fish being passed above the ladder at Kalama Falls. The Kalama River spring Chinook program has started to integrate natural-origin spring Chinook into the program with the 2008 broodyear. The release goal is 500,000, requiring approximately 280 adults.

Table 8. Total annual escapement of Lower Columbia River spring Chinook populations (PFMC 2010b).

Year or Average	Cowlitz River	Kalama River	Lewis River	Sandy River (Total)	Sandy River (natural-origin fish at Marmot Dam)[1]
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	1,609	1,796	3,777	5,329	2,445
2002	5,209	2,924	3,511	5,905	1,275
2003	15,987	4,553	5,044	5,615	1,151
2004	16,514	4,325	7,406	12,680	2,698
2005	9,353	3,374	3,500	7,668	1,808
2006	6,967	5,468	7,250	4,382	1,381
2007	3,974	8,016	7,529	2,813	790
2008	2,983	1,615	2,240	5,646	
2009	4,904	352	1,927	2,678	

[1]*Marmot Dam was removed in 2007 and is thus no longer available as a counting station*

The Cowlitz, Lewis, and Kalama river systems have all met their hatcheries escapement objectives in recent years with few exceptions, and are expected to do so again in 2010 and for the foreseeable future, thus ensuring that what remains of the genetic legacy is preserved and can be used to advance recovery. 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 current viability status of the Cowlitz, Lewis, and Kalama populations are all listed as very low. The Cowlitz and Lewis populations are designated as primary populations and are thus targeted in the LCFRB Plan for high or high plus viability (Table 5). Achieving high viability will require reintroducing the species and providing access to upstream habitat 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 (LCFRB 2010). The Kalama spring Chinook population is targeted for medium viability (Table 5). The prospects for improving the status for Kalama Spring Chinook are enhanced by passing fish above the falls to utilize inaccessible, but otherwise suitable habitat.

The viability status of the Sandy River spring population is current listed as medium. The Sandy River spring Chinook population is designated as a primary population to achieve high viability and thus will be important to the overall recovery of the ESU (Table 5). The Sandy River is managed with an integrated hatchery supplementation program that incorporates natural-origin brood stock. 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 prior to its removal averaged approximately 1,700 (Table 8), although 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 1,230 and 7,871, respectively (ODFW 2009). The return of natural-origin fish has therefore met the tentative delisting goal in recent years. The total return of spring Chinook to the Sandy including listed hatchery fish has averaged more than 5,600 since 2000 (Table 8).

Cascade Late Fall MPG

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 (Table 4). The viability status of the Lewis and Sandy populations are listed as very high and high; both populations are targeted for very high viability under the recovery scenario (Table 5).

The Technical Advisory Committee (TAC) provides estimates of the escapement of bright Chinook to the Sandy River (Table 9) (TAC 2008), but these are estimates of spawning escapement for a 16 km index area that is surveyed directly. (Estimates of peak redd counts in the index areas are expanded to estimates of spawning escapement by multiplying of 2.5.) The Oregon Plan includes an appendix that describes how index counts are expanded to estimates of total abundance (ODFW 2009, Appendix E). Appendix E provides the data set that was use in the recovery plan analysis, but the data ends in 2006. There is 67 linear km of spawning habitat. Index counts were therefore expanded using the ratio of spawning area to index area (67/16 = 4.2) to give estimates of total escapement (Table 9). There are some minor differences between the values reported in Appendix E and those shown in Table 9 that reflect revisions in prior index area estimates. The abundance target under Oregon's delisting scenario is 3,747 (ODFW 2009). Escapements have averaged about 3,300 since 1993.

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 escapement goal, based on estimates of maximum sustained yield, is 5,700. The escapement has averaged 9,500 over the last ten years and has generally exceeded the goal by a wide margin since at least 1980. Escapement was below goal in 2007 and 2008. The shortfall is consistent with a pattern of low escapements for other far-north migrating stocks in the region and can likely be attributed to poor ocean conditions. Escapement in 2009 improved, but was still just below the escapement goal at 5,400. The LCFRB Plan also identifies an abundance target of 7,300 (Table 5). The target is estimated from population viability simulations and is assessed as a median abundance over any successive 12 year period. The median escapement over the last 12 years is 9,462 thus exceeding the escapement target (Table 9). Escapement to the North Fork Lewis is expected to be above the goal in 2010 (PFMC 2010a), and continue to be above goal in the future.

Table 9. Annual escapement of Lower Columbia River bright fall Chinook populations (TAC 2008).

Year	Sandy River Index Area	Sandy River Escapement[1]	North Fork Lewis
1993	1,314	5,502	6,429
1994	941	3,940	8,439
1995	1,036	4,338	9,718
1996	505	2,115	12,700
1997	2,001	8,379	8,168
1998	773	3,237	5,167
1999	447	1,872	2,639
2000	84	352	8,727
2001	824	3,451	11,272
2002	1,275	5,339	13,284
2003	619	2,592	13,433
2004	601	2,517	14,165
2005	770	3,224	10,197
2006	1,130	4,732	10,522
2007	178	745	3,130
2008	602	2,521	4,823
2009	264	1,106	5,410

[1]Index Area counts are expanded to spawning escapement by multiplying by 4.2 based on method described in (ODFW 2009, Appendix E)

Gorge Fall MPG

There are twenty one populations of tule Chinook with some located in each of the three MPGs (Table 4). The four populations in the Gorge MPG include the Lower Gorge, Upper Gorge, White Salmon, and Hood. The baseline viability status for all of these populations is listed as very low, although a more recent analysis indicated that the status of the Hood population is higher, in transitional category two (Table 5). The recovery plans target the White Salmon and Gorge populations for medium viability, and the Hood population for high viability, although Oregon has indicated that it is unlikely that the high viability objective can be met (ODFW 2009). As discussed above, there is still some question regarding the historical role of the Gorge populations in the ESU and whether they truly functioned historically as demographically independent populations (Walton 2010).

Populations in the Gorge Fall MPG have been subject to the effects of a high incidence of naturally-spawning hatchery fish for years. The White Salmon, for example, is limited by Condit Dam which is located at river mile 3.3. There is natural spawning in the river below the Dam (NMFS 2010d). The number of fall Chinook spawners in the White Salmon has increased from low levels in the early 2000's to an average of 2,750 for the period from 1998 to 2007 (Roler 2009), but spawning is dominated by tule Chinook strays from the neighboring Spring Creek Hatchery and upriver brights from the production program in the adjoining Little White Salmon River (these fish are not part of the Lower Columbia River Chinook ESU). The Spring Creek 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 relatively little specific or recent information on the abundance of Chinook for the other populations in the Gorge MPG. Stray hatchery fish are presumed to dominate the spawning in these tributaries. ODFW reports that hatchery strays contribute about 90% of the escapement to the Lower Gorge, Upper Gorge, and Hood River populations on the Oregon side of the river (ODFW 2009). These populations are heavily influenced by hatchery strays from the Bonneville Hatchery located immediately below Bonneville Dam, and the Spring Creek and Little White Salmon Hatcheries located just above Bonneville Dam. The LCFRB Plan reports that the abundance of returning Chinook on the Washington side of the Lower and Upper Gorge populations is less than 50 (LCFRB 2010). It is reasonable to infer that tributaries in Gorge on the Washington side of the river are similarly affected by hatchery strays. As a consequence, hatchery origin fish contribute to and likely maintain spawning levels in all of the Gorge area tributaries.

Cascade Fall MPG

There are ten populations in the Cascade MPG. Of these only the Coweeman and East Fork Lewis are considered genetic legacy populations. The baseline viability status of all of these populations is listed as very low (Table 5). These determinations were generally based on assessments of status at the time of listing. More recent assessments listed under the Transitional Recovery Strategy Category (Table 5), indicate that the status of some of these populations have improved. These results are discussed in more detail in the following Overview section. Four of these populations are target for medium viability and four for very high viability in the recovery plans (Table 5).

The contribution of hatchery spawners to these populations is presumed to be relatively low, although even here the contribution may not be trivial from a genetic standpoint. All of the remaining populations are substantially affect by hatchery strays. The Washougal, Toutle, and Lower Cowlitz populations are all associated with significant in basin hatchery programs and are thus subject to large numbers of hatchery strays (for example see Table 10 for the Washougal and Lower Cowlitz populations). We have less information on returns to the Clackamas and Sandy rivers, but ODFW indicated for both that 90% of the spawners are likely hatchery-origin fish from as many as three adjacent hatchery programs (ODFW 2009).

Coastal Fall MPG

There are seven populations in the Coastal MPG. None are considered genetic legacy populations. The baseline viability status of all of the populations in the Coastal MPG is listed as very low. More recent assessments indicate that the status of the Grays and Mill/Abernathy/Germany populations are improved from their assessed status at the time of listing (see following Overview section). All of the populations are targeted for improved viability in the recovery plans. Four are targeted for high viability, while the Grays River is targeted for medium plus viability. The Big Creek and Youngs Bay populations are target for low viability (Table 5).

With the possible exception of the Grays River, all populations in the MPG are subject to significant levels of hatchery straying (Table 11). There was a Chinook hatchery on the Grays River, but that program was closed in 1997 with final returns coming a few years later. The relative absence of hatchery fish in the Grays from the in-basin program is therefore a relatively recent occurrence. A temporary weir was installed for the first time on the Grays River in 2008 to quantify escapement and help control the number of hatchery strays that might still be returning to the system. A significant number of out-of-ESU Rogue River "brights" from the Youngs Bay net pen programs were observed at the weir. Although recent estimates suggest that there are currently relatively few strays returning to the Grays, it will be a few years before we have better information on the exact composition of the fish returning to the Grays.

The Elochoman had an in basin fall Chinook hatchery production program that released 2,000,000 fingerlings annually. That program was recently eliminated with the last release in 2008. Closure of the hatchery program is consistent with the overall transition and hatchery reform strategy for tule Chinook. The number of natural spawners in the Elochoman has ranged from several hundred to several thousand in recent years with most being hatchery-origin (Table 11). The Mill/Abernathy/Germany population does not have an in basin hatchery program, but still has several hundred to several thousand spawners each year that are primarily hatchery-origin (Table 11). We have less information about the number of spawners in the Clatskanie and Scappoose, but ODFW estimates that hatchery strays have contributed approximately 90% of the fall Chinook spawners in both areas over the last 30 years (ODFW 2009). The Big Creek and Youngs Bay populations are both proximate to large net pen rearing and release programs that provide for a localized, terminal fishery in Youngs Bay. ODFW again estimates that 90% of the fish that spawn in these areas are hatchery strays.

Overview of Fall Population Status

In the 2009 biological opinion on PFMC fisheries, NMFS described methods and results from several analytical analyses that have been used in the past to assess the status of the populations and the effects of harvest on Lower Columbia River tule Chinook populations. The assessments provided information regarding the effects of harvest on the ability of populations to meet viability targets. Results from those analyses still contribute to our understanding of population status, but for brevity are incorporated here by reference to the prior biological opinion (NMFS 2009b).

Two additional assessments were conducted in 2009. The population risk assessment in the LCFRB Plan (2010) was updated (see Chapter 14, Appendix E). The Northwest Fisheries Science Center also conducted an expanded life-cycle modeling analysis that considered the effects of hatcheries, habitat conditions, and recovery actions on population risk at various harvest rates (NWFSC 2010). The results of all of the pertinent assessments were reviewed and summarized the NMFS Memo (Walton 2010). The review considered similarities and differences related to the conclusions regarding population status, and possible reasons for the underlying differences. The various analyses used different approaches and sometimes used different data sets. Assumptions related to future condition, particularly with respect to the treatment of hatchery fish, differed between the analyses. These differences influenced the results and conclusions. The memo provided several observations that are relevant to our consideration of the status of these populations, and concluded by dividing the populations into three status categories. These categories provide an updated and more refined assessment of status relative to those reported under Baseline Viability that relied on information and consideration of circumstances at the time of listing in 1999 (Table 5).

Among its observations, NMFS observed first that there is considerably uncertainty about the status of many (perhaps all) LCR tule Chinook populations. The NWFSC 2010 analysis, for example, relied in part on estimates of natural origin abundance for each population. Some populations, such as the Clatskanie, have very low estimated natural origin abundance compared to their modeled capacity, a result that leads directly to low estimated productivity and ultimately to a pessimistic evaluation of recovery potential under the scenarios explored (NWFSC 2010). However, that initial estimate of low natural origin abundance was itself dependent upon highly uncertain estimates of hatchery-origin spawners in this population. If these estimates turn out to be in error, the perceived status of this (and other) populations could change considerably.

Second, assuming that the low estimated productivities of most coastal stratum populations are correct, it is important to evaluate the factors that could be contributing to low productivity. Two factors appear to be the most likely cause of this very low productivity: poor habitat quality and impacts from hatchery/harvest management. With regard to habitat, the NWFSC 2010 analysis focused on recovery scenarios involving improvements only to tributary habitat, and modeled only a subset of the full range of tributary habitat actions in recovery plans. For the coastal populations in particular, improvements to estuary habitat may be crucial. If such improvements were included in the NWFSC 2010 model, the prospects for these populations would improve.

Finally, as discussed above, assumptions about the effect of hatchery fish on the spawning grounds is important. Some populations are likely more affected by stray hatchery fish than others. Populations like the Coweeman and Lewis are apparently less affected, but populations in the coastal stratum have been subject to hatchery straying and past high harvest rates, and as a consequence are unlikely to retain the genetic diversity and adaption that was originally present in these populations. The probable lack of local adaptation in these populations may be a contributing factor to their apparent low productivity.

After reviewing the available information, NMFS concluded that it is useful to divide LCR tule populations into three Transitional Recovery Strategy Categories (Table 5):

1. Populations with relatively low levels of past and current hatchery straying that appear to be self-sustaining and have a high persistence probability under current (~38%) harvest rates. Only the Coweeman and Lewis populations fall into this category. These populations are still below their target status but are relatively healthy compared to other LCR tule populations.

2. Populations that have relatively high current or past hatchery impacts, but that modeling suggests are able to be self-sustaining, either under current harvest rates or in some cases under rates less than the current rate. Based on the NWFSC 2010 and Ford et al. 2007 results, populations in this category include Washougal, Mill/Abernathy/Germany, and

Hood. Grays/Chinook possibly would also fall into this category, but this population was not modeled in the 2010 effort. Although also not explicitly modeled, by analogy to similar populations, the Lower Cowlitz, Kalama, and probably the Toutle populations also fall into this category. These populations may be at less immediate risk, but still clearly will require recovery actions that address habitat, hatchery, and harvest factors.

3. Populations that have very high current or past hatchery impacts that modeling suggests are not self-sustaining under current habitat conditions even with no harvest. Populations in this category include the Elochman, Clatskanie, and Scappoose, and probably Big Creek. These populations clearly require recovery actions that address habitat, hatchery and harvest factors.

These categories provide an updated and more refined assessment of status relative to those reported under Baseline Viability that relied on information and consideration of circumstances at the time of listing in 1999 (Table 5).

Table 10. Annual escapement of selected Lower Columbia River tule Chinook Cascade Strata populations (Ford, et. al 2007, LeFleur 2010).

	Coweeman		Washougal		Kalama		Lewis		Cowlitz	
Year	#	% wild	#	% wild	#	% wild	#	% wild	#	% wild
1974										
1975										
1976										
1977	337	100.0%	1,652	46.0%	6,549	50.0%	1,086		5,837	26.0%
1978	243	100.0%	593	46.0%	3,711	50.0%	1,448		3,192	26.0%
1979	344	100.0%	2,388	46.0%	2,731	50.0%	1,304		8,253	26.0%
1980	180	100.0%	3,437	46.0%	5,850	50.0%	899	100.0%	1,793	26.0%
1981	116	100.0%	1,841	46.0%	1,917	50.0%	799	100.0%	3,213	26.0%
1982	149	100.0%	330	46.0%	4,595	50.0%	646	100.0%	2,100	26.0%
1983	122	100.0%	2,677	46.0%	2,722	50.0%	598	100.0%	2,463	26.0%
1984	683	100.0%	1,217	46.0%	3,043	50.0%	340	100.0%	1,737	26.0%
1985	491	95.0%	1,983	46.0%	1,259	50.0%	1,029	100.0%	3,200	26.0%
1986	396	100.0%	1,589	46.0%	2,601	50.0%	696	100.0%	2,474	26.0%
1987	386	100.0%	3,625	46.0%	9,651	50.0%	256	100.0%	4,260	26.0%
1988	1,890	100.0%	3,328	46.0%	24,549	50.0%	744	100.0%	5,327	26.0%
1989	2,549	100.0%	4,578	46.0%	20,495	50.0%	972	78.0%	4,917	26.0%
1990	812	100.0%	2,205	46.0%	2,157	50.0%	563	100.0%	1,833	26.0%
1991	340	100.0%	3,673	47.0%	5,152	54.0%	470	100.0%	935	26.0%
1992	1,247	100.0%	2,399	76.0%	3,683	48.0%	335	100.0%	1,022	26.0%
1993	890	100.0%	3,924	52.0%	1,961	89.0%	164	100.0%	1,330	6.0%
1994	1,695	100.0%	3,888	70.0%	2,190	73.0%	610	100.0%	1,225	19.0%
1995	1,368	100.0%	3,063	39.0%	3,094	69.0%	409	100.0%	1,370	13.0%
1996	2,305	100.0%	2,921	17.0%	10,676	44.0%	403	100.0%	1,325	58.0%
1997	689	100.0%	4,669	12.0%	3,548	40.0%	305	100.0%	2,007	72.0%
1998	491	100.0%	2,971	24.0%	4,355	69.0%	127	100.0%	1,665	37.0%
1999	299	100.0%	3,129	68.0%	2,655	3.0%	331	100.0%	969	16.0%
2000	290	100.0%	2,155	70.0%	1,420	19.0%	515	100.0%	2,165	10.0%
2001	802	73.0%	3,901	43.0%	3,714	19.0%	750	70.0%	3,647	44.0%
2002	877	97.0%	6,050	47.0%	18,952	1.0%	1,032	77.0%	9,671	76.0%
2003	1,106	89.0%	3,444	39.0%	24,782	1.0%	738	98.0%	7,001	88.0%
2004	1,503	91.0%	10,597	25.0%	6,680	10.0%	1,388	29.0%	4,621	70.0%
2005	853	60.0%	2,678	41.0%	9,272	3.0%	607	100.0%	2,968	17.0%
2006	561	na	2,600	na	10,386	na	427	na	2,944	na
2007	234	na	1,528	na	3,296	na	948	na	1,401	na
2008	404	na	2,491	na	3,734	na	567	na	1,259	na
2009	780	63.3%	2,741	29.7%	7,548	9.8%	299	100.0%	2,602	44.8%

Table 11. Annual escapement of selected Lower Columbia River tule Chinook Coastal Strata populations (Ford, et. al 2007, LeFleur 2010).

	Clatskanie		Grays		Elochoman		Ge/Ab/Mi	
Year	#	% wild	#	% wild	#	% wild	#	% wild
1974	155	10.0						
1975	408	10.0						
1976	355	10.0						
1977	355	10.0	1,009	65.0	568			
1978	355	10.0	1,806	65.0	1,846			
1979	330	10.0	344	65.0	1,478			
1980	525	10.0	125	65.0	64	42.0	516	49.0
1981	330	10.0	208	65.0	138	42.0	1,367	48.0
1982	1050	10.0	272	65.0	340	42.0	2,750	50.0
1983	330	10.0	825	65.0	1,016	42.0	3,725	51.0
1984	253	10.0	252	65.0	294	42.0	614	52.0
1985	175	10.0	532	65.0	464	42.0	1,815	53.0
1986	330	10.0	370	65.0	918	42.0	980	49.0
1987	777	10.0	555	65.0	2,458	42.0	6,168	59.0
1988	447	10.0	680	65.0	1,370	42.0	3,133	69.0
1989	641	10.0	516	65.0	122	42.0	2,792	69.0
1990	175	10.0	166	65.0	174	42.0	650	63.0
1991	287	10.0	127	94.0	196	9.0	2,017	85.0
1992	287	10.0	109	100.0	190	100.0	839	47.0
1993	287	10.0	27	100.0	288	78.0	885	71.0
1994	136	10.0	30	100.0	706	98.0	3,854	40.0
1995	194	10.0	9	100.0	156	50.0	1,395	51.0
1996	1069	10.0	280	48.0	533	66.0	593	54.0
1997	155	10.0	15	64.0	1,875	11.0	603	23.0
1998	214	10.0	96	41.0	228	25.0	368	60.0
1999	233	10.0	195	51.0	718	25.0	575	69.0
2000	607	10.0	169	96.0	196	62.0	416	58.0
2001	607	10.0	261	64.0	2,354	82.0	4,024	39.0
2002	894	10.0	107	100.0	7,581	0.0	3,343	5.0
2003	1088	10.0	398	72.0	6,820	65.0	3,810	56.0
2004	401	10.0	766	90.0	4,796	1.0	6,804	2.0
2005	370	10.0	147	66.0	2,204	5.0	2,083	13.0
2006	212	10.0	383	na	317	na	322	na
2007	na	na	63	na	165	na	335	na
2008	na	na	40	na	841	na	747	na
2009	na	na	312	42.6	2,246	18.3	604	93.2

3.2.1.3 Spatial Structure and Diversity

The assessment of population status includes a consideration of the four VSP attributes of abundance, productivity, diversity and spatial structure (McElhany et al. 2000). Abundance and productivity are often treated together because of their close association. A population with low abundance and high productivity may have the same viability as a population with high abundance and low productivity. Information related to measures of abundance and productivity was discussed in the preceding section.

Spatial structure and diversity are generally treated separately. However, because of the difficulty of developing metrics for these two attributes that could be quantitatively link to extinction risk, a mix of qualitative and quantitative metrics were used. The LCFRB and ODFW recovery plans took somewhat different approaches when assessing spatial structure and diversity. The methods and results from the LCFRB Plan (2010) are reported in Appendix E of the Plan and summarized here in Table 11. The LCFRB Plan characterizes population status relative to persistence (which combines the abundance and productivity criteria), spatial structure, and diversity, and also habitat characteristics. This overview for tule populations suggests that risk related to abundance and productivity are higher than those for spatial structure and diversity (Table 11). 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. This general pattern of lower persistence scores and higher scores for spatial structure and diversity applied for other populations in the ESU as well.

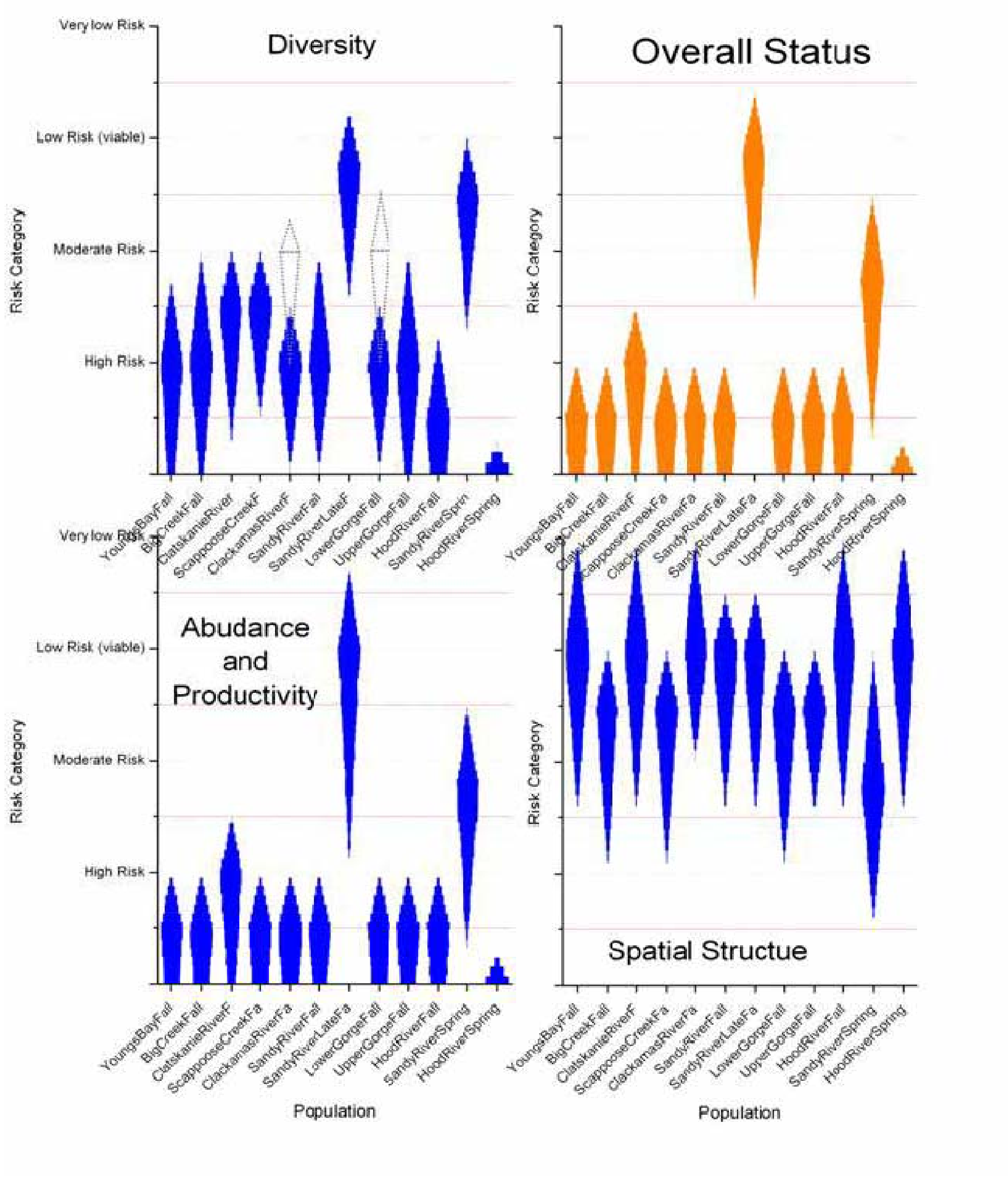
The methods used to score the spatial structure and diversity attributes for populations in Oregon are reported in McElhany et al. (2007) with resulting scores, including some updates, report in the Oregon Plan (ODFW 2009). Results from those assessments are shown in Figure 3 below. The results are presented graphically to help characterize the uncertainty of the designations. The assessments of spatial structure and diversity are combined with those of abundance and productivity to give an assessment of the overall status of Lower Columbia River Chinook populations in Oregon.

Table 12. Summary of current status for Lower Columbia River tule Chinook populations for VSP characteristics expressed as a categorical score (LCFRB 2010, 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
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
Gorge Fall	WA	Lower Gorge	1.8	3	2.5	2.5
	WA	Upper Gorge	1.8	2	2.5	2
	WA	Big White Salmon	1.7	2	2.5	1.5

Notes: Summaries are taken directly from the LCFRB Plan. All are on a 4 point scale, with 4 being lowest risk and 0 being highest risk.
<u>Persistence</u>: 0 = extinct or very high risk of extiction (0-40% probability of persistance in 100 years); 1 = Relatively high risk of extinction (40-75% probability of persistance in 100 years); 2 = Moderate risk of extinction (75-95% probability of persistance in 100 years); 3 = Low (negligible) risk of extinction (95-99% probability of persistance in 100 years); 4 = Very low risk of extinction (>99% probability of persistance in 100 years)
<u>Spatial Structure</u>: 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 historica range accessible but fish are not using it); 3 = Adequate to support a viable population but subcriteria for dynamics or catestrophic 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)
<u>Diversity</u>: 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.
<u>Habitat</u>: 0 = Quality not suitable for salmon production; 1 = Highly impaired; significant natural production may occur only in favorable years; 2 = Moderately impaired; signficant degredation in habitat quality associated with reduced population productivity; 3 = Intact habitat. Some degredation but habitat is sufficient to produce signficant numbers of fish; 4 = Favorable habitat. Quality is near or at optimums for salmon.

Figure 3. Extinction risk ratings for Lower Columbia River Chinook populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure, as well as overall ratings for populations that combine the three attributes. Where updated ratings differ from those presented in McElhany et al. (2007), the old rating is shown as an open diamond with a dashed outline.



3.2.1.4 Limiting Factors and Threats

Understanding the limiting factors and threats that affect Lower Columbia River Chinook provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. 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 including hydropower development on the Columbia River and its tributaries, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors including predation and environmental variability. Limiting factors and threats for the Lower Columbia River Chinook ESU are described in the following sections. For more detailed summaries see the Supplemental Comprehensive Analysis (SCA) done in association with the Federal Columbia River Power System (FCRPS) biological opinion (NMFS 2008g), and for the Washington and Oregon populations see the LCFRB and Oregon recovery plans, respectively (LCFRB 2010, ODFW 2009).

The Hydropower System

Hydropower development on the Columbia River and its tributaries has dramatically affected anadromous salmonids in the basin. Dams have eliminated spawning and rearing habitat and altered the natural hydrograph of the Columbia River – decreasing spring and summer flows and increasing fall and winter flows. Power operations cause flow levels and river elevations to fluctuate – slowing fish movement through reservoirs, altering riparian ecology, and stranding fish in shallow areas. The dams in the migration corridors kill smolts and adults and alter their migrations. The dams have also converted the once-swift river into a series of slow-moving reservoirs – slowing the smolts' journey to the ocean and creating habitat for predators.

Mainstem

The FCRPS consists of 14 sets of dams, powerhouses, and reservoirs, operated as a coordinated system for power production and flood control (while also effectuating other project purposes) on behalf of the Federal government under various Congressional authorities. These projects are: Dworshak, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams, power plants, and reservoirs in the Snake River basin; Albeni Falls, Hungry Horse, Libby, Grand Coulee and Banks Lake (features of the Columbia Basin Project), and Chief Joseph dams, power plants, and reservoirs in the upper Columbia River basin; and McNary, John Day, The Dalles, and Bonneville dams, power plants, and reservoirs in the lower Columbia River basin. The Bureau of Reclamation also operates a system of projects in the Upper Snake River. The FCRPS and Bureau of Reclamation Upper Snake River projects are collectively referred to here as the FCRPS and Reclamation Actions.

NMFS recently completed Section 7 consultations on the effects of the Federal Columbia River Power System (NMFS 2008h) and the Bureau of Reclamation's Upper Snake River irrigation storage projects (NMFS 2008i). 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 including Lower Columbia River Chinook. Only a few of the Gorge strata populations of Lower Columbia River Chinook ESU are located above Bonneville Dam, the lower most of the mainstem projects. The populations in the Gorge stratum are subject to the additional affects associated with upstream and downstream passage, and inundation of the lower reaches of tributaries. Most of the populations in the Lower Columbia River Chinook are subject to fewer effects from the FCRPS than other upstream ESUs or DPSs. However, all populations are likely still subject to effects resulting from storage and regulation of flows, and subsequent affects on the estuary. The two biological opinions and the associated Supplemental Comprehensive analysis (SCA) provide a current and comprehensive overview of conditions in the Columbia River Basin, the future effects of the FCRPS and Upper Snake River actions, and how they are likely to affect the status of Lower Columbia River Chinook. The biological opinions concluded that the FCRPS Reasonable and Prudent Alternative is not likely to jeopardize the continued existence of the Lower Columbia River Chinook ESU nor result in the destruction or adverse modification of designated critical habitat.

Cowlitz River

Two major hydroelectric dams impact anadromous fish runs on the Cowlitz River: Mayfield Darn, which was completed in 1962, and Mossyrock Dam, completed in 1968. These dams flooded miles of spawning and rearing habitat and blocked upstream and downstream migration, for both anadromous and resident fish. Between 1961 and 1968, downstream migrants were passed over Mayfield Dam via fish passage facilities. Since the construction of Mossyrock Dam and the Cowlitz Salmon Hatchery Barrier Dam in 1968, no volitional upstream passage remains. For brief periods, anadromous fish have been hauled around the dams by trucks to stock the upper watershed for sport fishing (Stober,1986), but anadromous fish production in the upper basin was effectively eliminated. Recent efforts are being made to reintroduce Chinook salmon in areas above the dams through a trap and haul operations. These supplementation programs are discussed in more detail below.

Other Tributary Hydropower Projects

Other projects on the Lewis, White Salmon, Sandy, and Hood rivers also impair or completely bock access to upstream spawning and rearing, and/or restrict spawning and rearing to sub-optimal habitat downstream of the dams. The specific effects to populations in the Lower Columbia River ESU are discussed elsewhere in this opinion and are reviewed in more detail in the LCFRB Plan (LCRPS 2010) and Oregon Plan (ODFW 2009).

Human-Induced Habitat Degradation

The LCFRB Plan (LCFRB 2010) provides a detailed overview and basin-specific assessment of habitat conditions on the Washington side of the Lower Columbia River. The Oregon Plan provides similar information for the Oregon side of the ESU (Oregon 2009). The quality and quantity of freshwater habitat in much of the Columbia River Basin has declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydrosystem development, mining, and other development have radically changed habitat conditions in the basin. Water quality in streams throughout the

Columbia River Basin has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and animal grazing, road construction, timber harvest activities, mining activities, and development. Over 2,500 streams, river segments, and lakes in the Northwest do not meet Federally-approved, state and tribal water quality standards and are now listed as water quality limited under section 303(d) of the Clean Water Act. Tributary water quality problems contribute to poor water quality when sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

Most of the water bodies in Oregon, Washington, and Idaho on the 303(d) list do not meet water quality standards for temperature. High water temperatures adversely affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land-use practices rather than point-source discharges. Some common actions that cause high stream temperatures are the removal of trees or shrubs that directly shade streams, water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals contribute to lower base-stream flows which, in turn, contribute to temperature increases. Activities that create shallower streams (e.g., channel widening) also cause temperature increases.

Pollutants also degrade water quality. Salmon require clean gravel for successful spawning, egg incubation, and the emergence of fry. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon.

Water quantity problems are also an important cause of habitat degradation and reduced fish production. Millions of acres of land in the basin are irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion of it. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, human consumption, and other uses increases temperatures, smolt travel time, and sedimentation. Return water from irrigated fields introduces nutrients and pesticides into streams and rivers. Water withdrawals (primarily for irrigation) have lowered summer flows in nearly every stream in the basin and thereby profoundly decreased the quantity and quality of habitat.

Blockages that stop downstream and upstream fish movement exist at many dams and barriers, whether they are for agricultural, hydropower, municipal/industrial, or flood control purposes. Culverts that are not designed for fish passage also block upstream migration. Migrating fish are often killed when they are diverted into unscreened or inadequately screened water conveyances or turbines. While many fish-passage improvements have been made in recent years, manmade structures continue to block migrations or kill fish throughout the basin.

On the landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density which, in turn, affect runoff timing and duration. Many riparian areas, flood plains, and wetlands that once stored water during periods of high runoff have been destroyed by development that paves over or compacts soil – thus increasing runoff and altering its natural pattern.

Land ownership has also played its part in the region's habitat and land-use changes. Federal lands, which compose 50 percent of the basin, are generally forested and influence upstream portions of the watersheds. While there is substantial habitat degradation across all ownerships, in general, habitat in many headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt et al. 1993; Frissell 1993; Henjum et al. 1994; Quigley and Arbelbide 1997). In the past, valley bottoms were among the most productive fish habitats in the basin (Stanford and Ward 1992; ISG 1996; Spence et al. 1996). Today, agricultural and urban land development and water withdrawals have substantially altered the habitat for fish and wildlife. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation. Floodplains have been reduced in size, off-channel habitat features have been lost or disconnected from the main channel, and the amount of large woody debris (large snags/log structures) in rivers has been reduced. Most of the remaining habitats are affected by flow fluctuations associated with reservoir management.

The Columbia River estuary (through which all the basin's species must pass) has also been changed by human activities. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. The mouth of the Columbia River was about four miles wide. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River kept the environment dynamic. Today, navigation channels have been dredged, deepened, and maintained; jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels; marsh and riparian habitats have been filled and diked; and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the Columbia River to two miles and increased the depth of the Columbia River channel at the bar from less than 20 to more than 55 feet. Sand deposition at river mouths has extended the Oregon coastline approximately four miles seaward and the Washington coastline approximately two miles seaward (Thomas 1981).

More than 50 percent of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948 (LCREP 1999). Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased.

Human-caused habitat alterations have also increased the number of predators feeding on Columbia River salmon. For example, researchers estimated that a population of terns on Rice Island (created under the Columbia River Channel Operation and Maintenance Program) consumed six to 25 million out-migrating salmonid smolts during 1997 (Roby et al. 1998) and seven to 15 million out-migrating smolts during 1998 (Collis et al. 1999). Even after considerable efforts by Federal and state agencies to remedy this problem, between 5 and 7 million smolts were consumed in 2001. As another example, populations of Northern pikeminnow (a salmonid predator) in the Columbia River have skyrocketed since the advent of the mainstem dams and their warm, slow-moving reservoirs.

To counteract all the ill effects listed in this section, Federal, state, tribal, and private entities are engaged – singly and in partnership – in recovery efforts to help slow and, eventually, reverse the decline of salmon and steelhead populations. A number of projects related to tributary, mainstem, and estuarine habitat have been implemented as a consequence of the biological opinion on the FCRPS (NMFS 2008h). The LCFRB has funded 142 other projects valued at $41.8 million for lower Columbia River tributary and mainstem habitat restoration through the Pacific Coast Salmon Recovery Funds (Anderson 2010a,b). There are other funding agencies that have implemented projects throughout the basin. Nevertheless, while these efforts represent a number of good beginnings, it must be stated that much remains to be done to recover Columbia River salmon. A discussion of the types of recovery strategies and management measures currently underway and under consideration can be found in the LCFRB Plan (LCFRB 2010) and Oregon Plan (ODFW 2009).

Hatcheries

For more than 100 years, hatcheries in the Pacific Northwest have been used primarily to (a) produce fish for harvest and (b) replace natural production lost to dam construction and other development – and in fewer instances, to protect and rebuild naturally produced salmonid populations. As a result, most salmonids returning to the region are derived primarily from hatchery fish. In 1987, for example, 95 percent of the coho salmon, 70 percent of the spring Chinook salmon, 80 percent of the summer Chinook salmon, 50 percent of the fall Chinook salmon, and 70 percent of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). Because hatcheries have traditionally focused on providing fish for harvest and technologies have been limited, it is only recently that the substantial adverse effects of hatcheries on natural-origin populations have been demonstrated. For example, the production of hatchery fish, among other factors, has contributed to the 90 percent reduction in natural-origin coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995).

NMFS has identified four primary ways hatcheries may harm wild-run salmon and steelhead: (1) ecological effects, (2) genetic effects, (3) overharvest effects, and (4) masking effects. Ecologically, hatchery fish can predate on, displace, and compete with natural-origin fish. These effects are most likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods. Hatchery fish also may transmit hatchery-borne diseases, and hatcheries themselves may release disease-carrying effluent into streams. Hatchery fish can affect the genetic variability of native fish by interbreeding with them. Interbreeding can also result from the introduction of stocks from other areas. Interbred fish are less adapted to the local habitats where the original native stock evolved and may therefore be less productive there.

In many areas, hatchery fish provide increased fishing opportunities. However, when natural-origin fish mix with hatchery stock in these areas, naturally produced fish can be overharvested. Moreover, when migrating adult hatchery and natural-origin fish mix on the spawning grounds, the health of the natural-origin runs and the habitat's ability to support them can be overestimated. This potential overestimate exists because the hatchery fish mask the surveyors' ability to discern actual natural-origin run status, thus resulting in harvest objectives that were too high to sustain the naturally produced populations.

Over the last several years, the role hatcheries play in the Columbia Basin has been expanded from simple production to supporting species recovery. The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia River is occurring through several processes, including: (1) the Lower Columbia River Recovery and Fish and Wildlife Subbasin Plan; (2) Hatchery Genetic and Management Plan development for ESA compliance; (3) FERC-related plans on the Cowlitz and Lewis Rivers; and, (4) the federally mandated Artificial Production Review and Evaluation. More recently a National Environmental Policy Act (NEPA) review of all Mitchell Act funded hatchery facilities was initiated which will include many of those producing Lower Columbia River Chinook. The Lower Columbia River recovery plans in Washington and Oregon identify strategies and measures to support recovery of naturally-spawning fish. The plans include associated research and monitoring elements designed to clarify interactions between natural and hatchery fish and quantify the effects artificial propagation has on natural fish. The plans also describe broad sense goals that include recovery of listed species to healthy, harvestable levels, a goal that will be achieved in part by reform of past hatchery practices. For more detail on the use of hatcheries in recovery strategies, see the LCFRB Plan (LCFRB 2010) and Oregon Plan (ODFW 2009).

When evaluating harvest actions affecting an ESU, NMFS may also consider the effect of fisheries on listed hatchery origin fish. Among other things, NMFS sometimes considers whether hatchery programs will meet their escapement objectives. This is particularly important for hatchery programs that are preserving the genetic legacy of key components of the ESU, or for programs used for recovery-related supplementation efforts. The spring Chinook programs in the Cowlitz, North Fork Lewis, and Kalama rivers are examples of hatchery programs that will play an important role in recovery.

The states of Oregon and Washington and other co-managers have recently completed a review of all hatchery programs in the Columbia River Basin 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 completed their work on Lower Columbia River Chinook programs with particular emphasis on those affecting tule populations (HSRG 2009). 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 populations that must achieve improved status to meet the requirements for delisting and broad sense recovery. 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. NMFS discussed the results on the HSRG analysis and some of the population specific recommendations in the 2009 biological opinion on PFMC fisheries (NMFS 2009). The HSRG recommendations have for the most part been incorporated into the LCFRB and Oregon recovery plan and associated initiatives that are being implemented by the state management agencies (Anderson 2010a).

The context and details of hatchery reforms for the Lower Columbia River Chinook populations have been developed over the last several years. Early in 2007 NMFS highlighted the need to change current hatchery programs and anticipated that decisions regarding the direction for those programs would be made soon (Lohn and McInnis 2007). NMFS followed with a letter to the states of Oregon and Washington in November 2007 that again highlighted the immediate need for decisions about hatchery programs (Turner 2007). 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 NMFS in January 2008 (Anderson and Bowles 2008) and includes:

- 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.

WDFW recently provided their current Conservation and Sustainable Fisheries Plan (CSFP) that describes the details of their hatchery reform plans, and the status of the related hatchery reform actions (Anderson 2010a).

NMFS reviewed the status of hatchery reform in their 2009 biological opinion (NMFS 2009b) and concluded that essential and significant parts of the program have already been implemented and therefore can be considered as part of the baseline. Additional progress is documented in the CSFP (Anderson 2010a). Task E in the proposed action is designed to maintain focus on essential hatchery reforms and to insure that they continue to be implemented on schedule.

Harvest

Salmon and steelhead have been harvested in the Pacific Northwest as long as there have been people there. For thousands of years, native Americans have fished on salmon and other species in the mainstem and tributaries of the Columbia River for ceremonial and subsistence use and for barter. Salmon were possibly the most important single component of the Native American diet, and were eaten fresh, smoked, or dried (Craig and Hacker 1940). A wide variety of gears and methods were used, including hoop and dip nets at cascades such as Celilo and Willamette Falls, to spears, weirs, and traps (usually in smaller streams and headwater areas).

Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. The development of non-Indian fisheries began in about 1830; by 1861, commercial fishing was an important economic activity. The early commercial fisheries used gill nets, seines hauled from shore, traps, and fish wheels. Later, purse seines and trolling (using hook and line) fisheries developed. Recreational fishing began in the late 1800s, occurring primarily in tributary locations (ODFW/WDFW 2000).

Salmonids' capacity to produce more adults than are needed for spawning offers the potential for sustainable harvest of naturally produced (versus hatchery-produced) fish. This potential can be realized only if two basic management requirements are met: (1) enough adults return to spawn and perpetuate the run, and (2) the productive capacity of the habitat is maintained. Catches may fluctuate in response to such variables as ocean productivity cycles, periods of drought, and natural disturbance events, but as long as the two management requirements are met, fishing can be sustained indefinitely. Unfortunately, both prerequisites for sustainable harvest have been violated routinely in the past. The lack of coordinated management across jurisdictions, combined with competitive economic pressures to increase catches or to sustain them in periods of lower production, resulted in harvests that were too high and escapements that were too low. At the same time, habitat has been increasingly degraded as described above, reducing the capacity of the salmon stocks to produce numbers in excess of their spawning escapement requirements.

In recent years harvest management has undergone significant reforms and many of the past problems have been addressed. Fishery catches have been scaled back coast wide and population harvest impacts have been reduced as a result (see for example the discussion Chapter 3 of the LCFRB 2010). Managers are relying increasingly on mark selective fisheries that are designed to provide harvest opportunity while keeping harvest impacts to natural origin fish low. Principles of weak stock management are now the prevailing paradigm. As a result, mixed stock fisheries are managed based on the needs of natural-origin stocks. Managers also account, where possible, for total harvest mortality across all fisheries. The focus is now on conservation and secondarily on providing harvest opportunity where possible that is directed at harvestable hatchery and natural-origin stocks. As a result, fishery catches and harvest impacts on nearly every stock has been reduced significantly.

Lower Columbia River Chinook are harvested throughout their migratory range from Alaska to Oregon and in fisheries in the lower Columbia River. Because of their broad distribution, Lower Columbia River Chinook are subject to management by several jurisdictions. The 2008 PST Agreement sets limits on harvest in Alaska, Canada, and in southern ocean and inland fisheries as far as south as Oregon. The U.S and Canada recently completed a new ten year agreement on fishing regimes managed under the PST. Details of the Agreement and the resulting effects to Lower Columbia River Chinook are discussed in NMFS' biological opinion (NMFS 2008d) on the 2008 PST Agreement. The action area for the 2008 PST Agreement includes all marine and freshwater areas in southeast Alaska, British Columbia, and the Pacific Northwest. In the southern U.S. this 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 (NMFS 2008d). The action area of the 2008 PST Agreement therefore includes all of the action area considered in this opinion.

The PFMC and Fraser Panel set regulations for fisheries off the southern U.S. coast and in northern Puget Sound. Fisheries managed under these jurisdictions are the subject of this consultation (described above under the Proposed Action). The action area for the PFMC and Fraser Panel fisheries is limited to the EEZ and inland waters of northern Puget Sound and is thus a subset of the action area considered under the PST Agreement (Figure 1).

Fisheries in the Columbia River Basin are managed subject to the recently completed 2008 U.S. v. Oregon Management Agreement. The action area for the 2008 U.S. v. Oregon Management Agreement is limited to the Columbia Basin, but Columbia River fisheries are link directly to the ocean fisheries since fisheries below Bonneville Dam are subject to a total exploitation rate on Lower Columbia River Chinook that is provided through NMFS' annual guidance letter to the Council. NMFS' biological opinion on the 2008 U.S v. Oregon Management Agreement describes the scope of that Agreement, the effects to Lower Columbia River Chinook, and the relationship between the ocean and inriver fishery actions (NMFS 2008e).

Additional harvest does occur on populations in the spring and tule Gorge MPGs that are located above Bonneville Dam. Three of the four populations Gorge tule populations, for example, are located above Bonneville Dam and are caught in what are primarily tribal fisheries that target returning upriver bright Chinook and fish returning to the Spring

Creek Hatchery in particular. There are no proposals to reduce these important tribal fisheries that target hatchery fish that are produced for that purpose. Harvest impacts on these three populations is therefore significantly higher than the other populations located below Bonneville Dam.

To address this complexity and help summarize applicable harvest limits for the year, NMFS provides guidance each year through the Council process that sets a total exploitation rate limit and requires that all the jurisdiction manage their fisheries to stay within the overall limit. Setting a total exploitation rate limit makes sense from a biological perspective since it can then be assessed relative to the biological requirements of the species. From a practical perspective it also allows the management processes to function and make the necessary allocation decisions to achieve the specified conservation objective. The close relation between the various fishery jurisdictions is described above in more detail in the Proposed Action.

In the following review we describe the magnitude and trends of past harvest for the spring, bright, and tule components of the Lower Columbia River Chinook ESU including how it has been distributed across the various fisheries. We also describe the results of a retrospective analysis that was done in conjunction with our review of the 2008 PST Agreement. The retrospective analysis was designed to help assess the effects of that agreement if implemented over the next ten years.

Past Harvest

Tables 13, 14, and 15 provide estimates of harvest impacts and their distribution across fisheries for spring, bright, and tule populations in the Lower Columbia River Chinook ESU.

Table 13 provides estimates of harvest impacts to Lower Columbia River spring Chinook populations. These estimates do not account for harvest reductions that have occurred in recent years as a result of implementation of mark selective fisheries in the Columbia River. Exploitation rates were generally higher prior to the mid 1990's averaging 50% through 1994. The overall abundance of spring Chinook stocks in the Columbia River, including Upper Willamette River spring Chinook, decreased significantly in the mid 1990's, which led to a significant reduction in harvest, particularly inriver. Stock abundance gradually increased, reaching another peak by the early part of the 2000 decade. Fishery impacts increased some in response to higher abundance, but by 1999, both Upper Willamette River Chinook and Lower Columbia River Chinook ESUs had been listed under the ESA. Reforms were implemented in response to further limit the effects of harvest. Fishery managers implemented mass-marking programs for hatchery-origin fish and phased in mark-selective fisheries. Since 1995 total exploitation rates have averaged about 27%, although actual exploitation rates on unmarked natural-origin fish are lower as a consequence of the implementation of mark-selective fisheries inriver.

A more recent analysis considered how harvest impacts to unmark spring Chinook changed as a result of implementation of mark selective fisheries in lower Columbia River mainstem and tributary fisheries over the last five years. Harvest rates in commercial and recreational mainstem, and tributary sport fisheries averaged 1.2% and

2.7%, respectively from 2005 to 2009. When these harvest rates for unmarked fish are combined with ocean impact estimates, the estimated total exploitation rate for all fisheries averaged 23% (LaVoy 2010b). The LCFRB Plan estimated that harvest impacts have been reduced to around 20% or less since listing by restricting of ocean fisheries and implementing mark-selective fisheries for hatchery spring Chinook in freshwater (LCFRB 2010). The Oregon Plan estimated that the total exploitation rate on Hood River spring Chinook was 25% or less (ODFW 2009). Harvest impacts to the Hood River population may be somewhat higher than populations located below Bonneville Dam because of the additional impacts that occur in tribal fisheries above the dam. Estimates of harvest mortality from Appendix C of the Oregon Plan indicate that exploitation rates on the Sandy River spring population were reduced to an average of about 18% once the lower river fisheries switched to catch and release requirements. These different analyses lead to somewhat different results, but they are consistent in suggesting that total exploitation rates are 25% or less.

Table 13. Total adult equivalent exploitation rates (catch/catch + escapement) for Cowlitz spring Chinook which are used as an example of exploitation rates on Lower Columbia River spring Chinook populations (Simmons 2008).

		Ocean					Columbia River	
			Canada		Southern US		Non-Indian	Indian
Year	Total Exploitation Rate	Southeast Alaska	WCVI	Other Canada	PFMC	PgtSd	Exp Rate	Exp Rate
1980	52%	2%	5%	4%	17%	0%	24%	0%
1981	48%	3%	5%	4%	17%	0%	20%	0%
1982	55%	2%	5%	3%	15%	0%	30%	0%
1983	57%	2%	9%	5%	9%	0%	32%	0%
1984	54%	2%	11%	5%	4%	0%	31%	0%
1985	43%	1%	5%	3%	8%	0%	25%	0%
1986	52%	1%	5%	3%	12%	0%	31%	0%
1987	45%	1%	5%	3%	11%	0%	25%	0%
1988	49%	1%	5%	2%	16%	0%	26%	0%
1989	50%	1%	3%	3%	19%	0%	25%	0%
1990	57%	1%	5%	2%	23%	0%	26%	0%
1991	54%	1%	4%	3%	14%	0%	32%	0%
1992	46%	1%	5%	3%	19%	0%	19%	0%
1993	48%	1%	5%	3%	15%	0%	25%	0%
1994	45%	1%	4%	3%	3%	0%	35%	0%
1995	10%	1%	2%	1%	4%	0%	1%	0%
1996	11%	1%	0%	0%	7%	0%	2%	0%
1997	16%	1%	1%	2%	5%	0%	7%	0%
1998	12%	1%	0%	2%	9%	0%	0%	0%
1999	38%	1%	1%	1%	15%	0%	20%	0%
2000	38%	1%	3%	1%	9%	0%	25%	0%
2001	21%	1%	2%	1%	7%	0%	10%	0%
2002	43%	1%	2%	2%	13%	0%	24%	0%
2003	34%	1%	3%	2%	13%	0%	16%	0%
2004	31%	1%	3%	2%	13%	0%	11%	0%

2005	36%	1%	4%	2%	17%	0%	11%	0%
2006	34%	1%	4%	3%	16%	0%	11%	0%

Table 14 provides estimates of harvest to the North Fork Lewis bright Chinook population. Exploitation rates were generally high through 1989 (averaging 56%), declined during the decade of the 1990s (averaging 36%), and increased slightly since 2000 (averaging 38%).

Table 14. Total adult equivalent exploitation rate (catch/catch + escapement) for North Fork Lewis bright Chinook population (Simmons 2008).

		Ocean					Columbia River	
			Canada		Southern US			
Year	Total exploitation rate	Southeast Alaska	WCVI	Other Canada	PFMC	PgtSd	Non-Indian Exp Rate	Indian Exp Rate
1979	64%	9%	8%	6%	9%	2%	29%	0%
1980	68%	11%	8%	7%	8%	2%	33%	0%
1981	39%	11%	6%	6%	6%	2%	7%	0%
1982	43%	9%	6%	6%	8%	2%	12%	0%
1983	42%	10%	11%	6%	4%	3%	8%	0%
1984	58%	10%	15%	7%	2%	2%	22%	0%
1985	54%	6%	7%	6%	5%	3%	27%	0%
1986	64%	5%	8%	6%	6%	4%	35%	0%
1987	65%	5%	8%	5%	5%	3%	39%	0%
1988	68%	6%	10%	5%	7%	3%	38%	0%
1989	44%	7%	3%	4%	4%	1%	24%	0%
1990	38%	8%	6%	4%	7%	2%	12%	0%
1991	57%	7%	5%	5%	5%	2%	33%	0%
1992	57%	7%	9%	6%	7%	3%	25%	0%
1993	51%	7%	6%	4%	7%	3%	25%	0%
1994	38%	7%	11%	9%	1%	3%	7%	0%
1995	36%	7%	3%	2%	1%	1%	22%	0%
1996	16%	7%	0%	0%	2%	2%	3%	0%
1997	25%	11%	2%	3%	2%	2%	7%	0%
1998	23%	11%	0%	2%	1%	1%	8%	0%
1999	19%	6%	1%	2%	7%	2%	0%	0%
2000	24%	6%	5%	1%	5%	2%	5%	0%
2001	31%	7%	4%	1%	6%	3%	11%	0%
2002	41%	9%	3%	3%	7%	3%	15%	0%
2003	50%	11%	3%	4%	5%	2%	24%	0%
2004	40%	9%	2%	2%	3%	1%	22%	0%
2005	50%	8%	6%	5%	8%	3%	20%	0%
2006	32%	10%	2%	3%	3%	1%	13%	0%

Table 15 provides estimates of harvest impacts for tule Chinook populations based on an aggregate of coded wire tag indicator stocks. Exploitation rates were generally higher through 1993 (averaging 69%), lower through 1999 (averaging 34%), then increasing since 2000 (averaging 49%). From 2002 to 2006 fisheries were managed subject to a

49% exploitation rate limit. Total exploitation rates have been higher in some years but averaged 49% from 2002 to 2006.

Table 15. Total adult equivalent exploitation rates (catch/catch + escapement) for Lower Columbia River natural-origin tule populations (Simmons 2008).

	Ocean					Columbia River	
Year	Total Exp. Rate	SEAK Exp. Rate	Canada Exp. Rate	PFMC Exp. Rate	Pgt Snd Exp. Rate	Non-Treaty Exp. Rate	Treaty Exp. Rate
1983	69%	4%	34%	21%	3%	7%	0%
1984	70%	4%	40%	6%	3%	16%	1%
1985	66%	4%	35%	16%	3%	9%	0%
1986	82%	3%	38%	15%	4%	22%	0%
1987	82%	2%	27%	20%	4%	28%	0%
1988	81%	3%	25%	15%	2%	36%	0%
1989	59%	4%	19%	10%	3%	23%	0%
1990	60%	4%	26%	19%	3%	9%	0%
1991	63%	3%	28%	15%	4%	12%	0%
1992	65%	3%	31%	21%	4%	8%	0%
1993	61%	3%	27%	18%	3%	9%	0%
1994	33%	4%	26%	2%	1%	0%	0%
1995	36%	4%	21%	6%	2%	3%	1%
1996	26%	3%	4%	7%	1%	9%	0%
1997	35%	5%	12%	7%	2%	10%	0%
1998	33%	4%	13%	6%	0%	9%	0%
1999	42%	3%	10%	13%	0%	15%	0%
2000	48%	4%	23%	9%	0%	13%	0%
2001	51%	2%	29%	12%	0%	7%	0%
2002	51%	3%	24%	14%	0%	9%	0%
2003	47%	4%	21%	10%	0%	12%	0%
2004	45%	4%	25%	9%	0%	7%	0%
2005	51%	4%	28%	11%	0%	7%	0%
2006	51%	4%	28%	12%	0%	7%	0%

Retrospective Analysis

NMFS reviewed the effect of the recent PST Agreement on Lower Columbia River Chinook (and other listed species) in the associated biological opinion (NMFS 2008d). The retrospective analysis was used to help assess the effects of that agreement if implemented over the next ten years. It therefore provides perspective about how the effects of harvest will change in the future as a result of the PST Agreement. The retrospective analysis relies on a review of past circumstances to develop an understanding of the likely effect of the 2008 PST Agreement on the fisheries, and on the exploitation rates and escapements of ESA listed species. 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. Methods and assumptions related to the analysis are described in the PST Agreement biological opinion (NMFS 2008d), and summarized in the 2009 PFMC opinion (NMFS 2009b). Instead of repeating the details here, we provide a brief summary of the anticipated effects on future harvest for spring, bright, and tule components of the ESU.

The retrospective analysis considered several scenarios. The 2008 Likely scenario considered what we can reasonably expect to occur with respect to harvest under the 2008 Agreement given an informed assessment of how fisheries are likely to be managed in the future. The 40% reduction scenario considered how the aggregate abundance-based management (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 was included to cover the prospect 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.

The 2008 Likely scenario indicates that the Agreement would have relatively little effect on harvest for spring Chinook populations because of their relative absence from northern fisheries. The scenario suggests that the Agreement would result in exploitation rate reductions of two percent and three percent for bright and tule populations, respectively, relative to what would have occurred under the prior PST Agreement.

The 40% reduction scenario indicates that the PST Agreement would be responsive to large scale changes in abundance. If abundance is reduced by 40%, catch will be reduced proportionally in order to maintain or even further reduce the overall exploitation rate. The retrospective analysis did not try to anticipate additional reductions in the southern ISBM fisheries that will need to occur to respond to the 40% reduction in abundance.

3.2.2 Rangewide Status of the 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). Because the proposed actions occur outside the range of the designated critical habitat, we provide a briefly summary of it status. The status of critical habitat is discussed in more detail in the

Supplemental Comprehensive Analysis (SCA) of the FCRPS biological opinion (NMFS 2008g).

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). For more information, see Chapter 4 of the SCA. 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.

In the lower Columbia River and its tributaries, major factors affecting PCEs 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.

3.3 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 action area in this case is limited to the offshore and near shore marine areas in the EEZ, and the coastal and inland marine waters of the states of Washington, Oregon and California which may be indirectly affected by the federal action, and the Strait of Juan de Fuca and San Juan Islands (Figure 1). Our discussion of activities that affect Lower Columbia River Chinook within the environmental baseline focuses on groundfish and salmon fisheries. We are not aware of other activities in the action area that have a significant effect on the ESU in question.

The harvest impacts to Lower Columbia River Chinook from salmon fisheries are described in some detail the preceding section that considers harvest as a limiting factor (Section 3.2.1). Some of that harvest occurs in the action area and has been previously consulted on and is therefore formally part of the environmental baseline. For greater clarity and to facilitate an overall summary of harvest impacts, we described the magnitude, trends, and distribution of harvest in the preceding section. In the following discussion of the environmental baseline, we refer back to that discussion and briefly distinguish what part of the overall harvest is considered part of the baseline.

3.3.1 Harvest Actions

3.3.1.1 Groundfish Fisheries

The PFMC also manages groundfish fisheries off the west coast under their Groundfish FMP. NMFS completed a supplemental biological opinion on that FMP in 2006 with particular attention to the whiting fishery and limited entry trawl fisheries (NMFS 2006d). The bycatch of salmon in these fisheries is limited primarily to Chinook, with relatively few individuals from other species caught each year. The bycatch of all Chinook salmon in the whiting fishery averaged about 7,300 from 1991 to 2005. This compares to an incidental take limit of 11,000 Chinook per year that is specified in the biological opinion. Since completing the consultation in 2006 the annual bycatch has declined averaging 4,100 from 2006 to 2009.

The bycatch of Chinook salmon in the limited entry trawl fishery averaged 11,320 fish from 2002 to 2004. However, the bycatch of Chinook salmon has dropped steadily from a high of over 18,000 in 2002 to less than 2,000 in 2004. The bycatch of Chinook salmon has continued to drop in recent years with less than 800 and 100 taken in 2005 and 2006, respectively (Bellman and Hastie 2008). The estimated bycatch of Chinook salmon in the limited entry trawl fishery in 2007 and 2008 was 234 and 389 (Heery, et al. 2009, Bellman, et al. 2010).

When the supplemental biological opinion on the groundfish fishery was completed in 2006 information related to the stock composition of the Chinook caught in the groundfish fisheries was relatively limited. Of the ESA listed Chinook ESUs, NMFS concluded that four (Snake River fall Chinook, Lower Columbia River Chinook, Upper Willamette Chinook, and Puget Sound Chinook) were the ones most likely to be subject to measurable impacts. Qualitative characterization of these ESU-specific impacts ranged from rare to exploitation rates that ranged from a "small fraction of 1% per year" to "less than 1% per year" depending on the ESU or populations being considered (NMFS 2006d). Since then new information regarding the stock composition of the Chinook bycatch as become available from samples taken in 2008 from the shoreside whiting fishery and at-sea fishery. The samples were analyzed using genetic stock identification (GSI) techniques. A total of 442 Chinook were sampled in Newport, Oregon from the shoreside fishery. The majority of Chinook were from the mid Oregon coast (40%), followed by Rogue, Klamath, California coastal, and Northern California/Southern Oregon stocks. ESA listed stocks from the Lower Columbia River including both spring and fall stocks, Snake River fall Chinook, and Puget Sound Chinook were present, although generally at low percentages (< 5% for each stock). Some of the California coastal stocks were also likely from ESA listed ESUs (Bellinger et al. 2009).

A total of 271 samples from the at-sea whiting fishery were also taken and used for GSI analysis. The at-sea fishery is more mobile than the shoreside fishery. As a result, the bycatch was distributed more broadly along the coast. The samples were stratified among three catch areas from northern Washington to northern California (similar to the INPFC catch reporting areas - Vancouver, Columbia, and Eureka). The samples were also stratified by season with an early period between 18 May 2008 and 15 August 2008 and a late period between 10 October and 31 December. Not surprisingly, the stock composition of Chinook caught in the at-sea fishery was more diverse, particularly when compared to the more localized shoreside fishery. Stocks from the mid Oregon coast, Rogue, Klamath, California coastal, and Northern California/Southern Oregon were still important contributors, but there were also more northern stocks from the Fraser/Thompson system in British Columbia. The bycatch included ESA listed stocks from the California coast, lower Columbia River, Snake River, and Puget Sound (Moran 2009).

These studies provide more specific information regarding the stock composition of the Chinook bycatch in the whiting fishery, but the results are consistent with the more qualitative expectations in the 2006 supplemental opinion (NMFS 2006d). ESA listed stocks are caught in the fishery, but their contribution is relatively low.

3.3.1.2 U.S. Fraser Panel Fisheries

Fraser Panel fisheries in 2010 and 2011 are the subject of this biological opinion, so are not included in the environmental baseline. Likewise, future Fraser Panel fisheries beyond 2011 have not been consulted upon and are not part of the environmental baseline. However, historical Fraser Panel fisheries have contributed to the current status of the species in the action area and are therefore considered in the environmental baseline. Information in Tables 13 to 15 allow us to approximate the magnitude of harvest of Lower Columbia River Chinook populations that has occurred in the Fraser Panel fisheries. Fraser Panel fisheries are a subset of those that have occurred under the heading of Southern U.S. – Puget Sound fisheries in those tables. Exploitation rate estimates from those tables therefore overestimate those that occur in the action area under the jurisdiction of the Fraser Panel. The average exploitation rate of Lower Columbia River spring Chinook has been zero (Table 13). The exploitation rate of Lower Columbia River bright populations has been consistent over the years and averaged about 2% (Table 14). The average exploitation rate to tule populations has also averaged about 2%, but has been near zero over the last ten years (Table 15).

3.3.1.3 PFMC Salmon Fisheries

PFMC fisheries in 2010 and 20111 are the subject of this biological opinion, so are not included in the environmental baseline. Likewise, future PFMC fisheries beyond 2011 have not been consulted upon and are not part of the environmental baseline. However, historical PFMC fisheries have contributed to the current status of the species in the action area and are therefore considered in the environmental baseline. Tables 13 to 15 also provide information on the harvest to Lower Columbia River Chinook that has occurred in the action area in Council area fisheries. The exploitation rate to Lower Columbia River spring Chinook populations in Council area fisheries has averaged about 12% since 1980 to 2006 (Table 13). The exploitation rate to Lower Columbia River bright populations has averaged about 5% (Table 14). For Lower Columbia River tule Chinook Council area fisheries have generally accounted for about 35% of the total harvest mortality. Exploitation rates in PFMC fisheries have been variable, but averaged 12% from 1983 to 2006 (Table 15).

3.3.1.4 Treaty Indian Fisheries

NMFS 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.

3.3.2 Recovery Planning

Recovery plans provide, among other things, an ESU level recovery scenario with population specific viability targets, and threats criteria for each listing factor that are designed to ensure that the underlying causes of decline have been addressed. The ESU level recovery scenario was discussed above in Section 3.2.1.1. What follows is a more detailed discussion of recommendations from the management unit recovery plans regarding actions that need to be taken to address harvest as a limiting factor. NMFS Memo also summarizes the overall recovery strategy with particular attention to spring and tule Chinook populations (Walton 2010).

Both the LCFRB Plan and Oregon Plan are predicated on the restoration of healthy natural-origin populations that provide significant harvest opportunity (LCFRB 2010, ODFW 2009). The recovery goals are therefore defined with the presumption that the recovery plan will provide for sustainable harvest of naturally spawning populations. The plans describe near-term strategies for limiting harvest impacts, and long-term strategies for restoring naturally-spawning populations to harvestable levels. The recovery plans describe species-specific actions that are designed to meet the near-term strategy to limit harvest to a level that will allow for rebuilding to achieve recovery in the future. The recovery plans therefore anticipates that "limited" harvest will occur during the recovery phase, and provides guidance regarding harvest levels that are consistent with recovery objectives and the intent to provide an "all-H" solution that shares the burden of conservation among all of the limiting factors. The task remains, however, to define the specific level of near term harvest that is consistent with future survival and recovery. That task is something that is properly considered through the consultation process based on NMFS' analysis of the proposed actions, recommendations from the management unit recovery plans and our own assessment of those plans, and other information on status, baseline conditions, and cumulative effects.

Chapter 5 of the LCFRB Plan describes strategies and measures designed to address the effects of harvest on Lower Columbia River Chinook. The Plan lists nine measures to be taken for Lower Columbia River Chinook. These include directions to:

1. implement actions to further reduce the exploitation rate of lower Columbia River tule fall Chinook in order to protect weak populations;
2. consider the use of a sliding scale for managing tule Chinook based on indicators of abundance and marine survival;
3. periodically review harvest targets for fall Chinook to assure that harvest objectives are synchronized with habitat productivity and capacity;
4. develop a collaborative forum among managers to consider how harvest impacts will be shared between ocean and river fisheries, and treaty and non-treaty fishers;
5. review management tools to assure impacts to fall Chinook remain within agreed limits;
6. manage ocean and inriver fisheries to meet the escapement goal for North Fork Lewis River Chinook;
7. develop better management tools for inseason monitoring of stock specific impacts of fall Chinook in Columbia River fisheries; assure that monitoring of mark-selective fisheries can effectively estimate fishery impacts on unmarked fish;
8. develop a basin wide marking plan for hatchery tule Chinook;
9. address technical and policy issues related to mass marking of tule Chinook and develop programs to monitor recoveries.

Most of the actions described in this section of the LCFRB Plan either have been or are being implemented. 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. Recovery planners and NMFS have been engaged in on ongoing review of harvest over the last several years. Initially, the Coweeman population was the only indicator available for analysis. Analysis related to the Coweeman population was used to set a harvest limit of 49% in 2002. In subsequent analyses, NMFS added two additional indicators (East Fork Lewis and Grays), and reduced harvest further over several years to our guidance level of 0.38 for 2009. The most recent SLAM analysis focused on eight of the nine tule populations designated through recovery planning for high viability (NWFSC 2010). Analysis in the recovery plans has also advanced and provides independent perspectives regarding recommended harvest levels. As indicated in our guidance letter to the Council in 2010, NMFS intends to continue its review with the goal of eventually providing recommendations for a long term harvest strategy that will be part of a more comprehensive recovery program (Thom and McInnis 2010).

Item 2 in the recovery plan suggests considering the development and use of an abundance base harvest matrix for tule populations. Implementation of abundance based management requires the ability to predict abundance. NMFS conducted a preliminary analysis of its ability to forecast the abundance of tule Chinook. The report suggested that it would be difficult to obtain forecasts that are meaningful to managers attempting to set harvest limits based on adult run size, and recommended collecting additional information on the abundance and age composition of the populations (Scheuerell 2010).

Both the LCFRB and Oregon plans recognize that abundance based management for tule Chinook is a long term goal that requires further development. Nonetheless, further work to assess options for advancing abundance based management is one of the tasks identified under the proposed action that will help determine the allowable exploitation rate on tule Chinook in 2011.

A forum for managing fall Chinook (item 4) has developed by necessity over the years through the Council and North of Falcon preseason planning processes.

Item 5 calls for a review of management practices to assure harvest impacts remain within prescribed limits. The Northwest Fisheries Science Center previously conducted such reviews (Kope 2005, 2006, 2007). The Council and ad hoc Work Group continued to focus on the problem in 2007 and 2008 (LCTCWG 2008). The Council approved a newly developed indicator stock for Lower Columbia River natural-origin tule Chinook for use in preseason modeling. The Work Group also developed a harvest indicator stock based on a composite of CWT groups that is compatible with that used by the Council (LCTCWG 2008). The Council made necessary adjustments in their assessment procedures. Periodic review of the current methods is appropriate, and will be an ongoing task.

Fisheries have been managed routinely to meet the escapement goal for the late fall North Fork Lewis population (item 6). This is consistent with the guidance that NMFS has provided to the Council in recent years (see for example Thom and McInnis 2010). Oregon's late fall Sandy population is also being managed consistent with recovery plan recommendations.

Further review of inseason management procedures for Columbia River fisheries may still be in order, although we are not aware of any particular problems with existing methods (item 7). The WDFW proposed a pilot scale recreational mark selective fishery in the ocean in 2010. An expanded sampling program is associated with these new fisheries. The recovery plans call for gradual expansion of mark-selective fisheries. Continued development and assessment of the monitoring programs for mark selective fisheries, and review of post season results for these fisheries is a high priority.

Items 8 and 9 from the LCFRB 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. By 2011 all returning hatchery-origin tule Chinook will be marked. A significant review of hatchery management policy has occurred through the HSRG process (discussed in more detail in section 3.2.1.4). The HSRG review is now complete and provides comprehensive assessment and recommendations for hatchery reform that are associated with complementary harvest and habitat related actions. A recent letter from WDFW provides an updated report on the status of marking and other hatchery reform actions (Anderson 2010a). These actions actually exceed the recommendations contained in items 8 and 9 LCFRB Plan.

Chapter 6 of the LCFRB Plan provides more specific recommendations regarding harvest. Harvest rates on spring Chinook populations in the past were 50% or more. The recovery strategy calls for a significant reduction in harvest through a combination of fishery impact limits, and implementation of mark-selective sport and commercial fisheries in the Columbia River. The front-loaded impact reduction strategy described in the LCFRB Plan sets harvest rate benchmarks of 15-25%. In recent years harvest has been reduced to 25% or less. The transition to mark-selective fisheries in the Columbia River during the spring is now complete. All fishery measures identified in the plan for spring Chinook have now been implemented, except the one (F.M26, in LCFRB 2010) that requires further consideration once significant natural populations are re-established in Washington subbasins as a result of the supplementation programs.

Recovery of spring Chinook on the upper Cowlitz and Lewis systems depend on successful reintroduction programs above blocking dams to access core production areas for these populations. The supplementation program on the Cowlitz is now being implemented. Supplementation on the Lewis River is expected to start with outplanting in 2011. Successful reintroduction for these systems will depend on improving collection and passage of both returning adults and outmigrating smolts. An integrated hatchery supplementation program has also been started on the Kalama with adult and juvenile fish being passed above Kalama Falls to productive, but otherwise inaccessible habitat.

For fall tule populations the LCFRB Plan acknowledges that substantial reductions in harvest have already occurred from the pre-listing baseline of approximately 65%. Since listing, harvest impacts limits have been reduced successively over the years to 49% in 2002 and the most recent limit of 38% in 2009. The Plan establishes an impact reduction benchmark of 25-35% that would be accompanied by implementation of mark-selective recreational fisheries in the ocean and Columbia River. The Plan is not more specific about how fisheries should be managed over the next few years, or when these benchmark harvest rates would be achieved. Mark-selective fisheries are expected to be phased in over the next several years (Anderson 2010a). The Plan concludes that impact reductions beyond the 25-35% range would require complete closure of non-Indian southern U.S. fisheries and have relatively little risk benefit.

The Oregon Plan (ODFW 2009) also provides general recommendations regarding management actions, and guidance regarding harvest levels and hatchery related actions. The Oregon Plan recommends assessing the feasibility of mark-selective fisheries, a process that is largely complete for spring Chinook and is underway for fall Chinook. The Plan recognizes that full implementation of mark selective fisheries for fall Chinook will take some time, but should occur within twenty years. The Oregon Plan also calls for development and implementation of an abundance based management framework. The Plan recognizes that the first steps related to abundance based management are those related to filling gaps in the necessary information.

Oregon has one late fall Chinook population in the Sandy River. The Oregon Plan concludes that the population is healthy and that no further harvest constraints are needed at this time.

The Oregon Plan provides recommendations regarding reintroduction for spring Chinook in the Hood River. Because the Hood River population is considered extirpated or nearly so, recovery now relies on the success of a reintroduction program. The reintroduction program for Hood River spring Chinook is using spring Chinook from the Deschutes River which is the nearest source for brood stock, but is from the Middle Columbia River ESU. Details related to the reintroduction program are described in the Revised Hood River Master Plan (BPA 2008) which is incorporated into Oregon's Recovery Plan. Although the reintroduction program has been underway since the mid-90s, it has not met its original goals for smolt-to-adult survival rates. Deficiencies are attributed to production practices (BPA 2008). Problems with the current program include precocity (too many fish returning as jacks), straying, and high incidence of bacterial kidney disease (BKD) which ultimately led to the program's inability to achieve its objectives. The updated Master Plan therefore laid out a new five year study that compares three alternative production and release strategies. The study is designed to provide the information necessary for co-managers to identify a long-term, biologically sound and cost effective spring Chinook salmon production strategy for the Hood River Basin that can lead to recovery.

Both the recovery plan (ODFW 2009) and Master Plan indicate that harvest on the Hood River spring population was on the order of 25%. The Master Plan indicated that harvest did not appear to be a significant factor limiting the success of the reintroduction program. Oregon's Recovery Plan also indicated that current harvest levels were not an impediment to recovery of Hood River spring Chinook (ODFW 2009, pg 162).

For the Lower Columbia River tule populations, the Oregon Plan recommended that the fishery-related mortality rate average 35% in the future. If mark-selective fisheries are implemented in ocean fisheries off Alaska and British Columbia, the fishery-related mortality may be maintained at a rate lower than 35%. The Plan is not specific about how fisheries should be managed in the near term or when the transition to a lower average should occur.

Walton (2010) provided a summary of the overall recovery strategy with particular attention to the spring and tule populations. The all-H strategy is important because it provides context for assessing the proposed action, and whether it conforms with the recovery strategy. It is clear from the preceding parts of this opinion that survival and recovery of the species depends on implementation of an effective all-H strategy. Harvest reductions are necessary, but even complete elimination of harvest is not sufficient to achieve recovery if other limiting factors are not addressed.

3.3.2.1 Spring Chinook Populations

The recovery strategy for the spring life-history component of the LCR Chinook ESU is an all-H approach aimed at restoring the Cascade spring stratum to a high probability of persistence and lowering the extinction risk of the two Gorge spring Chinook populations (Table 5).

The critical elements of the strategy are to (1) maintain and improve the Sandy spring Chinook population, which currently is the only LCR spring Chinook population with appreciable natural production, and (2) reestablish naturally spawning populations above dams on the Cowlitz and North Fork Lewis rivers, where populations historically were among the most productive but now are virtually extirpated. The recovery strategy also involves re-establishing naturally spawning populations in the Hood and White Salmon basins in the Gorge MPG.

Tributary and estuarine habitat improvements are important for all populations, as are reductions in predation. Hatcheries pose a threat to some populations; thus pHOS needs to be reduced in some subbasins and hatchery operations adjusted to reduce straying and genetic effects. Conversely, hatcheries will be a crucial tool for reintroducing extirpated populations. Harvest rates on natural-origin fish must be set consistent with expectations for recovery and the overall strategy that seeks to share the burden of recovery.

In the Cascade stratum, re-establishing populations above the dams in the Lewis and Cowlitz basins will be accomplished by improving adult and juvenile passage at the dams and developing and implementing hatchery reintroduction programs, using broodstock from within-basin hatchery programs. However, lasting benefits of dam passage improvements and hatchery reintroduction will not be realized without protection of favorable tributary habitat and restoration of degraded but potentially productive habitat—particularly in the upper subbasins where spring Chinook hold, spawn, and rear. Habitat improvements (both tributary and estuary) also will be important in maintaining and improving the Sandy population, as will reducing pHOS and predation.

In the Gorge stratum, the ongoing reintroduction program in the Hood River will be continued with a goal of establishing a viable population. Success will depend on achieving significant improvements in natural production and reducing pHOS. There is also a goal of re-establishing a population in the White Salmon Basin once Condit Dam is removed. Opportunities for habitat restoration above Bonneville Dam are constrained and will present a challenge to improving the status of Gorge populations. To compensate for limited prospects in the Gorge, the goal of high viability has been established for more than the minimum number of populations in the Cascade spring Chinook stratum.

The NMFS Memo provides additional information on the recovery actions necessary to address each threat category (Walton 2010). The Memo reiterates conclusions from the LCFRB and ODFW management unit plans with respect to harvest, and concurs that actions taken to date are consistent with the all-H strategy and sufficient to address harvest as a limiting factor at least for the time being. As reintroduction and passage improvement efforts begin to yield more natural production, it will be necessary to reevaluate harvest impacts and determine an appropriate harvest strategy.

3.3.2.2 Tule Fall Chinook Populations

The overall recovery strategy for the tule component of the LCR Chinook ESU is an all-H approach designed to restore the Coast and Cascade tule strata to a high probability of persistence and the Gorge stratum to a probability of persistence that, when combined with compensation in the other strata, is at an acceptable risk level (Table 5). The strategy involves transitioning from decades of management that allowed habitat degradation, emphasized hatchery production of fish for harvest, and resulted in diminished viability of all tule populations to management that supports a naturally self-sustaining ESU and preserves harvest opportunities in the long term. This transition will be accomplished by reducing impacts in all threat categories and sharing the burden of recovery across categories.

Among the most immediate and high-priority needs are aggressive efforts to (1) improve the quality and quantity of both tributary and estuary habitat, and (2) reduce the influence of hatchery fish on natural-origin fish. Also a high priority is the development of a detailed transition strategy addressing at least each primary population. This transition strategy, discussed in detail below, will specify timelines and strategies for reducing hatchery-origin spawners, benchmarks for habitat improvement, expected population response, and harvest adjustments as needed to ensure appropriate increases in natural-origin abundance. It will also include an adaptive management plan that provides a pathway for answering critical uncertainties and that establishes benchmarks and adaptive actions if benchmarks are not met.

Necessary elements of the transition strategy are described in the management unit recovery plans and summarized in the NMFS Memo (Walton 2010). However, it is apparent that there is still a need to develop the details and associated schedule to accelerate the process and bring greater certainty that the necessary actions will happen as quickly as possible. The tasks identified in the proposed action are designed to address the need for greater clarity and certainty.

One important element of the recovery strategy is to protect and improve the populations currently performing the best (Coweeman and Lewis). Accomplishing this will entail ensuring that habitat is protected and restored, reducing the proportion of hatchery origin spawners (pHOS), and ensuring that harvest rates allow for gains in productivity to translate into continued progress toward recovery.

Transition strategies for other populations must be designed to protect them from deterioration while moving them from high pHOS, with little or no natural production, through a period that addresses short-term demographic risks and reduces hatchery fractions while improving habitat condition. There is also a critical need for monitoring and evaluation to help validate and, as appropriate, update current assumptions regarding what is limiting the most poorly performing populations (i.e., what is the actual pHOS and which hatcheries are the source? how much natural production is occurring? to what extent are these populations locally adapted? what is driving their poor performance? how are these populations contributing to the overall genetic diversity of their stratum and the ESU?). Harvest will be adjusted to ensure appropriate increases in natural-origin abundance.

Walton (2010) also reviewed the recovery strategy from the stratum perspective. In the Coast tule stratum, the design and successful implementation of transition strategies to appropriately reduce pHOS and improve habitat productivity will be crucial for the Elochoman, Clatskanie, Scappoose, and Mill/Abernathy/Germany populations, all of which are targeted for high viability. The Grays population will be targeted for improvement to medium-plus viability, to be achieved through similar strategies. The Youngs Bay and Big Creek populations will be maintained at high risk to accommodate terminal fisheries targeting hatchery Chinook while minimizing the effects of those hatchery fish on other populations.

In the Cascade stratum, the higher performing populations (Coweeman, Lewis) must be protected as described above and moved to high viability. The Toutle and Washougal are also targeted for high or high-plus viability. The Lower Cowlitz and Kalama rivers are targeted for medium and medium-plus viability, respectively (these targets reflect, in part, a decision to accommodate hatchery production in the Lower Cowlitz and the Kalama). The Clackamas and Sandy populations are also targeted for medium viability, with the Upper Cowlitz and Salmon Creek populations considered "stabilizing" and projected to be maintained at their current status.

In the Gorge stratum, the Hood tule population is targeted for high viability and the Upper Gorge, Lower Gorge, and White Salmon populations for moderate viability. As indicated in the de-listing criteria, this scenario does not meet the criteria for a high probability of persistence as defined by the TRT, and meeting even this scenario is highly uncertain due to questions about the historical role of the Gorge populations and constrained opportunities for habitat restoration because of the Bonneville dam reservoir. To compensate for these limited recovery prospects, additional populations in the Coast and Cascade strata are prioritized for higher levels of viability.

The NMFS Memo provides additional information on the recovery actions necessary to address each threat category (Walton 2010). The Memo reiterates conclusions from the LCFRB and ODFW management unit plans with respect to harvest. Harvest has been reduced from rates that were once as high as 80 percent to the recent limit of 38 percent. These changes have contributed to the harvest reductions called for in the management unit plans. Both the LCFRB 2010 and Oregon 2009 plans envision that further reductions will be achieved through a strategy of implementing mark-selective fisheries when feasible as a tool to sustain important fisheries, and implementing abundance-based management when feasible. Some uncertainty remains about how quickly the transitions will occur, and what the limits on harvest will be over the long term. As discussed above, the LCFRB plan envisions harvest rates of 25-35% that would be achieved as mark selective fisheries are implemented. Oregon recommended an average harvest rate guideline of 35% as a long-term average under an abundance base framework and noted that further reductions—if possible—would be beneficial in the near term. The harvest limits described in NMFS' guidance letter (Thom and McInnis 2010) of 38% in 2010 and 36 or 37% in 2011 do not quite achieve the longer term benchmarks described in the manage unit plans, but are consistent with the direction, and broader intention to implement harvest reductions over time as part of the overall transition strategy.

3.3.3 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. He forecast and related background information can be found at: http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm.

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.

3.3.3.1 The Southern Oscillation Index

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.

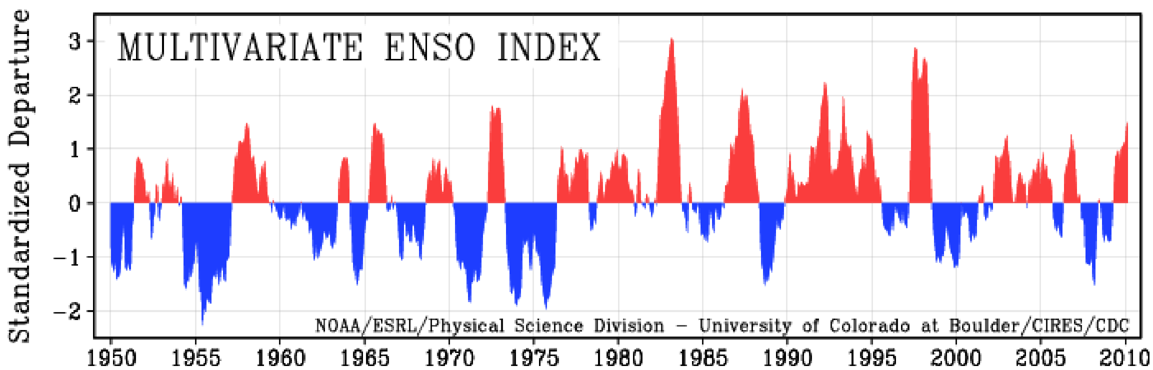
The warmer, drier weather in the Pacific Northwest often associated with El Niño can also cause or increase the severity of regional droughts. Droughts reduce streamflows through the Columbia and Snake River migratory corridor, increase water temperatures, and reduce the extent of suitable habitat in 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 4 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 4. Time-series of MEI conditions from 1950 through March 2010. Source: NOAA Earth Systems Research Laboratory http://www.esrl.noaa.gov/psd/enso/enso.mei_index.html



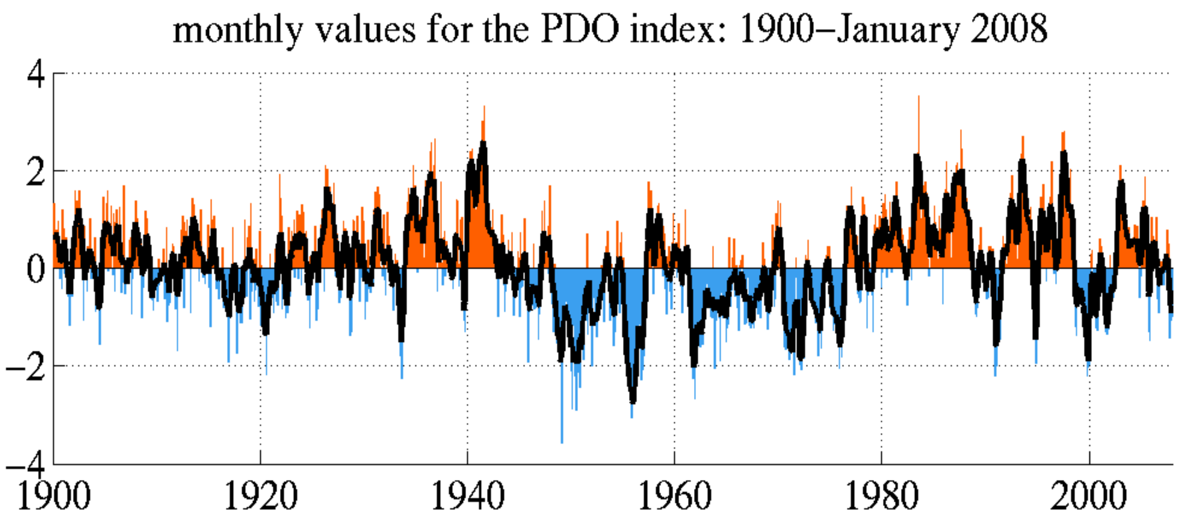
3.3.3.2 Pacific Decadal Oscillation

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 5). 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 5. 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.

3.3.3.3 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."2 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 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).

[2] 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).

- 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 CO2 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 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 discussed above. Because of the short duration of the proposed actions considered in this opinion (two years), the sorts of trends that may occur over years or decades are not directly relevant to our assessment of the effects of the proposed action. But they are relevant to our general consideration of the species status and how it might be affected by future events.

3.4 Effects of the Action

The purpose of this section is to identify and evaluate the effects of the proposed PFMC and U.S. Fraser Panel Fisheries on listed Lower Columbia River Chinook. The methods NMFS uses for evaluating effects are discussed first, followed by a discussion of the effects of the proposed fisheries on the ESU.

3.4.1 Factors to Be Considered

Fisheries may affect Lower Columbia River Chinook salmon in several ways which have bearing on the likelihood of continued survival and recovery of the species. Immediate mortality occurs from the capture, by hook or net, and subsequent retention of individual fish - those effects are considered explicitly in this opinion. In addition, any fish which is caught and released alive to comply with non-retention requirements that may be related to species or size limits may also die subsequently. Non-retention regulations are also sometimes used in mark-selective fisheries that target marked hatchery-origin fish for retention while requiring the release of unmarked natural-origin fish. This is important to consider in the review of fishery management actions, as catch-and-release mortalities primarily result from implementation of management regulations designed to reduce mortalities to listed fish through live release.

The catch-and-release mortality rate varies for different gear types, different species, and different fishing conditions, and those values are often not well known. Catch-and-release mortality rates have been estimated from available data and applied by the PFMC Salmon Technical Team (STT) and co-managers in the calculation of impacts to listed fish evaluated in this consultation. The STT applies a 7.0 to 26.0 percent incidental mortality rate to Chinook caught and released during recreational fishing and ocean troll activities in PFMC Fisheries, depending on the area caught and the age of the fish. Mortality rates ranging from 10 to 45 percent are applied to Chinook caught and released during purse seine or other commercial net fisheries inside Puget Sound, including Fraser Panel area fisheries.

The STT also applies an incidental mortality rate to Chinook that encounter the gear but drop off the gear before they can be handled by the fishermen. This drop off or 'other' mortality is estimated as 5 percent of total encounters for commercial troll and recreational gear, and from 1.0 to 3.0 percent for gillnet, setnet, and reef net gear (MEW, 2006). Estimates of catch-and-release mortality are combined with landed catch estimates when reporting the expected total mortality, and so are also specifically accounted for in this biological opinion.

As indicated above, the Lower Columbia River Chinook ESU includes spring-run and fall-run "bright" and "tule" life history types. All of these components are important to the ESU, but more time has been spent analyzing the effects of harvest on the tule populations and MPGs because harvest impacts are generally higher, the interactions of populations with hatchery fish are more complex, and because of the availability of data necessary for more detailed analysis.

Lower Columbia River Chinook were first listed in 1999. As is often the case with a new listing, the kind of information that one would like to have for a section 7 consultation is often limited. For example, information about the population structure of the ESU, the status of each of the populations, recovery objectives, and the relative effects of different limiting factors is often incomplete. NMFS is nonetheless required to conduct section 7 consultation on proposed actions based on best available information. Early consultations on a newly listed species are therefore often for one year, or short duration at least, to provide time to develop the information needed to consider a more programmatic action that would extend longer in time.

NMFS has consulted on the effects of harvest actions on Lower Columbia River Chinook several times over the last ten years. Through these consultations, the allowable harvest on Lower Columbia River tule Chinook has been reduced from 65% in 1999 to 38% in 2009. The sequence of biological opinions is described briefly in the Section 2.1 under consultation history. A more detailed discussion of the consultations and related considerations is provided in NMFS' 2009 opinion on PFMC fisheries (NMFS 2009b). The basic point is that information has developed over time that provided an increasingly sophisticated and detailed understanding of the status of the populations, and the actions that would be required to achieve recovery. In particular, we developed better information over time on more populations. Our first consultation focused on information related to the Coweeman population; our most recent analysis provides assessments specific to eight of the nine tule populations designated for primary status, with supplementary information for other tule populations from several sources. We have a better understanding now about the importance of hatchery fish on the spawning grounds. Recovery planning has also advanced and provides better information on populations that are prioritized for high viability, the overall recovery scenario, and the all-H recovery strategy.

In its 2009 guidance letter to the Council (Thom and McInnis 2009), NMFS expressed its expectation that it and other co-managers would be able to move away from the past year-by-year guidance and lay out a multi-year approach to harvest management of LCR Chinook beginning in 2010. The goal was to reduce the uncertainty associated with recovery, and add predictability to recreational, commercial and tribal fisheries. There has been significant progress over the last year on additional technical work and on recovery planning that has contributed to our ability to move to a long term harvest framework. NMFS has worked over the last year with the Northwest Fisheries Science Center, states, and recovery planners on a new analysis related to tule Chinook. Results from the Salmon Life-cycle Modeling (SLAM) analysis are discussed in more detail below. The SLAM analysis provides new insight and additional detail, but generally confirms our earlier understanding - all tule populations require improvement, but populations in the Coastal MPG are particularly problematic.

Recovery planning has also made significant progress over the last year. As described in Section 3.2, final drafts of the management unit recovery plans are now available and NMFS has developed a preliminary overview that consolidates these into a single recovery plan for listed species in the Lower Columbia River (Walton 2010). The recovery plans are important because they set the context for a comprehensive solution that addresses all of the limiting factors. The plans set benchmarks for survival improvements over the long term and describe the sorts of actions necessary to achieve those benchmarks. Recovery will depend on successfully achieving these improvements and executing a transition strategy that accounts for the time necessary for survival benefits from various actions to accrue. NMFS has indicated its support for the comprehensive approach developed through recovery planning and the associated transition strategy (Walton 2010). However, the ability to set a longer multi-year harvest framework requires reasonable certainty that actions necessary to improve survival within each limiting factor will be taken and achieve the anticipated survival improvements.

The actions taken to date to address the limiting factors are clearly positive, and NMFS is encouraged by the level of focus this ESU is receiving. It is a fact, however, that sustained ability to harvest tule fall Chinook at any level will require measurable achievement of results in all areas consistent with a more-specific plan for recovery. As explained in our guidance letter, NMFS had hoped that the planning effort announced to the Council in 2009 would have provided such a plan and support a longer term, multi-year opinion for harvest. The effort was positive, but unable to meet this ambitious objective.

As a consequence, NMFS will continue to consider the results of the ongoing research and assess progress on reforms designed to address the limiting factors. The tasks identified in the proposed action are designed to identify and accelerate progress on actions needed to address limiting factors. In this opinion, we focus on the effects of the fisheries in 2010 and 2011. This shorter term perspective allows us to continue to assess progress on implementing the reforms. It also recognizes that the reforms and resulting benefits will accrue over the next several years. It has taken decades for the populations to decline to their current status and will take years and perhaps decades for them to recover. A successful recovery strategy will require steady progress and patience. In this case, we must ensure that the near term risks associated with an orderly implementation of harvest and hatchery reforms are small, and that there is a high likelihood of recovery associated with the overall recovery strategy.

3.4.2 Effects of the Proposed Actions

3.4.2.1 Effect of the Actions on Populations

Gorge Spring MPG and Cascade Spring MPG

Council area fisheries are not subject to specific exploitation rate limits or management constraints for Lower Columbia River spring Chinook populations (Thom and McInnis 2010). Instead, as described above, the spring populations are managed to meet hatchery escapement goals. Mark selective fisheries in freshwater areas are used to limit the impacts to natural origin fish. Because of the collective conservation restrictions for several other Chinook populations, hatchery escapement goals have been met and exceeded with few exceptions in recent years. NMFS expects that hatchery escapement goals will be met in 2010 and for the foreseeable future.

The anticipated exploitation rate on Lower Columbia River spring Chinook populations in Council fisheries in 2010 is 0.16 (Table 16). The exploitation rate in Puget Sound fisheries, which includes Fraser Panel fisheries, is 0.001 in 2010. Some additional harvest occurs in marine and inriver fisheries that are outside the action area. The exploitation rate in marine fisheries to the north is 0.04. Fisheries directed at spring Chinook in the Columbia River are, with few exceptions, mark selective. The exploitation rate on natural origin spring Chinook from these inriver fisheries is 0.01. The exploitation rates in PFMC and Fraser Panel fisheries in 2011 will not be estimated until April 2011. However, they are expected to be similar to those in 2010 and recent years.

In summary, the effect of the proposed action is approximately a 16% reduction in the number of Gorge Spring MPG and the Cascade Spring MPG adults returning to hatcheries and spawning areas in 2010 and 2011, compared to the number that would return if the proposed action is not implemented. There are no quantitative analyses available to evaluate the effect of this mortality on the viability of LCR Chinook spring-run populations or MPGs, so the Integration and Synthesis section includes a qualitative analysis that places this mortality in the context of each population’s current status and recovery plans.

Table 16. Expected exploitation rates on Lower Columbia River spring Chinook in 2010 fisheries (LaVoy 2010a). Harvest that would occur as part of the proposed actions is shown in bold.

Southeast Alaska	0.007
British Columbia	0.029
Puget Sound	**0.001**
PFMC	**0.159**
Columbia River	0.010
Total	0.206

Cascade Late Fall MPG

Two extant natural-origin bright populations have been identified in the Lower Columbia River Chinook ESU. The North Lewis River stock is used as a harvest indicator for ocean and in-river fisheries. That is, the exploitation rates estimated for that population are representative of the expected exploitation rates for the other bright fall Chinook population. The natural escapement goal used for management purposes for the North Lewis River population is 5,700, based on estimates of maximum sustained yield. The LCFRB (2010) recommended a viable abundance goal of 7,300. The anticipated exploitation rate on Lower Columbia River bright Chinook populations in Council fisheries is 0.05 (Table 17). The exploitation rate in Puget Sound fisheries, which include Fraser Panel fisheries, is 0.001. Some additional harvest occurs in marine and inriver fisheries that are outside the action area. The combined exploitation rate from these fisheries is 0.19. The exploitation rate in 2011 in the various fisheries will not be estimated until April 2011, but is expected to be similar to 2010 and recent years.

Table 17. Expected exploitation rates on Lower Columbia River bright Chinook in 2010 fisheries (LaVoy 2010a). Harvest that would occur as part of the proposed actions is shown in bold.

Southeast Alaska	0.051
British Columbia	0.047
Puget Sound	**0.001**
PFMC	**0.051**
Columbia River	0.089
Total	0.238

Gorge Fall MPG, Cascade Fall MPG, and Coast Fall MPG

Unlike the spring populations or the bright component of the ESU, Lower Columbia River tule populations are caught in large numbers in Council fisheries, as well as in fisheries to the north and in the Columbia River. NMFS guidance to the Council indicated that fisheries in 2010 should be managed subject to a total exploitation rate of 0.38. As discussed above, the Council now uses a composite stock as the indicator for Lower Columbia River natural tule Chinook rather than the Coweeman as was done in the past. The anticipated exploitation rate on Lower Columbia River tule Chinook populations in Council fisheries is 0.15 (Table 18). The exploitation rate in Puget Sound fisheries, which included Fraser Panel fisheries, is 0.003. Some additional harvest occurs in marine and inriver fisheries that are outside the action area. The combined exploitation rate from these fisheries is 0.22. As discussed in the proposed action fisheries in 2011 will be subject to a total exploitation rate limit of 0.36 or 0.37. NMFS will indicate which limit is applicable it its 2011 guidance letter to the Council. The exact distribution of harvest impacts between fisheries will not be known until April 2011, but is expected to be similar to levels observed in each fishery in recent years.

Table 18. Expected exploitation rates on Lower Columbia River tule Chinook in 2010 fisheries (LaVoy 2010a). Harvest that would occur as part of the proposed actions is shown in bold.

Southeast Alaska	0.026
British Columbia	0.115
Puget Sound	**0.003**
PFMC	**0.151**
Columbia River	0.081
Total	0.375

3.4.2.2 Effect of the Actions on Critical Habitat

The designated critical habitat for the Lower Columbia River Chinook ESU does not include offshore marine areas of Puget Sound and the Pacific Ocean. The activities considered in this consultation will therefore not result in the destruction or adverse modification of any of the essential features of designated critical habitat for the Lower Columbia River Chinook ESU.

3.5 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 is the EEZ under the jurisdiction of the PFMC, the coastal and inland marine waters of the states of Washington, Oregon and California, and the waters of the Strait of Juan de Fuca and San Juan Islands under the control of the U.S. Fraser Panel.

Future tribal, state and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities in the action area are primarily those conducted under state, tribal or federal government management. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, and designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to geographic scope of the action area which encompasses several government entities exercising various authorities, and the changing economies of the region, make any analysis of cumulative effects difficult and, frankly, speculative. Although state, tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

3.6 Integration and Synthesis of Effects

As discussed in Section 3.4.2.2, the proposed actions will have no effect on designated critical habitat for Lower Columbia River Chinook, so the goal of this section is to summarize the information relevant to NMFS' jeopardy determination. NMFS' jeopardy determination must consider whether the proposed action, when added to the environmental baseline and cumulative effects, will appreciably reduce the likelihood of survival and recovery of the Lower Columbia River Chinook ESU. This ESU has a complex structure with populations organized within six MPGs consisting of three life history types, distributed across three ecological regions (Table 4). Therefore, in reaching a decision at the ESU level, NMFS must first review the direct and indirect effects of the action, when added to the environmental baseline and cumulative effects, on the six MPGs and their component populations and then aggregate that information to support a conclusion for the entire ESU. The effect of the proposed actions on listed hatchery fish and their effect on various populations is also an important consideration for various components of the ESU. Consideration of the effects of the proposed actions as an addition to the environmental baseline 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, the jeopardy determination is made in the context of a comprehensive recovery strategy that has been articulated through recovery planning and considered by NMFS (Walton 2010), and the continuing evolution of information over the last several years.

3.6.1 Spring Chinook Populations

Spring Chinook populations occur in both the Gorge and Cascade MPGs.

3.6.1.1 Gorge Spring MPG

The proposed action will result in an approximately 16% reduction of any LCR Chinook adults returning to the Hood River and White Salmon populations which are the only populations in the Gorge Spring MPG. Some additional harvest occurs in marine and inriver fisheries that are outside the action area. The total exploitation rate in all fisheries in 2010 is expected to be 0.21 (Table 16). The exploitation rates in PFMC and Fraser Panel fisheries in 2011 will not be estimated until April 2011. However, they are expected to be similar to those in 2010 and recent years.

The White Salmon population is extirpated, and the Hood River population is considered extirpated or nearly so. Recovery of these populations therefore depends on the success of reintroduction efforts, so the effect of the proposed fishery on the reintroduction program is the impact of primary concern with respect to the likelihood of recovery of these populations.

Condit Dam, located at river mile 3.3 on the White Salmon River, blocks all anadromous fish migration to historical habitats in the upper drainage. Condit Dam is scheduled for removal in 2010 or as soon as the permitting process is completed. Once the dam is removed, the White Salmon Recovery Plan calls for monitoring escapement into the basin for four to five years to see if recolonization occurs. At the end of that period a decision will be made about whether to proceed with a reintroduction program. Since there are currently no spring Chinook in the White Salmon River, none will be caught as a consequence of the proposed actions.

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. Because the Hood River population is considered extirpated or nearly so, recovery now relies on the success of a reintroduction program. The reintroduction program for Hood River spring Chinook is using spring Chinook from the Deschutes River which is the nearest source for brood stock, but is from the Middle Columbia River ESU. Details related to the reintroduction program are described in the Revised Hood River Master Plan (BPA 2008) which is incorporated into Oregon's Recovery Plan. Although the reintroduction program has been underway since the mid-90s, it has not met its original goals for smolt-to-adult survival rates. Deficiencies are attributed to production practices (BPA 2008). The reintroduction program is now the subject of a five year study to provide the information necessary for co□managers to identify a long-term, biologically sound and cost effective spring Chinook salmon production strategy for the Hood River Basin that can lead to recovery.

Both the recovery plan (ODFW 2009) and Master Plan indicate that harvest on the Hood River spring population was on the order of 25%. The Master Plan indicated that harvest did not appear to be a significant factor limiting the success of the reintroduction program. Oregon's Recovery Plan also indicated that current harvest levels were not an impediment to recovery of Hood River spring Chinook (ODFW 2009, pg 162).

NMFS has reviewed the over recovery strategy for the Gorge spring Chinook populations described in the LCFRB and Oregon recovery plans and concurred with the all-H strategy which took into account the additional risk to the Gorge populations, and the specific recommendations related to harvest (Walton 2010). Given the circumstances, NMFS concludes that the proposed fisheries in 2010 and 2011 are not likely to reduce the likelihood of survival and recovery for the Gorge MPG populations.

3.6.1.2 Cascade Spring MPG

There are seven spring Chinook populations in the Cascade Spring MPG. The Upper Cowlitz and Sandy populations are considered genetic legacy populations (Table 4), meaning that they have had minimal influence from nonendemic fish due to artificial propagation activities or that they exhibit important life history characteristics that are no longer found throughout the ESU. These populations provide the primary genetic reserves affecting diversity of this MPG and the ESU as a whole. The current viability status of all of the Cascade spring Chinook populations except the Sandy is listed as very low. The current status of the Sandy population is listed as medium (Table 5). The Upper Cowlitz, Cispus, Sandy, and Lewis populations are all targeted for high or very high viability as part of the overall recovery scenario. The Toutle and Kalama populations are targeted for medium and low viability, respectively (Table 5).

The recovery strategy for Lower Columbia River spring Chinook in the Cascade MPG is described in the management unit recovery plans. The essential elements of the strategy are to (1) maintain and improve the Sandy spring Chinook population, which currently is the only Lower Columbia River spring Chinook population with appreciable natural production, and (2) reestablish naturally spawning populations above dams on the Cowlitz and North Fork Lewis rivers, where populations historically were among the most productive but now are virtually extirpated. As discussed above, spring Chinook populations in the Gorge MPG are at greater risk and recovery for those populations is less certain. As a consequence, more than the minimum numbers of populations in the Cascade MPG are targeted for high viability, in part, to mitigate the risks and uncertainty for recovery of the Gorge spring populations. NMFS concurred with this overall recovery strategy previously in their 2005 Supplement to the draft LCFRB recovery plan (NMFS 2005e), and recently reaffirmed their support (Walton 2010).

The Upper Cowlitz, Cispus, and Tilton are populations in the Cowlitz River and are all located above Mayfield Dam. These populations have been homogenized and, as described below are the subject of an ongoing reintroduction program. References to individual populations within this group apply to the expectation that population-specific distinctions will re-emerge following successful reintroduction. In the short-term, extinction risk is reduced for the three Cowlitz populations and for the North Fork Lewis population by hatchery programs that are producing large numbers of listed hatchery fish that preserve genetic legacy, reduce the risk of immediate extinction, and provide a source for the reintroduction program.

A key part of the recovery strategy is to reestablish naturally spawning populations above blocking dams on the Cowlitz and Lewis rivers. The reintroduction program on the Cowlitz has already started. The supplementation program on the Lewis River is scheduled to begin in 2011. The success of both of these programs depends on providing adequate juvenile and adult passage over the dams, and improving habitat conditions (Walton 2010). An integrated supplementation program has also been initiated on the Kalama River. Passing fish above Kalama falls improves the prospects for recovery of this population by utilizing inaccessible, but otherwise suitable habitat.

For the Sandy population in Oregon the return of natural origin fish to Marmot Dam has averaged approximately 1,700 in recent years (Table 8). 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 1,230 and 7,871, respectively (ODFW 2009). The return of natural-origin fish has therefore met the tentative delisting goal in recent years. The total return of spring Chinook to the Sandy including listed hatchery fish has averaged more than 5,600 since 2000 (Table 8). The Sandy River is also managed with an integrated hatchery supplementation program that incorporates natural origin fish into the broodstock. The hatchery program provides a reserve that helps mitigate the short term risk of decline for the population.

There are many limiting factors for populations in the Cascade Spring MPG that are summarized in the LCFRB Plan (2010) and Oregon Plan (ODFW 2009). These are discussed in detail in Section 3.2.1.4, but include effects related to hydro, habitat, hatchery, and harvest activities. For the three Cowlitz populations (Upper Cowlitz, Cispus, and Tilton) and the North Fork Lewis population, the paramount limiting factor is the dams that block access to their historic spawning and rearing habitat.

The recovery strategy for Lower Columbia River spring Chinook includes substantially reducing hatchery impacts on natural-origin spring Chinook. Hatchery-related actions will include excluding hatchery fish from portions of the Sandy through the use of weirs, traps, and other measures; fully acclimating hatchery fish before release to the Sandy River; and developing a sliding scale that describes how natural-origin broodstock will be used in the integrated hatchery program in the Sandy River watershed. For the Sandy, lessening the effects of hatchery-origin fish on naturally produced fish is expected to provide greater benefit than any other general category of action. In Washington actions include integrating natural-origin broodstock into some hatchery programs to improve fitness, and eliminating or adjusting some releases.

While both the Washington and Oregon recovery plans discuss harvest as a limiting factor for Lower Columbia River spring Chinook, harvest is currently not as significant a limiting factor as dam passage constraints, tributary and estuary habitat degradation, and hatchery effects. Harvest impacts on natural-origin fish averaged about 50 percent per year around the time of listing and are currently around 25 percent. The Oregon Plan considers the current 25 percent harvest rate to be consistent with recovery of natural-origin spring Chinook (p. 223) and does not include reductions in harvest in its population threat reduction scenarios for spring Chinook. The LCFRB plan recommends a front-loaded impact reduction strategy with a harvest rate of 15 to 25 percent.

Estimates of harvest impact on natural origin spring Chinook vary a bit depending on the source. Harvest impacts to natural origin spring Chinook are reduced through the use of mark selective fisheries in the Columbia River and its tributaries. When estimates of harvest in freshwater fisheries are combined with ocean impact estimates, LaVoy estimated that the total exploitation rate on Lower Columbia River spring Chinook for all fisheries averaged 23% in recent years (LaVoy 2010b). The LCFRB Plan estimated that harvest impacts rates have been reduced to around 20% or less since listing by restrictions of ocean fisheries and implementation of mark-selective fisheries for hatchery spring Chinook in freshwater. The Oregon Plan estimated that the total exploitation rate on Hood River spring Chinook was 25% or less (ODFW 2009). Estimates of harvest mortality from Appendix C of the Oregon Plan indicate that the exploitation rate on the Sandy River population was reduced to an average of about 18% once the lower river fisheries switched to catch and release requirements. Although these estimates vary a bit, they are all consistent with the recommendations of the Oregon Plan and fall within the range recommended by the LCFRB. NMFS has reviewed the over recovery strategy for the Cascade spring Chinook populations described in the LCFRB and Oregon recovery plans and concurred with the all-H strategy including the specific recommendations related to harvest (Walton 2010).

The proposed action will result in direct and indirect mortality of fish of all populations in the Cascade Spring MPG. Estimates for the expected harvest impacts are available for 2010 and are expected to be similar in 2011. The exploitation rate that would occur in Council and Fraser Panel area fisheries that are considered under the proposed action is expected to be 0.16 (Table 16), meaning that approximately 16% fewer adults will return to natal areas in 2010 than if the proposed action does not occur. In 2010, the total exploitation rate on natural origin Lower Columbia River spring Chinook in all fisheries, including those outside the action area, is expected to be 0.21.

The 16% reduction in returning adults in 2010 that will occur as a result of the proposed action, compared to the number that would return if the action does not occur, will have little effect on the survival or potential for recovery of the three Cowlitz River populations or the North Fork Lewis population. As described in the Status and Environmental Baseline sections above, dams block passage to spawning habitat and survival and recovery are dependent upon a hatchery program and fledgling reintroduction programs. The only fish that will be able to reach the blocked habitat in 2010 and 2011 will be those collected for the reintroduction program and hauled above the dams. In recent years, when harvest rates have been equal to or greater than those included in the proposed action, there have been more than enough returning adults to supply the reintroduction program and the broodstock needs for the ongoing hatchery program. It is likely that there will continue to be sufficient returns in 2010 and 2011.

The 16% reduction in returning adults in 2010 also will have little effect on the Sandy population. As described above and in Status section, this population has averaged approximately 1,700 natural-origin spawners in recent years, not counting those spawning in the river below the site of Marmot Dam, which is high enough to pose little risk of short-term extinction and is above the delisting goal of 1,230 natural spawners. Because exploitation rates as high or higher than that proposed occurred during those years, it is likely that returns will continue to be consistent with the delisting abundance goal in 2010 and 2011.

The proposed actions will reduce by approximately 16% the number of adults returning to the Toutle and Kalama populations in 2010 and 2011. This is unlikely to affect the short-term extinction risk of the Kalama population because numbers of combined natural and listed hatchery fish have averaged 3,400 over the last ten years and exceeded the escapement goal years but one (Table 8). The actions are also unlikely to diminish the potential for recovery of the Kalama population which, as described in the LCFRB Plan, can only occur through a comprehensive and long-term effort to address the combined effects of all the limiting factors.

The proposed actions will reduce by approximately 16% the number of adults returning to the Toutle population in 2010 and 2011. Numerical estimates are not available for the Toutle River population, and this uncertainty suggests that the proposed actions may reduce its likelihood of both survival and recovery. The Toutle is particularly challenging because of the high sediment loads that still remain as a result of the Mount St Helens eruption. The recovery plans call for reducing harvest rates and fixing other limiting factors. The lower harvest proposed in 2011 is consistent with this strategy.

In summary, the proposed actions are not likely to appreciably reduce the likelihood of survival and recovery of the Cascade Spring MPG because it is likely that the four primary populations designated for high viability will survive and retain the potential to recover if the proposed actions are implemented. The proposed actions are also unlikely to reduce the short term risk of survival or diminish the prospects for recovery of the Kalama population. Less is known about the Toutle population. The proposed actions may reduce the prospects for survival and recovery of the Toutle population, but the impact is likely to be low, at least in part, because of the short duration of the actions. Although the Toutle population is designated as a contributing population that will require an improvement in status over the long term, it is one of six populations that have been designated for improved status in an MPG that has only seven populations. Therefore, the potential effect of the proposed actions on the Toutle population does not change the overall conclusion that the actions are not likely to appreciably reduce the likelihood of survival and recovery of the Cascade Spring MPG.

3.6.2 Bright Chinook Populations

3.6.2.1 Cascade Late Fall MPG

The North Fork Lewis and Sandy River populations are the only bright populations in the ESU. The current viability status for the North Fork Lewis population is listed as very high. The population is also targeted for very high viability at delisting (Table 5). The North Fork Lewis population is the principal indicator stock for management for this component of the ESU. It is a natural-origin population with little or no hatchery influence. The escapement goal for management purposes is 5,700 and is based on estimates of the escapement needed to achieve maximum sustained yield (MSY). The LCFRB Plan also identifies an abundance target of 7,300 (Table 5). The target is estimated from population viability simulations and is assessed as a median abundance over any successive 12 year period. Escapements over the last three years have been below the MSY goal, but the median escapement over the last 12 years is 9,462 thus exceeding the abundance target (Table 9). Ocean and inriver fisheries are managed specifically to achieve the MSY escapement goal for the Lewis River. Escapement to the North Fork Lewis is expected to be above the goal in 2010 (PFMC 2010a). It is reasonable to expect that it will be above goal again in 2011 consistent with observations in recent years and the overall management objective.

Oregon classified the current viability status of the Sandy bright population has high, and set the delisting viability objective as very high (Table 5). The abundance target under

Oregon's delisting scenario is 3,747 (ODFW 2009). Escapements have averaged about 3,300 since 1993 and 2,650 over the last 12 years (Table 9).

Key limiting factors described in the LCFRB Plan 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 (ODFW 2009).

Harvest was considered a limiting factor for both populations. Harvest in both ocean and in-river fisheries has declined over the years. Both management unit recovery plans recommend that harvest for these populations continue to be managed as it has in recent years. The Oregon Plan indicated that the Sandy population is viable under current harvest patterns (ODFW 2009). The LCFRB Plan recommends that the North Fork Lewis population continue to be managed for the escapement goal of 5,700.

The exploitation in all fisheries has been reduced from an average of 0.54 prior to 1993 to 0.34 since (Table 14). The combined effect of recent changes in harvest management has therefore been to help alleviate the effect of harvest as a limiting factor. The recent PST Agreement will result in further reductions in exploitation rate in northern fisheries. The retrospective analysis done in conjunction with the biological opinion on the PST Agreement indicted that the exploitation rate on Lower Columbia River bright Chinook would be reduced in the future by two percentage points relative to what it would have been under the prior PST Agreement. Fisheries in Alaska, Canada, and in the Columbia River occur outside the action area, but account for more than 80% of the overall harvest. Since 1993 the exploitation rate in fisheries in Alaska, Canada, and the Columbia River averaged 0.28; the average in Council and Fraser Panel area fisheries is 0.06.

The proposed action will result in direct and indirect mortality of fish of both populations in the Cascade Late Fall MPG. The exploitation rate that would occur in Council and Fraser Panel fisheries that are considered under the proposed actions in 2010 is expected to be 0.05 (Table 17), meaning that approximately 5% fewer adults will return to natal areas in 2010 than if the proposed actions do not occur. The exploitation rate that will occur in 2011 will not be known with certainty until next year, but can reasonably be assumed to be approximately the same as the level expect in 2010. In 2010, the total exploitation rate on Lower Columbia River Chinook in all fisheries is expected to be 0.24. In 2011, fisheries will be subject to the same management constraints for Lower Columbia River bright populations. Impacts will therefore be consistent with observations in recent years and the overall management objective.

A reduction of approximately 5% in returning adults in 2010 and 2011 that will occur as a result of the proposed actions, compared to the number that would return if the action does not occur, will have little effect on the survival or potential for recovery of the populations in the Cascade Late Fall MPG. Returns in 2010 and 2011 are expected to be in the thousands for both populations, indicating a low risk of extinction in the short-term. The North Fork Lewis population has varied in recent years, but on average has exceeded both the escapement goal of 5,700 and the target abundance level of 7,300. Available analysis indicates that the proposed action will have limited affect on the return of the North Fork Lewis population in 2010 and 2011, and the returns will continue to meet the overall abundance objectives (PFMC 2010a). The abundance of the Sandy population has averaged 3,300 compared to a delisting abundance objective of 3,747. The draft Oregon recovery plan included an analysis that indicated that the Sandy population is viable under current harvest patterns (ODFW 2009). In summary, NMFS concludes that the proposed actions are not likely to appreciably reduce the likelihood of survival and recovery of the Cascade Late Fall MPG.

3.6.3 Tule Chinook Populations

There are twenty one populations of tule Chinook with some located in each of the three MPGs (Table 4). There are four populations in the Gorge MPG, ten in the Cascade MPG, and seven in the Coastal MPG.

Before discussing the details of populations within each MPG, it is useful to consider several points that are relevant to our consideration of all of the Lower Columbia River tule populations. The theme of past harvest consultations for this ESU has been one of developing information and an expectation that key issues would be resolved in the near future (NMFS 2009b). For example, recovery plans were still under development, we were building on our understanding of population status, and developing a greater appreciation of the pervasive effect of hatchery fish on populations in this ESU. Because of the related uncertainties and prospects for better information in the near term, NMFS has provided a series of one year biological opinions since 2006.

In its 2009 guidance letter, NMFS indicated its hope that information would develop to the point that it could provide a multi-year consultation in 2010. The goal of the multi-year approach was to reduce the uncertainty associated with recovery, and add predictability to the various fisheries. Although NMFS, the co-managers and recovery planners made significant progress over the last year in developing additional information to inform recovery and the determination that must be made in this opinion, the effort did not meet the conditions necessary to support a long term harvest regime. Instead, NMFS provided guidance through their letter to the Council that applied to fisheries in 2010 and 2011 only (Thom and McInnis 2010). Nonetheless, significant progress was made on key issue, and it is useful to summarize those findings.

First of all recovery plans are now nearly complete. The status of the recovery planning process and time line for its completion are described in Section 3.2. But these plans are now at a point where they provide consistent and useful information. Recovery plans are an important source of information that describe, among other things, the status of the species and its component populations, limiting factors, recovery goals and actions that are recommended to address limiting factors. Recovery plans are not regulatory documents, but they do provide an all-H perspective that is important when assessing the effects of an action. NMFS has reviewed these recovery plans and provided a preliminary endorsement of key parts of the overall recovery strategy (Walton 2010).

One of the key products of recovery planning is an ESU level recovery scenario that identifies population specific viability targets for Lower Columbia River Chinook (Table 5). The recovery scenario generally conforms with the recommendations of the TRT, except for details related to the Gorge stratum. The scenario proposes that three of the four Gorge populations be managed to achieve medium viability. The Oregon Plan designates the Hood population for high viability, but indicates that it is unlikely that the desired status can be achieved. The recovery plans indicate that the prospects for recovery of Gorge tule populations are constrained by current low numbers, limited habitat availability, and inundation of historically productive habitats by Bonneville Dam. The plans also questioned the designation of the Gorge populations by the TRT and suggest that those designations be reevaluated. The recovery plans propose to ameliorate the ESU-wide risk by targeting more populations in adjacent strata for higher levels of viability.

NMFS acknowledged the difficulties related to the Gorge populations and concurred that recovery opportunities in the Gorge were limited. NMFS also recognized the uncertainty regarding the TRT's MPG delineations between the Gorge and Cascade MPG populations, and that several Chinook populations downstream from Bonneville Dam may be quite similar to those upstream of Bonneville Dam. The proposal to include more than the minimum number of populations required in the Cascade and Coastal MPGs was considered more precautionary than merely assuming that efforts related to the Gorge MPG would be successful (Table 5). NMFS concluded in its 2005 Supplement and more recent review (Walton 2010) that the recovery plan recommendations describe a clear rationale for this divergence from the TRT's recommendations for delisting and a clear argument that the ESU scenario proposed by the Plan could result in a delisting of the ESU if the biological criteria described in the Plan are achieved, and the associated threats to the ESU were adequately addressed.

We have discussed in this opinion at some length the relative abundance of hatchery and natural-origin fish and how it affects our understanding and assessment of the status of tule populations in particular. 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. 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. Past circumstances are such that it is very unlikely that the tule Chinook salmon currently spawning in the coastal stratum rivers in particular represent the genetic diversity and adaptation that was originally present in these populations. The probable lack of locally adapted populations is likely a contributing factor to the apparent low productivity of these populations (Walton 2010). Other populations in the ESU may be less affected by these circumstances. Two tule populations in the Cascade stratum, Coweeman and Lewis, have not had direct releases of hatchery fish and have relatively lower fractions of hatchery origin spawners than the other tule populations. These populations are more likely to have retained appreciable local adaptation to natural conditions. All other Cascade and Gorge stratum tule populations have likely been composed of over 50 percent hatchery origin spawners for decades, and we expect that this has also depressed the fitness of these populations.

The pervasive influence of hatchery fish also affects the required approach to recovery. 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. 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. The transition will most often involve reducing the effect of limiting factors, and allowing time for habitat improvements to take effect and for the population to readapt to existing 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.

NMFS' understanding of the status of Lower Columbia River tule populations has evolved over time as a result of an ongoing sequence of assessments and studies. NMFS summarized the results from earlier studies in the 2009 PFMC biological opinion (NMFS 2009). Additional work was done this year to further inform the determination in this opinion. The LCFRB updated their risk assessment (see Appendix E, Chapter 14 LCFRB 2010). The Northwest Fisheries Science Center also provided a new analysis that took a more detailed look at the status of more populations and recovery actions that were proposed to improve their status (NWFSC 2010). Walton (2010) provides an overview of the findings of the various assessments. The review highlights key uncertainties. For example, available information suggests that some populations, particularly those in the coastal stratum, are very unproductive. But that conclusion is based on highly uncertain estimates of the proportion of hatchery origin spawners on the spawning grounds. Getting better information on the composition of the spawning fish is therefore essential. If the populations really are as unproductive as they seem, it is important to evaluate the factors that are contributing to the low productivity. Two factors appear to be the most likely cause of this very low productivity: poor habitat quality and impacts from hatchery spawners and past harvest practices. As discussed elsewhere in this opinion, harvest impacts have been reduced substantially in recent years. Whether further reductions will be required remains an open question that is being considered, at least in part, in this opinion.

After reviewing the information from past and recent studies, NMFS provided a more current and nuanced assessment of the status of the tule populations (Table 5). The populations were divided into three categories:

4. Populations with relatively low levels of past and current hatchery straying that appear to be self-sustaining and have a high persistence probability under current (~38%) harvest rates. Only the Coweeman and Lewis populations fall into this category. These populations are still below their target status but are relatively healthy compared to other LCR tule populations.

5. Populations that have relatively high current or past hatchery impacts, but that modeling suggests are able to be self-sustaining, either under current harvest rates or in some cases under rates less than the current rate. Based on the NWFSC 2010 and Ford et al. 2007 results, populations in this category include Washougal, Mill/Abernathy/Germany, and Hood. Grays/Chinook possibly would also fall into this category, but this population was not modeled in the 2010 effort. Although also not explicitly modeled, by analogy to similar populations, the Lower Cowlitz, Kalama, and probably the Toutle populations also fall into this category. These populations may be at less immediate risk, but still clearly will require recovery actions that address habitat, hatchery, and harvest factors.

6. Populations that have very high current or past hatchery impacts that modeling suggests are not self-sustaining under current habitat conditions even with no harvest. Populations in this category include the Elochman, Clatskanie, and Scappoose, and probably Big Creek. These populations clearly require recovery actions that address habitat, hatchery and harvest factors.

Another result of recovery planning is development of a comprehensive recovery strategy. The overall recovery strategy for the tule component of the LCR Chinook ESU is an all-H approach designed to restore the Coast and Cascade tule strata to a high probability of persistence, and the Gorge stratum to a probability of persistence that, when combined with compensation in the other strata, is at an acceptable risk level (Table 5). The strategy involves transitioning from decades of management that allowed habitat degradation, emphasized hatchery production of fish for harvest, and resulted in diminished viability of all tule populations, to management that supports a naturally self-sustaining ESU and preserves harvest opportunities in the long term. This transition will be accomplished by reducing impacts in all threat categories and sharing the burden of recovery across categories.

Among the most immediate and high-priority needs for recovery are aggressive efforts to (1) improve the quality and quantity of both tributary and estuary habitat, and (2) reduce the influence of hatchery fish on natural-origin fish. Necessary elements of the transitional strategy are well described in the management unit recovery plans and summarized in the NMFS Memo (Walton 2010).

The all-H recovery strategy presumes that the adverse effects of each of the limiting factors can be addressed and that the actions necessary to address those effects are reasonably certain to occur. If so, then we can assess harvest, or any other action, by considering whether it is meeting expectations specified in the plan for that H sector. The nature of the recovery process and complexities of the limiting factors that must be addressed are such that certainty is likely unachievable. One reason for limiting this biological opinion to two years is to bring greater certainty to the actions that are need now. The tasks listed in the proposed action are design for that purpose. Even so, certainty of success of a recovery plan that will take decades is likely to remain elusive. However, the relative lack of certainty can be mitigated by continued assessment and monitoring. This will include continued monitoring of the status of each population. Washington and Oregon have both improved their status monitoring programs with particular emphasis on both abundance and the proportion of hatchery origin fish. Task H in the proposed action is specifically designed to address status monitoring capabilities. Uncertainty can also be mitigated by establishing expectations for actions designed to address the limiting factors, and routinely assessing whether those actions are occurring and having the intended effect. Other tasks listed in the proposed action are designed to bring greater certain with respect to habitat actions (tasks A through D), monitoring and management of hatchery fish on the spawning grounds (task E), mark selective fisheries (task F), and abundance based fishery management (task G).

A premise of this opinion is that we can use the recovery strategy developed through recovery planning as a benchmark for evaluating the proposed action. Consistency of a proposed action with a recovery plan does not by itself satisfy the need for an independent jeopardy determination. But is does provide a context for assessing an action. NMFS has reviewed the overall recovery strategy and, at least preliminarily, endorsed the plan (Walton 2010). The NMFS Memo reviewed the elements of the recovery plan related to harvest of tule Chinook. The Memo reiterates conclusions from the LCFRB and ODFW management unit plans with respect to harvest. Harvest has been reduced from rates that were once as high as 80 percent to the recent limit of 38 percent with further reductions proposed for 2011. These changes are consistent with the large scale harvest reductions called for in the management unit plans. Both the LCFRB (2010) and Oregon (2009) plans envision that further reductions will be achieved through a strategy of implementing mark-selective fisheries when feasible as a tool to sustain important fisheries, and implementing abundance-based management when feasible. The harvest limits described in NMFS' guidance letter (Thom and McInnis 2010) of 38% in 2010 and 36 or 37% in 2011 do not quite achieve the longer term benchmarks described in the manage unit plans, but are consistent with the direction, and broader intention to implement harvest reductions over time as part of the overall transition strategy.

3.6.3.1 Gorge Fall MPG

There are four tule Chinook populations in the Gorge Fall MPG including the Lower Gorge, Upper Gorge, White Salmon, and Hood. The baseline viability status for all of these populations is listed as very low, although a more recent analysis indicated that the status of the Hood population is higher, in transitional category two (Table 5). Under the recovery scenario, three populations are targeted for medium viability. The Hood population is targeted for high viability, although Oregon has indicated that it is unlikely that that objective can be met (Table 5). All of the populations are targeted for improved status, but the recovery plans acknowledge uncertainty about the designations for these populations, and the constraints to recovery imposed by existing conditions. Additional populations in adjacent MPGs are targeted for high viability to mitigate the greater risk to the ESU.

The exploitation rate that would occur in Council and Fraser Panel fisheries in 2010 that are considered under the proposed action is 0.15 (Table 18). The exploitation rate that will occur in 2011 under the proposed action will not be known with certainty until next year, but can reasonably be assumed to be at or below the level expect in 2010. The effect of the proposed action in 2010 and 2011 will therefore generally be to reduce the escapement to each population by approximately 15% relative to what it would be without the proposed actions. Absent better information, we necessarily assume that all populations in the Gorge Fall MPG are subject to the same level of harvest in these fisheries. Because of the relative lack of information, the effect of the 15% reduction in abundance in 2010 and 2011 on the likelihood of survival and recovery on the Gorge tule populations must be inferred qualitatively.

The reduction in adult returns poses little near-term risk to survival of the White Salmon population because of the presence of large numbers of hatchery fish. The White Salmon is limited by Condit Dam which is located at river mile 3.3. The number of fall Chinook spawners in the White Salmon has increased from low levels in the early 2000's to an average of 2,750 for the period from 1998 to 2007 (Roler 2009), but that spawning is dominated by tule Chinook strays from the neighboring Spring Creek Hatchery and upriver brights from the production program in the adjoining Little White Salmon River (these fish are not part of the Lower Columbia River Chinook ESU). The Spring Creek 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 are no proposals to make substantive changes to these production programs. 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.

Similarly, large numbers of listed and non-listed hatchery fish suggest that there is little near-term risk to survival of the other three populations. ODFW reports that hatchery strays contribute about 90% of the escapement to the Lower Gorge, Upper Gorge, and Hood River populations on the Oregon side of the river (ODFW 2009). These populations are heavily influenced by hatchery strays from the Bonneville Hatchery located immediately below Bonneville Dam, and the Spring Creek and Little White Salmon Hatcheries located just above Bonneville Dam. It is reasonable to infer that tributaries in the Gorge on the Washington side of the river are similarly affected. Hatchery goals have been met or exceeded in recent years for all of these hatcheries when harvest rates were as high or higher than those proposed have been implemented.

While there is not likely to be an appreciable reduction in the likelihood of survival of the Gorge Fall MPG populations because of the presence large numbers of listed hatchery fish, the reduction in adult returns in 2010 and 2011 may affect the likelihood of recovery.

Only the Hood River population was the subject of viability modeling. As described in the Effects section, the proposed fishery (if continued over a long time period) is likely to increase the risk of extinction, compared to not implementing the proposed fishery. The same is probably true for the other Gorge Fall MPG populations.

Recovery planning documents call for a reduction in harvest rates to achieve recovery goals. Both the LCFRB 2010 and Oregon 2009 plans envision that further reductions will be achieved through a strategy of implementing mark-selective fisheries when feasible as a tool to sustain important fisheries, implementing abundance-based management when feasible, and applying weak-stock management principles.

- As described previously, Lower Columbia River Chinook harvest rates have been cut in half in recent years, which is consistent with the recovery strategy.
- The proposed action for 2011 will represent a further 1-2% reduction in the overall exploitation rate, which is also consistent with recovery planning expectations.
- The LCFRB and Oregon recovery plans listed several specific recovery actions related to harvest and, as described in Section 3.3.2, all of these actions have been implemented in whole or in part.
- The actions are only two years in duration, which will limit impacts on long-term recovery, and allow for continued modification of exploitation rates and implementation of the all-H strategy that is called for by the recovery plans and endorsed preliminarily by NMFS (Walton 2010).

As explained in the preceding overview section on Tule Chinook Populations, harvest in fisheries below Bonneville Dam has been reduced from rates that were once as high as 80 percent to the recent limit of 38 percent with further reductions proposed for 2011. These changes are consistent with the large scale harvest reductions called for in the management unit plans. The combined effect of recent changes in harvest management has therefore helped alleviate the effect of harvest as a limiting factor. Additional harvest does occur on three of the four populations that are located above Bonneville Dam in what are primarily tribal fisheries above Dam that target returning upriver bright Chinook and fish returning to the Spring Creek Hatchery in particular. There are no proposals to reduce these important tribal fisheries that target hatchery fish that are produced for that purpose.

Because of the long history of input of stray fish from several hatcheries, the Gorge populations are no longer the relatively isolated, uniquely adapted entities that we normally think of as populations. They are instead amalgams resulting from the hatchery strays and whatever natural production may result from their spawning. Actions are being taken that will improve the status of these populations (e.g., removal of Condit and Powerdale dams), but they do not include addressing limitations that occur as a result of Bonneville Dam, current hatchery production programs, or the associated fisheries above Bonneville Dam. NMFS expects that the status of these populations will improve over the long term, but is likely to continue to be limited by the prevailing baseline conditions.

NMFS acknowledged the unique difficulties associated with improving the status of the Gorge tule populations in their supplement to the Interim Regional Recovery Plan (NMFS 2005f), and more recent NMFS Memo (Walton 2010) but concluded that delisting could nonetheless occur despite these shortcomings if other biological criteria described in the Plan were achieved, and the associated threats to the ESU were otherwise adequately addressed.

Based on the above described considerations, NMFS concludes that the proposed actions are not likely to appreciably reduce the likelihood of survival and recovery of the Gorge Fall MPG.

3.6.3.2 Cascade Fall MPG

There are ten populations in the Cascade Fall MPG. The viability status of all of these populations is listed as very low, based on baseline conditions at the time of listing. A more recent analysis reassessed the status of seven of these populations. The Coweeman and Lewis were assigned to transitional category one; five of the others were assigned to transitional category two (Table 5). Category one populations have relatively low levels of past and current hatchery straying, and appear to be self-sustaining and have a high persistence probability under current (~38%) harvest rates. Category two populations have relatively high current or past hatchery impacts, but are apparently self-sustaining with harvest rates that are either at or below current levels.

The recovery scenario for the Cascade Fall stratum targets four populations for high plus viability and four more for medium or medium plus viability. The remaining two populations are designated as stabilizing and would continue to have very low viability (Table 5).

Returns to the Coweeman and Lewis populations have been several hundred fish per year and are subject to relatively little hatchery straying (Table 10). Returns to the Washougal, Toutle, and Lower Cowlitz populations have generally been in the thousands per year (Table 10). These populations are all associated with significant in basin hatchery programs and are thus subject to large numbers of hatchery strays. We have less information on returns to the Clackamas and Sandy rivers, but ODFW indicated for both that 90% of the spawners are likely hatchery-origin fish from as many as three adjacent hatchery programs (ODFW 2009).

As discussed in Section 3.2.1.4 Lower Columbia River tule populations 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. As discussed above, most of the populations have been subject to the effects of a high incidence of naturally-spawning hatchery fish for decades.

Harvest is considered a limiting factor for Lower Columbia River tule populations. As explained in the preceding overview section on Tule Chinook Populations, harvest has been reduced from rates that were once as high as 80 percent to the recent limit of 38 percent with further reductions proposed for 2011. These changes are consistent with the large scale harvest reductions called for in the management unit recovery plans. The combined effect of recent changes in harvest management has therefore helped alleviate the effect of harvest as a limiting factor.

Hatchery straying is a limiting factor for many of the populations in the Cascade Fall MPG. The Coweeman and Lewis populations do not have in basin hatchery programs and are generally subject to less straying. Significant hatchery reforms have been implemented to reduce the effects of straying. On station release levels on the Washougal, Toutle and Lower Cowlitz have been reduced. Brood stock management practices for all hatcheries are revised to conform with HSRG recommendations. Weirs are being operated on the Kalama to assist with brood stock management, and on the Coweeman to further assess and control hatchery straying on that system. These are examples of actions the states have taken as part of a comprehensive program of hatchery reform to address the effects of hatcheries as a limiting factor. The nature and scale of the reform actions were described by Anderson and Bowles (2008), and in a more recent letter from WDFW (Anderson 2010). It is clear from these reports that significant progress has been made in addressing hatcheries as a limiting factor.

It is more difficult to document the scale and efficacy of projects designed to address habitat conditions that are limiting. There is clearly more that needs to be done here, but it is also clear that actions have been and are being taken to help address habitat concerns. For example, the LCFRB through the Pacific Coast Salmon Recovery Funds has funded 142 projects valued at $41.8 million for lower Columbia River tributary and mainstem habitat restoration (Anderson 2010a,b).

The exploitation rate that would occur in Council and Fraser Panel fisheries in 2010 that are considered under the proposed action is 0.15 (Table 18). The exploitation rate that will occur in 2011 under the proposed action will not be known precisely until next year, but can reasonably be assumed to be at or below the level expect in 2010. The effect of the proposed action in 2010 and 2011 will therefore generally be to reduce the escapement to each population by approximately 15% relative to what it would be without the proposed actions. In 2010, the total exploitation rate on Lower Columbia River tule Chinook in all fisheries is expected to be 0.38. In 2011, the total exploitation rate on Lower Columbia River tule Chinook in all fisheries is expected to be 0.36 or 0.37 as explained in the proposed action. Absent better information, we necessarily assume that all populations in the cascade MPG are subject to the same level of harvest.

Consideration of the effects of the proposed actions therefore requires us to consider the relative status of each population.

The Coweeman and East Fork Lewis populations are particularly important to the overall recovery strategy because they are the only tule populations that are presumed to retain their unique genetic characteristics. Preserving these stocks is therefore a high priority and a central part of the overall recovery strategy. The Coweeman and East Fork Lewis populations were assigned to transitional category one which suggests that they are self-sustaining and have a high persistence probability under current (~38%) harvest rates (Walton 2010). This is consistent with the conclusions from earlier analyses that were summarized in detail in the 2009 PFMC biological opinion (NMFS 2009b). The results of these analyses suggest that harvest levels associated with the proposed action are consistent with expectations for the survival and recovery of these populations even if continued into the future.

Five other populations were assigned to transitional category two which suggests that they are subject to relatively high current or past hatchery impacts, but are apparently self-sustaining with harvest rates that are either at or below current levels. The five category 2 populations include the Lower Cowlitz, Kalama, Washougal, Toutle, and Clackamas. The abundance of spawners for populations like the Lower Cowlitz, Washougal, and Kalama (and likely the Toutle although similar annual spawner estimates are not available) generally number in the thousands of fish per year due, at least in part, to the contribution of hatchery-origin fish from in basin hatchery programs (see Table 10). The proposed action would generally reduce the return to these populations by 15%. High abundance mitigates the near term risk to survival for these populations. Despite an exploitation rate of 0.15 associated with the proposed actions, these populations will continue to be populated by large numbers of spawning fish as they have in the past under harvest levels that were much higher than those being proposed in 2010 and 2011.

We have less specific information about the Clackamas and Sandy populations. Their abundance is presumably lower and comprised primarily (on the order of 90%) of hatchery origin fish (ODFW 2009). The exploitation rate associated with the proposed actions is 0.15. A continuing 15% reduction in the number of returning adults would indicate a reduced likelihood that populations would achieve the contributing status objectives currently suggested for these populations if continued for a number of years. For the 2010 and 2011 proposed actions, the short duration of the action, the ongoing contribution of hatchery fish to the spawning areas, and past reductions in harvest that have helped alleviate the effects harvest as a limiting factor largely mitigate the immediate risk to the survival of these populations.

For the time being, the proposed actions do little to reduce the prospects for the survival of the Coweeman or Lewis populations or other populations in the MPG that are dominated by hatchery strays as the hatcheries will continue to maintain natural spawning levels that have been observed in recent years, at least for as long as they continue to produce fish. By the same token, the proposed actions in 2010 and 2011 will do little to reduce the prospects for recovery so long as the option for implementing an effective and comprehensive recovery program remains. However, the status quo is not a viable long-term strategy. Comprehensive reform designed to address the limiting factors is essential to achieve the recovery objectives of the ESA. The short duration of this opinion mitigates the risk from the proposed actions to populations in the Cascade Fall MPG that are dominated by hatchery strays. But the effects of future harvest can only be rationalized if done within the context of a comprehensive transitional strategy that is designed to achieve recovery. Recovery planning is the appropriate forum for describing that transitional strategy. Necessary elements of the overall recovery strategy are described in the management unit recovery plans which are summarized and endorsed, at least preliminarily, in the NMFS Memo (Walton 2010). A premise of this opinion is that we can use the recovery strategy as a benchmark that contributes to our ability to assess the proposed action.

Recovery planning documents call for a reduction in harvest rates to achieve recovery goals. Both the LCFRB 2010 and Oregon 2009 plans envision that further reductions will be achieved through a strategy of implementing mark-selective fisheries when feasible as a tool to sustain important fisheries, implementing abundance-based management when feasible, and applying weak-stock management principles.

- As described previously, Lower Columbia River Chinook harvest rates have been cut in half in recent years, which is consistent with the recovery strategy.
- The proposed action for 2011 will represent a further 1-2% reduction in the overall exploitation rate, which is also consistent with recovery planning expectations.
- The LCFRB and Oregon recovery plans listed several specific recovery actions related to harvest and, as described in Section 3.3.2, all of these actions have been implemented in whole or in part.
- The actions are only two years in duration, which will limit impacts on long-term recovery, and allow for continued modification of exploitation rates and implementation of the all-H strategy that is called for by the recovery plans and endorsed preliminarily by NMFS (Walton 2010).

Based on these considerations and others, NMFS has determined that the proposed actions that limit harvest to 38% in 2010 and 36 or 37% in 2011 are consistent the overall recovery strategy (Walton 2010).

The nature of the recovery process and complexities of the limiting factors that must be addressed are such that certainty is likely unachievable. One reason for limiting this biological opinion to two years is to bring greater certainty to the actions that are need now. The tasks listed in the proposed action are design for that purpose. Even so, certainty of success of a recovery plan that will take decades is likely to remain elusive. However, the relative lack of certainty can be mitigated by continued assessment and monitoring. This will include continued monitoring of the status of each population. The lack of certainty can also be mitigated by establishing expectations for actions designed to address the limiting factors, and routinely assessing whether those actions are occurring and having the intended effect. Continued assessment and monitoring is therefore a key feature of the overall recovery strategy (Walton 2010).

Based on the above described considerations, NMFS concludes that the proposed action is not likely to appreciably reduce the likelihood of survival and recovery of the Cascade Fall MPG.

3.6.3.3 Coastal Fall MPG

There are seven populations in the Coastal Fall MPG. The viability status of all of these populations, based on baseline conditions at the time of listing, is listed as low or very low. A more recent analysis assigned the Grays and Mill/Abernathy/Germany populations to transitional category two and the remaining populations to category three. Category two populations have relatively high current or past hatchery impacts, but are apparently self-sustaining with harvest rates that are either at or below current levels. Category three populations have very high current or past hatchery impacts but are not self-sustaining under current habitat conditions even with no harvest.

The recovery scenario for the coastal fall stratum targets the Elochoman, Mill/Abernathy/Germany, Clatskanie, and Scappoose populations for high viability. The Grays population is targeted for medium plus viability. The Youngs Bay and Big Creek populations are associated with large scale net pen or hatchery production programs and are expected to stay in the low viability category.

Returns to the Elochoman and Germany/Abernathy/Mill populations have numbered in the hundreds or even low thousands in recent years (Table 11). Returns to the Grays have averaged a few hundred fish but have been stable. There is less certainty about the number of fish returning to coastal populations on the Oregon side. There are estimates of escapement for the Clatskanie, but the estimates of hatchery fraction are highly uncertain. Estimates for the Scappoose were assumed to be similar to the Clatskanie absent better information. In 2009, Oregon implemented a new randomly stratified survey method that is designed to provide better estimates of abundance and hatchery composition. Improved monitoring capabilities is an important part of the overall recovery strategy.

As discussed in more detail in Section 3.2.1.4, populations in the Coastal Fall MPG are subject to the full range of limiting factors including mainstem hydropower development and the secondary effects of flow and estuary degradation, harvest, and ecological factors related to predation and degradation of the estuary from non-hydro related activities. 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.

Harvest is considered a limiting factor for Lower Columbia River tule populations. As explained in the preceding overview section on Tule Chinook Populations, harvest has been reduced from rates that were once as high as 80 percent to the recent limit of 38 percent with further reductions proposed for 2011. These changes are consistent with the large scale harvest reductions called for in the management unit recovery plans. The combined effect of recent changes in harvest management has therefore helped alleviate the effect of harvest as a limiting factor.

Hatchery straying is a significant problem for all of the populations in the Coastal Fall MPG, although the proportion of hatchery strays on the Grays is likely less than other populations in the MPG. There was a Chinook hatchery on the Grays River, but that program was closed in 1997. The lower proportion of hatchery fish in the Grays is therefore likely a relatively recent occurrence. Weirs were placed and operated in the Elochoman and Grays rivers in 2008 and 2009 to improve escapement estimates and control hatchery straying. Use of these weirs will continue in the future (Anderson 2010). The Elochoman had an in basin fall Chinook hatchery production program with annual releases of 2,000,000 fingerlings. That program was closed with the last release of fish in 2008 as part of the overall hatchery reform program. The hatchery closure will greatly reduce the problem of hatchery straying in that system. The Mill/Abernathy/Germany population does not have an in basin hatchery program, but still has several hundred to several thousand spawners each year that are primarily hatchery-origin (Table 11). Closure of the Elochoman program should help reduce straying on the Mill population complex and other neighboring systems as well. We have less information about the number of spawners in the Clatskanie and Scappoose, but ODFW estimates that hatchery strays have contributed approximately 90% of the fall Chinook spawners in both areas over the last 30 years (ODFW 2009). The Big Creek and Youngs Bay populations are both proximate to large net pen rearing and release programs that provide for a localized, terminal fishery in Youngs Bay. ODFW again estimates that 90% of the fish that spawn in these areas are hatchery strays. The number of fish released at the Big Creek hatchery has been reduced with additional changes in hatchery practices to help reduce straying into the Clatskanie and other neighboring systems. These programs are otherwise expected to continue to provide fish for ocean fisheries and localized terminal harvest opportunity. These are examples of actions the states have taken as part of a comprehensive program of hatchery reform to address the effects of hatcheries as a limiting factor. The nature and scale of the reform actions were described in more detail in Anderson and Bowles (2008), and in a more recent letter from WDFW (Anderson 2010). It is clear from the record that significant progress has been made in addressing hatcheries as a limiting factor.

It is more difficult to document the scale and efficacy of projects designed to address habitat conditions that are limiting. There is clearly more that needs to be done here, but it is also clear that actions have been and are being taken to help address habitat concerns. For example, the LCFRB through the Pacific Coast Salmon Recovery Funds has funded 142 projects valued at $41.8 million for lower Columbia River tributary and mainstem habitat restoration (Anderson 2010a,b).

The exploitation rate that would occur in Council and Fraser Panel fisheries in 2010 that are considered under the proposed action is 0.15 (Table 18). The exploitation rate that will occur in 2011 under the proposed actions will not be known precisely until next year, but can reasonably be assumed to be at or below the level expect in 2010. The effect of the proposed action in 2010 and 2011 will therefore generally be to reduce the escapement to each population by approximately 15% relative to what it would be without the proposed actions. In 2010, the total exploitation rate on Lower Columbia River tule Chinook in all fisheries is expected to be 0.38. In 2011, the total exploitation rate on Lower Columbia River tule Chinook in all fisheries is expected to be 0.36 or 0.37 as explained in the proposed action. Absent better information, we necessarily assume that all populations in the coastal MPG are subject to the same level of harvest. Consideration of the effects of the proposed actions therefore requires us to consider the relative status of each population.

The abundance of spawners for the Elochoman and Mill/Abernathy/Germany populations are generally in the hundreds or thousands of fish per year because of the contribution of hatchery-origin fish from in basin or adjacent hatchery programs (see Table 11). High abundance mitigates the near term risk to survival for these populations. Despite an exploitation rate of 0.15 in 2010 (and a similar rate in 2011) associated with the proposed actions, these populations will continue to be populated by large numbers of spawning fish as they have in the past under harvest levels that are much higher than those being proposed for the next two years. Operation of the weir on the Elochoman will allow better enumeration and control of fish returning to that system. The effects of hatchery program reductions and closures will become increasingly apparent beginning in 2011.

The abundance of spawners on the Grays has generally been lower, on the order of a few hundred fish per year, but the population has been relatively stable under harvest impacts that were the same or higher than those anticipate under the proposed actions indicating that the proposed action will have little near term risk to survival. The Grays population was characterized as a transitional category 2 population indicating that it was more productive than most of the other populations in the coastal MPG. Continued operation of the weir on the Grays will also allow better enumeration and control of fish returning to that system.

There is less specific information about the four other populations on the Oregon side of the Coastal Fall MPG. The Youngs Bay and Big Creek populations are not proposed for status improvements in proposed delisting scenarios; the Clatskanie and Scappoose are proposed for high viability (Table 5). The abundance of all of these populations is presumably lower than those on the Washington side and comprised primarily (on the order of 90%) of hatchery-origin fish (ODFW 2009). The exploitation rate associated with the proposed actions is 0.15 in 2010 and approximately the same in 2011. A continuing 15% reduction in the number of adults that would otherwise return to spawn may reduce the likelihood that the status of these populations will improve if continued over time. However, for the proposed actions in 2010 and 2011, the short duration of the action (2 years), the ongoing contribution of hatchery fish to the spawning areas, the continuing availability of these hatchery fish that can be used to recover these populations, and past reductions in harvest that have helped alleviate the effects of harvest as a limiting factor largely mitigate the immediate risk to the survival of these populations.

This biological opinion considers the effect of fishery actions that are proposed to occur in 2010 and 2011. All the populations in the Coastal Fall MPG that are prioritized for improved status are heavily influenced by hatchery-origin spawners particularly the Elochoman, Mill/Abernathy/Germany, Clatskanie, and Scappoose populations. The proposed actions would generally reduce the return to these populations by 15% in 2010 and a similar level in 2011, but do little to reduce the prospects for the survival of these populations as the hatcheries will continue to maintain natural spawning levels that have been observed in recent years, at least for as long as they continue to produce fish. By the same token, the proposed actions in 2010 and 2011 will do little to reduce the prospects for recovery so long as the option for implementing an effective and comprehensive recovery program remains. However, the status quo is not a viable long-term strategy. Comprehensive reform designed to address the limiting factors is essential to achieve the recovery objectives of the ESA. The short duration of this opinion mitigates the risk from the proposed actions to populations in the Coastal Fall MPG that are dominated by hatchery strays. But the effects of future harvest can only be rationalized if done within the context of a comprehensive transitional strategy that is designed to achieve recovery. Recovery planning is the appropriate forum for describing that transitional strategy. Necessary elements of the overall recovery strategy are described in the management unit recovery plans which are summarized and endorsed, at least preliminarily, in the NMFS Memo (Walton 2010). A premise of this opinion is that we can use the recovery strategy as a benchmark that contributes to our ability to assess the proposed action.

Recovery planning documents call for a reduction in harvest rates to achieve recovery goals. Both the LCFRB 2010 and Oregon 2009 plans envision that further reductions will be achieved through a strategy of implementing mark-selective fisheries when feasible as a tool to sustain important fisheries, implementing abundance-based management when feasible, and applying weak-stock management principles.

- As described previously, Lower Columbia River Chinook harvest rates have been cut in half in recent years, which is consistent with the recovery strategy.
- The proposed action for 2011 will represent a further 1-2% reduction in the overall exploitation rate, which is also consistent with recovery planning expectations.
- The LCFRB and Oregon recovery plans listed several specific recovery actions related to harvest and, as described in Section 3.3.2, all of these actions have been implemented in whole or in part.
- The actions are only two years in duration, which will limit impacts on long-term recovery, and allow for continued modification of exploitation rates and implementation of the all-H strategy that is called for by the recovery plans and endorsed preliminarily by NMFS (Walton 2010).

Based on these considerations and others, NMFS has determined that the proposed actions that limit harvest to 38% in 2010 and 36 or 37% in 2011 are consistent the overall recovery strategy (Walton 2010).

The nature of the recovery process and complexities of the limiting factors that must be addressed are such that certainty is likely unachievable. One reason for limiting this biological opinion to two years is to bring greater certainty to the actions that are need now. The tasks listed in the proposed action are design for that purpose. Even so, certainty of success of a recovery plan that will take decades is likely to remain elusive. However, the relative lack of certainty can be mitigated by continued assessment and monitoring. This will include continued monitoring of the status of each population. The lack of certainty can also be mitigated by establishing expectations for actions designed to address the limiting factors, and routinely assessing whether those actions are occurring and having the intended effect. Continued assessment and monitoring is therefore a key feature of the overall recovery strategy (Walton 2010).

Based on the above described considerations, NMFS concludes that the proposed actions are not likely to appreciably reduce the likelihood of survival and recovery of the Coastal Fall MPG.

3.6.4 All MPGs

As described above in this section, the likelihood of survival and recovery of each of the six MPGs is not likely to be appreciably reduced by the proposed 2010 and 2011 PFMC and Fraser panel fisheries.

- There are two populations in the Gorge Spring MPG. The White Salmon population is extirpated and the Hood population is extirpated or nearly so. Recovery on the White Salmon is not expected to proceed until Condit Dam is removed, a period of assessment is completed, and reintroduction measures are initiated. In the meantime, there are no listed fish to take. A reintroduction program has been initiated in Hood River with an out of ESU stock. That program is currently being reevaluated to improve its efficacy. Oregon recovery planners concluded that further reductions in harvest are not required to achieve the desired status for that population. The proposed fishery in 2010 and 2011 will do little to reduce the likelihood of survival and recovery of these populations.

- There are seven populations in the Cascade Spring MPG. Four are targeted for high or very high viability. The Sandy population is key to recovery since it is the only spring Chinook population in the ESU with appreciable natural production. The natural spawning escapement on the Sandy has exceeded the tentative delisting target in recent years and is expected to continue to do so even with impacts associated with the proposed actions. Another element of the recovery strategy is reestablishing naturally spawning populations above dams on the Cowlitz and North Fork Lewis rivers. In the short-term, the survival of these populations is insured by hatchery programs that are producing large numbers of listed hatchery fish that preserve their genetic legacy, and provide a source for the reintroduction program. For these populations, meeting hatchery escapement goals is important because they provide the resource necessary for the reintroduction program that is key to recovery. Hatchery goals have been met in most recent years and are expected to continue to do so in 2010 and 2011 even with the proposed actions.

- The Cascade Late Fall MPG is composed of two populations that are expected to have adult returns in 2010 and 2011, with the proposed fishery, that will meet or exceed target abundance objectives. Both populations are being managed consistent with recovery plan recommendations for harvest.

- The Gorge Fall MPG consists of four populations that will have little risk of near-term extinction because of the existence of hatchery programs that preserve what remains of genetic characteristics of the populations. The anticipated reduction in adult returns in 2010 and 2011 will reduce the likelihood of recovery compared to not implementing the action, but the short duration of the action, the ongoing contribution of hatchery fish to spawning areas, and past reductions in harvest that help alleviate the effects of harvest as a limiting factor mitigate this concern. Actions are being taken that will improve the status of these populations (e.g., removal of Condit and Powerdale dams), but they do not include addressing limitations that occur as a result of Bonneville Dam, current hatchery production programs, or the associated fisheries above Bonneville Dam. NMFS expects that the status of these populations will improve over the long term, but is likely to continue to be limited by the prevailing baseline conditions. NMFS acknowledged the likelihood of this outcome, but concluded that delisting could nonetheless occur if other biological criteria were achieved, and the associated threats to the ESU were otherwise adequately addressed.

- The Cascade Fall MPG consists of ten populations that have little risk of near-term extinction. The status of populations in the Cascade Fall MPG is good at least relative to that of the other tule strata with two populations in transitional category one and five more in transitional category two. The reduction in adult returns that will result from the proposed actions, even if continued for multiple years, would be consistent with attaining viability goals for the Coweeman and Lewis indicator populations. Other populations in the MPG that are prioritized for higher viability are dominated by stray hatchery-origin spawners. There is little risk to the near-term survival of these populations, despite the proposed actions, because of the short duration of the actions, the ongoing contribution of hatchery fish to spawning areas, and past reductions in harvest that have helped alleviate the effects harvest as a limiting factor. Although the baseline conditions must be improved, the proposed actions in 2010 and 2011 will do little to reduce the prospects for long term recovery. Recovery can only occur through implementation of a comprehensive recovery strategy that addresses all of the limiting factors, a goal that can best be implemented through recovery planning. The necessary recovery strategy is now described and endorsed by NMFS, and thus provides the basis for consideration of harvest in a broad context that provides the only reasonable prospect for successful recovery.

- The Coast Fall MPG consists of seven populations. The status of the Grays and Mill/Abernathy/Germany populations is higher than that of the other populations in the stratum, but all populations are at relative high risk and in need of substantial improvements in baseline conditions. Hatchery straying is a significant problem for all of the populations in the coastal MPG, and this, along with degraded habitat conditions and other adverse baseline conditions, reduces the status of some populations to the point that they would not be viable even with the elimination of harvest. The presence of hatchery fish mitigates the near term risk of extinction by providing a continuing source of spawners, but is also an impediment to long term recovery. The effects of limiting factors are being addressed. Harvest has been reduced from high levels to levels that are consistent with the overall recovery strategy and plans for the ongoing transition of the fishery. Hatchery reform actions have been taken with others planned that will help address limitations related to the hatchery production. Actions have been taken to improve habitat, but it is clear that there is more to be done. The tasks listed in the proposed action are designed to identify and bring greater certainty that required recovery actions will continue to occur. There is little risk to the near-term survival of these populations, despite the proposed actions that will reduce abundance by 15% in 2010 and a similar level in 2011, because of the short duration of the actions, the ongoing contribution of hatchery fish to spawning areas, and past reductions in harvest that have helped alleviate the effects harvest as a limiting factor. Recovery can only occur through implementation of a comprehensive recovery strategy that addresses all of the limiting factors, a goal that can best be implemented through recovery planning. The necessary recovery strategy is now described and endorsed by NMFS, and thus provides the basis for consideration of harvest in a broad context that provides the only reasonable prospect for successful recovery. Based on these considerations, NMFS concludes that the proposed actions in 2010 and 2011 do little to reduce the prospects for survival and recovery for this MGP.

3.7 Conclusion

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, NMFS concludes that the proposed actions are not likely to jeopardize the continued existence of Lower Columbia River Chinook salmon.

The designated critical habitat for the Lower Columbia River Chinook ESU does not include offshore marine areas of Puget Sound and the Pacific Ocean. The activities considered in this consultation will therefore not result in the destruction or adverse modification of any of the essential features of designated critical habitat for the Lower Columbia River Chinook ESU.

NMFS concluded in Section 2.1 of this opinion that the proposed PFMC fisheries will have no effect to any of the ESA listed rockfish DPS'. NMFS reviewed information related to the effects of the U.S. Fraser Panel fisheries on ESA listed rockfish in Appendix A. After reviewing the current status of yelloweye rockfish, canary rockfish and bocaccio within the Puget Sound/Georgia Basin DPSs, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NMFS concludes that the proposed Fraser Panel fishery action is not likely to jeopardize the continued existence of ESA-listed rockfish. Critical habitat for the rockfish species has not yet been designated.

4 Incidental Take Statement

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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 by regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species by significantly disrupting normal behavior patterns which include, but are not limited to, 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. Section 7(b)(4) and Section 7(o)(2) provide that taking that is incidental to an otherwise legal agency action is not considered to be prohibited taking under the ESA, if that action is performed in compliance with the terms and conditions of this incidental take statement.

4.1 Amount or Extent of Incidental Take Anticipated

NMFS anticipates that Lower Columbia River Chinook will be taken as a result of proposed PFMC and U.S. Fraser Panel Fisheries in 2010 and 2011. The incidental take occurs as a result of catch and retention, or mortalities resulting from catch and release, or mortalities resulting from encounter with fishing gear, as a consequence of fishing activity. The amount of anticipated take is expressed below in terms of exploitation rates that include landed catch and other sources of non-retention mortality.

The expected take of the spring, bright, and tule components of the ESU is described here in terms of anticipated exploitation rates that will occur as a result of the proposed actions. We also provide estimates of total exploitation rates that are expected to occur as a result of all fisheries combined since the take that may occur in the PFMC and Fraser Panel fisheries is, for the spring and tule components in particular, limited by the applicable total exploitation rate limit. For example, the total exploitation rate of 0.38 applies to tule Chinook in 2010 and constrains the take that may occur in PFMC and Fraser Panel fisheries).

Estimates of exploitation rates are based on model analysis of fisheries that are described in detail in Preseason Report III (PFMC 2010a). Exploitation rates cannot be monitored directly inseason, but the fisheries can be monitored to insure that they proceed consistent with those planned preseason. The preseason fishery plan includes details related to seasons, quotas, gear types, and other management measures.

The expected exploitation rates for Lower Columbia River spring Chinook (Cascade Spring MPG and Gorge Spring MPG) in Council and Fraser Panel fisheries in 2010 are 0.16 and 0.001, respectively. The exploitation rate on natural-origin spring Chinook in all fisheries is expected to be 0.21 (Table 16). The expected level of take in the Council and Fraser Panel fisheries in 2011 will not be known precisely until the preseason planning process is complete, but will be similar to that observed in 2010. In any case, the exploitation rate to natural-origin spring Chinook resulting from all fisheries in 2011 is expected to be less than 0.25, which is the expectation set through the recovery planning process (Walton 2010).

The expected exploitation rates for Lower Columbia River bright Chinook (Cascade Late Fall MPG) in Council and Fraser Panel fisheries in 2010 are 0.05 and 0.001, respectively. The exploitation rate on bright Chinook in all fisheries in 2010 is expected to be 0.24 (Table 17). The expected level of take in the Council and Fraser Panel fishing areas in 2011 will not be known precisely until the preseason planning process is complete. Council area and other inriver fisheries are managed subject to the 5,700 fish escapement goal for North Fork Lewis fall Chinook. Exploitation rates therefore may vary from year to year, but are expected to be similar to those observed in recent years (Table 14).

The take of Lower Columbia River tule Chinook (Gorge Fall MPG, Cascade Fall MPG, and Coastal Fall MPG) in 2010 is subject to a total exploitation rate limit of 0.38 for all ocean and inriver fisheries below Bonneville Dam. The harvest impacts are distributed between Alaskan and Canadian fisheries, those in the Council and Fraser Panel areas, and those that occur in the Columbia River. The expected exploitation rate from all fisheries is 0.375 and is thus consistent with the specified exploitation rate limit (Table 18). The expected exploitation rates in Council and Fraser Panel fisheries in 2010 are 0.15 and 0.003, respectively. The expected exploitation rate in fisheries in the Columbia River is 0.08. The distribution of impacts between the Council and Fraser Panel fisheries, and those that occur inriver, may change inseason so long as the total exploitation rate for all fisheries (including Canadian and Alaskan fisheries) does not exceed 0.38. In 2011 the total exploitation rate will be limited to 0.36 or 0.37. The limited will be specified prior to the start of the 2011 season in NMFS' guidance letter to the Council. The expected level of take in the Council and Fraser Panel fishing areas will not be known precisely until the preseason planning process is complete, but will be similar to that observed in recent years. In any case, take resulting from the proposed actions in 2011 will be subject to the total exploitation rate limit, after accounting for anticipated impacts in northern fisheries and freshwater fisheries that are outside the action area.

NMFS anticipates that some take of ESA-listed rockfish will occur as a result of the indirect effects of lost nets in the Fraser Panel fisheries. An estimated 12 nets become derelict within the Puget Sound region per year, though not all of these nets are associated with the Fraser Panel fisheries, and approximately 80% are eventually recovered. Estimating the specific number of ESA-listed rockfish that are killed from a derelict net depends upon the location of its loss, the habitat which it eventually catches on, and the occurrence of fish within or near that habitat. Though such estimates are difficult to precisely quantify, NMFS estimates that the loss of four nets used in the 2010 and 2011 Fraser Panel salmon fisheries would degrade approximately 45,000 square feet of benthic habitats used by ESA-listed rockfish.

4.2 Effect of the Take

In this biological opinion, NMFS has determined that the level of anticipated take is not likely to jeopardize the continued existence of Lower Columbia River Chinook or any of the ESA listed Puget Sound/Georgia Basin rockfish DPS'. Critical Habitat for Lower Columbia River Chinook was designated in 2005 (NMFS 2005b), but does not include offshore marine areas of Puget Sound and the Pacific Ocean. The bounds of the action area are therefore outside the bounds of critical habitat for Lower Columbia River Chinook. The activities considered in this consultation will therefore not result in the destruction or adverse modification of any of the essential features of designated critical habitat for the Lower Columbia River Chinook ESU. Critical habitat for the rockfish species has not been designated.

4.3 Reasonable and Prudent Measures

Reasonable and prudent measures are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). Terms and conditions implement the reasonable and prudent measures (50 CFR 402.14). These must be carried out for the exemption in section 7(o)(2) to apply.

NMFS concludes that there are two reasonable and prudent measures necessary and appropriate to minimize the impacts to Lower Columbia River Chinook from fisheries considered in this biological opinion.

1. Inseason management actions taken during the course of the fisheries shall be consistent with the exploitation rate limits defined in Section 4.1 of the Incidental Take Statement above. NMFS shall consult with the PFMC, states and tribes to account for the catch of Chinook in PFMC area fisheries as these occur through the season. NMFS will track the results of these monitoring activities, in particular, and any anticipated or actual increases in the incidental exploitation rates of listed Lower Columbia River Chinook from those expected preseason.

2. Harvest impacts on listed salmon stocks shall be monitored using best available measures. Although NMFS is the federal agency responsible for seeing that this reasonable and prudent measure is carried out, in practical terms, it is the states and tribes that conduct monitoring of catch and non-retention impacts.

NMFS also concludes that the following reasonable and prudent measure is necessary to minimize the impacts to ESA listed Puget Sound/Georgia Basin rockfish.

3. Derelict gear impacts on listed rockfish shall be reported using best available measures. Although NMFS is the federal agency responsible for seeing that this reasonable and prudent measure is carried out, in practical terms, it is the states and tribes that operate and enforce such reporting requirements.

4.4 Terms and Conditions

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

1a. NMFS shall confer with the affected states and tribes, the PFMC chair and the U.S. Fraser Panel, as appropriate, to ensure that inseason management actions taken during the course of the fisheries are consistent with the exploitation rate limits specified in Section 4.1 of the Incidental Take Statement above.

1b. NMFS shall confer with the affected states and tribes, the PFMC chair, and the U.S. Fraser Panel to account for the catch of the PFMC and U.S. Fraser Panel fisheries throughout the season. If it becomes apparent inseason that the fisheries have changed in any way such that estimates of exploitation rates may exceed those specified in the Incidental Take Statement, then NMFS, in consultation with the PFMC, and states and tribes, shall take additional management measures to reduce the anticipated catch as needed to conform to the Incidental Take Statement.

2a. NMFS shall ensure that monitoring of catch in the PFMC and U.S. Fraser Panel commercial and recreational fisheries by the PFMC, states, and tribes is sufficient to provide statistically valid estimates of the catch of salmon. The catch monitoring program shall be stratified by gear, time and management area. Sampling of the commercial catch shall entail daily contact with buyers regarding the catch of the previous day. The recreational fishery shall be sampled using effort surveys and suitable measures of catch rate.

2b. NMFS, in cooperation with the affected states and tribes, the PFMC chair, and the U.S. Fraser Panel, as appropriate, shall monitor the catch and implementation of other management measures, e.g., non-retention fisheries, at levels that are comparable to those used in recent years. The monitoring is to ensure full implementation of, and compliance with, management actions specified to control the various fisheries within the scope of the action.

2c. NMFS, in cooperation with the affected states and tribes, the PFMC chair, and the U.S. Fraser Panel, as appropriate, shall sample the fisheries for stock composition, including the collection of coded-wire-tags in all fisheries and other biological information, to allow for a thorough and statistically valid post-season analysis of fishery impacts on listed species.

2d. The use of non-retention in both commercial and recreational fisheries is becoming more prevalent in fisheries management, as a way to decrease impacts on stocks of concern and/or increase fishing opportunity. NMFS shall ensure that postseason harvest assessment by the states, tribes and PFMC include estimates of mortality in non-retention fisheries and a description of the methods used in the estimation.

3. NMFS, in cooperation with the Washington State Department of Fish and Wildlife, and Puget Sound tribes, and the U.S. Fraser Panel, as appropriate, shall ensure that commercial fishers report the loss of any fishing gear immediately to appropriate authorities.

4.5 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

For the reasons discussed above, NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented.

1. NMFS provided a list of tasks in its guidance letter to the Council that are designed to accelerate recovery by identifying and promoting actions that will benefit Lower Columbia River tule populations in particular (Thom and McInnis 2010). All of the tasks are discretionary and designed to provide better information that will promote recovery or minimize the effects of future harvest. The list of tasks is therefore also provided here as conservation recommendations.

   a) Describe the primary funding sources for habitat improvement projects, and existing data bases and/or summaries of all past and present projects that benefit LCR tule populations. The report should include an assessment of the feasibility and utility of developing a more coordinated and centralized reporting system. The report will also comment on how to best improve coordination and reporting of all future projects.

   b) Identify the amount and distribution of extant marsh type habitats currently inaccessible for juvenile rearing. The report will focus specifically on lower tributary and mainstem Columbia juvenile rearing habitats used by Lower Columbia River tule Chinook populations. The report should also identify ongoing efforts to gather additional data on current and potential juvenile rearing habitat distribution in the Lower Columbia River.

c) Identify milestones or expected trends in improved habitat conditions in high priority tributary and intertidal areas for tule Chinook populations.

d) Describe a recovery plan implementation schedule that identifies specific actions for a 3 to 5 year period, potential implementing entities, costs, location and duration of actions, funding sources, VSP and limiting factors affected, and linkages to milestones for improved habitat conditions.

e) Describe the transition strategy for reducing the proportion of hatchery fish in natural spawning areas for primary tule Chinook populations in a manner that addresses short term demographic risks while promoting progress to recovery objectives.

f) Analyze options for implementing mark selective fisheries. The report should include an analysis of the feasibility of mark selective fisheries, the magnitude of differential harvest impacts to marked and unmarked fish, and the relative benefits of efforts to reduce the harvest mortality to natural origin fish and reduce the proportion of hatchery fish on the spawning grounds. The report should also provide a schedule for assessing selective fishing gear and mortality rates of released fish.

g) Analyze options for incorporating abundance driven management principles into Lower Columbia tule Chinook management.

h) Review and update existing escapement estimate time series for selected primary tule populations with particular attention to estimates of hatchery contribution. The report should also describe current escapement monitoring programs and how they are designed to address key uncertainties.

2. NMFS, in collaboration with the PFMC, states, and tribes, should evaluate, where possible, improvement in gear technologies and fishing techniques that reduce the mortality of listed species, e.g., use of live tanks, net configuration, and release methods.

3. NMFS, in collaboration with the PFMC, states, and tribes, should continue to evaluate the effects to listed species of mark/selective, non-retention commercial and recreational fishing methods. Additional information is needed on:

   a) Release mortality rates, particularly in inriver, fall season fisheries;
   b) The design of sampling programs that provide necessary estimates of encounter rates of unmarked fish that are released;
   c) Criteria that can be used to evaluate the scale of mark/selective fisheries with the goal of limiting potential adverse affects.

4. NMFS, in collaboration with the PFMC, states, and tribes, should continue to improve the quality of information gathered on ocean rearing and migration patterns to improve the understanding of the utilization and importance of these areas to listed Pacific salmon.

5. NMFS, in collaboration with the PFMC, states, and tribes, should continue to evaluate the potential selective effects of fishing on the size, sex composition, and age composition of salmon populations.

4.6 Re-initiation of Consultation

This concludes the biological opinion on the 2010 and 2011 PFMC and U.S. Fraser Panel Fisheries. 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 agency action on listed species or designated critical habitat in a manner or to an extent not considered in this Opinion, 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion, or 4) a new species is listed or critical habitat designated that may be affected by the action.

5 Magnuson-Stevens Act EFH 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 NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2)); NMFS 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 NMFS 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 NMFS 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 NMFS 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.

5.1 Identification of Essential Fish Habitat

The PFMC is one of eight Regional Fishery Management Councils established under the Magnuson-Stevens Act. The PFMC develops and carries out fisheries management plans for Pacific coast groundfish, coastal pelagic species and salmon off the coasts of

Washington, Oregon, and California, and recommends Pacific halibut harvest regulations to the International Pacific Halibut Commission.

Pursuant to the Magnuson-Stevens Act, the 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. mikiss), 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.

5.2 Proposed Action and Action Area

For this EFH consultation, the proposed actions and action area are as described in detail above. The proposed actions are (1) NMFS’ promulgation of ocean fishing regulations within the Exclusive Economic Zone (EEZ) of the Pacific Ocean and, (2) NMFS’ regulation of U.S. Fraser Panel fisheries in northern Puget Sound under the Pacific Salmon Treaty (PST). The action area includes the EEZ, which is directly affected by the federal action, and the coastal and inland marine waters of the states of Washington, Oregon and California, which may be indirectly affected by the federal action. For the U.S. Fraser Panel Fisheries, the action area includes the U.S. waters of the Strait of Juan de Fuca and the San Juan Islands in northern Puget Sound. The estuarine and offshore marine waters are designated EFH for various life stages of groundfish and five coastal pelagic species. The action area also encompasses the Council-designated EFH for Chinook and coho salmon.

5.3 Effects of the Proposed Action

While harvest related activities do affect passage in that fish are intercepted, those impacts are accounted for explicitly in the ESA analyses regarding harvest related mortality. The harvest-related activities of the proposed actions considered in this consultation involve boats using hook-and-line gear and commercial purse seines, reef nets and gill nets. The use of these gears affects the water column and the shallower estuarine and nearshore 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). The PFMC also assessed the effects of fishing activities, including ghost fishing by gillnets, on EFH for groundfish and provided recommended conservation measures that were adopted for Amendment 19 to the Pacific Coast Groundfish Management Plan (PFMC 2005). The final rule implementing Amendment 19 will provide measures necessary to conserve EFH for groundfish. Therefore, no additional EFH recommendations are necessary for this proposed action.

Of the three types of impact on EFH identified by the PFMC for fisheries in Council waters, the concern regarding gear-substrate interactions and removal of salmon carcasses are also potential concerns for the fisheries in U.S. Fraser Panel waters. The types of salmon fishing gear that are used in U.S. Fraser Panel Fisheries - purse seine, reef net, and gillnet - actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. Consequently, there will be minimal disturbance to vegetation, and negligible harm to rearing habitat, or to water quantity and water quality. The PFMC conservation recommendations to address the concern regarding removal of salmon carcasses were to manage for maximum sustainable spawner escapement and implementation of management measures to prevent overfishing. Both of these conservation measures are basic principles of Fraser Panel management (PST 1999; Puget Sound Salmon Management Plan 1985). 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.

5.4 Conclusion

The 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. The U.S. Fraser Panel fisheries are unlikely to adversely affect EFH as described in Subsection 5.3 above.

Therefore, NMFS concludes that EFH has been adequately addressed for the PFMC and U.S. Fraser Panel Fisheries.

5.5 EFH Conservation Recommendation

Pursuant to Section 305(b)(4)(A) of the Magnuson-Stevens Act, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. However, because NMFS concluded that (1) conservation recommendations have been made and adopted for the PFMC Fisheries and (2) the proposed U.S. Fraser Panel Fisheries would not adversely affect the EFH, no additional conservation recommendations beyond those identified and already adopted are needed.

5.6 Statutory Response Requirement

Because there are no conservation recommendations, there are no statutory response requirements.

5.7 Consultation Renewal

NMFS must reinitiate EFH consultation if the proposed PFMC or U.S. Fraser Panel Fisheries 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)).

6 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 proposed 2010 and 2011 PFMC and U.S. Fraser Panel Fisheries will not jeopardize the Lower Columbia River Chinook Salmon ESU. NMFS can therefore write a no-jeopardy Biological Opinion for the incidental take of ESA-listed Lower Columbia River Chinook during conduct of 2010 and 2011 PFMC and U.S. Fraser Panel Fisheries. The intended users are the members of the PFMC, the U.S. Fraser Panel and their respective communities. 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 PFMC and U.S. Fraser Panel. This biological opinion will be posted on the NMFS 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 NMFS 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 NMFS 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 NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

7 References

Anderson and Bowles. 2008. Letter from Philip Anderson (WDFW) and Ed Bowless (ODFW) to Robert A. Turner (NMFS). January 12, 2008. 5pp w/ attacments

Anderson, P. 2010a. Letter from Philip Anderson (WDFW) to Barry Thom, NMFS. February 22, 2010. 7 p. w/ attachment.

Anderson, P. 2010b. Letter from Philip Anderson (WDFW) to Barry Thom, NMFS. February 24, 2010. 3 p.

Bellinger, M.R., M. Banks, L. Weitkamp, P. Lawson. 2009. Mixed Stock Analsyis of Chinook Salmon in Pacific Whiting (Hake) Bycatch Collected Shoreside in Newport, Oregon. Project CROOS Collaborative Research on Oregon Ocean Salmon. Preliminary Report. May 21, 2009. 9 p.

Bellman, M. and J. Hastie. 2008. Observed and Estimated Total Bycatch of Salmon in the 2005-2006 West Coast Limited-Entry Bottom Trawl Groundfish Fishery. February 22, 2008. 8 pp.

Bellman, M. A., E. Heery, and J. Majewski. 2010. Observed and Estimated Bycatch of Salmon in the 2008 U.S. West Coast Groundfish Fisheries. Northwest Fisheries Science Center. February 2, 2010. 31 p.

Bonneville Power Administration (BPA). 2008. Revised Master Plan for the Hood River Production Program. Technical Report 2008. DOE/BP-P106494. April 2008.

Casillas, E., L. Crockett, Y. deReynier, J. Glock, M. Helvey, B. Meyer, C. Schmitt, M. Yoklavich, A. Bailey, B. Chao, B. Johnson, T. Pepperell. 1998. Essential Habitat West Coast Groundfish Appendix. National Marine Fisheries Service, Montlake, Washington. 778 p.

Columbia Basin Fish and Wildlife Authority (CBFWA). 1990. Integrated system plan for salmon and steelhead production in the Columbia River Basin, 442 p. Northwest Power Planning Council, 851 S. W. Sixth Ave., Suite 1100, Portland Oregon 97204-1348.

Collis, K., S. Adamany, D. D. Roby, D. P. Craig, and D. E. Lyons. 1999. Avian predation on juvenile salmonids in the lower Columbia River. Report to Bonneville Power Administration and U.S. Army Corps of Engineers. Columbia River Inter-Tribal Fish Commission, Portland, Oregon, and Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis. October.

Craig, J. A. and R. L. Hacker. 1940. The history and development of the fisheries of the Columbia River. U.S. Bureau of Fisheries Bulletin. 49(32): 133-215.

Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999. Status of Chinook salmon and their habitat in Puget Sound, volume 2. Final report. S.P. Cramer and Associates, Gresham, Oregon.

Crozier, L., R. Zabel, and A. Hamlet. 2008. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology 14:236-249.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the watershed: a new approach to save America's river ecosystems. Island Press, Washington D.C.

Flagg, T. A., F. W. Waknitz, D. J. Maynard, G. B. Milner, and C.V.W. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the lower Columbia River. In Uses and effects of cultured fishes in aquatic systems. Transactions of the American Fisheries Society 15: 366-375.

Ford, M., N. Sands, P. McElhany, R. Kope, D. Simmons, and P. Dygert. 2007. Analyses to Support a Review of an ESA Jeopardy Consultation on Fisheries Impacting Lower Columbia River Tule Chinook Salmon. October 5, 2007. 66pp

Frissell, C. A. 1993. A new strategy for watershed restoration and recovery of Pacific salmon in the Pacific Northwest. Prepared for the Pacific Rivers Council, Eugene, Oregon.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-WFSC-66, 598 p.

Hare, S. R., N. J. Mantua and R. C. Francis. 1999. Inverse production regimes: Alaskan and West Coast Salmon. Fisheries 24(1):6-14.

Heery, E., M. Bellman, and J. Hastie. 2009. Observed and Estimated Total Bycatch of Salmon in the 2007 U.S. West Coast Groundfish Fisheries. March 21, 2009. 33 pp.

Henjum, M. G., J. R. Karr, D. L. Bottom, D. A. Perry, J. C. Bednarz, S. G. Wright, S. A. Beckwitt, and E. Beckwitt. 1994. Interim Protection for late-successional forests, fisheries, and watersheds: national east of the Cascade Crest, Oregon and Washington. The Wildlife Society, Bethesda, Maryland.

Hatchery Scientific Review Group (HSRG). 2009. Columbia River Hatchery Reform System-Wide Report. February 2009.

Hannah, R.W., and S.A. Jones. 2007. Effectiveness of bycatch reduction devices (BRDs) in the ocean shrimp (Pandalus jordani) trawl fishery. Fisheries Research 85: 217-225.

Independent Science Group (ISG). 1996. Return to the river: Restoration of salmonid fishes in the Columbia River ecosystem. Northwest Power Planning Council, Portland, Oregon. Publication No. 96-6. 584 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB, Report 2007-2, Portland, Oregon.

Jones and Stokes. 2009. Final Lewis River Hatchery and Supplementation Plan (FERC Project Nos. 935, 2071, 2111, 2213). Prepared for: PACIFICORP ENERGY AND COWLITZ PUD by: Jones & Stokes. December 23, 2009. 56 p.

Kope, R. 2005. Performance of Ocean Salmon Fisheries Management Relative to National Marine Fisheries Service Endangered Species Act Consultation Standards. November 17, 2005. 18 pp.

Kope, R. 2006. Ocean fishery impacts on Lower Columbia River tule fall Chinook. Memorandum to Peter Dygert (NMFS). March 1, 2006. 4 pp.

Kope, R. 2007. Memorandum to Peter Dygert. February 15, 2007. 2 pp.

LaVoy, L. 2010a. Memorandum to Peter Dygert. April 15, 2010. 1 pp.

LaVoy, L. 2010b. Memorandum to Peter Dygert. February 11, 2010. 1 pp.

LeFleur, C. 2010. Personal communication from C. LeFleur, WDFW, to Paul McElhany, NOAA-NWFSC.

Lohn, D.R. 2006. Letter from D. Robert Lohn (NMFS) to C. Gregoire, J. Koenings, and G. Trott. February 3, 2006. 2 pp.

Lohn, D.R. and Rodney McInnis. 2006. Letter from NMFS Northwest and Southwest Regional Administrators to Don Hansen, Chairman of the Pacific Fisheries Management Council, regarding ESA consultation standards and guidance on the effects of the 2006 fishing season on ESA listed species. March 6, 2006. 13 pp.

Lohn, D.R. and Rodney McInnis. 2007. Letter from NMFS Northwest and Southwest Regional Administrators to Don Hansen, Chairman of the Pacific Fisheries Management Council, regarding ESA consultation standards and guidance on the effects of the 2007 fishing season on ESA listed species. March 1, 2007. 15 pp.

Lower Columbia River Estuary Program (LCREP). 1999. Comprehensive Conservation and Management Plan. Volume 1: June 1999. Lower Columbia River Estuary Program, Portland, Oregon.

Lower Columbia River Fish Recovery Board (LCFRB). 2004. Lower Columbia River Salmon Recovery and Fish and Wildlife Subbasin Plan. http://www.lcfrb.gen.wa.us December 15, 2004. In 2 volumes and 5 technical appendices.

Lower Columbia Fish Recovery Board (LCFRB). 2010. Washington lower Columbia salmon recovery and fish & wildlife subbasin plan updates.

Lower Columbia Tule Chinook Working Group (LCTCWG). 2008. Addendum to analyses to support a review of an ESA jeopardy consultation on fisheries impacting lower Columbia River tule Chinook salmon, October 5, 2007.

Mantua, N.J. and S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997: A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society, 78, pp. 1069-1079.

Mantua, N.J., and S.R. Hare. 2002. The Pacific decadal oscillation. Journal of Oceanography 58:35-44.

MEW (Model Evaluation Workgroup). 2006. Fishery Regulation Assessment Model (FRAM). An Overview for Chinook and Coho. PFMC. Portland, OR.

McElhany, P. , M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 156 pp. http://www.nwfsc.noaa.gov/pubs/ .

McElhany, P., Busack, C., Chilcote, M., Kolmes, S., McIntosh, B., Myers, J., Rawding, D., Steel, A., Steward, C., Ward, D., Whitesel, T., and Willis, C. 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia Basins. Review draft. April 1, 2006.

McElhany, P., Chilcote, M., Myers, J., and Beamesderfer, R. 2007. Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins. Public Review Draft, June 25, 2007

Minobe, S. 1997. A 50-70 year climatic oscillation over the North Pacific and North America. Geophysical Research Letters 24(6):683-686.

Moran, P. E. Iwamota, R. Shama, and V. Tuttle. 2009. Chinook salmon bycatch stock composition estimates in the 2008 Pacific hake fishery. September 1, 2009. 23 p.

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D.M. Van Doornik, and M.T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-73, 311 p.

NMFS (National Marine Fisheries Service). 1993a. Designated critical habitat; Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River fall Chinook salmon. Final rule. Federal Register 58:247(28 December 1993):68543-68554.

NMFS. 1993b. Designated critical habitat; Sacramento River Winter-run, Sacramento River Chinook salmon. Final rule. Federal Register 58:33212 (16 June 1993): 33212-33219.

NMFS. 1996a. Endangered Species Act - Section 7 Consultation - Biological Opinion. The Fishery Management Plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon and California. March 8, 1996. 53 pp + attachments.

NMFS. 1997a. Endangered Species Act - Section 7 Consultation and Formal Conference- Supplemental Biological Opinion and Conference. The Fishery Management Plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon, and California of the Pacific Fishery Management Council. April 30, 1997. 17 pp. + attachment.

NMFS. 1998a. Endangered Species Act - Section 7 Consultation - Supplemental Biological Opinion. The Fishery Management Plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon and California of the Pacific Fisheries Management Council. April 29, 1998. 19 pp.

NMFS. 1999a. Endangered Species Act - Section 7 Consultation - Supplemental Biological Opinion and Incidental Take Statement. The Pacific Coast Salmon Plan and Amendment 13 to the Plan. NMFS, Protected Resources Division. April 28, 1999. 39 pp. + attachment.

NMFS. 1999b. Designated critical habitat; revision of critical habitat for Snake River spring/summer Chinook salmon. Final Rule. Federal Register 64:205 (25 October 1999): 57399-57403.

NMFS. 1999c. Designated Critical Habitat; Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon. Final Rule. Federal Register 64:86 (5 May 1999): 24049-24062.

NMFS. 1999d. Endangered Species Act – Reinitiation of Section 7 Consultation – Biological Opinion and Incidental Take Statement. The Fishery Management Plan for Commercial and Recreational Fisheries off the Coasts of Washington, Oregon, and California of the Pacific Fishery Management Council. NMFS. Sustainable Fisheries Division. April 30, 1999. 46 pp.

NMFS. 1999e. Endangered and threatened species; threatened status for three Chinook salmon Evolutionarily Significant Units (ESUs) in Washington and Oregon, and endangered status for one Chinook salmon ESU in Washington. Federal Register 64: 56 (March 24, 1999) 14308-14328.

NMFS. 2000a. Endangered Species Act - Reinitiated Section 7 Consultation - Effects of Pacific coast ocean and Puget Sound salmon fisheries during the 2000-2001 annual regulatory cycle. NMFS, Protected Resources Division. April 28, 2000. 99 pp.

NMFS. 2000b. Endangered Species Act - Reinitiated Section 7 Consultation - Biological Opinion and Incidental Take Statement. Effects of Pacific Coast Salmon Plan on California Central Valley spring-run Chinook, and California coastal Chinook salmon. NMFS, Protected Resources Division. April 28, 2000. 31 pp.

NMFS. 2001a. NMFS Determination Memorandum: Summer Chum Salmon Conservation Initiative - An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca - Harvest Management Component, April 27, 2001.

NMFS. 2001b. Endangered Species Act - Reinitiated Section 7 Consultation Biological Opinion and Incidental Take Statement - Effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel fisheries on Upper Willamette River Chinook, Lower Columbia River Chinook, Lower Columbia River chum. NMFS Protected Resources Division. April 30, 2001. 55 pp.

NMFS. 2004a. Endangered Species Act (ESA) Section 7 Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. Effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel fisheries on the Puget Sound Chinook and Lower Columbia River Chinook Salmon Evolutionarily Significant Units. National Marine Fisheries Service, Northwest Region. April 29, 2004. 89 p.

NMFS. 2004b. NOAA Fisheries' Approach to Making Determinations Pursuant to the Endangered Species Act about the Effects of Harvest Actions on Listed Pacific Salmon and Steelhead. Northwest Region, Sustainable Fisheries Division. November 16, 2004. 13 pp w attachments.

NMFS. 2005a. Endangered and threatened species; final listing determinations for 16 evolutionarily significant units of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs. Final rule. Federal Register 70:123(28 June 2005):37160-37204.

NMFS. 2005b. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of West Coast salmon and steelhead in Washington, Oregon, and California. Final rule. Federal Register 70:170(2 September 2005):52630-52858.

NMFS. 2005c. Endangered and threatened wildlife and plants: endangered status for Southern Resident killer whales. Federal Register 70:222(18 November 2005):69903-69912.

NMFS. 2005d. Memorandum to the Record. From Rodney R. McInnis. Subject: Endangered Species Section 7 Consultation on the Effects of Ocean Salmon Fisheries on California Coastal Chinook Salmon: Performance of the Klamath Ocean Harvest Model in 2004 and Implementation of the Reasonable and Prudent Alternative of the April 28, 2000, Biological Opinion. June 13, 2005. 14 pp.

NMFS. 2005e. Draft Interim Regional Recovery Plan for Portions of Three Evolutionarily Significant Units (ESUs) of Salmon and Steelhead—Lower Columbia River Chinook (Oncorhynchus tshawytscha), Columbia River Chum (Oncorhynchus keta), and Lower Columbia River Steelhead (Oncorhynchus mykiss)—within the Washington Lower Columbia Management Unit. NMFS' Supplement to the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan. April 15, 2005. 28 pp.

NMFS. 2006a. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast Steelhead. Final rule. Federal Register 71:3(5 January 2006):834-862.

NMFS. 2006b. Endangered and threatened wildlife and plants: threatened status for Southern distinct population segment of North American Green Sturgeon. Federal Register 71:67(7 April 2006):17757-17766.

NMFS. 2006c. Endangered and threatened species; designation of critical habitat for Southern Resident killer whale. Federal Register 71:229(29 November 2006): 69054-69070

NMFS. 2006d. Endangered Species Act - Section 7 Consultation - Biological Supplemental Opinion. Reinitiation of Section 7 Consultation Regarding the Pacific Fisheries Management Council's Groundfish Fishery Management Plan. NMFS, Northwest Region. March 11, 2006. 34 pp.

NMFS. 2007a. Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead. Final rule. Federal Register 72:91 (11 May 2007): 26722-26735.

NMFS. 2007b. Biological Opinion on the effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel Fisheries on the Lower Columbia River Coho and Lower Columbia River Chinook Evolutionarily Significant Unit Listed Under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation for 2007. April 30, 2007. 110 pp.

NMFS. 2007c. Columbia River Estuary ESA recovery plan module for salmon and steelhead. Proposed Plan. Prepared for National Marine Fisheries Service by the Lower Columbia River Estuary Partnership. November 5, 2007.

NMFS. 2008a. Endangered and Threatened species. Final Threatened Listing Determination, Final Protective Regulations, and Final Designation of Critical Habitat for the Oregon Coast Evolutionarily Significant Unit of Coho Salmon. Final rule. Federal Register 73:28 (11 February 2008): 7816:7873.

NMFS. 2008b. Endangered and threatened wildlife and plants: Proposed rulemaking to designated critical habitat for the threatened Southern DPS of North American green sturgeon. Federal Register 73:174(8 September 2008):52084-52110.

NMFS. 2008c. Biological Opinion on the effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel Fisheries on the Lower Columbia River Coho and Lower Columbia River Chinook Evolutionarily Significant Units Listed Under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation. April 29, 2008. 120 pp.

NMFS. 2008d. 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. NMFS, Northwest Region. December 22, 2008.

NMFS. 2008e. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin Subject To the 2008-2017 US v. Oregon Management Agreement. NMFS, Northwest Region. May 5, 2008.

NMFS. 2008f. Effects of the Proposed 2008 U.S. Fraser Panel Salmon Fisheries on the Southern Resident Killer Whale (Orcinus orca) Distinct Population Segment. Biological Assessment June 27, 2008. 84 pp.

NMFS. 2008g. Supplemental comprehensive analysis of the Federal Columbia River Power System and mainstem effects of USBR Upper Snake and other tributary actions. NMFS, Portland, Oregon.

NMFS. 2008h. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. NMFS, Portland, Oregon.

NMFS. 2008i. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation Management Act Consultation for the operation and maintenance of 12 U.S. Bureau of Reclamation Projects in the upper Snake River Basin above Brownlee Reservoir. NMFS, Northwest Region. May 5, 2008.

NMFS. 2009a. Endangered Species Act - Section 7 Consultation Biological Opinion. Effects on the Pacific coast salmon plan on the Southern Resident Killer Whale (*Orcinus orca*) Distinct Population Segment. NMFS, Northwest Region. May 5, 2009. 79 p

NMFS. 2009b. Biological Opinion on the effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel Fisheries on the Lower Columbia River Chinook Evolutionarily Significant Units Listed Under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation. April 30, 2009. 129 pp.

NMFS. 2010a. Endangered and threatened species; final listing determinations for southern distinct population segment of Eulachon. Final rule. Federal Register 75:52(18 March 2010):13012-13024.

NMFS. 2010b. Endangered and threatened species: final listing determination for the Puget Sound/Georgia Basin distinct populations segments of yelloweye, canary, and bocaccio rockfish. Final rule. Federal Register 75:52(28 April 2010):22276-22290.

NMFS. 2010c. Endangered Species Act - Section 7 Consultation Biological Opinion. Authorization of Ocean Salmon Fisheries Pursuant to the Pacific Coast Salmon Fishery Management Plan and Additional Protective Measures as it affects Sacramento River Winter Chinook Salmon. April 30, 2010.

NMFS. 2010d. Draft ESA recovery plan for the White Salmon River Sub-Basin. February 2010.

NOAA (National Oceanic and Atmospheric Administration). 2008. Time-series of MEI conditions from 1950 through November 2007. NOAA. Physical Sciences Division, Earth System Research Laboratory, Boulder, Colorado.

Northwest Fisheries Science Center (NWFSC). 2010. Lower Columbia River Chinook Salmon Life-Cycle Modeling. Draft Report. February 10, 2010. 46 p. w/ Appendices.

ODFW. 2005. 2005 Oregon Native Fish Status Report - Volume I Species Management Unit Summaries. ODFW Fish Division 3406 Cherry Avenue N.E. Salem, OR 97303-4924. 164 pp.

ODFW. 2007. Draft Oregon Lower Columbia Recovery Plan. July 20, 2007.

ODFW. 2009. Lower Columbia River conservation and recovery plan for Oregon populations of salmon and steelhead. December 18, 2009.

Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife (ODFW/WDFW). 2000. Status Report. Columbia River Fish Runs and Fisheries, 1938-1999. 309 pp.

Pacific Fishery Management Council (PFMC). 1998. Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to the Pacific Coast Groundfish Plan. October 1998.

PFMC. 1999. Amendment 14 to the Pacific Coast Salmon Plan. Appendix A: Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council, Portland, Oregon.

PFMC. 2003. Pacific Coast Salmon Plan – Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as revised through Amendment 14 (Adopted March 1999). Pacific Fishery Management Council, Portland, Oregon. September 2003.

PFMC. 2005. Amendment 19 to the Pacific Coast Groundfish Fishery Management Plan. Pacific Fishery Management Council. November 2005.

PFMC. 2010a. Preseason Report III Analysis of Council Adopted Management Measures for 2010 Ocean Salmon Fisheries. April 2010.

PFMC. 2010b. Review of 2009 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2010.

Pacific Salmon Treaty (PST). 1999. U.S. - Canada agreement relating to the Pacific Salmon Treaty. Annex IV, Chapter 4. June 30, 1999.

Puget Sound Salmon Management Plan. 1985. United States v. Washington (1606 F. Supp. 1405).

Quigley, T. M., and S. J. Arbelbide (eds). 1997. An assessment of ecosystem components in the interior Columbia River basin and portions of the Klamath and Great Basins: Volume 3. Gen. Tech. Rep. PNW-GTR-405. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol. (Quigley T. M., tech. ed.: The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment).

Roby, D. D., D. P. Craig, K. Collis, and S. L. Adamany. 1998. Avian predation on juvenile salmonids in the lower Columbia River. Report to Bonneville Power Administration and U.S. Army Corps of Engineers. Oregon Cooperative Fish and Wildlife Research Unit, Corvallis, and Columbia River Inter-Tribal Fish Commission, Portland, Oregon. September revision.

Roler, R. 2009. Washington Columbia River Tributary Stream Survey Sampling Results - 2007. Vancouver, Washington.

Scheuerell, M.D., J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14(6):448-457.

Scheuerell, M.D. 2010. A preliminary examination of run-size forecasting for Lower Columbia River tule Chinook salmon. Attachment 5 to Lower Columbia River Chinook Salmon Life-Cycle Modeling. Draft Report. Northwest Fisheries Science Center. 2010. February 10, 2010.

Simmons, D. 2008. Harvest impact distribution tables. Memorandum to P. Dygert, National Marine Fisheries Service, from D. Simmons, National Marine Fisheries Service, Lacey, Washington. April 17.

Stober, Q.J. 1986. Reintroduction of anadromous fish runs to the Tilton and upper Cowlitz Rivers. Washington State Department of Fisheries and Department of Game.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Prepared by Management Technology for the National Marine Fisheries Service. TR-4501-96-6057. (Available from the NMFS Habitat Branch, Portland, Oregon.).

Stanford, J. A., and J. V. Ward. 1992. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. Pages 91-124 in R. J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.

Steel, E. A., and M. B. Sheer. 2003. Appendix I: Broad-Scale Habitat Analyses to Estimate Fish Densities for Viability Criteria. In Willamette/Lower Columbia Technical Recovery Team, Interim Report on Viability Criteria for Willamette and Lower Columbia Basin Pacific Salmonids. Northwest Fisheries Science Center, NMFS, Seattle, WA.

TAC (U.S. v. Oregon Technical Advisory Committee). 2008. Biological assessment of incidental impacts on salmon species listed under the Endangered Species Act in the 2008-2017 non-Indian and treaty Indian fisheries in the Columbia River Basin.

Thomas, D. W. 1981. Historical analysis of the Columbia River estuary: An ecological approach. Draft report to the Columbia River Estuary Study Taskforce.

Thom, B. A. and Rodney McInnis. 2009. Letter from NMFS Northwest and Southwest Regional Administrators to Don Hansen, Chairman of the Pacific Fisheries Management Council, regarding ESA consultation standards and guidance on the effects of the 2009 fishing season on ESA listed species. March 3, 2009.

Thom, B. A. and Rodney McInnis. 2010. Letter from NMFS Northwest and Southwest Regional Administrators to David Ortmann, Chairman of the Pacific Fisheries Management Council, regarding ESA consultation standards and guidance on the effects of the 2010 fishing season on ESA listed species. March 2, 2010.

Turner 2007. Letter from Robert A. Turner to Ed Bowles (ODFW) and Philip Anderson (WDFW). November 28, 2007. 4 pp w/ table attached

U.S. v. Oregon Parties. 2008. 2008-2017 United States v. Oregon Management Agreement. May 2008. 143 pp.

Walton, R. 2010. Memorandum to Peter Dygert from R. Walton re Preliminary recovery strategy for the tule and spring components of the lower Columbia River Chinook ESU. April 6, 2010. 20 p. w/ attachment.

Willamette/Lower Columbia Technical Recovery Team (WLC-TRT). 2003. Interim Report on Viability Criteria for Willamette and Lower Columbia Basin Pacific Salmonids. March 31, 2003.

Willamette/Lower Columbia Technical Recovery Team (WLC-TRT). 2004. Status Evaluation of Salmon and Steelhead Populations in the Willamette and Lower Columbia River. July 2004.

Zabel, R. W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20 (1):190-200

Appendix A

Consideration of effects of the Strait of Juan de Fuca and San Juan salmon fisheries under the jurisdiction of the U.S. Fraser Panel pursuant to the Pacific Salmon Treaty to ESA-listed rockfish.

Current Rangewide Status of the Species

On April 28, 2010, NMFS listed the Puget Sound/Georgia Basin Distinct Population Segments (DPSs) of yelloweye rockfish (*Sebastes ruberrimus*) and canary rockfish (*Sebastes pinniger*) as threatened, and listed the Puget Sound/Georgia Basin DPS of bocaccio (*Sebastes paucispinis*) as endangered under the ESA (72 FR 2276; April 28, 2010). The listing of each species will become effective on July 27, 2010. These DPSs include all yelloweye rockfish, canary rockfish and bocaccio found in waters of the Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill (Figure 1). Puget Sound is the second-largest estuary in the United States, located in northwest Washington State, covering an area of about 2,330 square km (900 square miles), including 4,000 km (2,500 miles) of shoreline and is home to a rapidly-expanding human population. Puget Sound is part of a larger inland waterway, the Georgia Basin, situated between southern Vancouver Island, British Columbia, Canada and the mainland coasts of Washington State. Puget Sound can be subdivided into five interconnected basins separated by shallow sills: (1) The San Juan/Strait of Juan de Fuca region (also referred to as "North Sound"), (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. We use the term ''Puget Sound Proper'' to refer to all of these basins except the San Juan/Strait of Juan de Fuca region. All five basins have unique temperature regimes, water residence times and circulation patterns, biological condition, depth profiles and contours, species compositions, and nearshore and benthic habitats (Ebbesmeyer 1984, Burns 1985, Rice 2007).

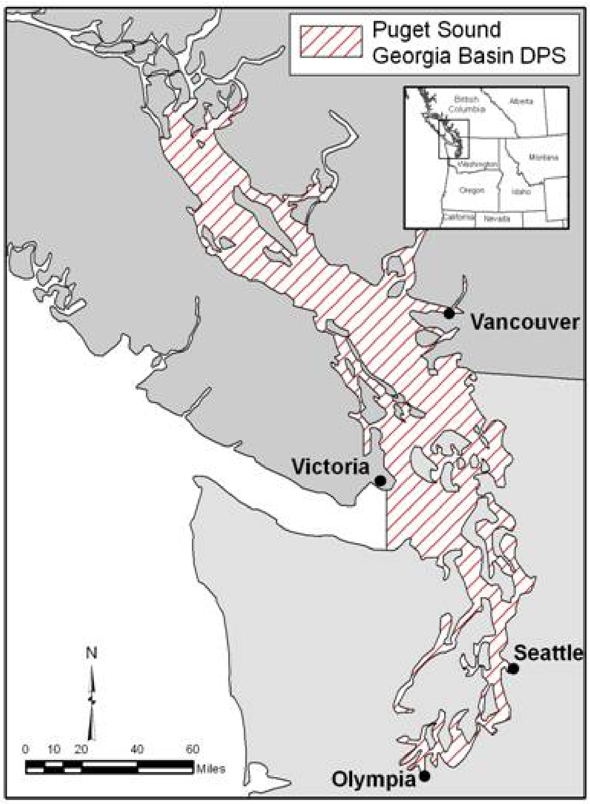


Figure 6. Puget Sound/Georgia Basin DPS for ESA-listed rockfish.

The life-histories of the yelloweye rockfish, canary rockfish and bocaccio include a larval and pelagic juvenile stage followed by a nearshore juvenile stage and sub-adult and adult stage. Much of the life-history for these three species is similar, with differences noted below.

Larval and Pelagic Juvenile Stage. Rockfish fertilize their eggs internally and the young are extruded as larvae. As larvae, rockfish generally occupy the upper 100 meters of the water column and are often near the surface (Love et al., 2002). Larvae can make small local movements to pursue food immediately after birth (Tagal et al., 2002), but are nonetheless passively distributed with prevailing currents. Larvae are observed under free-floating algae, seagrass and detached kelp (Shaffer et al., 1995, Love et al., 2002). Unique oceanographic conditions within Puget Sound Proper likely result in the larvae staying within the region where they are released rather than being broadly dispersed (Drake et al., 2010).

Nearshore Juvenile Stage. When bocaccio and canary rockfish reach sizes of 3 to 9 cm or 3 to 6 months old, they settle onto shallow nearshore waters in rocky or cobble substrates with or without kelp (Love et al., 1991, Love et al., 2002). These habitat features offer a beneficial mix of warmer temperatures, food and refuge from predators (Love et al., 1991). Areas with floating and submerged kelp species support the highest densities of most juvenile rockfish (Carr 1983, Halderson and Richards 1987, Matthews, 1989, Hayden-Spear 2006). Unlike bocaccio and canary rockfish, juvenile yelloweye rockfish do not typically occupy intertidal waters (Love et al., 1991; Studebaker et al. 2009), but settle in 30 to 40 meters of water near the upper depth range of adults (Yamanaka and Lacko 2001).

Sub-Adult and Adult. Subadult and adult yelloweye rockfish, canary rockfish and bocaccio typically utilize habitats with moderate to extreme steepness, complex bathymetry and rock and boulder-cobble complexes (Love et al., 2002). Within Puget Sound Proper, each species has been documented in areas of high relief rocky and non-rocky substrates such as sand, mud and other unconsolidated sediments (Washington, 1977 and Miller and Borton, 1980). Yelloweye rockfish remain near the bottom and have small home-ranges, while some canary rockfish and bocaccio have larger home ranges, move long distances, and spend time suspended in the water column (Love et al., 2002). Adults of each species are most commonly found between 40 to 250 m (Love et al., 2002, Orr et al., 2000). In southeast Alaska, adult yelloweye and canary rockfish were observed at mean depths of 46 and 53 meters and minimum depths of 21 and 37 meters, respectively (Johnson et al., 2003).

Yelloweye rockfish are one of the longest lived of the rockfishes, reaching more than 100 years of age, and reach 50 percent maturity at sizes around 40 to 50 cm and ages of 15 to 20 (Rosenthal et al., 1982, Yamanaka and Kronlund 1997). Maximum age of canary rockfish is at least 84 years (Love et al., 2002), although 60 to 75 years is more common (Caillet et al., 2000). They reach 50 percent maturity at sizes around 40 cm and ages of 7 to 9. The maximum age of bocaccio is unknown, but may exceed 50 years, and they are first reproductively mature near age 6 (Love et al., 2002). The timing of larval release for each species varies throughout the geographic range. In Puget Sound, there is some evidence that larvae are extruded in early spring to late summer for yelloweye rockfish (Washington et al. 1978). In British Columbia, parturition peaks in February for canary rockfish (Hart 1973, Westrheim and Harling 1975). Along the coast of Washington state, female bocaccio release larvae between January and April (Love et al., 2002). Each species produces from several thousand to over a million eggs (Love et al., 2002).

Viability Criteria

In the following section, the condition of the yelloweye rockfish, canary rockfish and bocaccio DPSs are summarized at the DPS level according to the following demographic risk criteria: abundance and productivity, spatial structure/connectivity, and diversity. These viability criteria are outlined in McElhaney et al. (2000), and reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species. These criteria describe demographic risks that individually and collectively provide strong indicators of extinction risk (Drake et al., 2010).

Abundance & Productivity

The abundance of individuals in a population is important in assessing two aspects of extinction risk. First, population size can be an indicator of whether the population can sustain itself in the face of environmental fluctuations and small-population stochasticity, even if it currently may be stable or increasing. Second, abundance in a declining population is an indicator of the time expected until the population reaches critically low numbers (Drake et al., 2010). Small rockfish populations are subject to additional risks that include: 1) environmental variation such as altered temperature regimes and circulation patterns that could disrupt food-webs, larval dispersal or juvenile rearing, 2) genetic processes, such as the accumulation of negative mutations, 3) demographic stochasticity, such as imbalanced sex ratios, 4) ecological feedback, such as other fish species occupying the niche left by the depleted population which hinders recovery, and 5) catastrophes, such as oil spills, which disrupt benthic environments or larval/juvenile rearing habitats and food sources (McElhaney et al., 2000). An additional risk from low abundance is depensatory processes (termed "Allee" effects) that occur when mates cannot find one another (Courchamp et al., 2008).

There is no single reliable historic or contemporary population estimate for yelloweye rockfish, canary rockfish or bocaccio within the Puget Sound/Georgia Basin DPS (Drake et al., 2010). Despite this limitation, there is clear evidence each species' abundance has declined dramatically (Drake et al., 2010). The total rockfish population in the Puget Sound region is estimated to have declined around three percent per year for the past several decades, which corresponds to an approximate 70 percent decline from the 1965 to 2007 time period (Drake et al., 2010). Catches of each species have declined as a proportion of the overall rockfish catch (Palsson et al., 2009, Drake et al., 2010). Yelloweye rockfish were 2.4 percent of the harvest in North Sound during the 1960s, occurred in 2.1 percent of the harvest during the 1980s, but then decreased to an average of one percent from 1996 to 2002 (Palsson et al., 2009). In Puget Sound Proper, yelloweye rockfish comprised 4.4 percent of the harvest during the 1960's, only 0.4 percent during the 1980's, and 1.4 percent from 1996 to 2002. Canary rockfish occurred in 6.5 percent of the North Sound recreational harvests during the 1960's and then declined to 1.4 percent and to 0.6 percent during the subsequent two periods. During the 1960's, canary rockfish comprised 3.1 percent of the Puget Sound Proper rockfish harvest and then declined to one percent in the 1980's and 1.4 percent from 1996 to 2002.

Bocaccio were reported to consist of eight to nine percent of the overall rockfish catch in the late-1970s (Drake et al., 2010), and declined in frequency, relative to other species of rockfish, from the 1970s to the 1980's to the 1990's. From 1975-1979, bocaccio were reported as an average of 4.63 percent of the catch. In 1980-1989, they were 0.24 percent of the 8,430 rockfish identified (Palsson et al. 2009). From 1996 to 2007, bocaccio were not observed out of the 2,238 rockfish identified in the dockside surveys of the recreational catches. In 2008, several fish were reported by recreational anglers in the Central Sound (WDFW unpublished data).

Fishery-independent estimates of population abundance come from spatially and temporally limited research trawls, drop camera surveys and underwater remotely operated vehicle (ROV) surveys conducted by the Washington Department of Fish & Wildlife (WDFW). These population estimates should be interpreted in the context of the sampling design and gear. The trawl surveys were conducted on the bottom to assess marine fish abundance for a variety of species. These trawls generally sample over non-rocky substrates where yelloweye rockfish, canary rockfish and bocaccio are less likely to occur compared to steep-sloped, rocky habitat (Drake et al., 2010). The drop camera surveys sampled habitats less than 120 feet, which is potential habitat for juveniles, but less likely habitat for adults of the three listed species. Similarly, because juvenile yelloweye rockfish are less dependent on rearing in shallow nearshore environments, the likelihood of documenting them with drop camera surveys less than 120 feet is less than for canary rockfish and bocaccio.

The ROV surveys were conducted exclusively within the rocky habitats of the San Juan Island region in 2008, and represent the best available abundance data for one region of the DPS for each species to date. Rocky habitats have been mapped within the San Juan Island region, which allows a randomized survey of these habitats to assess species assemblages and collect data for abundance estimates. In 200 transects the WDFW surveyed a subset of rocky habitats stratified as "shallower than" and "deeper than" 120 feet. The total area surveyed within each stratum was calculated using the average transect width multiplied by the transect length. The mean density of yelloweye rockfish, canary rockfish, and bocaccio rockfish were calculated by dividing the species counts within each stratum by the area surveyed. Population estimates for each species were calculated by multiplying the species density estimates by the total survey area within each stratum (WDFW unpublished data). Since the WDFW did not survey non-rocky habitats of the San Juan Island region with the ROV, these estimates do not account for ESA-listed rockfish in non-rocky habitat in 2008.

The WDFW expanded the survey data to estimate total abundance in the San Juan Island region. From the mid-water trawl and drop camera surveys, the WDFW has reported population estimates in the North Sound and the Puget Sound Proper (Table 1).

Table 1. WDFW Population Estimates for Yelloweye Rockfish, Canary Rockfish and Bocaccio.

WDFW Survey Method	Yelloweye Population Estimate		Percent Standard Error (or Variance)	
	North Sound	Puget Sound Proper		
Bottom Trawl	Not detected	600	NA	400 (variance)
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	50,656 (San Juan Region)		29	
WDFW Survey Method	Canary Population Estimate		Percent Standard Error (or Variance)	
	North Sound	Puget Sound Proper		
Bottom Trawl	16,100	Not detected	260.6 (variance)	NA
Drop Camera	2,751	Not detected	89.3	NA
Remotely Operated Vehicle	1,648 (San Juan Region)		100	
WDFW Survey Method	Bocaccio Population Estimate		Percent Standard Error	
	North Sound	Puget Sound Proper		
Bottom Trawl	Not detected	Not detected	NA	NA
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	4,487 (San Juan Region)		100	

Though the bottom-trawl and drop camera surveys did not detect canary rockfish or bocaccio in Puget Sound Proper, each species has been historically present there and each has been caught in recreational fisheries from 2004 to 2008 (WDFW unpublished data). The lack of detected canary rockfish and bocaccio in Puget Sound Proper is likely due to the following factors: 1) populations of each species are depleted, 2) the general lack of rocky benthic areas in Puget Sound Proper may lead to densities of each species that are naturally less than the San Juan region, and 3) the study design or effort may have not been sufficiently powerful to detect each species. Though yelloweye rockfish were detected in Puget Sound Proper within bottom-trawl surveys, we do not consider the WDFW estimate of 600 fish to be a complete estimate, for the reasons given above.

Productivity is the measurement of a population's growth rate through all or a portion of its life-cycle. Life-history traits of yelloweye rockfish, canary rockfish and bocaccio suggest generally low levels of inherent productivity because they are long-lived and mature slowly, with sporadic episodes of successful reproduction (Tolimieri and Levin 2005, Drake et al., 2010). Historic over fishing can have dramatic impacts on the size or age structure of the population, with effects that can influence ongoing productivity. When the size and age of females declines, there are negative impacts to reproductive success. These impacts, termed maternal effects, are evident in a number of traits. Larger and older females of various rockfish species have a higher weight-specific fecundity (number of larvae per unit of female weight) (Bobko and Berkeley 2004, Sogard et al., 2008, Boehlert et al., 1982). A consistent maternal effect in rockfishes relates to the timing of parturition (larval birth). The timing of larval release can be crucial in terms of matching favorable oceanographic conditions for larvae because most are released on only one day each year, with a few exceptions in southern coastal populations and yelloweye in Puget Sound (Washington et al., 1978). Larger or older females release larvae earlier in the season compared to smaller or younger females in several studies of rockfish species (Sogard et al., 2008, Nichol and Pikitch 1994). Larger or older females provide more nutrients to larvae by developing a larger oil globule released at parturition, which provides energy to the developing larvae (Berkeley et al. 2004, Fisher et al. 2007), and in black rockfish enhances early growth rates (Berkeley et al., 2004). An additional maternal effect in black rockfish indicates that older females are more successful in completing recruitment of progeny from primary oocyte to fully developed larva (Bobko and Berkeley 2004).

Contaminants such as PCBs, chlorinated pesticides, and PBDEs appear in rockfish collected in urban areas (Palsson et al., 2009). While the highest levels of contamination occur in urban areas, toxins can be found in the tissues of fish in all regions of the sound (Puget Sound Action Team, 2007). Although few studies have investigated the effects of toxins on rockfish ecology or physiology, other fish in the Puget Sound region that have been studied do show a substantial impact, including reproductive dysfunction of some sole species (Landahl et al., 1997). Reproductive function of rockfish is also likely affected by contaminants (Palsson et al., 2009), and other life history stages may be as well (Drake et al., 2010).

Yelloweye Rockfish Abundance and Productivity

Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Islands region of the DPS. Though there is a lack of a reliable population-census (ROV or otherwise) within the regions of Puget Sound Proper, the San Juan region has the most suitable rocky benthic habitat (Palsson et al., 2009) and historically was the area of greatest angler catches (Moulton and Miller 1987). Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from two to 4.6 percent (Wallace 2007, Yamanaka and Kronlund 1997). Productivity may also be particularly impacted by Allee effects. As adults have been removed by fishing, the density and proximity of mature fish is decreased. Adult yelloweye typically occupy relatively small ranges (Love et al., 2002), and may not move to find suitable mates. Maternal effects on yelloweye rockfish productivity within the DPS are similar to those previously described for rockfish generally.

Canary Rockfish Abundance and Productivity

Historically the South Puget Sound was thought to be a population stronghold within the DPS, but it appears to be greatly depleted (Drake et al., 2010). Natural annual mortality ranges from six to nine percent (Methot and Stewart 2005, Stewart 2007). Life history traits suggest intrinsically slow growth rate and low rates of productivity for this species, specifically its age at maturity, long generation time and its maximum age (84 years) (Love et al., 2002). Past commercial and recreational fishing removals may have depressed the DPS to a threshold beyond which optimal productivity is unattainable (Drake et al., 2010). Maternal effects on canary rockfish productivity within the DPS are similar to those previously described for rockfish.

Bocaccio Abundance and Productivity

Bocaccio within the Puget Sound/Georgia Basin were historically most common within the South Sound and Central Sound regions (Drake et al., 2010), with just several documented occurrences within Hood Canal and none within the San Juan region. Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin (Drake et al., 2010), their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Bocaccio may be absent in significant segments of their formerly-occupied habitat; from 1998 to 2008 fish were reported by anglers in only one region of the DPS. Productivity is driven by high fecundity and episodic recruitment events, largely correlated with environmental conditions, thus bocaccio populations do not follow consistent growth trajectories and sporadic recruitment drives population structure (Drake et al., 2010). Natural annual mortality is approximately 15 percent (Tolimeri and Levin 2005). Tolimeri and Levin (2005) found that bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of failed recruitment being the norm (Tolimieri and Levin 2005). Given their severely reduced abundance, Allee effects may be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates.

Spatial Structure and Connectivity

Spatial structure consists of a population's geographical distribution and the processes that generate that distribution (McElhaney et al., 2000). A population's spatial structure depends on habitat quality, spatial configuration, and dynamics as well as dispersal characteristics of individuals within the population (McElhaney et al., 2000).

Yelloweye Rockfish Spatial Structure & Connectivity

Yelloweye rockfish spatial structure and connectivity is likely threatened by the apparent reduction (or absence) of fish within all or portions of Hood Canal and the South Sound. The severe reduction or complete loss of fish in these regions may eventually result in a contraction of the DPS's range (Drake et al., 2010). The likelihood of juvenile recruitment from the San Juan region may be diminished due to the generally retentive circulation patterns of Puget Sound Proper. Combined with limited adult movement, yelloweye rockfish population viability may be highly influenced by the probable localized loss of populations within the DPS, which decreases spatial structure and connectivity.

Canary Rockfish Spatial Structure and Connectivity

Several historically large populations in the canary rockfish DPS may have been lost, including an area of historic distribution in South Puget Sound which has declined due to harvest and perhaps because of low dissolved oxygen events (Drake et al., 2010). The apparent steep reduction of fish in Puget Sound Proper leads to concerns about the viability of these populations (Drake et al., 2010). The ability of adults to migrate hundreds of kilometers could allow the DPS to re-establish spatial structure and connectivity in the future under favorable conditions (Drake et al., 2010).

Bocaccio Spatial Structure & Connectivity
Bocaccio may have been historically spatially limited to several regions within the DPS. They were apparently historically most abundant in the Central and South Puget Sound (Drake et al., 2010), with no documented occurrences in the San Juan region until 2008 (WDFW unpublished data), and only a few confirmed occurrences in Hood Canal (Miller and Borton, 1980). Positive signs for spatial structure and connectivity come from the propensity of some adults and pelagic juveniles to migrate long distances, which could reestablish aggregations of fish in formerly occupied habitat (Drake et al., 2010). The apparent reduction of populations of bocaccio in large portions of the DPS represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.

Diversity
Characteristics of diversity for rockfish include fecundity, timing of the release of larva and their condition, morphology, age at reproductive maturity and physiology and molecular genetic characteristics. In spatially and temporally varying environments, there are three general reasons why diversity is important for species and population viability: 1) diversity allows a species to use a wider array of environments, 2) it protects a species against short-term spatial and temporal changes in the environment, and 3) genetic diversity provides the raw material for surviving long-term environmental changes. Though there are no genetic data within the DPSs of ESA-listed rockfish, the unique oceanographic features and relative isolation of some of its regions may have led to unique adaptations, such as timing of larval release (Drake et al., 2010).

Yelloweye Rockfish Diversity
Yelloweye rockfish size (and age) distribution have been truncated. Recreationally caught yelloweye rockfish in the 1970's spanned a broad range of sizes. By the 2000's, there was some evidence of fewer older fish in the population (Drake et al., 2010). However, overall numbers of fish in the database were also much lower, making it difficult to determine if clear size truncation occurred. Within the WDFW ROV surveys, no adult yelloweye were observed. As a result, the reproductive burden may be shifted to younger and smaller fish. This shift could alter the timing and condition of larval release, which may be miss-matched with habitat conditions within the DPS, potentially reducing the viability of offspring (Drake et al., 2010).

Canary Rockfish Diversity
Canary rockfish size (and age) distribution have been truncated (Drake et al., 2010). As a result, the reproductive burden may be shifted to younger and smaller fish. Canary rockfish exhibited a broad spread of sizes in the 1970's. However, by the 2000's, there were far fewer size classes represented and no fish greater than 55 cm were recorded in the recreational data (Drake et al., 2010). Although some of this truncation may be a function of the overall lower number of sampled fish, the data in general suggest few older fish remain in the population. This shift could alter the timing and condition of larval release which may be miss-matched with habitat conditions within the DPS, potentially reducing the viability of offspring (Drake et al., 2010).

Bocaccio Diversity
Size-frequency distributions for bocaccio in the 1970's indicate a wide range of sizes, with recreationally caught individuals from 25 to 85 cm. This broad size distribution suggests a spread of ages, with some successful recruitment over many years. A similar range of sizes is also evident in the 1980's catch data. The temporal trend in size distributions for bocaccio also

suggests size truncation of the population, with larger fish becoming less common over time. By the decade of the 2000's, no bocaccio data were available. Bocaccio in the Puget Sound/Georgia Basin may have physiological or behavioral adaptations due to the unique habitat conditions of the DPS. The potential loss of diversity in the bocaccio DPS, in combination with their relatively low productivity, may result in a mismatch with habitat conditions and further reduce population viability (Drake et al., 2010).

Current Rangewide Status of Critical Habitat

Critical habitat has not yet been designated for the listed yelloweye rockfish, canary rockfish or bocaccio DPSs'.

Environmental Baseline

Habitats used by ESA-listed rockfish have been altered by a number of factors. The degradation of some rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality are threats to rockfish habitat in the Puget Sound region (Drake et al., 2010, Palsson et al., 2009). Though adult yelloweye rockfish, canary rockfish and bocaccio have been documented along areas of high relief and non-rocky substrates such as sand, mud and other unconsolidated sediments (Washington 1977, Miller and Borton 1980), it is very likely that densities of bocaccio, canary rockfish, and yelloweye rockfish are highest near rocky habitats. Such habitat is extremely limited in Puget Sound, with only 10 km^2 (3.8 sq miles) of such habitat in Hood Canal and waters east of Admiralty Inlet, and 207 km^2 (80 sq miles) in the eastern Strait of Juan de Fuca and the San Juan region (Palsson et al., 2009). Rocky habitat is threatened by, or has been impacted by, derelict fishing gear, construction of bridges, sewer lines and other structures, deployment of cables and pipelines, and burying from dredge spoils (Palsson et al., 2009). Derelict fishing gear can continue "ghost" fishing and is known to kill rockfish as well as degrade rocky habitat by altering bottom composition (Palsson et al., 2009). There is an ongoing program run by the Northwest Straits Initiative to remove derelict gear throughout the Puget Sound region, mostly concentrated in waters less than 100 feet (33 meters) deep. Because habitats deeper than 100 feet are most readily used by adult yelloweye rockfish, canary rockfish and bocaccio, there is an unknown but potentially significant impact from deepwater derelict gear on each population within the DPS.

Juvenile bocaccio and canary rockfish utilize nearshore waters with substrates of rock or cobble compositions, and/or kelp species (Love et al., 1991, Love et al. 2002). Kelp cover is highly variable and has shown long-term declines in some regions, while kelp beds have increased in areas where artificial substrate provides additional kelp habitat (Palsson et al., 2009). Threats to kelp communities include toxins such as petroleum products which lower photosynthesis and respiration, activities associated with oyster culture and boat operations, and harvest (Mumford 2007). Indirect stressors to kelp include low dissolved oxygen, eutrophication, and changes in trophic structure resulting from harvest of organisms that feed upon kelp (Mumford, 2007). Development has occurred along approximately 30 percent of the Puget Sound shoreline (Broadhurst 1998), and has increased in recent years (Cornwall and Mayo 2008). Development along the shoreline has been linked to reduced invertebrate abundance and species taxa diversity (Dugan et al., 2003), and reduced forage fish egg viability (Rice, 2006). These are examples of food web changes that may alter forage fish prey composition or abundance for these rockfish.

Over the last century, human activities have introduced a variety of toxins into the Georgia Basin at levels that may affect adult and juvenile rockfish habitat, and/or the prey that support them. The Washington State Department of Ecology (Ecology) estimates that Puget Sound receives between 14 and 94 million pounds of toxic pollutants per year, which include oil and grease, polychlorinated biphenyls (PCBs), phthalates, polybrominated diphenyl ethers (PBDEs), and heavy metals that include zinc, copper and lead (Ecology 2010). Several urban embayments in the Sound have high levels of heavy metals and organic compounds (Palsson et al., 2009). About 32 percent of the sediments in the Puget Sound region are considered to be moderately or highly contaminated (Puget Sound Action Team, 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Puget Sound Partnership, 2010).

In addition to chemical contamination, water quality in the Puget Sound region is also influenced by sewage, animal waste, and nutrient inputs. The Washington Department of Ecology has been monitoring water quality in the Puget Sound region for several decades. Monitoring includes fecal coliform, nitrogen, ammonium, and dissolved oxygen. In 2005, of the 39 sites sampled, eight were classified as highest concern, and 10 were classified as high concern for some of these parameters. Hood Canal has seen persistent and increasing areas of low dissolved oxygen since the mid 1990's. Typically, rockfish move out of areas with dissolved oxygen less than 2 mg/l; however, when low dissolved oxygen waters were quickly upwelled to the surface in 2003, about 26 percent of the rockfish population was killed (Palsson et al., 2009). In addition to Hood Canal, periods of low dissolved oxygen are becoming more widespread in waters south of Tacoma Narrows (Palsson et al., 2009).

Degraded habitat and its consequences to rockfish can only be described qualitatively because the precise spatial and temporal impacts to populations of yelloweye rockfish, canary rockfish and bocaccio are poorly understood. However, there is sufficient evidence to indicate that rockfish productivity may be impacted from the habitat structure and water quality stressors discussed above (Drake et al., 2010).

Effects of the Proposed Action

In its biological opinions, NMFS analyzes the effects of proposed Federal actions, as defined in 50 CFR 402.02, to determine whether the actions are likely to jeopardize the continued existence of the affected listed ESUs or result in the destruction or adverse modification of designated critical habitat. Effects of the action means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02).

Direct Effects

The proposed action will result in the authorization of commercial harvest of salmon within the Puget Sound/Georgia Basin DPSs of ESA-listed rockfish, mostly concentrated in the Strait of Juan de Fuca and San Juan Island regions. Most commercial salmon fishers within the rockfish DPS use purse seines and gill nets (WDFW 2010). A relatively small amount of salmon are harvested within the DPS by reef nets and beach seines. Gill nets and purse seines rarely catch rockfish of any species. From 1990 to 2008, no rockfish were recorded as caught in the purse seine fishery (WDFW 2010). In 1991, one rockfish (of unknown species) was recorded in the gill net fishery, with no other fish through 2008 (WDFW 2010). Low encounter rates may be attributed to a variety of factors. For each net type, the mesh size restrictions that target salmon based on size tend to allow juvenile rockfish to pass through. Gill net and purse seine operators also tend to avoid fishing over rockfish habitat, as rocky reef structures that would increase the likelihood of damage to their gear. In addition, most nets are deployed in the upper portion of the water column, thus avoiding interactions with most adult ESA-listed rockfish. In the mid 1990's commercial salmon net closure zones were established in much of Puget Sound for seabird protection. Some of these closed areas overlap with rockfish habitat, reducing the potential for encountering rockfish. Specific areas include: 1) a closure of the waters inside the San Juan Islands, 2) a closure extending 1,500 feet along the northern shore of Orcas Island, and 3) a closure of waters three miles from the shore inside the Strait of Juan de Fuca (WDFW 2010).

Reef nets are deployed near rockfish habitat in the San Juan Islands and Lummi Island, and are subject to the same area closures as gill nets and purse seines for seabird protection. Beach seines are used next to sandy or gravely beaches, and in each fishery all non-targeted fish are released. Because most adult yelloweye rockfish, canary rockfish and bocaccio occupy waters much deeper than surface waters fished by reef nets and beach seines, the bycatch of adults is likely low to non-existent. Similarly, catch of juveniles of each species is likely very low to non-existent because they are small enough to pass through the mesh of reef nets. Juvenile yelloweye rockfish, canary rockfish and bocaccio are unlikely to be caught in beach seines, which are generally not used along kelp areas where juvenile canary rockfish and bocaccio may be found (WDFW 2010). If incidental catch of adults or juvenile yelloweye rockfish, canary rockfish and bocaccio did occur, released fish would have a large chance of survival because they would not be brought to the surface from extreme depths, thus avoiding barotrauma, and would not be removed from the water.

In summary, the life-history of yelloweye rockfish, canary rockfish and bocaccio, in combination with the methods of commercial salmon harvest described above, lead to the conclusion that no ESA-listed rockfish will be killed within retrieved gill nets or purse seines. There is a remote possibility that a reef net could capture a juvenile canary rockfish or bocaccio, though it is unlikely that these fish would die because they would not be brought from depths greater than 60 feet, and would not be removed from the water prior to their release.

Indirect Effects

The greatest risk to rockfish from the use of gill nets and purse seines comes from their inadvertent loss. Derelict nets generally catch on bottom structure such as rocky reefs and large boulders that are also attractive to rockfish (NRC, 2007). Dead rockfish have been found within derelict nets because the net can continue to 'fish' when a portion of it remains suspended near the bottom and is swept by the current. Aside from killing fish, derelict nets alter habitat suitability by trapping fine sediments out of the water column, making a layer of soft sediment over rocky areas that changes habitat quality and suitability for benthic organisms (NRC, 2007). This gear covers habitats used by rockfish for shelter and pursuit of food and may cause a depletion of food sources. For example, a study of several derelict nets in the San Juan Islands reported an estimated 107 invertebrates and 16 fish (of various species) entangled per day (NRC, 2008). One net had been in place for 15 years, entangling an estimated 16,500 invertebrates and

2,340 fish (NRC, 2008). Though these estimates are coarse, they illustrate the potential impacts of derelict gear within the DPS.

The state has established a no-fault reporting system for lost gear for fishermen. It is estimated that less than 12 nets are lost and become derelict within the Puget Sound region per year (K. Antonelis, pers comm.), although not all of these nets are associated with the Fraser panel fisheries. Approximately 80 percent of lost nets reported by fishermen are recovered relatively soon after their loss (J. June, Natural Resource Consultants, personal communication, November 2009). It is possible that one or more nets would be lost, reported to authorities, but not successfully retrieved before it becomes derelict during the course of the 2010 and 2011 Fraser Panel salmon fisheries. The impacts of net loss would depend upon the location of its loss, the habitat which it eventually catches on, and the occurrence of ESA-listed rockfish within or near that habitat. For perspective, fishery mortality targets of 0.5 of natural mortality is likely most precautionary for rockfish species, and is considered a rate that would not hinder population viability (Walters and Parma 1996, Scientific and Statistical Committee 2000). Thus, several hundred yelloweye rockfish, canary rockfish, and bocaccio would have to perish in lost nets associated with the 2010 and 2011 Fraser Panel salmon fisheries to reach levels that threaten population viability. To date, one canary rockfish has been found within derelict gear (J. June, Natural Resource Consultants, electronic communication, February, 2010).

Given the expected low number of lost nets that become derelict gear and kill ESA-listed rockfish, the likelihood of mortality levels that would alter the viability of the yelloweye rockfish, canary rockfish or bocaccio DPSs is extremely low.

Cumulative Effects

See section 3.5 of this Biological Opinion.

Conclusion

The three listed DPS' are at risk with regard to the each of the four viability criteria. Yelloweye rockfish are most at risk from an apparent contraction of spatial structure from portions of the DPS. It may be difficult for yelloweye rockfish to become reestablished throughout the range of the DPS due to their productivity being naturally very low, the loss of larger adult fish, their sedentary behavior, and Allee effects. Canary rockfish may be most at risk from truncated size and age distributions that would reduce reproductive success. While they are present throughout their former range, their abundance appears to be most concentrated within the Strait of Juan de Fuca and San Juan regions (Palsson et al., 2009). Historically they were also relatively abundant in the Central and South Sound (Drake et al., 2010). The apparent loss of population strongholds within the DPS may further reduce their overall viability. Very low abundance and intrinsically low productivity of bocaccio reduce the likelihood the population will recover, even in the absence of harvest or other environmental stressors (Drake et al., 2010). Prior to historic fisheries, bocaccio may have been concentrated in the Central and South Sound. The apparent contraction in these areas adds significant risk to their overall viability.

Habitats utilized by ESA-listed rockfish are impacted by nearshore development, existing derelict fishing gear, contaminants within the food-web and regions of poor water quality, among other stressors. Benefits to habitat within the DPSs have come through the removal of thousands of derelict fishing nets, though nets deeper than 100 feet remain a threat. Degraded habitat and its consequences to ESA-listed rockfish can only be described qualitatively because the precise spatial and temporal impacts to populations of yelloweye rockfish, canary rockfish and bocaccio are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be reduced because of alterations to habitat structure and function.

The possibility of the loss of a few yelloweye rockfish, canary rockfish or bocaccio by entrapment in derelict gear, in combination with their current status, the condition of the environmental baseline, and cumulative effects would not threaten the viability of their respective DPSs.

After reviewing the current status of yelloweye rockfish, canary rockfish and bocaccio within the Puget Sound/Georgia Basin DPSs, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of ESA-listed rockfish.

Incidental Take Statement

See Section 4 of the biological opinion

References

Berkeley, S. A., C. Chapman, and S. M. Sogard. 2004. Maternal age as a determinant of larval growth and survival in a marine fish, *Sebastes melanops*. Ecology 85:1258-1264.

Broadhurst, G. 1998. Puget Sound Nearshore Habitat Regulatory Perspective: A Review of Issues and Obstacles. Puget Sound/Georgia Basin International Task Force Work Group on Nearshore Habitat Loss for Coastal Training Program by Elliott Menashe, Greenbelt Consulting. 2004.

Bobko, S. J., and S. A. Berkeley. 2004. Maturity, ovarian cycle, fecundity, and age-specific parturition of black rockfish, (*Sebastes melanops*). Fishery Bulletin, U.S. 102:418-429.

Boehlert, G. W., W. H. Barss, and P. B. Lamberson. 1982. Fecundity of the widow rockfish, *Sebastes entomelas*, off the coast of Oregon. Fishery Bulletin, U.S. 80:881-884.

Burns, R. 1985. The shape and forms of Puget Sound. Published by Washington Sea Grant, and distributed by the University of Washington Press.

Cailliet, G. M., E. J, Burton, J. M. Cope, and L. A. Kerr (eds). 2000. Biological characteristics of nearshore fishes of California: A review of existing knowledge. , Vol. Final Report and Excel Data Matrix, Pacific States Marine Fisheries Commission. California Department of Fish and Game.

Carr, M.H. 1983. Spatial and temporal patterns of recruitment of young of the year rockfishes (genus Sebastes) into a central California kelp Forest. Masters thesis, San Francisco State University, CA 94132, 104p)

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2008. Assessment and status report on the Yelloweye Rockfish (sebastes ruberrimus).

Cornwall, W. and J. Mayo. 2008. Beaches suffer as walls go up. Seattle Times. Printed May 13, 2008.

Courchamp, F., L. Berec, and J. Gascoigne. 2008. Allee Effects in Ecology and Conservation. Oxford: Oxford University Press, 2008.

Drake, J. and nine co-authors. 2010. (Preliminary Scientific Conclusions of the Review of the Status of 5 Species of Rockfish: Bocaccio (*Sebastes paucispinis*), Canary Rockfish (*Sebastes pinniger*), Yelloweye Rockfish (*Sebastes ruberrimus*), Greenstriped Rockfish (*Sebastes elongatus*) and Redstripe Rockfish (*Sebastes proriger*) in Puget Sound, Washington National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, WA. 225p

Dugan, J.E., Hubbard, D.M., McCrary, M.D. and M.O. Pierson. 2003. The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. Estuarine, Coastal and Shelf Science 58S (2003) 25–40.

Ebbesmeyer, C.C., Cannon, G.A., and Barnes, C.A. 1984. Synthesis of current measurements in Puget Sound, Washington. Volume 3: Circulation in Puget Sound: an interpretation based on historical records of currents. NOAA Tech. Memo. NOS OMS, **5**: 1–73.

Fisher, R., S. M. Sogard, and S. A. Berkeley. 2007. Trade-offs between size and energy reserves reflect alternative strategies for optimizing larval survival potential in rockfish. Marine Ecology Progress Series 344: 257-270.

Halderson, L. and L.J. Richards. 1987. Habitat use and young of the year copper rockfish ( ) in British Columbia. In Proc. In. Rockfish Symp., Anchorage, Alaska, p. 129-141. Alaska Sea grant Rep. 87-2, Fairbanks 99701.

Hannah, R.W., and K.M. Matteson. 2007. Behavior of nine species of Pacific rockfish after hook-and line capture, recompression, and release. Transactions of the American Fisheries Society 136: 24-33.

Hart, J. L. 1973. Pacific Fishes of Canada. Fisheries Research Board of Canada Bulletin 180.

Hayden-Spear, J. 2006. Nearshore habitat associations of young-of-year copper (*Sebastes caurinus)* and quillback (*S. maliger)* rockfish in the San Juan Channel, Washington.

Jarvis, E.T., and C.G. Lowe. 2008. The effects of barotrauma on the catch-and-release survival of southern California nearshore and shelf rockfish (Scorpaenidae, *Sebastes* spp.). Canadian Journal of Aquatic and Fishery Sciences 65: 1286-1296.

Johnson, S.W., Murphy, M.L., and D.J. Csepp. 2003. Distribution, habitat, and behavior of rockfishes, *Sebastes* spp., in nearshore waters of southeastern Alaska: observations from a remotely operated vehicle. Environmental Biology of Fishes 66:259-270.

Landahl, J. T., L. L. Johnson, J. E. Stein, T. K. Collier, and U. Varanasi. 1997. Approaches for Determining Effects of Pollution on Fish Populations of Puget Sound. Transactions of the American Fisheries Society 126: 519-535.

Love, M.S., M. Carr, and L. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. Env. Bio. Fish. 79: 533-545.

Love, M.S., M. M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Matthews, K.R. 1989. A comparative study of habitat use by young-of-the year, subadult, and adult rockfishes on four habitat types in Central Puget Sound. Fishery Bulletin, U.S. 88-223-239.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U. S. Dept. Commerce NMFS-NWFSC-42.

Methot, R., and I.J. Stewart. 2005. Status of U.S. canary rockfish resource in 2005. Pacific Fishery Management Council, Portland, OR.

Miller, B.S., and S.F. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. University of Washington Fisheries Research Institute, 3 vols.

Moulton, L.L. and B.S. Miller. 1987. Characterization of Puget Sound marine fishes: survey of available data. Fisheries Research Institute, School of Fisheries, University of Washington. FRI-UW 8716.

Mumford, T.F. 2007. Kelp and eelgrass in Puget Sound. Technical Report 2007-5. Prepared in support of the Puget Sound Nearshore Partnership.

Nichol, D. G., and E. K. Pikitch. 1994. Reproduction of darkblotched rockfish off the Oregon coast. Transactions of the American Fisheries Society 123(4): 469-481.

Natural Resource Consultants (NRC). 2007. Derelict fishing gear priority ranking project. Prepared for the Northwest Straights Initiative.

Natural Resources Consultants (NRC). 2008. Rates of marine species mortality caused by derelict fishing nets in Puget Sound, Washington. Prepared for the Northwest Straits Initiative.

Orr J.W., M.A. Brown, and D.C. Baker. 2000. Guide to rockfishes (Scorpaenidae) of the genera Sebastes, Sebastolobus, and Abelosebastes of the northeast Pacific Ocean, Second Edition. NOAA Technical Memorandum NMFS-AFSC

Palsson, W. A., T.-S. Tsou, G. G. Barbman, R. M. Buckley, J. E. West, M. L. Mills, Y. W. Cheng, and R. E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Olympia WA.

Parker, S. J., H. I. McElderry, P. S. Rankin, and R. W. Hannah. 2006. Buoyancy Regulation and Barotrauma in Two Species of Nearshore Rockfish. Transactions of the American Fisheries Society 135:1213-1223.

Puget Sound Partnership. 2010. 2009 state of the sound. A report on ecosystem status and a performance management system to tract action agenda implementation.

Puget Sound Action Team. 2007. State of the Sound 2007. Puget Sound Action Team, Olympia, WA. Publication No. PSAT:07-01.

Rice, C.A. 2006. Effects of shoreline modification in northern Puget Sound: beach microclimate and embryo survival in summer spawning surf smelt (*Hypomesus pretiosus*). Estuaries and Coasts 29(1):63-71.

Rice, C. A. 2007. Evaluating the biological condition of Puget Sound. Ph.D. University of Washington, School of Aquatic and Fisheries Sciences. 270 pp.

Rosenthal, R.J., L. Haldorson, L.J. Field, V. Moran-O'Connell, M.G. LaRiviere, J. Underwood, and M.C. Murphy. 1982. Inshore and shallow offshore bottomfish resources in the southeastern Gulf of Alaska. Alaska Coastal Research and University of Alaska, Juneau. 166 p.

Scientific and Statistical Committee. 2000. Scientific and Statistical Committee statement on default maximum sustainable yield fishing rate within the harvest rate policy. Supplemental SSC Report D. 13. (2). June 2000.

Shaffer, J. A. Doty, D.C., Buckley, R.M., and J. E. West. 1995. Crustacean community composition and trophic use of the drift vegetation habitat by juvenile splitnose rockfish *Sebastes diploproa.* Marine Ecology Progress Series. Vol. 123, pp 13-21. 1995.

Sogard, S. M., S. A. Berkeley, and R. Fisher. 2008. Maternal effects in rockfishes *Sebastes* spp.: a comparison among species. Marine Ecology Progress Series 360: 227-236.

Stewart, I.J. 2007. Status of the U.S. canary rockfish resource in 2007. Stock Assessment and Fishery Evaluation. Pacific Fishery Management Council, 2130 SW Fifth Ave., Suite 224, Portland OR. 362 p.

Studebaker, R.S., Cox, K.N., and T. J. Mulligan. 2009. Recent and historical spatial distributions of juvenile rockfish species in rocky intertidal tide pools, with emphasis on black rockfish. Transactions of the American Fisheries Society 138:645-651, 2009.

Tagal, M, K. C. Massee, N. Ashton, R. Campbell, P. Pleasha, and M. B. Rust. 2002. Larval development of yelloweye rockfish, sebastes ruberrimus. National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center.

Tolimieri, N. and P. S. Levin. 2005. The roles of fishing and climate in the population dynamics of bocaccio rockfish. Ecological Applications 15:458-468.

Washington State Department of Ecology. 2010. Reports reconfirm surface runoff as leading source of toxics in Puget Sound. Water Quality Program. Available at: http://www.ecy.wa.gov/pubs/0810097.pdf

Washington, P. 1977. Recreationally important marine fishes of Puget Sound, Washington. National Oceanic and Atmospheric Administration, Northwest and Alaska Fisheries Center. Washington State Department of Fish and Wildlife. Unpublished rockfish bycatch data, on file with the National Marine Fisheries Service, Sandpoint Way NE, Seattle, WA 98115.

Washington, P. M., R. Gowan, and D. H. Ito. 1978. A biological report on eight species of rockfish (*Sebastes* spp.) from Puget Sound, Washington. Northwest and Alaska Fisheries Center Processed Report, National Marine Fisheries Service, Seattle.

Washington State Department of Fish and Wildlife. 2010. Draft narratives of Puget Sound Fisheries. Unpublished document, on file with the National Marine Fisheries Service, Sandpoint Way NE, Seattle, WA 98115.

Westrheim, S. J., and W. R. Harling. 1975. Age-length relationships for 26 scorpaenids in the northeast Pacific Ocean. Technical Report 565, Fisheries and Marine Service Research Division, Nanaimo, British Columbia.

Yamanaka, K.L., and A.R. Kronlund. 1997. Inshore rockfish stock assessment for the west coast of Canada in 1996 and recommended yields for 1997. Can. Tech. Rep. Fish. Aquat. Sci. 2175.

Yamanaka K.L., and L.C. Lacko. 2001. Inshore Rockfish (Seb. ruberrimus, S. malinger, S. cauinus, S. melanops, S. nigrocinctus, and S. nebulosus). Stock assessment for the west coast of Canada and recommendation for management. SSC 2000.

Wallace, J.R. 2007. Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. West Coast in 2007, Pacific Fishery Management Council, Portland, OR.

Walters, C., and A.M. Parma. 1996. Fixed exploitation rate strategies for coping with effects of climate change. Canadian Journal of Fisheries and Aquatic Sciences. 53:148-158. Scientific and Statistical Committee, 2000. Statement on default maximum sustainable yield fishing rate within the harvest rate policy. Supplemental SSC Report D. 13.(2) June 2000.