ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

ACTION: 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

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region, Protect Resources Division

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Introduction

Fisheries in the Exclusive Economic Zone (EEZ) are managed by NOAA's National Marine Fisheries Service (NMFS) under authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act or MSA). NMFS is also responsible for administering the Endangered Species Act (ESA) with respect to most marine species, including anadromous salmonids. Section 7(a)(2) of the ESA requires federal agencies that propose an action which may affect listed species consult with NMFS to ensure that the action is not likely to jeopardize the continued existence[1] of any threatened or endangered species under NMFS's jurisdiction, or destroy or adversely modify any habitat designated by NMFS as critical for their survival. NMFS is responsible for authorizing ocean salmon fisheries in the EEZ, through its Sustainable Fisheries Division (SFD). NMFS also reviews the effects of those fisheries on listed species for which it has jurisdiction, through its Protected Resources Division (PRD). For the purposes of consultations on federal fishery management activities under the ESA, NMFS serves as both the action and consulting agency.

Commercial and recreational ocean salmon fisheries in the U.S. EEZ off the coasts of Washington, Oregon, and California are authorized by NMFS under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Specifically, these fisheries are managed under the Federal Pacific Coast Salmon Fishery Management Plan (FMP) (PFMC 2003). Consistent with the FMP, more detailed management regulations are developed annually, designed to respond to new information and the current status of each salmon stock. Pursuant to the MSA, the Pacific Fishery Management Council (PFMC) develops recommendations for the development of the FMP, FMP amendments,

[1] "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species …" (50 CFR §402.02).

and annual management measures and provides those recommendations to the Secretary of Commerce, through NMFS, for review and approval. The Secretary may approve the PFMC's recommendations for implementation as federal regulation if found to be consistent with the MSA and other applicable law, including the ESA.

Twenty-eight (28) salmon evolutionarily significant units (ESUs) and steelhead distinct population segments (DPSs) are listed as threatened or endangered under the ESA on the west coast of the United States. Beginning in 1991, NMFS considered the effects on ESA-listed salmon species resulting from PFMC fisheries 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 Salmon FMP including spring/summer Chinook, fall Chinook, and sockeye salmon from the Snake River and Sacramento River winter Chinook (NMFS 1996). Subsequent biological opinions beginning in 1997 considered the effects of PFMC fisheries on the growing catalogue of listed species (see Table 3; NMFS 2009a). 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. Beginning with its biological opinion on the 2000-2001 ocean salmon fisheries, NMFS combined its consultation on Pacific coast salmon fisheries with those that occurred in Puget Sound (including 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.

The Sacramento River Winter Chinook (herein referred to as winter-run) ESU is one of the ESUs listed as endangered. In the past, regulatory actions have been taken to reduce the incidental take of this ESU in the ocean salmon fishery, as well as in numerous other non-fishery activities. The most recent consultation regarding the impacts of the ocean salmon fishery on winter-run occurred in 2004. At this time, SFD is requesting reinitiation of consultation of the ocean salmon fishery on winter-run because the current biological opinion that authorizes incidental take of winter-run by the fishery expires on April 30, 2010. Other ESA-listed ESUs are currently covered by other existing opinions. NMFS continues to review the most up-to-date information in determining whether or not to reinitiate consultation for all ESA-listed salmon ESUs.

Critical habitat of all ESA-listed salmon ESUs has been designated in the spawning and rearing habitats found in the fresh water portion of salmonid life history. To date, no critical habitat for any salmonid has been designated by NMFS in the marine environment. The ocean salmon fishery does not occur within the boundaries of any designated critical habitat for any ESA-listed salmon, including winter-run, and does not impact that habitat either directly or indirectly. Therefore, critical habitat for salmon will not be considered in this opinion.

I. CONSULTATION HISTORY

NMFS first listed Sacramento River Winter Chinook under the ESA as threatened in November 1990 and then reclassified it as endangered in 1994. There have been 4 biological opinions issued for the ocean salmon fishery's effects on winter-run (1991, 1996/1997,[2] 2002, and 2004). The most recent biological opinion and incidental take statement was issued in 2004 (NMFS 2004a) and covered the 2004 through 2009 fishing years. In the early 1990s, harvest impacts of the ocean salmon fishery had not been quantified but life history information suggested that the fishery impacts were relatively low. Harvest was, therefore, not identified as a primary factor of the species' population decline at the time. Initial action involved shortening the recreational fishery south of Point Arena by two weeks on each end to allow more opportunity for maturing fish to exit the ocean. Additional restrictions to reduce impacts in the ocean fisheries were implemented as a result of the 1996/1997 consultation. By 2001 it was apparent that abundance and productivity were much improved. Fishery impacts have nonetheless been held at previously reduced levels (NMFS 2004b).

The proposed action considered in the 2002 opinion was authorization of ocean salmon fisheries consistent with the FMP, but absent any specific management objectives for winter-run. The 1996/1997 and 2002 opinions concluded that the proposed action was likely to jeopardize the continued existence of winter run and thus offered, as a reasonable and prudent alternative (RPA), a set of protective measures intended to reduce the incidental take of winter-run and avoid the likelihood of jeopardizing the continued existence of this ESU. The RPA became the so-called jeopardy standard for purposes of the FMP conservation objective. The proposed action in the 2004 Biological Assessment (BA) included additional protective measures for winter-run not contained in the FMP, and the 2009 BA submitted by NMFS SFD proposes the same measures. The proposed action consists of two parts: the first part is authorization by NMFS of ocean salmon fisheries consistent with the FMP; the second part is a set of management measures, proposed by NMFS SFD to provide specific protection for winter-run, that are intended to avoid the likelihood of jeopardizing the continued existence of this ESU.[3]

In the fall of 2008, NMFS SFD began informal discussions with NMFS PRD to alert them of the intent to reinitiate consultation in response to the expiration of the 2004 Opinion on April 30, 2010. Throughout 2009, SFD and PRD worked closely to discuss the current fishery management, which is implemented according to the 2004 Opinion, possible modifications, and the ESA consultation process and requirements. PRD, SFD, and the Southwest Fisheries Science Center (SWFSC) agreed that the following information on winter-run would be necessary for the consultation:

- spatial and temporal ocean distribution data

[2] Because the logic and outcomes of the two opinions were closely related, they are discussed jointly with particular focus on the 1997 opinion.

[3] (Also see Appendix A for table of the consultation history)

- the spawner reduction rate
- the age-specific ocean fishery impact rate

It was also agreed that the SWFSC would conduct the necessary analysis to derive this information.

To get this information, between August and November 2009, the SWFSC gathered and analyzed recovered coded wire tag (CWT) data of winter-run from the calendar years 2000 to 2007. PRD was involved in providing assistance in conducting these analyses to varying degrees. In October, 2009, preliminary results of the cohort reconstructions and analyses of fishing impact were made available by the SWFSC for consideration by SFD and PRD. In November 2009, PRD provided SFD with a letter summarizing what would be required to formally initiate consultation. In mid-December, PRD asked SFD to provide the information necessary to initiate formal consultation knowing that the final results from the SWFSC had not yet been provided with the understanding that when that information was available, SFD would provide it as a supplement to the package, along with any other additional information requested by PRD after reviewing the initiation package. The draft BA, with the SWFSC's preliminary findings, was provided by SFD in mid-December, and the finalized analyses and supplemental document were provided in early January 2010.

II. DESCRIPTION OF THE PROPOSED ACTION

A. Pacific Coast Salmon Fishery Management Plan

Commercial and recreational ocean salmon fisheries in the U.S. EEZ off the coasts of Washington, Oregon, and California are authorized by NMFS under the MSA. Specifically, these fisheries are managed under the federal Salmon FMP (PFMC 2003). Consistent with the FMP, more detailed management regulations are developed annually, designed to respond to new information and the current status of each salmon stock. Pursuant to the MSA, the PFMC develops recommendations for the development of the FMP, FMP amendments, and annual management measures and provides those recommendations to the Secretary of Commerce, through NMFS, for review and approval. The Secretary may approve the PFMC's recommendations for implementation as federal regulation if found to be consistent with the MSA and other applicable law, including the ESA.

All species of salmon (both natural and of hatchery origin) that are contacted by the PFMC ocean salmon fishery in the west coast EEZ and in need of conservation and management fall under the jurisdiction of the Salmon FMP,[4] including target stocks (stocks that fishers seek to catch for sale or personal use) and non-target stocks (fish

[4] Salmon of U.S. and Canadian origin are included except when specific species are managed in those waters by another management entity with primary jurisdiction (*i.e.*, sockeye and pink salmon by the Fraser River Panel of the Pacific Salmon Commission in the Fraser River Panel Area (U.S.) between 49°N latitude and 48°N latitude).

caught incidentally during the pursuit of target stocks in a fishery). Management of this fishery is complicated by the fact that salmon stocks from different spawning areas co-mingle in the ocean, making it a "mixed stock" ocean fishery, *i.e.*, individuals from various stocks can be caught together. Therefore, management regulations for the ocean fishery are designed each year to prevent overfishing and protect the weakest stocks, such as ESA-listed salmon, or reduce fishing pressure on the stocks that contribute heavily to the ocean harvest when they are depressed, such as Sacramento River Fall Chinook (SRFC), while allowing some harvest of abundant stocks to their optimum yield.[5]

Each salmon stock affected by the fishery is managed according to a conservation objective specified in the FMP (see Table 3.1 of the FMP; PFMC 2003). Conservation objectives have been specified for stock components of Chinook, Coho, and Pink (odd-numbered year) salmon, and ESA-listed salmon that are measurably impacted by the ocean salmon fishery. The FMP contains no conservation objectives for even-numbered year Pink salmon, Chum (*O. keta*), Sockeye (*O. nerka*), Steelhead (*O. mykiss*), or Sea-run cutthroat (*O. clarki*) because the PFMC does not make management recommendations to NMFS for these species and incidental catches are inconsequential (low hundreds of fish each year) to very rare (PFMC 2003).

Amendments 12 (1997) and 14 (2003) to the FMP added all ESA-listed salmon stocks, including winter-run, to the list of stocks managed under the FMP. The conservation objective of ESA-listed stocks was identified generically as 'consistency with NMFS's ESA jeopardy standards or recovery plans'; they are referred to as "consultation standards." ESA jeopardy standards/consultation standards are understood to be the requirements for ESA-listed species developed through ESA Section 7 consultations and set out in NMFS's biological opinions. The FMP requires that NMFS provide consultation standards for each ESA-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 PFMC prior to the start of the annual preseason planning process (typically the beginning of March). In addition, NMFS can include updated information and any recommendations for any additional protective measures for ESA-listed stocks, including winter-run, beyond the consultation standards set forth in the biological opinions that are in effect. NMFS provides the necessary review for these consultation standards through an associated biological opinion (see Table 3; NMFS 2009a). The FMP requires the PFMC to set management recommendations that meet or exceed NMFS consultation standards.

The Salmon FMP and its regulations[6] define the fishing year for the salmon fishery as starting on May 1 through April 31 of the following year. This is the time period for which annual regulations are developed and apply. Descriptions of open fishing periods and locations for the annual ocean salmon fishery are published at the conclusion of each

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[5] See MSA §301(a)(1) and the National Standard 1 Guidelines (50 CFR Part 600.310(e)(3)) for the requirements and NMFS guidance on "optimum yield".

[6] Found at 50 CFR part 660, subpart H.

year's April PFMC meeting (*e.g., Preseason Report III, Analysis of Council Adopted Management Measures for 2008 Ocean Salmon Fisheries; PFMC 2009*). The fishing periods and locations may be modified in-season in response to changes in projected salmon abundance, fishing effort, or weather conditions in order to assure achievement of the management objectives and consideration for safety concerns. The proposed action would start in the 2010 fishing year, *i.e.,* May 1, 2010. The annual planning process for the ocean salmon fishery begins in March each year, thus, development of the 2010 regulations will begin at the PFMC meeting starting March 4, 2010. The proposed action is scheduled to occur each year thereafter, consistent with the consultation standards specified in this biological opinion.

The fishery is managed using a variety of area-specific measures including open and closed seasons, catch quotas, landing limits, bag limits, size limits, and gear restrictions. A detailed description of the specific fishery locations and historical catch and effort data is found in the Review of Ocean Salmon Fisheries document produce annually (*e.g*. PFMC 2009a) and available at each year's March PFMC meeting and on the PFMC website.[7] The proposed action will be implemented each year using annual regulations designed with the methods identified above and consistent with the MSA, other applicable laws, the FMP, and all applicable ESA consultation standards.

Additional specialized research projects designed to improve the information used for management, such as the genetic stock identification (GSI) program, may also be authorized in conjunction with the conservation objectives and consultation standards of the FMP. GSI sampling is intended to be conducted in areas open to fishing, with samples taken from the fish harvested by commercial troll vessels. For sampling undertaken in areas that are closed to commercial fishing, sampling will be conducted by commercial troll vessels that are chartered by and under direction of NMFS staff. All fishing in the closed areas will be catch-and-release; no retention allowed. Boats will be equipped with geographic information system (GIS) recorders to monitor the vessel track and to record the exact time and location of each fish caught. The fishermen will collect tissue and scale samples for GSI and age analysis, and record fish length and depth of capture. Fish may be tagged for future identification. To reduce handling time and stress to the fish, each boat will have two fishermen (captain and crew) specially trained and equipped in catch and release sampling.

B. Action area

In developing its annual recommendations for ocean salmon fisheries, the PFMC analyzes management options for fisheries occurring in the EEZ off the states of Washington, Oregon and California (*i.e*., west coast EEZ). This analysis includes assumptions regarding the levels of harvest in state marine, estuarine, and freshwater areas, which are regulated under authority of the states and federally recognized tribes with fishing rights. Due to the mixed stock nature of the fishery, the scope of the west coast EEZ that is open to salmon fishing and the length of time the areas are open in any one year depends on salmon stock abundances in excess of the conservation objectives

[7] www.pcouncil.org

and the spatial distribution of constraining stocks. NMFS establishes fishery management measures for ocean salmon fisheries occurring in the west coast EEZ based on the PFMC recommendations. Because Washington, Oregon, and California are members of the PFMC, they generally manage their marine waters consistent with the regulations approved by NMFS. If a state's actions substantially and adversely affect the carrying out of the FMP, the Secretary may, under the MSA, assume responsibility for the regulation of ocean fishing in state marine waters; however that authority does not extend to a state's internal waters. For the purposes of this Opinion, the action area is the U.S. west coast EEZ (which is directly affected by the proposed federal action) and the marine waters, other than internal, of the states of Washington, Oregon, and California (which may be indirectly affected by the federal action) (Figure 1).

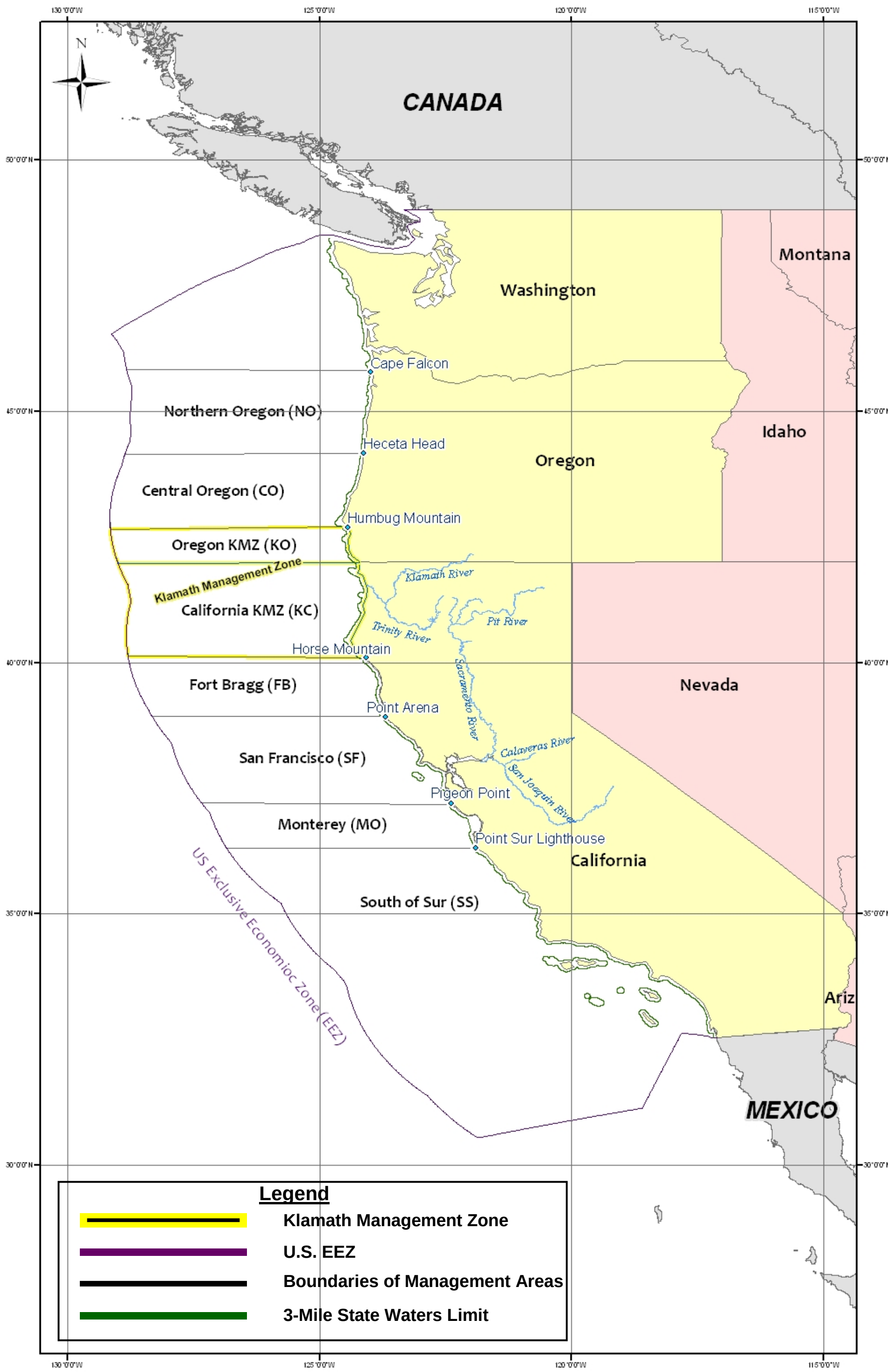

Figure 1: Map of the action area, including identification of Salmon FMP management areas.

C. Gear and methods

The ocean salmon fishery primarily consists of recreational and commercial troll fisheries that use hook-and-line gear. Commercial troll vessels catch fish by "trolling" bait or lures (Figure 2). Typically, four to six main wire lines are fished at a time, each with a 50 lb. lead "cannon ball" weight and between eight to twelve nylon leaders spaced out along its length. Each nylon leader contains a lure or baited hook. Troll vessels come in a variety of lengths and styles.

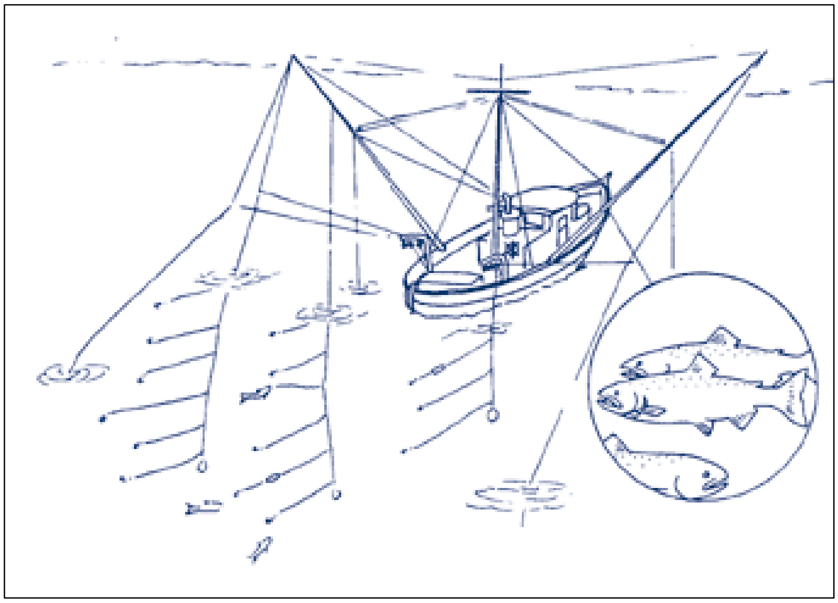

Figure 2: Commercial troll vessel (California Seafood Council website (CSC 2009).

In the ocean salmon recreational fishery, anglers fish from private boats and from commercial passenger fishing vessels (CPFVs) (*i.e.*, charter fishing trip, often called 'party boats'). Methods include trolling and mooching. Mooching is typically used when boats drift above salmon that have congregated into schools and are feeding in a small area. Weights or sinkers are used to drop the lines straight down to avoid tangling multiple lines in the water, particularly from CPFVs. Trolling is used when a greater distance needs to be covered to pursue the fish. Mooching is a method used frequently off Monterey, California, and used to be very popular method with CPFVs in the 1990s. However, studies showed that there are greater mortality rates among sublegal, released fish caught by mooching than trolling because the fish caught by mooching tend to swallow the bait, getting hooked in the gut or gills; whereas the fish caught by trolling are typically hooked in the mouth. Studies found that the use of circle hooks significantly reduced the hooking mortality on sublegal-sized salmon. Since 1997, recreational anglers have been required to use barbless, circle hooks to reduce the hooking mortality on released salmon (Grover *et al*. 2002; Boydstun *et al*. 2001).

D. Conservation measures included in the proposed action

As part of this action, SFD also proposes to maintain the same additional protective measures for winter-run that were approved by NMFS in the 2004 biological opinion for the same action (*i.e.*, time and area closures, and minimum size limits):

Recreational Salmon Fishery:
• Between Point Arena, California and Pigeon Point, California, the recreational salmon fishery shall open no earlier than the first Saturday in April and close no later than the second Sunday in November.
• Between Pigeon Point and the U.S.-Mexico Border, the recreational salmon fishery shall open no earlier than the first Saturday in April and close no later than the first Sunday in October.
• The minimum size limit shall be at least 20 inches.

Commercial Salmon Fishery:
• Between Point Arena, California, and the U.S.-Mexico Border, the commercial salmon fishery shall open no earlier than May 1 and close no later than September 30, with the exception of an October fishery that may be conducted Monday through Friday between Point Reyes and Point San Pedro, but shall end no later than October 15.
• The minimum size limit shall be at least 26 inches.

SFD believes these measures have been effective at minimizing the impact of the salmon ocean fishery on winter-run, and are in addition to measures specified by the FMP or required by NMFS's biological opinions for other ESA-listed salmon stocks. These measures act to substantially reduce the ocean fishery take of winter-run salmon principally by completely closing the fisheries between Point Arena, California, and the U.S./Mexico Border from mid-November through March, the period of time during which most mature winter-run adults migrate from the ocean to their spawning grounds in the Sacramento River.[8] The closure of the recreational fishery in this area during the February through March time period, in particular, is the biggest factor in reducing the overall harvest of winter-run in the ocean fishery (see Effects analysis). At this time, no additional fishery management measures to protect winter-run are being considered.

III. STATUS OF SPECIES AND CRITICAL HABITAT

The following endangered or threatened species and designated critical habitat may be present in the action area, as defined above, and may be affected by the proposed action:

Table 1. ESA-listed species under NMFS jurisdiction within the action area

Marine Mammals	Status
Blue whale (*Balaenoptera musculus*)	Endangered

[8] The Sacramento River recreational fishery is managed by the State of California, and while not part of the proposed action, is also closed to Chinook salmon harvest during the period of time when winter-run mature adults are present in the Sacramento River, eliminating this portion of the "overall" fishery harvest.

Fin whale (*Balaenoptera physalus*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered
Sperm whale (*Physeter macrocephalus*)	Endangered
Killer whales - southern resident DPS (*Orcinus orca*)	Endangered
North Pacific right whale (*Eubalaena japonica*)	Endangered
Steller sea lion - eastern distinct population segment (DPS) (*Eumetopias jubatus*)	Threatened
Guadalupe fur seal (*Arctocephalus townsendi*)	Threatened
Sea turtles	
Leatherback turtle* (*Dermochelys coriacea*)	Endangered
Loggerhead turtle **(*Caretta caretta*)	Endangered
Olive ridley (*Lepidochelys olivacea*)	Endangered/Threatened
Green turtle (*Chelonia mydas*)	Endangered/Threatened
Marine fish	
Green Sturgeon, southern DPS (*Acipenser medirostris*)	Threatened
Pacific eulachon, southern DPS*** (*Thaleichthys pacificus*)	Threatened
Marine invertebrates	
White abalone (*Haliotis sorenseni*)	Endangered
Black abalone (*Haliotis cracherodii*)	Endangered

Salmonids		
Chinook (*Oncorhynchus tshawytscha*)	Sacramento River winter, evolutionarily significant unit (ESU)	Endangered
	Central Valley Spring ESU	Threatened
	California Coastal ESU	Threatened
	Snake River Fall ESU	Threatened
	Snake River Spring/Summer ESU	Threatened
	Lower Columbia River ESU	Threatened
	Upper Willamette River ESU	Threatened
	Upper Columbia River Spring ESU	Endangered
	Puget Sound ESU	Threatened
Chum (*Oncorhynchus keta*)	Hood Canal Summer Run ESU	Threatened
	Columbia River ESU	Threatened
Coho (*Oncorhynchus kistuch*)	Central California Coastal ESU	Endangered
	S. Oregon/N. CA Coastal ESU	Threatened
	Oregon Coast ESU	Threatened
	Lower Columbia River ESU	Threatened
Sockeye (*Oncorhynchus nerka*)	Snake River ESU	Endangered
	Ozette Lake ESU	Threatened

Steelhead (*Oncorhynchus mykiss*)	Southern California DPS	Endangered
	South-Central California DPS	Threatened
	Central California Coast DPS	Threatened
	California Central Valley DPS	Threatened
	Northern California DPS	Threatened
	Upper Columbia River DPS	Endangered
	Snake River Basin DPS	Threatened
	Lower Columbia River DPS	Threatened
	Upper Willamette River DPS	Threatened
	Middle Columbia River DPS	Threatened

Critical Habitat		
Stellar sea lion (*Eumetopias jubatus*)	Rogue Reef: Pyramid Rock Oxnard Reef: Long Brown Rock and Seal Rock Ano Nuevo I. Southeast Farrallon I. Sugarloaf I.	Associated aquatic zones 3,000 feet seaward in State and Federally managed waters from the baseline of each rookery
Green Sturgeon, southern DPS (*Acipenser medirostris*)	US coastal marine waters within 60 fathoms from Monterey Bay, CA, to Cape Flattery, WA, the Sacramento River and other select waters within the Sacramento-San Joaquin River-Delta system, and other select coastal bays and estuaries waters within California, Oregon, and Washington.	

* Critical habitat for leatherbacks was proposed on January 5, 2010. The proposed designation includes two adjacent marine areas totaling approximately 119,400 km² stretching along the California coast from Point Arena to Point Vincente; and one 63,455 square km²) marine area stretching from Cape Flattery, Washington to the Umpqua River (Winchester Bay), Oregon east of a line approximating the 2,000 meter depth contour. Proposed critical habitat extends from the surface down to a depth of 80 m (75 FR 319).
** The listing of nine distinct population segments of loggerhead sea turtles was proposed on March 16, 2010. This action area of this proposed action would include the North Pacific Ocean DPS of loggerheads, which is now proposed for listing as endangered (75 FR 12598).
*** The final listing determination as threatened takes effect on May 17, 2010 (75 FR 13012)

No incidental take of ESA-listed sea turtles, marine mammals, abalone, steelhead, or eulachon has been documented or would be expected in the salmon ocean fishery. Consequently, no further consideration will be given to direct interactions between these species and the fishery in this opinion. There is a possibility that the removal of a predator like salmon from coastal areas by the ocean fishery could be a benefit to the newly listed eulachon species, which may constitute a prey source for adult salmon in the marine environment. The potential effect of the salmon ocean fishery on green sturgeon was considered after the Southern DPS of green sturgeon was listed in 2006 (NMFS 2007). There was no indication or record of any green sturgeon being taken in the salmon fishery. The absence of catch in the fishery is consistent with our understanding of the feeding habitats of sturgeon and the fishing methods used to catch salmon.

Sturgeon are bottom oriented benthic feeders. Salmon are surface or mid-water feeders that focus on pelagic prey. Salmon fishing methods are such that sturgeon encounters are unexpected. Based on these observations, NMFS concluded that salmon fishing under the Council's Salmon FMP likely has no effect on green sturgeon. The final rule designating critical habitat for the Southern DPS of green sturgeon can be found at 50 CFR Part 226 (74 FR 52300). While it is in the action area of the west coast EEZ, NMFS's main concerns are with activities that affect water quality or affect benthic habitat. Salmon hook and line fishing methods do not disrupt the benthic habitat or water quality. At this time, NMFS concludes that any pollution generated by vessels in the salmon ocean fishery fleet during fishing operations is likely to be insignificant and discountable. In addition, the prey resources important to green sturgeon within the marine portion of their life-cycle (as well as in the freshwater environment) are believed to include mainly benthic invertebrate and similarly related fishes (74 FR 52300). Salmon do not appear to be an important prey resource. As a result, NMFS concludes that the salmon ocean fishery is not likely to affect green sturgeon critical habitat.

A. Southern Resident killer whales

Southern Resident killer whales (Southern Residents) are known to rely heavily upon salmon as their main source of prey (about 96% of their diet) throughout the areas and times for which reliable data on prey consumption is available (Ford and Ellis 2006). Studies have indicated that Chinook salmon generally constitute a large percentage of the Southern Resident salmon diet, with some indications that Chinook are strongly preferred at certain times in comparison to other salmonids (Ford and Ellis 2006; Hanson *et al*. 2007). Results have also suggested that Chinook salmon from ESUs from California to British Columbia are being consumed by Southern Residents (Hanson *et al*. 2007).

An analysis of the impact of the Pacific Coast Salmon Plan on Southern Residents was most recently presented in a 2009 Biological Opinion by the Northwest Region of NMFS (NMFS 2009b). Using a model that related estimates of prey reduction associated with the salmon fishery to the metabolic requirements of Southern Residents and the remaining levels of prey availability, NMFS concluded that the salmon fishery was not likely to result in jeopardy for Southern Residents. No additional analysis of salmon fishery impacts to Southern Residents will be considered in this Opinion

B. Stellar sea lions and their critical habitat

Critical habitat for Steller sea lions is designated at Ano Nuevo Island, Sugarloaf Island, and the southeast Farrallon Islands in California; and Pyramid Rock at Rogue Reef, and Long Brown Rock and Seal Rock at Orford Reef in Oregon (50 CFR 226, Table 1). Critical habitat includes associated aquatic zones 3,000 feet seaward in State and Federally managed waters from the baseline of each rookery (50 CFR 226.202(b)). These aquatic zones around rookery sites were chosen based on evidence that many foraging trips made by lactating adult females may be relatively short (Merrick and Loughlin 1997). Also foraging trips by young-of-the-year Steller sea lions are likely to be short as they are just learning how to feed on their own (Merrick and Loughlin 1997, Loughlin *et al*. 2003).

One element of this critical habitat is related to prey availability in the aquatic environment. Stellar sea lions are known to feed on a wide variety of demersal and off-bottom schooling fish and are noted for their flexibility in exploiting forage resources, including salmon (Pitcher 1981, Sigler *et al*. 2004). The limited amount of information about foraging in areas off the coast of Oregon and California indicate that rockfish species and hake make up significant portions of their diet (58 FR 45270). It is also likely that species like eulachon, sardines, and squid are important as well (Pitcher 1981, Sigler *et al*. 2004).

The exact locations of fishing effort are not available so it is not possible to determine how much, if any, salmon fishing occurs within the designated critical habitat area. It is possible that some of the fish harvested may represent potential prey that would otherwise eventually be present within the designated critical habitat for Steller sea lions that is no longer available. However, considering that salmon are not known to be a significant source of food for these animals off Oregon and California, the potential effect of prey removal by salmon harvest spread out along the entire west coast is likely to be discountable in localized areas such as the critical habitat rookeries. Therefore, the salmon fishery is not likely to adversely affect Steller sea lions or result in the destruction or adverse modification of critical habitat.

C. Salmon final listing determinations for 16 salmon ESUs

On June 28, 2005, NMFS published its final listing determinations for 16 ESUs (70 FR 37160). Critical habitat that has been designated for salmon is limited to fresh water and some estuarine areas. The marine environment where the salmon fishery occurs is not proposed for, or included in, critical habitat for any salmon ESUs; therefore, possible impacts of the proposed action on salmonid critical habitat will not be considered in this Opinion.

In the June 2005 final rule, NMFS included a number of within-ESU hatchery fish in the listed unit. This followed a lawsuit and substantial review by NMFS of the salmon listings at that time. A number of reports and workshops considered the viability of individual ESUs, the viability of natural populations within the ESUs, and the influence and role of hatcheries in the recovery of salmon. As required under regulations implementing section 7(a)(2) of the ESA, this opinion analyzes the effect of the proposed action on the entire listed ESU, both wild and hatchery populations.

As mentioned above, there are other biological opinions which address the impacts of the ocean salmon fishery on the ESA-listed salmon ESUs which are likely to be affected by the fishery (see NMFS 2009a for a reference list of which opinions address which ESUs). Some of the opinions are in effect for a set period of time while others remain in force until such time that new information becomes available which warrants review of potential impacts not previously considered. The 2004 opinion on winter-run expires on

April 30, 2010, and consultation must be reinitiated in order for the fishery to remain compliant with the ESA. Although NMFS is constantly reviewing the most current information and best available science for all ESA-listed salmonids that may be affected by the ocean salmon fishery, this opinion will only analyze the impacts of the fishery on winter-run.

D. Chinook salmon general life history[9]

Chinook are the largest species of salmon in North America. They are anadromous – they are born in fresh water rivers and streams then migrate to estuaries to rear before entering marine water to mature. Pacific salmon return to fresh water (usually their natal streams) as mature adults to spawn and then die. The time in each of these life stages is variable from a few weeks or months in natal streams and months to years in the marine environment. Chinook salmon have a highly variable life history, *e.g.*, variation in fresh water rearing, time to marine outmigration, ocean migratory patterns, age and season of spawning which are influenced by both genetics and environmental conditions (Healey 1991).

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). Adult "stream-type" Chinook salmon enter freshwater months before spawning, and juveniles reside in freshwater for a year or more, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation of the fish at the time of river entry, thermal regime, and flow characteristics of their spawning sites, and the actual time of spawning (Myers *et al.* 1998). Both winter-run and spring-run tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. Fall-run enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are necessary to allow adult passage to upstream holding habitat. Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning

[9] Much of the information on the status of Sacramento River winter run Chinook comes directly from the NMFS 2009c, Biological Opinion, which contains a more detailed description of the ecological status and conditions facing winter run in the Sacramento River-Delta System.

typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad.

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The length of development for Chinook salmon embryos is dependent on the ambient water temperature surrounding the egg pocket in the redd. Colder water necessitates longer development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. Fry typically range from 25 mm to 40 mm at this stage. Upon emergence, fry swim or are displaced downstream (Healey 1991). Some fry may take up residence in their natal stream for several weeks to a year or more, while others are displaced downstream by the stream's current. Once started downstream, fry may continue downstream to the estuary and rear there, or may take up residence in river reaches farther downstream for a period of time ranging from weeks to a year (Healey 1991). When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991).

Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The daily migration of juveniles passing Red Bluff Diversion Dam is highest in the 4-hour period prior to sunrise (Martin *et al.* 2001). Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (ppt, Healey 1980, Levy and Northcote 1981). Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975, Meyer 1979, Healey 1980). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levings 1982, Levy and Northcote 1982, Levings *et al.* 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Available data indicate that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

E. Sacramento River winter-Run Chinook salmon

The distribution of winter-run spawning and rearing historically is limited to the upper Sacramento River and its tributaries, where spring-fed streams provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento rivers, and Hat and Battle creeks, historically provided clean, loose gravel; cold, well-oxygenated water; and optimal stream flow in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters necessary for egg and fry development and survival, and juvenile rearing over the summer. The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which has its own impediments to upstream migration (Moyle *et al.* 1989; NMFS 1997a, 1998a, 1998b). Approximately 299 miles of tributary spawning habitat in the upper Sacramento River is now inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the Upper Sacramento had a "potential spawning capacity" of 14,303 redds. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Winter-run exhibit characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run migrate to sea after only 4 to 7 months of river life (ocean-type). Adult winter-run enter San Francisco Bay from November through June (Hallock and Fisher 1985), enter the Sacramento River basin between December and July, the peak occurring in March (Table 2; Yoshiyama *et al.* 1998, Moyle 2002), and migrate past the Red Bluff Diverison Dam (RBDD) from mid-December through early August (NMFS 1997a). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Yoshiyama *et al*. 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and

Marine 1991). The majority of winter-run spawners are 3 years old.

Table 2. The temporal occurrence of (a) adult and (b) juvenile winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River basin[a]	Medium, Medium	Medium, Medium	High, High	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium					Medium, Medium
Sac. River[b]	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium					Medium, Medium	Medium, Medium
b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River @ Red Bluff[c]	Low, Low	Low, Low	Low, Low				Low, Medium	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium
Sac. River @ Red Bluff[b]	Low, Low	Low, Low	Low, Low				Low, Low	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium	Medium, Medium
Sac. River @ KL.[d]	Medium, Medium	Medium, Medium	Medium, Medium	Low, Low	Low, Low			Low, Low	Low, Low	Low, Low	High, High	High, High
Lower Sac. River (seine)[e]	High, High	High, High	Medium, Medium	Low, Low	Low, Low					Low, Low	Medium, Medium	High, High
West Sac. River (trawl)[e]	Medium, Medium	Medium, Medium	High, High	Medium, Medium	Low, Low						Low, Low	Medium, Medium

KL = Knights Landing

Relative Abundance: High / Medium / Low (shading)

Sources: Yoshiyama *et al*. (1998); Moyle (2002); Myers *et al*. (1998); Vogel and Marine (1991) ; Martin *et al.* (2001); Snider and Titus (2000); USFWS (2001a, 2001b)

Winter-run fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). Emigration of juvenile winter-run past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997a). From 1995 to 1999, all winter-run outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile winter-run occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento (river mile (RM) 57; USFWS 2001a, 2001b). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continue through May (Fisher 1994, Myers *et al.* 1998).

1. Range-wide (ESU) status and trends

Historical winter-run spawner escapement estimates, which included males and females, grilse and adults, were as high as over 117,800 adults in 1969 (Mills and Fisher 1994), but declined to under 200 fish in the 1990s (Figure 3, Table 3). A rapid decline occurred from 1969 to 1979 after completion of the RBDD (Figure 3). Over the next 20 years, escapement eventually reached a low point of only 186 fish in 1994. At that point, winter-run was at a high risk of extinction, as defined in the most recent guideline for recovery of Central Valley salmonids (Lindley *et al*. 2007). If not for a very successful captive broodstock program (started in early 1990s), construction of a temperature control device (TCD) on Shasta Dam (1994), having the RBDD gates up for much of the year (originally identified in 1992), and restrictions on the ocean fishery (beginning 1991), the population would have likely failed to exist in the wild. In recent years, the carcass survey spawner escapement estimates reached a high of 17,304 (Table 3) in 2006, followed by a precipitous decline in 2007 that continued in 2008 when less than 3,000 fish returned to the upper Sacramento River (CDFG 2009). The preliminary estimate of 2009 escapement is 4,537 (PFMC 2010)

A conservation program at Livingston Stone National Fish Hatchery (LSNFH) located at the base of Keswick Dam annually supplements winter-run production by releasing on average 250,000 winter-run smolts into the upper Sacramento River. The LSNFH operates under strict guidelines for propagation that include genetic testing of each pair of adults and contributing less than 25 percent of the total returns. This conservation program and the captive broodstock program (phased out in 2007) were instrumental in stabilizing winter-run following very low spawner returns in the 1990s.

The status of winter-run is typical of most endangered species populations, that is, a sharp downward decline followed by years of low abundance (Figure 3). Since there is only one extant winter-run population, there currently are no other populations to act as a reserve should a catastrophic event happen in the mainstem Sacramento River. Four highway bridges cross the upper Sacramento River spawning grounds. One large truck overturning could spill enough oil or contaminants to extirpate an entire year class. The winter-run population is completely dependent on coldwater releases from Shasta Dam in order to sustain the one remaining population (NMFS 2009d).

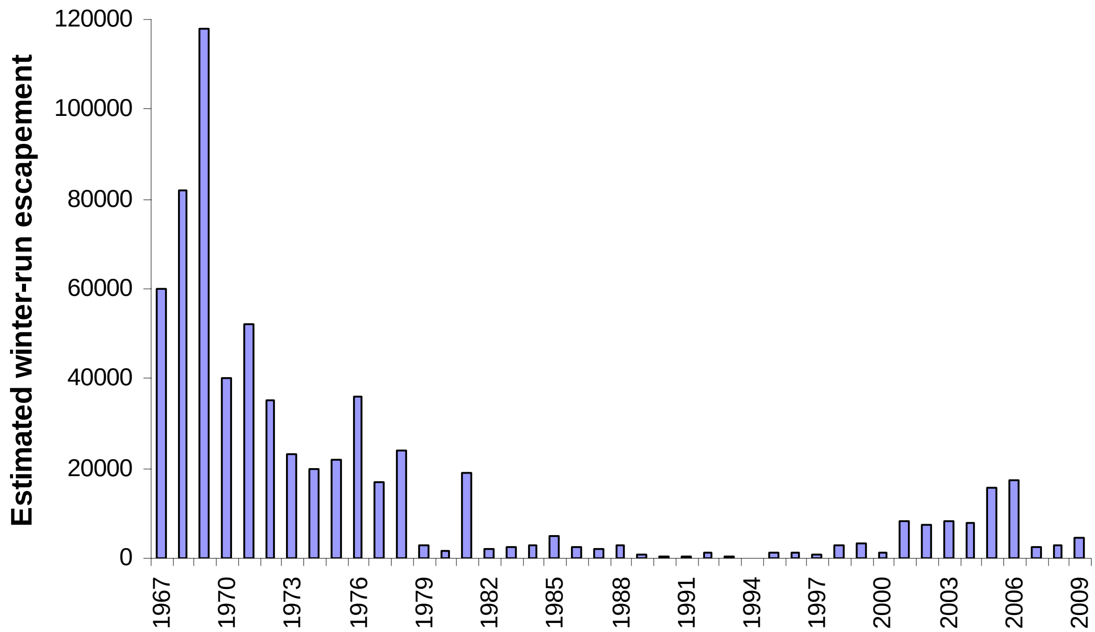

Figure 3: Estimated yearly spawning escapement of winter-run from 1967-2008 (1967-1985 are from Mills and Fisher 1994; 1986-2008 are from CDFG 2009; 2009 is preliminary from PFMC 2010).

The upper Sacramento River is the only spawning area used by winter-run, although occasional strays have been reported in Battle Creek and Clear Creek. Since 2001, winter-run spawning has shifted upstream, presumably in response to improved fish passage at the Anderson Cottonwood Irrigation Dam (ACID) Dam and temperature management compliance. The majority of winter-run in recent years (*i.e.*, > 50 percent since 2007) spawn in the area from Keswick Dam downstream to the ACID Dam (approximately 5 miles) (NMFS 2009c). Keswick Dam re-regulates flows below Shasta Dam and mixes it with water diverted from the Trinity River through the Spring Creek diversion tunnel. When the diversion gates are down at RBDD or flashboards are in at the ACID Dam, access to the upper Sacramento River basin, including tributaries, can only be achieved through the RBDD and ACID Dam fish ladders, which delay passage upstream.

Anderson et al. (2009) recommend using the "spawner-per-recuit" ratio (equivalently, the cohort replacement rate, CRR) as the basis for assessing salmon population productivity and viability. Lack of age-specific estimates of winter-run escapement precludes direct calculation of this metric. However, because the winter-run age-3 maturation rate exceeds 85% (see Table 7, page 49), the escapement in any given year is generally dominated by age-3 fish. This implies that the ratio of the escapement in any given year divided by the escapement three years earlier will provide a close approximation to the CRR for that brood. The results of applying this calculation for the CRR are shown in Table 3.

Table 3. Winter-run spawning escapement estimates from RBDD counts (1986 to 2000) and carcass surveys (2001 to 2009), and corresponding cohort replacement rates for the years since 1986 (CDFG 2009).

Year	Spawning Escapement[a]	3-Year Moving Average of Escapement	Cohort Replacement Rate[b]	3-Year Moving Average of Cohort Replacement Rate
1986	2,566	-	-	-
1987	2,185	-	-	-
1988	2,878	2,543	-	-
1989	696	1,920	0.27	-
1990	430	1,335	0.20	-
1991	211	446	0.07	0.18
1992	1,240	627	1.78	0.68
1993	387	613	0.90	0.92

1994	186	604	0.88	1.19
1995	1,297	623	1.05	0.94
1996	1,337	940	3.45	1.79
1997	880	1,171	4.73	3.08
1998	2,992	1,736	2.31	3.50
1999	3,288	2,387	2.46	3.17
2000	1,352	2,544	1.54	2.10
2001	8,224	4,288	2.75	2.25
2002	7,464	5,680	2.27	2.19
2003	8,218	7,969	6.08	3.70
2004	7,869	7,850	0.96	3.10
2005	15,875	10,654	2.13	3.05
2006	17,304	13,683	2.11	1.73
2007	2,533	11,904	0.32	1.52
2008	2,725	7,521	0.17	0.87
2009[c]	4,537	3,265	0.26	0.25
median	**2,550**	**2,465**	**1.54**	**1.79**

[a] Escapement estimates were based on RBDD counts until 2001. Starting in 2001, escapement estimates were based on carcass surveys.

[b] The majority of winter-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the escapement estimates of a given year, divided by the escapement estimates 3 years prior.

[c] Preliminary estimate (PFMC 2010).

2. Current viability of Sacramento River winter-run Chinook

One prerequisite for predicting the effects of a proposed action on a species is an understanding of the likelihood of the species in question becoming viable, and whether the proposed action can be expected to reduce this likelihood. The abundance of spawners is just one of several criteria that must be met for a population to be considered viable. McElhany *et al*. (2000) acknowledged that a viable salmonid population at the ESU scale is not merely a quantitative number that needs to be attained. Rather, for an ESU to persist, populations within the ESU must be able to spread risk and maximize future potential for adaptation. ESU viability depends on the number of populations and subunits within the ESU, their individual status, their spatial arrangement with respect to each other, sources of catastrophic disturbance, and diversity of the populations and their habitats (Lindley *et al*. 2007). Populations comprise diversity groups, which are intended to capture important components of habitat, life history or genetic diversity that contribute to the viability of the ESU (Hilborn et al. 2003 *op. cit*. Lindley *et al.* 2007, Bottom *et al*. 2005 *op. cit*. Lindley *et al*. 2007). Lindley *et al*. (2007) suggest that at least two viable populations within each diversity group are required to ensure the viability of the diversity group, and hence, the ESU.

In order to determine the current likelihood of winter-run becoming viable, we used the historical population structure of winter-run presented in Lindley *et al*. (2004) and the concept of VSP for evaluating populations described by McElhany *et al.* (2000). While McElhany *et al.* (2000) introduced and described the concept of VSP, Lindley *et al.* (2007) applied the concept to the winter-run ESU. Lindley *et al.* (2004) identified four historical populations within the winter-run ESU, all independent populations, defined as those sufficiently large to be historically viable-in isolation and whose demographics and extinction risk were minimally influenced by immigrants from adjacent populations (McElhany *et al*. 2000). All four independent populations, however, are extinct in their historical spawning ranges. Three (Little Sacramento; Pit, Fall, Hat; and McCloud River) are blocked by the impassable Keswick and Shasta Dams (Lindley *et al*. 2004), and the Battle Creek independent population is no longer self-sustaining (Lindley *et al*. 2007).

Although Lindley *et al*. (2007) did not provide numerical goals for each population of Pacific salmonid to be categorized at low risk for extinction, they did provide various quantitative criteria to evaluate the risk of extinction (Table 4).[10] A population must meet all the low-risk thresholds to be considered viable. The following provides the evaluation of the likelihood of winter-run becoming viable based on the VSP parameters of population size, population growth rate, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000).

3. Population size

Information about population size provides an indication of the type of extinction risk that a population faces. For instance, smaller populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (McElhany *et al.* 2000). One risk of low population sizes is depensation. Depensation occurs when populations are reduced to very low densities and per capita growth rates decrease as a result of a variety of mechanisms [*e.g.,* failure to find mates and therefore reduced probability of fertilization, failure to saturate predator populations (Liermann and Hilborn 2001)]. Another is resilience of small populations to random stochastic variability in environmental conditions that affect growth, survival, and reproduction.

As provided in Table 3, the winter-run population, as represented by the 3-year moving average for adult escapement, was following an increasing trend from the mid-1990s until 2006. In 2007, the winter-run population declined precipitously. Low adult escapement was repeated in 2008, and again in 2009. Likewise, the 3-year moving average cohort replacement rate was relatively stable since the late 1990s, with each cohort approximately doubling in size. Currently, due to recent declines in returns for 3 consecutive years, the average is now trended well below replacement (0.25). At the time of publication, Lindley *et al*. (2007) indicated that winter-run satisfies the low-risk criteria for population size, population decline, and catastrophe. However, they also acknowledged that the previous precipitous decline to a few hundred spawners per year in the early 1990s would have qualified it as high risk at that time, and the 1976-77

[10] These criteria were modified from similar approach in Allendorf *et al*. 1997.

drought would have qualified as a high-risk catastrophe. In consideration of the substantial decreases in population since 2007, coupled with drought conditions observed since 2007, and recent periods of poor environmental conditions in the marine environment (see Ocean productivity in the Environment Baseline section) which could be qualified as a high-risk catastrophe(s), NMFS concludes that winter-run is at a moderate to high risk of extinction based on the small population size and greater risks associated with only one population.

Table 4. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids (reproduced from Lindley *et al*. 2007).

	Risk of Extinction		
Criterion	High	Moderate	Low
Extinction risk from PVA	> 20% within 20 years	> 5% within 100 years	< 5% within 100 years
	– or any ONE of –	– or any ONE of –	– or ALL of –
Population size[a]	$N_e \leq 50$	$50 < N_e \leq 500$	$N_e > 500$
	–or–	–or–	–or–
	$N \leq 250$	$250 < N \leq 2500$	$N > 2500$
Population decline	Precipitous decline[b]	Chronic decline or depression[c]	No decline apparent or probable
Catastrophe, rate and effect[d]	Order of magnitude decline within one generation	Smaller but significant decline[e]	not apparent
Hatchery influence[f]	High	Moderate	Low

[a] Census size N can be used if direct estimates of effective size N_e are not available, assuming $N_e/N = 0.2$.
[b] Decline within last two generations to annual run size $\leq$ 500 spawners, or run size > 500 but declining at $\geq$ 10% per year. Historically small but stable population not included.
[c] Run size has declined to $\leq$ 500, but now stable.
[d] Catastrophes occuring within the last 10 years.
[e] Decline < 90% but biologically significant.
[f] See Figure 1 for assessing hatchery impacts.

4. Population growth rate

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). This guideline seems reasonable in the absence of numeric abundance targets.

Winter-run have declined substantially from historic levels and in the last generation (3 years). The one remaining population of winter-run on the mainstem Sacramento River comprises the entire current ESU. Although the population growth rate (indicated by the cohort replacement rate) increased since the mid 1990s, it drastically decreased in 2007, 2008, and 2009, indicating that the population is not replacing itself. Lindley *et al*. (2007) develop criteria for assessing the relative extinction risk associated with various population growth scenarios (Table 4). The precipitous decline observed in the last generation places winter-run in the high risk category. As mentioned above, the severity of the observed decline is more comparable to a catastrophic event approaching one order of magnitude decline over a short period of time (90% decline), which places winter-run in the moderate extinction risk category and very nearly in the high extinction risk category. The combination of these two factors is sufficient to conclude that winter-run is at a high risk of extinction in the foreseeable future based on recent population growth rates.

5. Spatial Structure

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany *et al.* 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et al*. 2000). The spatial structure of winter-run resembles that of a panmictic population, where there are no subpopulations, and every mature male is equally likely to mate with every other mature female. The four historical independent populations of winter-run have been reduced to one population, resulting in a significant reduction in their spatial diversity. An ESU comprised of one population is not viable because it is unlikely to be able to adapt to significant environmental changes. A single catastrophe (*e.g*., volcanic eruption of Lassen Peak, prolonged drought which depletes the cold water pool at Lake Shasta, or some related failure to manage cold water storage, spill of toxic materials, or a disease outbreak) could extirpate the entire winter-run ESU, if its effects persisted for 3 or more years. The overwhelming majority of winter-run return to spawn in 3 years (in the same place), so a single catastrophe with effects that persist for at least 3 years would affect all of the winter-run cohorts. Therefore, NMFS concludes that winter-run are at a high risk of extinction based on spatial structure.

6. Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The primary factor affecting the diversity of winter-run is the limited area of spawning habitat available on the mainstem Sacramento River downstream of Keswick Dam. This specific and narrow spawning habitat limits the flexibility and variation in spawning locations for winter-run to tolerate environmental variation. For example, a catastrophe on the mainstem Sacramento River could affect the entire population, and therefore, ESU. However, with the majority of spawners being 3 years old, winter-run do reserve some genetic and behavioral variation in that in any given year, two cohorts are in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

Another aspect of diversity that may be significant for winter-run is related to the age structure for this run where most fish return at age 3. There is evidence to suggest that age of maturity is at least a partially heritable trait for many fish, including Pacific salmonids, and activities such as fishing that result in consistent selective pressure can induce changes on a population scale (Ricker 1981; Law 2000; Hard *et al*. 2008). Currently, winter-run does not express a great deal of diversity in this life history trait, as about 90% of returning fish are age 3 (see Effects below). A more varied age structure, especially at the age of maturity, would provide more adaptive ability for this stock to respond to changing environmental conditions.

Although LSNFH is characterized as one of the best examples of a conservation hatchery operated to maximize genetic diversity and minimize domestication of the offspring produced in the hatchery, it still faces some of the same diversity issues as other hatcheries in reducing the diversity of the naturally-spawning population. Therefore, Lindley *et al*. (2007) characterizes hatchery influence as a looming concern with regard to diversity. Even with a small contribution of hatchery fish to the natural spawning population, hatchery contributions could compromise the long term viability and extinction risk of winter-run.

NMFS concludes that the current diversity in this ESU is much reduced compared to historic levels, and that winter-run are at a high risk of extinction based on the diversity VSP parameter.

7. Summary of the current viability of Sacramento River winter-Run Chinook salmon

An age-structured density-independent model of spawning escapement by Botsford and Brittnacker (1998 *op. cit.* Good *et al*. 2005) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al*. 2005). This model did not include the increase in population growth rates observed from the late 1990's through 2006. Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. This analysis found a biologically significant expected quasi-extinction probability of 28 percent. Again, the model did not contain data indicative of the increased growth rates observed up to 2006.

Recently, Lindley *et al.* (2007) determined that the winter-run population, which is confined to spawning below Keswick Dam, is at a moderate extinction risk according to population viability analysis (PVA), and at a low risk according to other criteria (*i.e.*, population size, population decline, and the risk of wide ranging catastrophe). However, concerns of genetic introgression with hatchery populations are increasing. Hatchery-origin winter-run from LSNFH have made up more than 5 percent of the natural spawning run in recent years and in 2005, it exceeded 19 percent of the natural run (Table 5). If this proportion of hatchery origin fish from the LSNFH had exceeded 15 percent in 2006-2007, Lindley *et al*. (2007) recommended reclassifying the winter-run population extinction risk as moderate, rather than low, based on the impacts of the hatchery fish over multiple generations of spawners (13.8% was the estimate in 2006). In addition, data used for Lindley *et al*. (2007) did not include the significant decline in adult escapement numbers in the last 3 years, and thus, does not reflect the current status of the population size or the recent population decline. Furthermore, the current drought conditions in the Central Valley were not incorporated into the analysis of the winter-run population status in Lindley *et al*. (2007) as a potential catastrophic event. These factors suggest that the extinction risk of winter-run has increased significantly in recent years since the Lindley *et al*. (2007) recommendations.

Table 5. Estimated percentage of total spawning escapement of hatchery origin 2001-2007 (USFWS 2007).

	2001	2002	2003	2004	2005	2006	2007
Hatchery origin	513	921	474	633	3092	2382	139
Total spawners	8224	7464	8218	7869	15839	17205	2542
% Hatchery origin	6.2	12.3	5.8	8.0	19.5	13.8	5.5

Lindley *et al.* (2007) also states that the winter-run ESU fails the "representation and redundancy rule" because it has only one population, and that population spawns outside of the eco-region in which it evolved. In order to satisfy the "representation and redundancy rule," at least two populations of winter-run would have to be re-established in the basalt- and porous-lava region of its origin. An ESU represented by only one spawning population at moderate risk of extinction is at a high risk of extinction over an extended period of time (Lindley *et al*. 2007). There is only one population of winter-run, and it depends on cold-water releases from Shasta Dam which could be vulnerable to a prolonged drought (Good *et al*. 2005). Based on the above descriptions of the population viability parameters, NMFS believes that the winter-run ESU is currently not viable and is at high risk of extinction as a single population representing the entire ESU in an apparent state of decline.

8. Recovery planning

On October, 2009, NMFS released to the public a *Draft Recovery Plan for the Evolutionary Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring Run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead.*[11] The goal of the Recovery Plan is to describe the type of actions and activities that need to be undertaken in order to improve the viability of these species such that they can be removed from Federal protection under the ESA. Highlighted goals of the Plan include:

- Develop phased reintroduction plans for primary candidate watersheds
- Restore ecological flows throughout the Sacramento and San Joaquin River basins and the Delta
- Large scale Delta Ecosystem Restoration
- Restore the ecological habitat function and reduce non-native fish predation
- Create incentives for statewide water conservation
- Management of salmon harvest levels to support the recovery of ESA-listed ESUs

Recovery criteria for winter-run have been established in the *Draft Recovery Plan*. They include:

-Establishment and maintenance of at least 3 populations
-Census population size is >2500 adults[12],[13], or effective pop. is >500
-No productivity declines are apparent, run is stable
-No catastrophic events occurring or apparent in the last 10 years
-Hatchery influence is low, conservation hatchery uses best management practices

[11] A copy of the Draft Recovery Plan can be found: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf

[12] Absolute population size (assumed to be sum of 1 generation (3 years) of spawner returns (Lindley *et al.* 2007)).

[13] In the initial draft recovery plan, the population level criteria was 10,000 spawning females annually (NMFS 1997a). The evaluation of appropriate population level criteria for a centralized mainstem population such as the Sacramento River winter-run is ongoing. It is expected that final recovery criteria for this population will be much higher than 2,500.

9. Hatchery activities

As mentioned before, LSNFH is a small program which produces approximately 250,000 winter-run juveniles for annual release, for purposes of supplementing the naturally spawning population and for monitoring the population. Initially, the program jump started recovery of appreciable abundance (along with the Shasta cold water temperature device to ensure habitat availability) of a population that was on the verge of extinction (186 spawners in 1994). However, there is a strong perception that hatchery fish may negatively affect the genetic constitution of wild fish (Allendorf *et al.* 1997; Hindar *et al.* 1991). One of the concerns is that hatchery fish are adapted to the hatchery environment; therefore, natural spawning with wild fish may reduce the fitness of the subsequent natural population (Taylor 1991). To minimize hatchery effects in the population, LSNFH preferentially collects wild winter-run adults for their breeding program. A maximum of 15 percent of the estimated winter-run spawning escapement, but no more than 120 natural-origin winter-run per broodyear may be collected for broodstock use. If necessary, up to 10 percent (a maximum of 12 fish) of the LSNFH broodstock may be composed of hatchery-origin returning spawners. A significant amount of research went into the development of winter-run genetic markers (in partnership with the UC-Davis Bodega Marine Laboratory, and funding from the California Department of Water Resources and US Bureau of Reclamation), and the program takes a genetic sample from every trapped adult to confirm its genetic identity before it is spawned for the program (there is a 48-hour turnaround on the genetic analysis). Current estimates of the numerical contribution of the LSNFH hatchery program to the natural population are estimated between 5 and 20% (Lindley *et al*. 2007; Table 5). There is concern that if the contribution of hatchery fish remains at the higher end of this range, potential impacts associated with genetic introgression are a risk.

All hatchery production at LSNFH is marked with an adipose fin clip and tagged with a CWT. CWTs are inserted into the snouts of salmon before they are released. The tags provide information on the origin of the fish and year released and can be scanned in live fish or retrieved and read from carcasses. The CWTs allow salmon stocks and ESUs to be tracked in the marine environment and provides the information on the distribution and magnitude of harvest for individual ESUs that can be used to evaluate impacts of various fishery regulations.

10. River recreational fishery

Depending on the status of Sacramento River Fall Chinook (SRFC) and the run timing of other ESUs, the California Fish and Game Commission sets a recreational fishing season for Chinook in the Central Valley on an annual basis. In recent years, the fishery has been limited to a relatively short stretch of the Sacramento River in November and December in an attempt to limit impacts on SRFC and target the late-fall run. Even when the river recreational fishery is provided additional opportunity, the fishery is not open during the time when impacts to winter-run are likely to occur, as the fishery closes no later than January 1.

IV. ENVIRONMENTAL BASELINE IN THE ACTION AREA

The environmental baseline includes 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).

A. Bycatch in groundfish fishery (whiting and bottom trawl)

Large numbers of salmon are caught in the bottom trawl and whiting components of the groundfish fishery off the coasts of Washington, Oregon, and California. A number of section 7 consultations have been conducted to determine effects of the fishery on ESA listed salmon. In each of the consultations, NMFS has determined that the incidental take of salmon in the fishery would not likely jeopardize the continued existence of the ESUs under consideration. The 1999 groundfish FMP opinion included an incidental take statement that permits the bycatch of 11,000 Chinook salmon in the whiting fishery (primarily a mid-water trawl) and 9,000 Chinook salmon in the bottom trawl component of the groundfish fishery (NMFS 1999). Consultation on the groundfish fishery was reinitiated in 2006 as a result of data that indicated that the incidental take statement for Chinook salmon had been exceeded in some fashion in 3 out of 4 years between 2002 and 2005 (NMFS 2006a). Ultimately, the supplemental biological opinion concluded that the fishery was not likely to jeopardize those ESUs and that the incidental take statement in place remained adequate for the groundfish fishery going forward. The groundfish trawl fishery operates in areas offshore most of the U.S. west coast, with the exception of southern California, but the amount of salmon bycatch associated with California Central Valley ESUs is not believed to be high. A recent study of salmon bycatch in the whiting fishery estimated about 3% of the salmon were Central Valley fall-run, and no evidence of Sacramento winter-run was detected (Moran *et al*. 2009), although this finding was based on data from only one year. Based on the information available from CWT recoveries, it seems likely that the bycatch of winter-run north of Point Arena would be minimal (see Effects Analysis).

B. Bycatch in coastal pelagic species fisheries

Other fisheries that are known to incidentally take salmon as bycatch along the U.S. west coast, Chinook salmon in particular, involve fisheries that target coastal pelagic species (CPS) such as sardines and squid. Typically, these fisheries involve a purse seine operation or some similar round haul net that is designed to surround and capture large aggregations of these species. Effort in Oregon and Washington that is usually concentrated near the mouth of the Columbia River has been associated with salmon bycatch in the past (Culver and Henry 2004; PFMC 2008). In 2005, NMFS issued a biological opinion which considered the impacts of Amendment 11 to the CPS FMP on several ESUs including: Lower Columbia River Chinook salmon, Snake River Chinook salmon, Upper Willamette River Chinook salmon, Puget Sound Chinook, and Lower Columbia River Coho. Take estimates derived from observer estimates from Washington

(2000-2004) for Chinook salmon ranged from 650 to 4,118 per year, and coho salmon take estimates ranged from 1,011 to 7,152 (NMFS 2006b). Information derived from logbook reports and the level of effort that has been observed in recent years suggests that the incidental take of salmon may have been far less than what was considered in the opinion (PFMC 2008). The portion of the sardine fishery off the California coast where winter-run are likely to be encountered (south of Point Arena) has not been associated with much salmon bycatch (1 salmon has been observed by dockside samplers in over 20 years of sampling (NMFS 2010)). Other CPS fisheries, such as targeting squid off California, are also possible sources of salmon bycatch although there is very little information available about salmon bycatch in those fisheries.

C. Salmon ocean fishery

Since 1977, salmon fisheries in the exclusive economic zone (EEZ) (three to 200 miles offshore) off Washington, Oregon, and California have been managed under the salmon FMP. While salmon fishing has likely always been associated with inhabitants of the region along the Pacific west coast of North America, significant salmon harvest (historically more common in the fresh water river systems) dates back to the 19th century. As early as the end of the 19th century, the California Fisheries Commission had already identified that runs of salmon in California were not as large as previously recorded, presumably as a result of substantial harvest and increased human impacts on spawning habitat (Yoshiyama *et al*. 2001).

In modern times, the salmon ocean fishery has been a major source of mortality for Chinook salmon off the coast of California, with nearly 1 million fish being harvested per year during the late 1980s (Table 6). It is unknown exactly what fraction of these fish were winter-run, but it is clear that winter-run returns during that time were very reduced from historical levels. After the ESA-listing, steps have been made to reduce the impact of the salmon fishery on winter-run. Assessments of historical fishing impacts on winter-run have been made previously, although the data and methods used may not be as reliable as those used in the modern analysis. The historical estimates of the total harvest fraction of winter-run before most of the actions to restrict winter-run take in the ocean salmon fishery were taken (prior to 1996/1997) were typically found to be around 0.50, or about 50% (NMFS 1997b). In the more recent 2004 biological opinion, cohort reconstruction analysis indicated that impacts to age-3 fish from three broods (1998, 1999, and 2000) ranged from 0.20-0.23, and total spawner reduction rates ranged from 0.23-0.26 (NMFS 2004a). While not absolutely comparable to historical impact rates, it does appear that winter-run impacts in the fishery may be reduced somewhat from what occurred in the past. The Effects Analysis below will describe the most recent available information regarding the effects of the fishery on winter-run.

Table 6. Annual landings in California of Chinook salmon caught in the ocean salmon fishery.

	CA Chinook landed		
	commercial	recreational	total
1976-1980	618,637	92,422	711,059
1981-1985	484,587	109,097	593,684
1986-1990	795,767	166,396	962,163
1991-1995	349,159	170,296	519,455
1996	380,851	164,032	544,883
1997	487,415	228,968	716,383
1998	226,936	122,013	348,949
1999	264,452	87,845	352,297
2000	480,352	185,851	666,203
2001	193,086	98,783	291,869
2002	391,655	182,044	573,699
2003	491,894	94,674	586,568
2004	502,110	221,114	723,224
2005	340,862	143,257	484,119
2006	69,728	96,292	166,020
2007	114,141	47,704	161,845
2008	-	6	6

D. Status of the species within the action area

Despite the importance of the marine phase of their life-cycle, there has been very limited information available on the status of the salmon ESUs while in the marine waters. Once salmon leave their natal rivers, they are difficult the track. Chinook salmon generally migrate out of their natal rivers within six months to a year of emergence and will spend one to seven years at sea. Winter-run are somewhat unique in that the overwhelming majority of fish return at age 3, as indicated by the CWT recoveries from the spawning grounds (maturation rates of age-3 fish exceed 85%: see Effects Analysis later in the document for more details). Information on salmon abundance and distribution once they leave fresh water is based upon CWT recoveries from ocean fisheries. For over 30 years, the marine distribution and relative abundance of specific stocks, including ESA-listed ESUs, has been estimated using a representative CWT hatchery stock (or stocks) to serve as proxies for the natural and hatchery-origin fish within ESUs. One extremely important assumption of this approach is that hatchery and natural stock components are assumed to be similar in their life histories and ocean migration patterns. Based upon 30 years of collecting and analyzing CWTs, salmon that are born in rivers north of Cape Falcon, OR have been found to travel north of Cape Falcon during their marine life stage. Salmon that are born south of Cape Falcon generally remain in the coastal waters off southern Oregon and California (Kope 2005). Information from winter-run CWT recoveries suggest that winter-run tend to remain in southern waters rarely showing up in the salmon fishery north of Point Arena, CA (see Effects section for more information).

The validity of using a hatchery stock as a proxy for a wild stock has been brought up as a serious issue in fisheries management. Differences in the performance, survival, behavior, and physical condition between natural and hatchery-origin salmonids have been identified in numerous studies (see Chittenden *et al*. 2009 for a review of some references). However, studies have focused on features associated with relative fitness with regard to early-life dynamics. Once in the marine environment, there is little evidence of exactly how these differences influence movement or exposure to harvest in fisheries. After examining nearly 2 million CWT recovery locations, Weitkamp and Neely (2002) found consistency between natural and hatchery coho CWT recovery patterns on the North American west coast, and concluded the use of hatchery populations as a proxy for marine distribution was reasonable. There have been some attempts to compare the exploitation of natural and hatchery-origin salmon. Looking at coho from Vancouver Island, Labelle *et al*. (1997) found that hatchery fish were generally subject to higher exploitation (by a relatively small amount) than their natural counterparts, although factors such as timing and size of hatchery release substantially influence survival and subsequent exploitation. Looking strictly at survival rates to adult, Unwin (1997) estimated that hatchery produced Chinook from one stream in New Zealand survived at a rate 4 times higher than naturally produced fry. However, considering the relative size difference of the hatchery reared fish (average weight 38 grams at release) vs. naturally produced fry (0.3 grams at emergence) in this study, it was not possible to draw many conclusions other than the size advantage of extended hatchery rearing for this stock did not appear to provide the concordant benefit toward survival that might have been expected.

Based on the available information, it is not clear what the relationship is between the status of natural and hatchery-origin winter-run in the marine environment. Currently, CWT data provides the only information that is available on parameters such as distribution, survival, and exploitation. As mentioned before, the conservation hatchery at Livingston Stone is considered an example of how to practice good hatchery management. Winter-run pre-smolts are released at the tail end of the outmigration period in order to minimize the effect on the natural production. Although initial variation in survival during freshwater migrations is possible, it is likely that the relative exposure to various threats or environmental conditions after fish enter the marine environment is similar. Until specific data relative to natural-origin winter-run becomes available or new methods of calibrating CWT data to natural fish are developed, NMFS will continue to rely on CWT to inform management decisions.

E. Factors affecting species environment within the action area

1. Predation

Beyond the impacts of fisheries described above, at-sea survival of salmon can be affected by both biotic and abiotic factors. Juvenile salmon are prey for marine birds, marine mammals, and larger fish. Adult salmon are prey to pinnipeds such as sea lions, harbor seals (NMFS 1997c) and killer whales in the Pacific Northwest (see Osborne 1999 and NMFS 2009b for more quantitative information about killer whale predation estimates). In certain areas where salmon and predators are in close proximity in relatively high concentrations, predation has been identified as a significantly limiting factor for certain ESUs (*e.g.* sea lions at Bonneville Dam (NMFS 2008)). There is no specific information about the exposure of winter-run to predation, but it is reasonable to assume that winter-run experience the same sort of pressure from predators in the marine environment as other salmon. One possible source of acute pressure may come from Southern Resident killer whales who have been observed in central California waters as far south as Monterey Bay during winter in recent years and may be taking advantage of the winter timing of the winter-run spawning return to the Sacramento River (see NMFS 2009c for more detail).

2. Environmental conditions in the marine environment

a. Ocean productivity

The time at which juvenile salmonids enter the marine environment marks a critical period in their life history. Studies have shown the greatest rates of growth and energy accumulation for Chinook salmon occur during the first 1 to 3 months after they enter the ocean (Francis and Mantua 2003, MacFarlane *et al*. 2008). Emigration periods and ocean entry can vary substantially among, and even within, races in the Central Valley. For example, winter-run typically rear in freshwater for 5-9 months and exhibit a peak emigration period in March and April. Spring-run emigration is more variable and can occur in December or January (soon after emergence as fry), or from October through March after rearing for a year or more in freshwater. Fall run emigration into the ocean occurs primarily in May and June after a fairly short rearing period (4 or 5 months). This general timing pattern of ocean entry is commonly attributed to evolutionary adaptations that allow salmonids to take advantage of highly productive ocean conditions that typically occur off the California coast beginning in spring and extending into the fall (MacFarlane *et al*. 2008). Therefore, the conditions that juvenile salmonids encounter when they enter the ocean can play an important role in their early marine survival and eventual development into adults.

While information specific to the distribution of California ESUs during early ocean residence is mostly lacking, fall Chinook from Oregon and Washington reside very near shore and near their natal river for some time after ocean entry, before moving away into the marine environment (Brodeur *et al*. 2004). As they grow, they tend to migrate along the coast, as most juvenile salmon are observed over the shelf (Emmett 2006; Weitkeamp *in review*). Fisheries biologists believe that the time of ocean entry is especially critical to the survival of juvenile salmon, as they are small and thus vulnerable to many predators (Pearcy 1992). If feeding conditions are good, growth will be high and starvation or the effects of size-dependent predation may be lower. Thus, the conditions at the time of ocean entry and near the point of ocean entry are likely to be especially important in determining the survival of juvenile Chinook (Lindley *et al*. 2009). Recent studies have provided evidence that growth and survival rates of salmon in the California Current off the Pacific Northwest can be linked to fluctuations in ocean conditions

(Peterson *et al.* 2006; Wells *et al*. 2008a). The timing of the onset of upwelling is critical for juvenile salmon that migrate to sea in the spring. If upwelling and the pelagic food web it supports is well developed when young salmon enter the sea, they can grow rapidly and tend to survive well. If spring upwelling is not well-developed, or its onset is delayed, growth and survival may be poor[14] (Lindley *et al*. 2009).

In response to the poor spawning returns of Sacramento River fall Chinook in 2007 and 2008, a team of scientist led by the SWFSC investigated the potential causes for the decline. The group focused on potential factors that would have affected the 2004 and 2005 brood years. A review of all the available information related to the environmental conditions throughout the freshwater and marine life stages of these broods suggested that anomalously poor physical and biological conditions in 2005 and 2006 were the proximate cause of the poor survival of the 2004 and 2005 broods (Lindley *et al*. 2009). In general, these anomalous conditions are related to the timing of upwelling conditions, with early onset in the spring typically indicative of greater productivity through the spring and summer (Wells and Mohr 2008, Peterson *et al*. 2006, Lindley *et al*. 2009). Other factors including coastal sea surface temperature and sea level height (representative of the strength of the California current and southern transport) values are also related to improved ocean productivity (Wells and Mohr 2008).

Peterson *et al*. (2006) evaluated three sets of ecosystem indicators to identify ecological properties associated with warm and cold ocean conditions and determine how those conditions can affect salmon survival. The three sets of ecosystem indicators include: (1) large-scale oceanic and atmospheric conditions [specifically, the Pacific Decadal Oscillation (PDO) and the Multivariate ENSO Index]; (2) local observations of physical and biological ocean conditions off northern Oregon (*e.g*., upwelling, water temperature, plankton species compositions, *etc*.); and (3) biological sampling of juvenile salmon, plankton, forage fish, and Pacific hake (which prey on salmon). When used collectively, this information can provide a general assessment of ocean conditions in the northern California Current that pertain to multi-year warm or cold phases. It can also be used to develop a qualitative evaluation for a particular year of the effect these ocean conditions have on juvenile salmon when they enter the marine environment and the potential impact to returning adults in subsequent years.

Wells *et al*. (2008b) developed a multivariate environmental index that can be used to assess ocean productivity on a finer scale for the central California region. This index has also tracked the Northern Oscillation Index, which can be used to understand ocean conditions in the North Pacific Ocean in general. The divergence of these two indices in 2005 and 2006 provided evidence that ocean conditions were worse off the California coast than they were in the broader North Pacific region. The Wells *et al.* (2008b) index incorporates 13 oceanographic variables and indices and has correlated well with the productivity of zooplankton, juvenile shortbelly rockfish (*Sebastes jordani*), and common murre (*Uria aalge*) production along the California coast (MacFarlane *et al*. 2008). In addition to its use as an indicator of ocean productivity in general, the index may also

[14] More detailed information on how upwelling and other ecological conditions factor into productivity can be found in Lindley *et al*. 2009 and Wells *et al*. 2008a

relate to salmon dynamics due to their heavy reliance on krill and rockfish as prey items during early and later life stages. For instance, not only did the extremely low index values in 2005 and 2006 correlate well with the extremely low productivity of salmon off the central California coast in those years, but the index also appears to have correlated well with maturation and mortality rates of adult salmon from 1990-2006 in that region (Wells and Mohr 2008).

The generally warmer ocean conditions in the California Current that began to prevail in late 2002 have resulted in coastal ocean temperatures remaining 1-2°C above normal through 2005. A review of the previously mentioned indicators for 2005 revealed that almost all ecosystem indices were characteristic of poor ocean conditions and reduced salmon survival. For instance, in addition to the high sea surface temperatures, the spring transition, which marks the beginning of the upwelling season and typically occurs between March and June, was very late, postponing upwelling until mid-July. In addition, the plankton species present during that time were the smaller organisms with lower lipid contents associated with warmer water, as opposed to the larger, lipid-rich organisms believed to be essential for salmon growth and survival throughout the winter. The number of juvenile salmon collected during trawl surveys was also lower than any other year previously sampled going back to 1998 (Peterson *et al*. 2006).

A review of the available information suggests ocean conditions in 2007 and 2008 improved substantially over those observed in 2005 and 2006. For instance, the spring transition was earlier in 2007 and 2008 compared to 2005 and 2006. Thus, contrary to the poor ocean conditions observed in the spring of 2005 and 2006, the Wells *et al*. (2008b) index parameters available at this time indicated spring ocean conditions were generally favorable for salmon survival off California in 2007 and 2008. This agrees with updated information provided on the Northwest Fisheries Science Center Climate Change and Ocean Productivity website[15] that shows the transition to colder ocean conditions, which began in 2007, persisted throughout 2008. All ocean indicators pointed toward a favorable marine environment for those juvenile salmon that entered the ocean in 2008. After remaining neutral through much of 2007, PDO values became negative (indicating a cold California Current) in late 2007 and remained negative through at least August, 2008, with sea surface temperatures also remaining cold. Coastal upwelling was initiated early and will likely be regarded as average overall. Furthermore, the larger, energy-rich, cold water plankton species were present in large numbers in 2007 and 2008. Therefore, ocean conditions in the broader California Current appear to have been more favorable for salmon survival in 2007 and to a greater extent in 2008. Despite the positive outlook suggested by these factors, indications are that neither SFRC or winter-run spawning returns in 2009 reflected any dramatic improvement in survival or escapement compared to parental spawning broods.

Evidence exists that suggests early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and local scale, provides an indication of the role they play in

[15] http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm

salmon survival in the ocean. Moreover, when discussing the potential extinctions of salmon populations, Francis and Mantua (2003) point out that climate patterns would not likely be the sole cause but could certainly increase the risk of extinction when combined with other factors, especially in ecosystems under stress from humans. Thus, the efforts to try and gain a greater understanding of the role ocean conditions play in salmon productivity will continue to provide valuable information that can be incorporated into the management of these species and should continue to be pursued. However, the highly variable nature of these environmental factors makes it very difficult, if not impossible, to accurately predict what they will be like in the future. Because the potential for poor ocean conditions exists in any given year, and there is no way for salmon managers to control these factors, any deleterious effects endured by salmonids in the freshwater environment can only exacerbate the problem of an inhospitable marine environment.

b. Climate

Climate change will affect the entire life cycle of salmon through warmer ocean periods, changes in age and size at maturity, decline in prespawn survival and fertility due to higher stream temperatures, and a loss of lower elevation habitat (Crozier *et al*. 2008). In California, observations reveal trends in the last 50 years toward warmer winter and spring temperatures, a smaller fraction of precipitation falling as snow, a decrease in the amount of spring snow accumulation in lower and middle elevation mountain zones and an advance in snowmelt of 5 to 30 days earlier in the spring (Knowles *et al.* 2006). Impacts to salmon in the fresh water environment are likely to be manifested through increases in fresh water temperature, substantial increases in variation and decline of average precipitation over time, and changes in timing of peak monthly mean river flows due to reduced snow pack and earlier melting, as well as the frequency of critically dry years (Dettinger *et al.* 2004 *op. cit*. Lindley *et al*. 2007, VanRheenen *et al*. 2004 *op. cit*. Lindley *et al*. 2007)[16].

There is evidence to suggest that salmon abundance is linked to variation in climate effects on the marine environment. It is widely understood that variations in marine survival of salmon correspond with periods of cold and warm ocean conditions, with cold regimes being generally favorable for salmon survival and warm ones unfavorable (Behrenfeld *et al.* 2006, Wells *et al.* 2006). Both short term, El Nino Southern Oscillation (ENSO) and longer term climate variability, (PDO), appear to play a part in salmon survival and abundance. An evaluation of conditions in the California Current since the late 1970s reveals a generally warm, unproductive regime that persisted until the late 1990s. This regime has been followed by a period of high variability that began with colder, more productive conditions lasting from 1999 to 2002. In general, salmon populations increased substantially during this period. However, this brief cold cycle was immediately succeeded by a 4-year period of predominantly warm ocean conditions beginning in late 2002, which appeared to have negatively impacted salmon populations in the California Current (Peterson *et al*. 2006). Evidence suggests these regime shifts follow a more or less linear pattern beginning with the amount and timing of nutrients provided by upwelling and passing “up” the food chain from plankton to forage fish and

[16] See the Draft Recovery Plan for more discussion

eventually, salmon. There are also indications that these same regime shifts affect the migration patterns of larger animals that prey on salmon (*e.g*., Pacific hake, sea birds) resulting in a "top-down" effect as well (Peterson *et al*. 2006). Fishing records indicate that in the past, these shifts in temperature and consequent salmon abundance, appear to last several decades (Mantua *et al.* 1997). However, the long term viability of salmon cannot be dependent on periods of good ocean conditions alone, as the relative importance of good ocean conditions is difficult to quantify (McClure *et al*. 2003) and it is quite possible that the climate patterns observed in the 20th century may not repeat in the 21st century due to long term climate change (Mantua and Francis 2004; IPCC 2001).

F. Summary of Baseline

In general, salmon are affected by a number of manmade and natural factors once they reach the marine environment. The environmental conditions related to the availability of biological resources for developing salmon, especially during their initial entry into the ocean, are perhaps the most important factor in determining the relative success and abundance of winter-run in the marine environment. Evidence is beginning to point to some of the physical mechanisms of wind patterns and upwelling that may serve to predict how populations of salmon, including winter-run, are likely to respond to these conditions. In order to survive for the extended period of time in the ocean required to mature and return to the spawning grounds, winter-run must avoid threats associated with natural predation and manmade sources of mortality such as harvest in commercial and recreational fisheries. With respect to climate influences, uncertainties abound at all levels. We have only the crudest understanding of how salmonid habitats will change and how salmonid populations will respond to those changes, given any particular climate scenario.

V. EFFECTS OF THE ACTION

A. Exposure

Much of the information that is used in management of the ocean salmon fisheries under the Pacific Salmon Fishery Management Plan is derived from the recovery of CWTs in ocean and river monitoring programs. As mentioned before, NMFS must rely on CWTs from hatchery-origin winter-run until additional information becomes available. It is impossible to determine the origin of a Chinook salmon based on physical appearance. Many, but not all, hatchery salmon are marked with a clipped adipose fin. Hatchery and tagging programs differ from State-to-State and hatchery-to-hatchery. Many of those fin-clipped fish, but not all, also contain CWTs (it is important to note that all winter-run hatchery production is adipose fin clipped and tagged with a CWT)[17]. CWT recoveries from landed fish taken by dockside samplers employed by state fish and game agencies allow for a scientific approach to the collection of data used to understand the origin and distribution of individuals caught in the ocean fishery. There are additional techniques

[17] Due to the automated process of tagging and tag-loss associated shedding, some small percentage less than 100% of hatchery produced winter-run actually have a CWT.

and research programs, such as the GSI project, that may become available or provide additional sources of information for use by fishery managers in the future.

1. Distribution of winter-run harvest

CWT recoveries from salmon landed in the ocean fishery indicate that winter-run CWTs are recovered primarily south of Point Arena (97%; NMFS 2009a) in the San Francisco (SF), Monterey (MO), and South of Sur (SS) management areas in both the commercial and recreational ocean salmon fisheries (Figures 4 & 5). It is evident from the CWT recoveries from brood years 1998-2005[18] that more tags are recovered in the recreational fishery (83% of estimated harvest impacts; NMFS 2009a) than the commercial fishery, and the relative amount of recoveries in SF and MO is similar. Raw CWT recovery results are consistent with estimates of hatchery-origin winter-run harvest for broods 1998-2005 (Figure 5) and the tagged portion of the winter-run stock for broods 1991-1995 (Figure 6). Harvest estimates in Figures 5 and 6 are made by expanding CWT recoveries for non-exhaustive sampling of ocean fisheries and hatchery marking/tagging rates of less than 100% (See O'Farrell et al. 2010 for a more detailed description of harvest impact estimates derived from CWT recoveries).

For the most part, fishery impacts on winter-run in recent broods have demonstrated a similar pattern by area for SF, MO, and SS since 1999 (Figure 7). With the exception of two years (2000 and 2005), SF had the highest total annual estimated impact followed closely by MO, with varied impacts in SS. Fishing year 2004 and 2005 saw dramatically higher total estimated impacts compared with the other years. The relatively high numbers in 2004 and 2005 correspond with the two highest spawning escapement estimates in recent years (2005 and 2006 return years). The 2002 and 2003 broods that contributed age-3 recoveries in 2004 and 2005, and age-3 escapement in 2005 and 2006, likely experienced high rates of survival during the early portion of their life-cycle (O'Farrell *et al*. 2010; NMFS 2009a).

[18] Essentially represents fishing years 2000-2007, and 2 age-2 fish recovered in 1999.

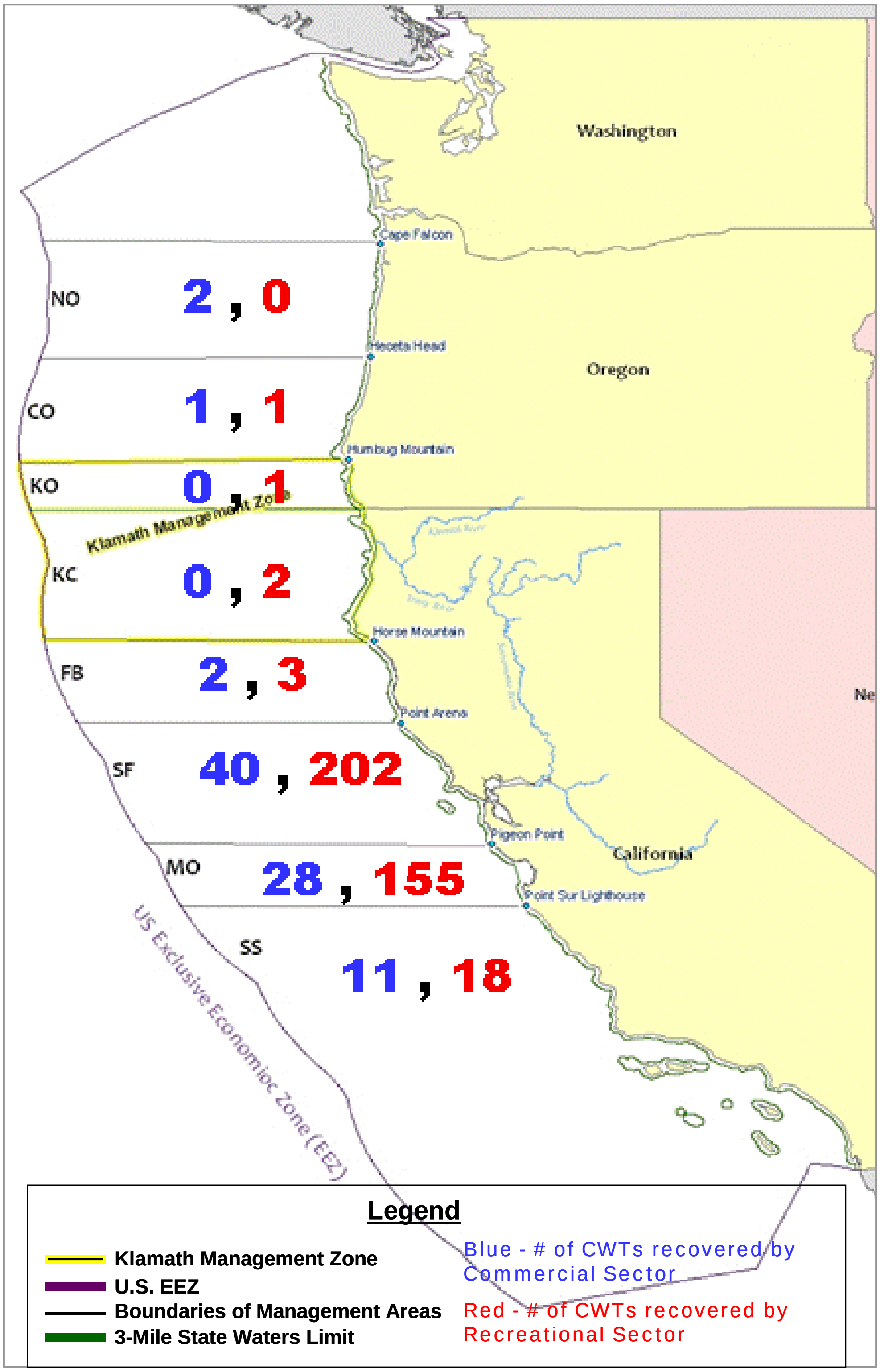

Figure 4: Map of recovered winter-run CWTs from brood years 1998-2005, by management zone.

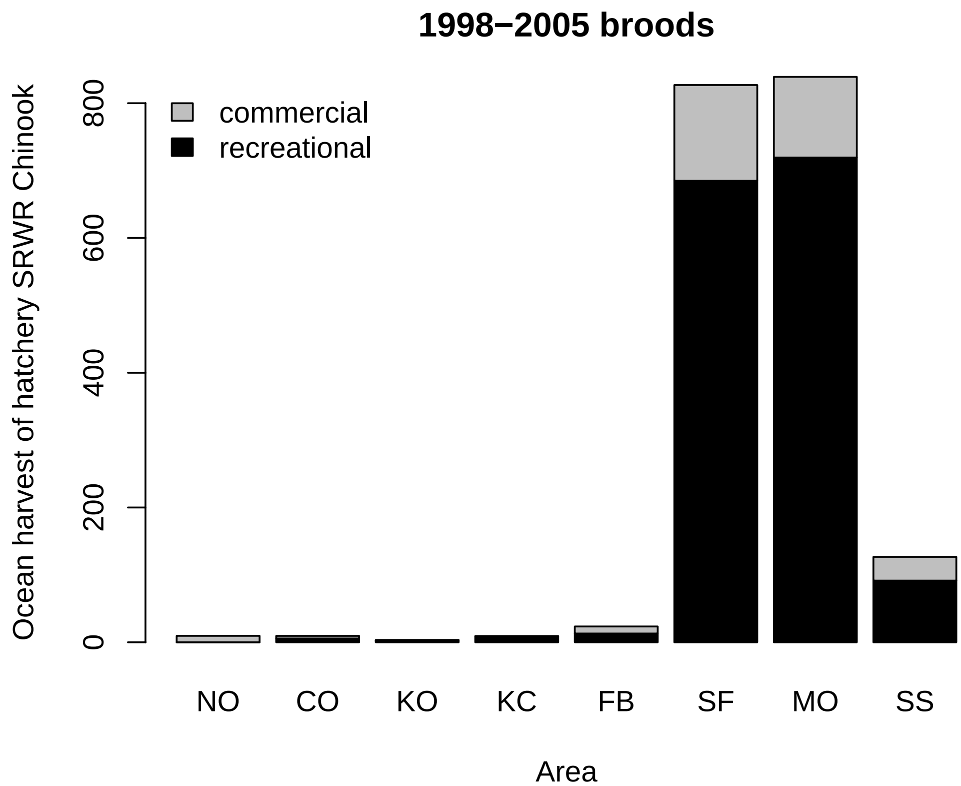

Figure 5: Estimated harvest of hatchery-origin winter -run for brood years 1998-2005, by management zone (NMFS 2009a).

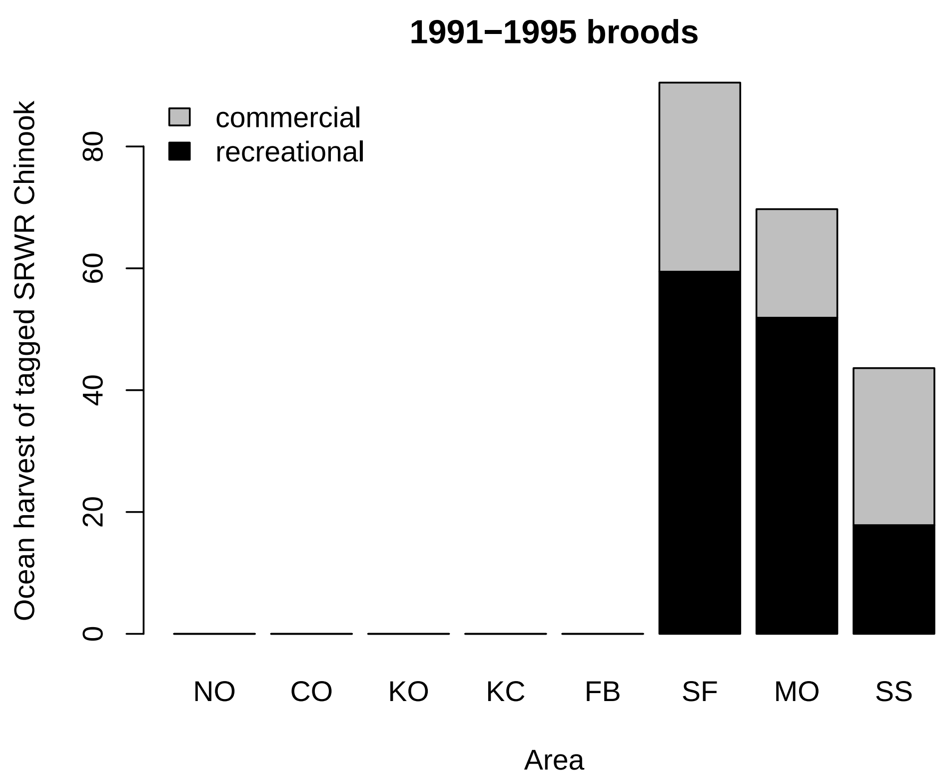

Figure 6: Estimated harvest of coded-wire-tagged winter-run for brood years 1991-1995 by management zone (Grover *et al*. 2004).

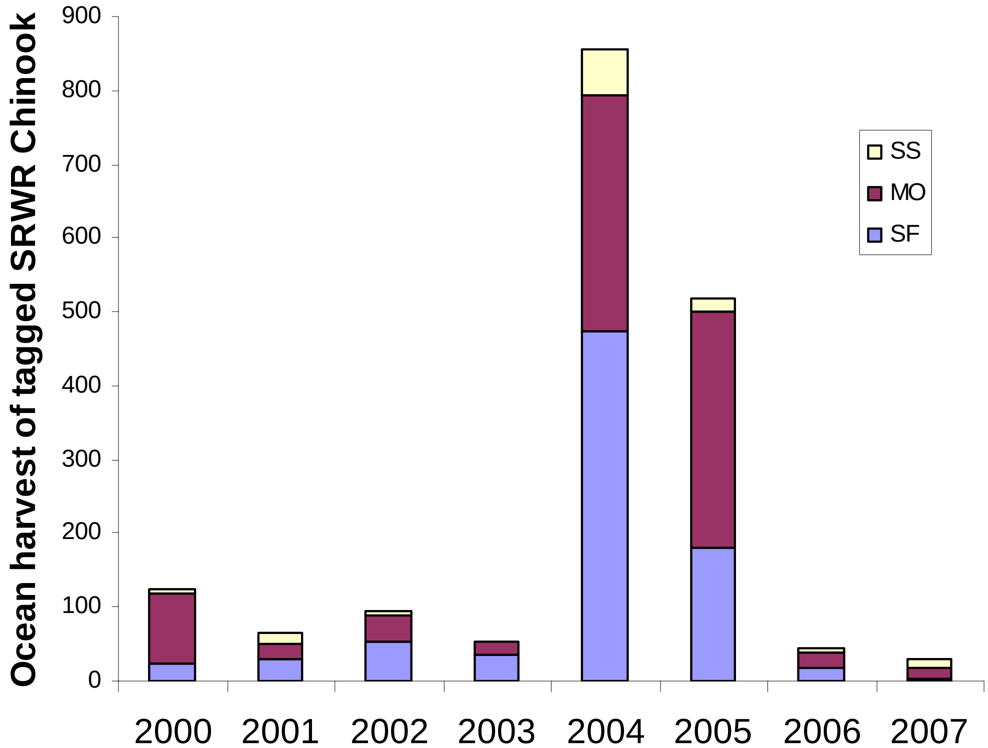

Figure 7: Estimated annual harvest of hatchery-origin winter -run by management zone from 2000-2007.

The temporal pattern of winter-run harvest in the commercial and recreational fisheries is illustrated in Figure 8. According to the CWT recovery and cohort reconstruction analysis, most of the harvest impacts in the commercial fishery occurred in June and July, although effort in terms of vessel days fished in the southern portion of the fishery did consistently occur at significant levels from May through August during this time period, depending on the exact structure of each fishing year (table A-20; PFMC 2009a). In the recreational fishery, most harvest impacts occurred from May through July. This coincides with peak effort in the fishery, but effort as measured in angler trips does typically occur at significant levels from April through August (Figure 9; table A-22; PFMC 2009a). The recreational fishery season has been much more consistent than the commercial fishery, historically, in terms of the season south of Point Arena opens in April and closes in October or November, with very little variation in the last ten years.

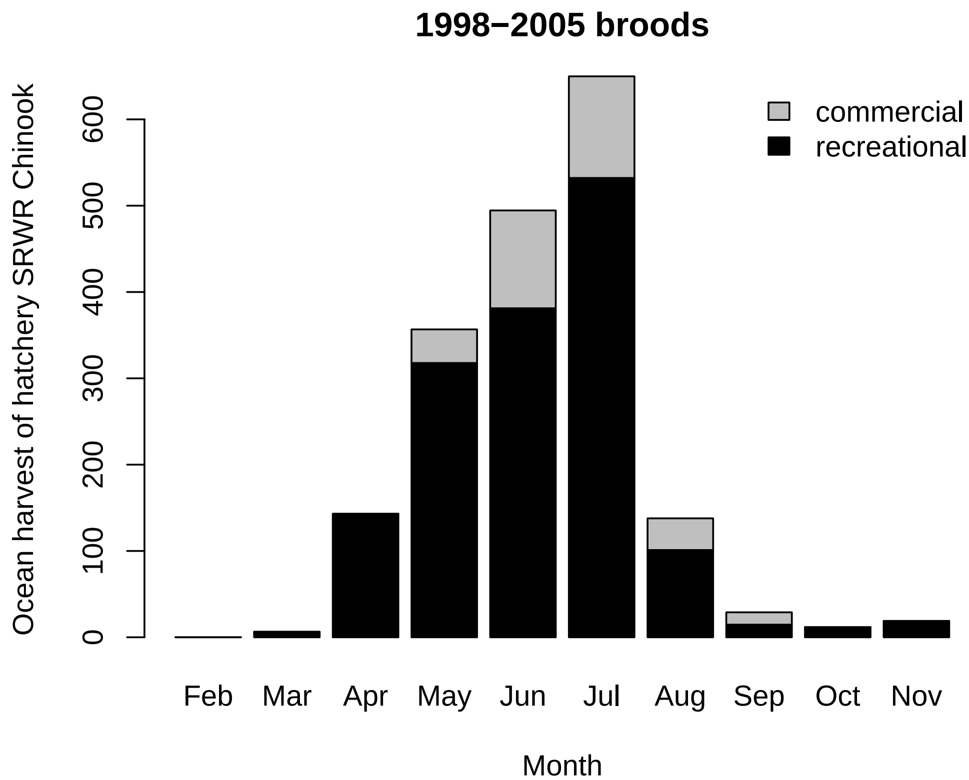

Figure 8: Distribution of winter-run harvest by month from brood years 1998-2005.

It is informative to look at the recent pattern of harvest compared to other times in the past before implementation of the management measures to reduce winter-run impacts from the ocean fishery. During the early 1970's, a study estimating harvest of marked winter-run impacts from fishing was conducted (CDFG 1989). At that time, fisheries were much less regulated. In particular, the recreational fishery was open throughout a larger portion of the year. In this study, about 80% of all harvest of marked winter-run occurred in the recreational fishery and 28% of all harvest occurred in the February and March recreational fishery (Figure 10). Prior to the initial ESA-listing of winter-run in 1989, the recreational fishery off most of California typically opened in mid-February. To a large degree, any success of management measures implemented to minimize winter-run impacts compared to historic levels may be attributed to elimination of fishing effort during the early part of the year (February and March), especially in the recreational fishery south of Point Arena.

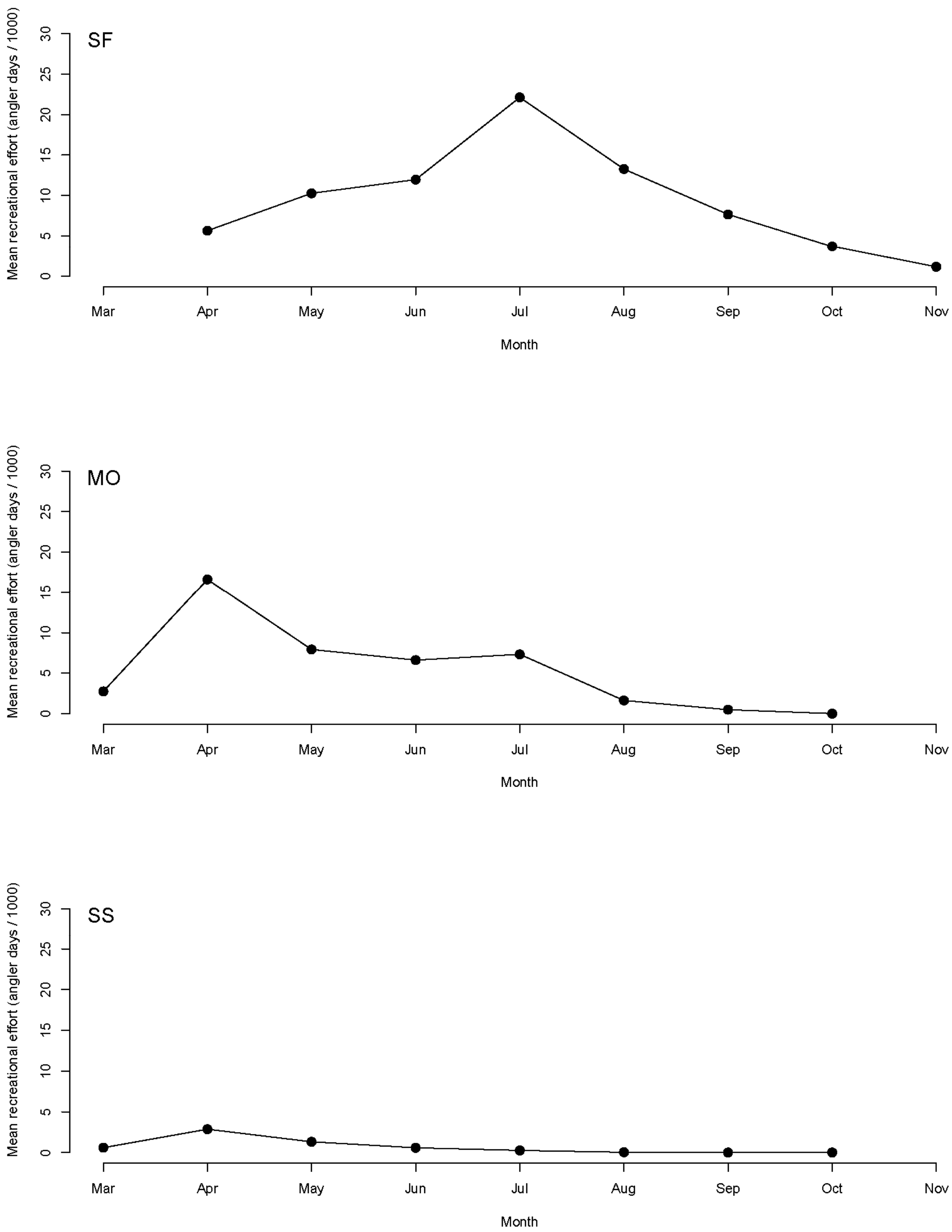

Figure 9. Average recreational fishing effort per month in angler days (in thousands) in San Francisco (SF), Monterey (MO), and South of Sur (SS) for fishing years 2000-2007.

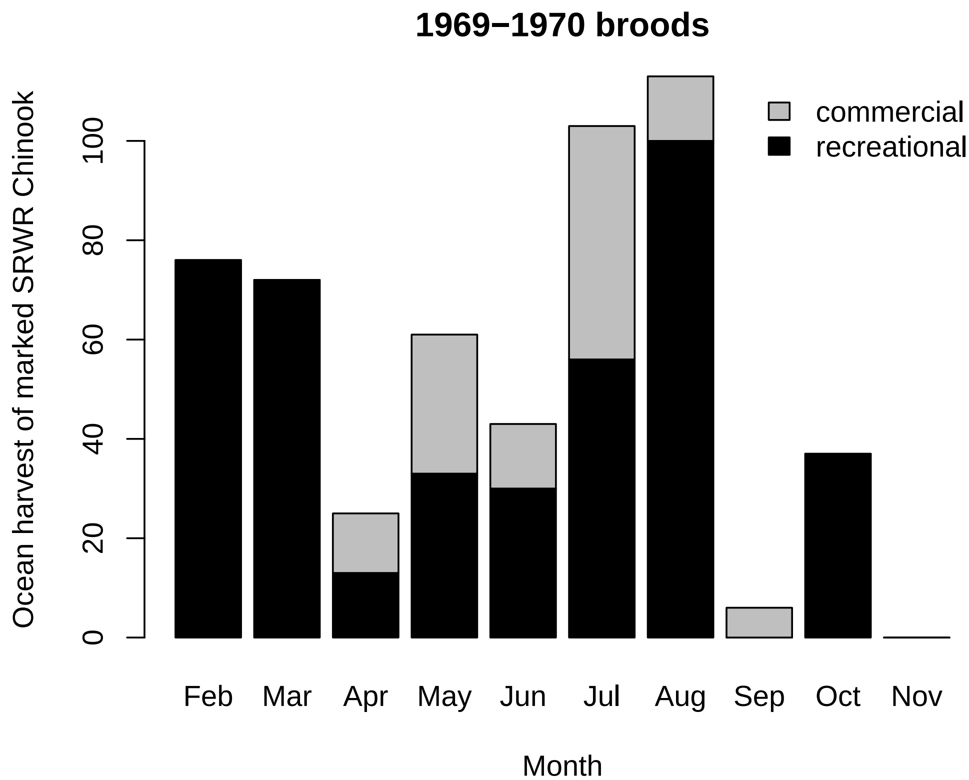

Figure 10: Marked (fin-clipped) winter-run harvest by month from the pooled 1969 and 1970 brood years (CDFG 1989).

2. Salmon ocean fishery

Estimates based on CWT recoveries indicate that the recreational fishery has accounted for 3 or 4 times greater impacts than the commercial fishery. The units of effort for the recreational and commercial fisheries are not equivalent (angler days vs. vessel fishing days, respectively), but there are some similarities in the temporal effort trends in the southern management areas (south of Point Arena) during the last ten years. In general, the relative level of total annual effort in each has fluctuated similarly (Figure 11). It could appear from the scale of effort in this graph that the recreational fishery does represent significantly more effort than the commercial fishery, which might then help explain the greater impact of the recreational fishery. However, in terms of fish landed in the two fisheries, the commercial fishery is usually responsible for 2 to 3 times more fish than the recreational fishery, with the exception of recent years when fishing effort and catch in both sectors has decreased (Figure 12).

The discrepancy between the large amount of fish landed in the commercial fishery versus the smaller impact of the commercial fishery on winter-run compared to the recreational fishery even though they operate in similar areas is likely related to the different size limits of the two sectors. Given the average size-at-age of winter-run (Figure 13), it is apparent that most winter-run are likely to be of legal size in the recreational fishery (usually a 20-inch size limit) by the end of their second year. However, the average size of winter-run does not exceed the typical minimum legal size in the commercial fishery (at least 26 inches) until the middle of summer for age-3 fish.

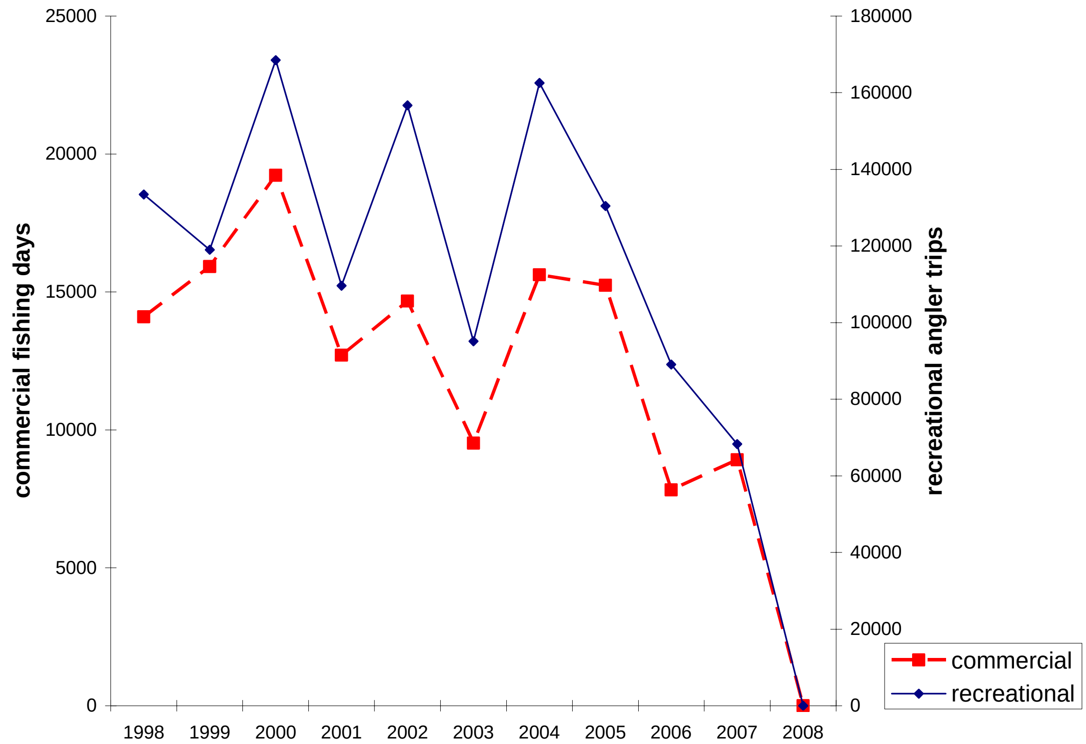

Figure 11: Effort in the commercial and recreational ocean salmon fisheries south of Point Arena. Commercial effort is in total vessel days and recreational effort is in number of angler trips.

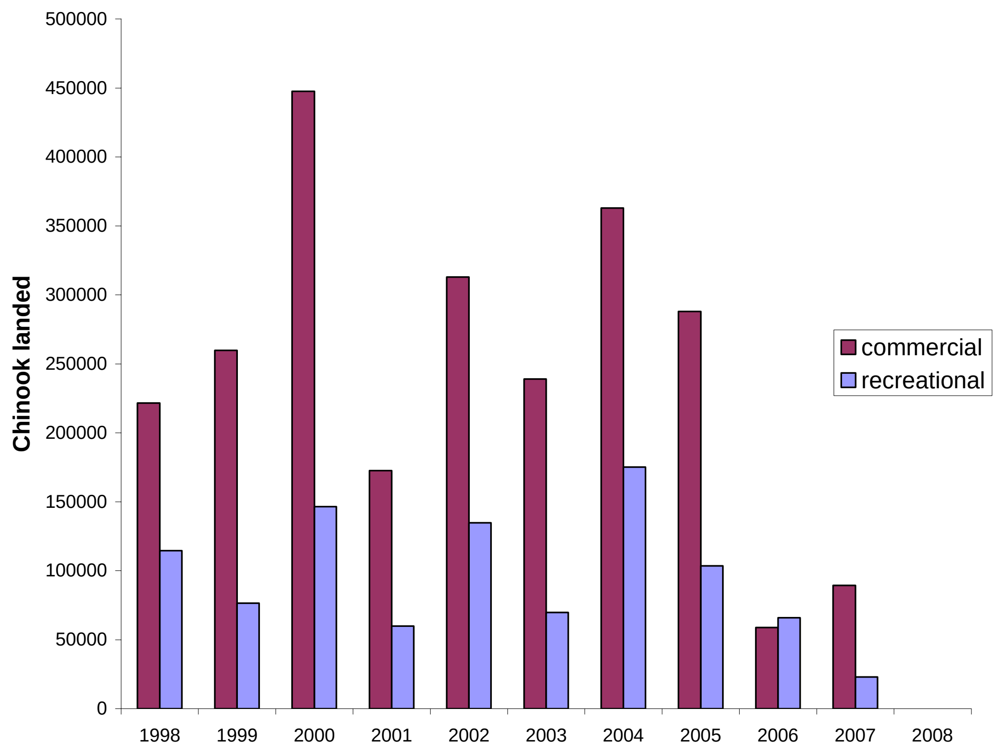

Figure 12: Chinook landed in the commercial and recreation fisheries south of Point Arena

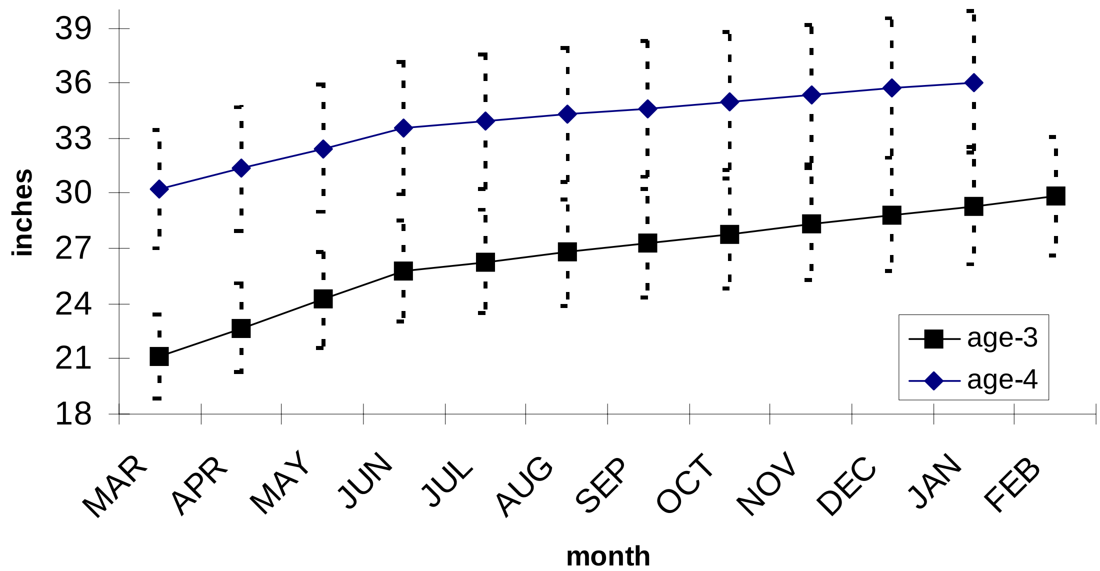

Figure 13: Average size at age of winter-run with 1 standard deviation (confidence interval of about 70%) (CDFG 1989; O'Farrell *et al*. 2010)

There are also other possible explanations for why the commercial fishery has a smaller impact on winter-run than the recreational fishery. Commercial fishermen may operate such that they target larger fish, which could reduce the chance of catching winter-run. This could theoretically be done via several mechanisms related to gear or methods. Perhaps the difference stems from differences in the manner of fishing, or differences in the location of fishing within management areas that the two fisheries operate in. Anecdotal indications are that commercial fishermen tend to move away from areas where they are catching undersized fish. However, no definitive explanation for this difference has been accepted by NMFS or the PFMC, and no concrete evidence exists that suggests winter-run are more or less susceptible to the gear and methods of either fishery.

Estimates of winter-run fishery impacts account for total deaths due to fishery interactions which includes harvest, release mortality of sub-legal sized fish, and drop off mortality (fish that contact the fishing gear, are not successfully retrieved, but die as a result of the encounter, *e.g*, due to injury or predation). To account for release of sublegal sized fish, estimates of harvest are expanded based on the proportion of the age-specific winter-run contacted that are expected to be of legal size (see O'Farrell *et al*. 2010 for details of methods used). Release mortality rates are then applied to the estimated number of fish contacted that are smaller than the minimum legal size. One source of mortality that may not be fully accounted for is the susceptibility of age-2 release mortalities in either the commercial or recreational fisheries because there is little chance of retention based on size limits, and consequently little chance of CWT recovery.[19]

[19] There are very rare recoveries of age-2 fish in ocean fisheries, which is consistent with the expected size-at-age for winter-run (data in O'Farrell *et al*. 2010).

The relationship between effort and fishery impacts is best illustrated by the graphs displayed in Appendix B. Age-3 impact rates are plotted as a function of effort on a monthly basis for each management area. As previously mentioned, the two effort metrics of the commercial and recreational fishery are not equivalent, and thus direct comparisons of fishing effort between recreational and commercial fisheries are not valid. For the recreational fishery, it is clear that the highest impact rates per unit of fishing effort occur in the SF, MO, and SS areas. Impact rates and fishing effort are highest in the SF and MO areas, particularly during the months of May, June, and July. Recreational fishing effort is typically highest in MO during April, but is usually comparable between SF and MO during May and June (Figure 9). After June, the SF region has experienced higher effort relative to MO, though impact rates tend to be low in SF after August. The highest impact rates per unit effort, indicated by the highest magnitude slope, occurs in the SS area, resulting from moderate observed impact rates at very low levels of effort. A similar pattern to the one described above exists for the commercial fishery, although the absolute value of impacts is much lower than in the recreational sector (Appendix B). In the commercial fishery, the highest age-3 impact rates per unit effort are clustered in the SF and MO areas from June to August and in the SS area in June and July.

In considering the pattern of fishing, it is important to understand how the interplay of fishery management given FMP conservation objectives for target stocks (SRFC and KRFC in the southern areas) and consultation standards for ESA-listed stocks (primarily winter-run and California Coastal Chinook (CCC)) has worked to shape to the fishery in the southern areas in recent years. The history for quite a while now has been:

- the recreational fishery south of Pt. Arena is constrained only by the winter-run consultation standards (except for 2008 and 2009), which has resulted in a stable season from year to year.
- the commercial fishery south of Pt. Arena is usually constrained because of KRFC 35,000 spawner floor (and since KRFC are now in a rebuilding status, the PFMC must target for 40,700 until they are rebuilt).
- the commercial fishery is occasionally constrained by the CCC standard, which calls for no greater than 16% age-4 ocean harvest rate on KRFC (happened in 2003 and 2007).
- closure of almost all recreational and commercial fishing in 2008 and 2009 because of the poor returns of SRFC.

All of these objectives and measures collectively combine to minimize the effort and potential impacts to all stocks, including winter-run.

In the last two years, the main stock influencing management of ocean salmon fisheries south of Cape Falcon is SRFC. According to the FMP (PFMC 2003), one of the conservation objectives that must be met annually is a projected return of at least 122,000 natural and hatchery adult SRFC escapement to the spawning grounds. The ocean abundance of SRFC stock is indexed by the Sacramento Index (SI), which is an estimate of the total ocean harvest of SRFC south of Cape Falcon plus the adult escapement for

SRFC, including in-river harvest (O'Farrell *et al*. 2008). The general level of SRFC fishing mortality can be gauged by the SI Harvest Index, which is the ocean harvest of SRFC south of Cape Falcon divided by the SI (PFMC 2009b). Since 2005, the SI Harvest Index has not exceeded 60%, and was only 6% in 2008 owing to a nearly complete closure of ocean salmon fishing south of Cape Falcon (Figure 14). In earlier years the SI Harvest Index was quite high, sometimes exceeding 80% (Figure 14; PFMC 2009b). In recent years, the SI Harvest Index has tracked the SI fairly well. This is consistent with the intention of the overall management scheme of the fishery as one of the main conservation objectives of the FMP is to appropriately match fishing effort and harvest in the southern portion of the fishery with the status of affected stocks, including SRFC and KRFC. One notable instance where the SI and SI Harvest Index fell out of sync was in 2007, when the preseason abundance estimate (based on age-2 jack returns of Central Valley Chinook) vastly overestimated the ocean abundance and projected returns of SRFC. However, management of the fishery caught up with the status of the stock in 2008 and 2009 and virtually no fishing effort has been allowed off the coast of California and Oregon for the past two years. As was suggested in the Environment Baseline, the recent dramatic declines in SRFC escapement and the SI, at least with respect to brood years 2004 and 2005 (largely influencing returns in 2007 and 2008 for SRFC), may be partly attributed with poor oceanic conditions facing juvenile salmon in central California during the mid 2000's (Lindley *et al*. 2009).

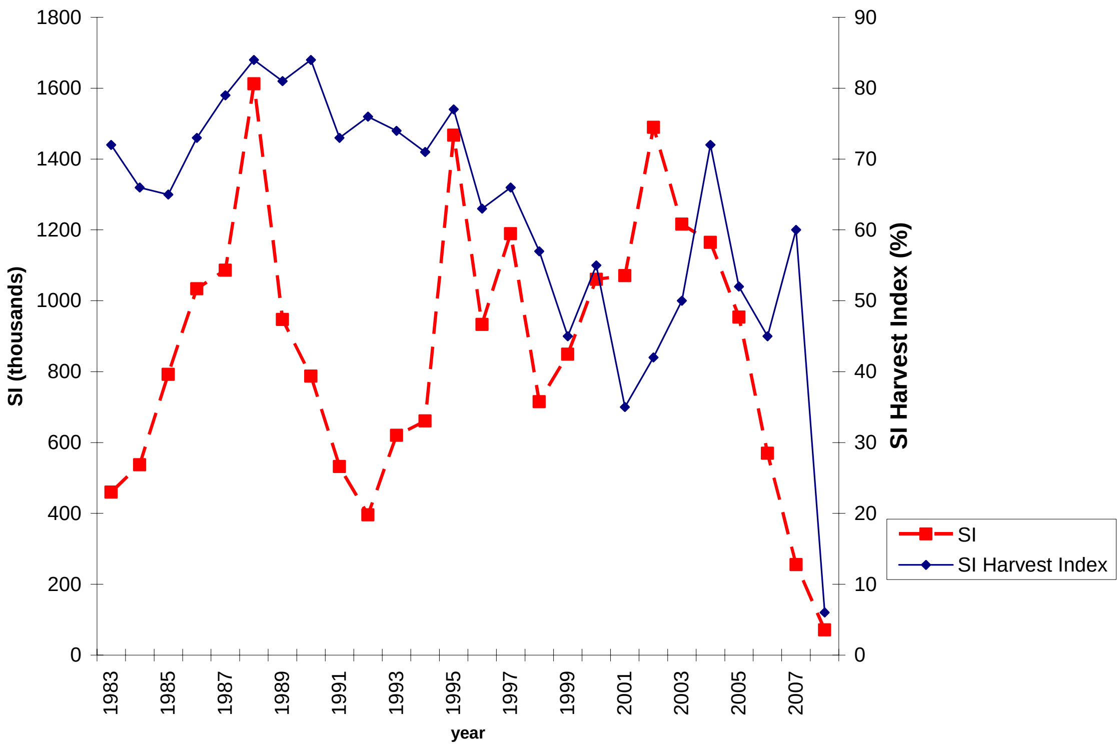

Figure 14: Sacramento Index and SI Harvest Index 1995-2008.

3. Non-retention of winter-run in the fisheries including depredation and delayed mortality

Sacramento River Fall Chinook, and to a lesser degree Klamath River Fall Chinook are the target salmon species of the ocean fishery off of California. However, due to the mixed-stock nature of the fishery (as explained in section II.A) and the inability of methods to distinguish salmon from targeted stocks versus non-targeted (*i.e.*, ESA-listed ESUs) in the ocean fishery, it is assumed that all salmon of legal size that are caught and hauled onboard the boat are retained and landed (bag limits not withstanding). However, there are several opportunities for fish to be hooked but ultimately not retained and landed at the dock. As described above, sublegal-sized salmon must be released. Within the bounds of the ESA consultation standards, MSA requirements, and other applicable laws, regulations for the minimum size limit are set annually along with the timing of the fishing season for both the recreational and commercial fisheries. In general, the minimum size for the commercial fishery is significantly larger than the recreational fishery. In both of the fishery sectors, it is understood that not all of the salmon released are going survive as a result of the injuries and stress associated with capture. As part of the management process used to estimate catch under different fishing scenarios, as well as modeling efforts used to estimate ESU or river-specific impact rates,[20] hook-and-release mortality rates (HMR) can be factored into the calculations to account for the proportion of undersized, released fish that will die due to release mortality. These rates have been established as a result of research efforts and the judgment of experts from state and Federal Agencies participating in the PFMC. The HMR for all Chinook caught in the commercial sector of the fishery is estimated to be 26% (STT 1994; STT 2000). In California and southern Oregon (South of Cape Falcon), HMR in the recreational fishery depends on the method of fishing: for troll-caught fish, the HMR is 14%[21] (STT 2000); in the drift mooch fishery, the HMR is estimated at 42% (Grover *et al*. 2002). For the purposes of any GSI research program implemented, the HMR is the same as used in the commercial fishery (26%), since GSI activities are slated to be conducted using commercial troll fishing gear.

As mentioned before, it is possible that hook release mortalities on age-2 fish are underestimated as part of the total estimates of fishery impact. Difficulty in completely accounting for age-2 impacts is a common problem in cohort reconstructions. Most age-2 winter-run are likely to be sublegal (even in the recreational fishery) and cannot be retained. While some data do exist for the number of sublegal fish released in California mixed-stock salmon fisheries, specifically characterizing the number of winter-run encounters for ages when they are all (or nearly all) sublegal is problematic. It is conceded that brood-specific spawner reduction rate estimates (see section 4 below) do not incorporate potential hook and release mortalities on sublegal age-2 fish if no age-2 coded-wire tagged winter-run from that brood are harvested and recovered. If so, this may result in the true spawner reduction being greater than the estimates reported in O'Farrell *et al*. 2010 and this biological opinion.

[20] See the cohort reconstruction methodology (O'Farrell et *al*. 2010) for more details.
[21] HMR is 14% for the entire recreational fishery North of Point Arena, where mooching is not common.

In addition, some salmon are contacted by fishing gear but never make it to the boat because they escape the hook, break the line, or otherwise fall off the gear. Also, some fish are depredated by other animals while they are being retrieved from the gear by fishermen. Most notably in California, this commonly involves pinniped species such as California sea lions (*Zalophus californianus*) and harbor seals (*Phoca vitulina)* (STT 1994; STT 2000; Hanan 2004; Weise and Harvey 2005). Currently, the PFMC employs a standard 5% drop-off mortality rate, applied to all fishery contacts in their assessment models to account for these impacts to fish that are never handled by fishermen, and the potential to recover a CWT is lost (STT 1994; STT 2000). However, some research has indicated that pinniped depredation in certain times and areas can be considerably higher, up to around 20% of the catch or more (Hanan 2004; Weise and Harvey 2005).

4. Cohort reconstructions and fishing impact analysis

The recovery of CWTs from salmon caught in ocean fisheries, river fisheries, and from fish that return to spawning grounds allows for ocean abundance reconstruction of cohorts, which in turn enables the estimation of fishery impact and maturation rates for these cohorts (see O'Farrell *et al*. 2010 for a detailed explanation of methods). In brief, cohort reconstruction is the sequential estimation of a cohort's abundance from the end of the cohort's life span, when abundance is zero, to a specified earlier age (commonly age-2). Age-specific escapement and harvest estimates are necessary inputs for a cohort reconstruction, and can be derived from CWT recoveries. Cohort reconstructions for the hatchery-origin portion of the winter-run Chinook stock are possible owing to the availability of CWT data collected in ocean and river monitoring programs.

Estimation of maturation rates derived from cohort reconstructions indicates that the majority of winter-run that survive through age-3 will mature and return to the river to spawn at age-3 (Table 7). Although there is variation most likely associated with ocean conditions and the availability of biological resources for maturing winter-run, the maturity rates of age-3 fish have ranged between 85-97%. This agrees with the general conclusions drawn in previous biological opinions that age-3 fish are the fish that are most vulnerable to harvest in the fishery because age-2 fish are typically smaller than the minimize size limits, and very few age-4 fish remain in the ocean to be available for harvest.

Table 7. Maturation rates for brood years 1998-2003[22]

	Brood Year					
	1998	**1999**	**2000**	**2001**	**2002**	**2003**
Maturation rate						
age-2	0.043	0.175	0.065	0.060	0.036	0.041
age-3	0.854	0.955	0.945	0.974	0.930	0.949
age-4	0.827	1.000	1.000	1.000	1.000	0.946

[22] Broods 2004 and 2005 are incomplete therefore no maturation rates are displayed.

Results of the cohort reconstruction estimates of age-specific fishery impact rates are provided in Table 8 and Figure 15. With respect to the age-3 impact rates, the results indicate a fairly consistent rate ranging between .15-.20 (15-20% of the age-3 cohort abundance at the beginning of the March 1 winter-run biological year were killed as a result of contact with ocean fisheries in that year). Age-4 impact rates have varied much more and were considerably higher than age-3 impact rates most years (up to .6 and .7 in some years). However, it is important to remember that, regardless of the magnitude of the age-4 impact rate, a relatively small number of total fishery-induced age-4 mortalities will occur due to the low abundance of age-4 winter-run in the ocean following the very high probability of maturing at age-3 and leaving the ocean to spawn. It is also important to acknowledge that age-4 impact rate estimates are generated from very few tag recoveries (a total of 36 recoveries from the ocean salmon fishery and 66 from the carcass survey at the spawning ground; O'Farrell *et al*. 2010) across brood years 1998-2004). When the amount of tag recoveries is so small, any factor that leads to a failure to recover any tags that would otherwise be available has a large influence on the estimate values. This situation is more vulnerable to errors and the absolute value of age-4 impact rates should be viewed with some caution.

Cohort reconstructions allow for estimation of the spawner reduction rate, defined as the total reduction in brood returns to the spawning grounds (all ages) that can be attributed to impacts in ocean salmon fisheries (Table 8 and Figure 16). Because most of the impacts are associated with age-3 fish, the winter-run spawner reduction rate tracks age-3 impact rates closely, with estimated reduction rates ranging from 11-25%. There is some uncertainty in the estimates of the spawner reduction rate for the 2004 and 2005 brood years because the data from the entire potential lifespan of those cohorts are not yet available. However, considering the fact that winter-run CWT recoveries are not expected from the ocean fishery in 2008 and 2009 due to the closure off most of Oregon and California (including all of the fishing opportunity south of Point Arena) during these years, the final estimates of the spawner reduction rates are almost certainly going to be the low end of the range displayed in Figure 16.

Table 8. Impact and spawner reduction rates for brood years 1998-2005[23].

Brood year								
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Impact rate								
age-3	0.214	0.191	0.201	0.103	0.214	0.152	0.151	0.168
age-4	0.125	0.717	0.547	0.672	0.383	0.231	0.000	--
Spawner reduction rate	0.245	0.177	0.216	0.113	0.235	0.160	--	--

[23] Broods 2004 and2005 are incomplete, and therefore estimates of the spawner reduction rates are not final. Estimates of age-4 escapement and impact rate for brood year 2005 are not available.

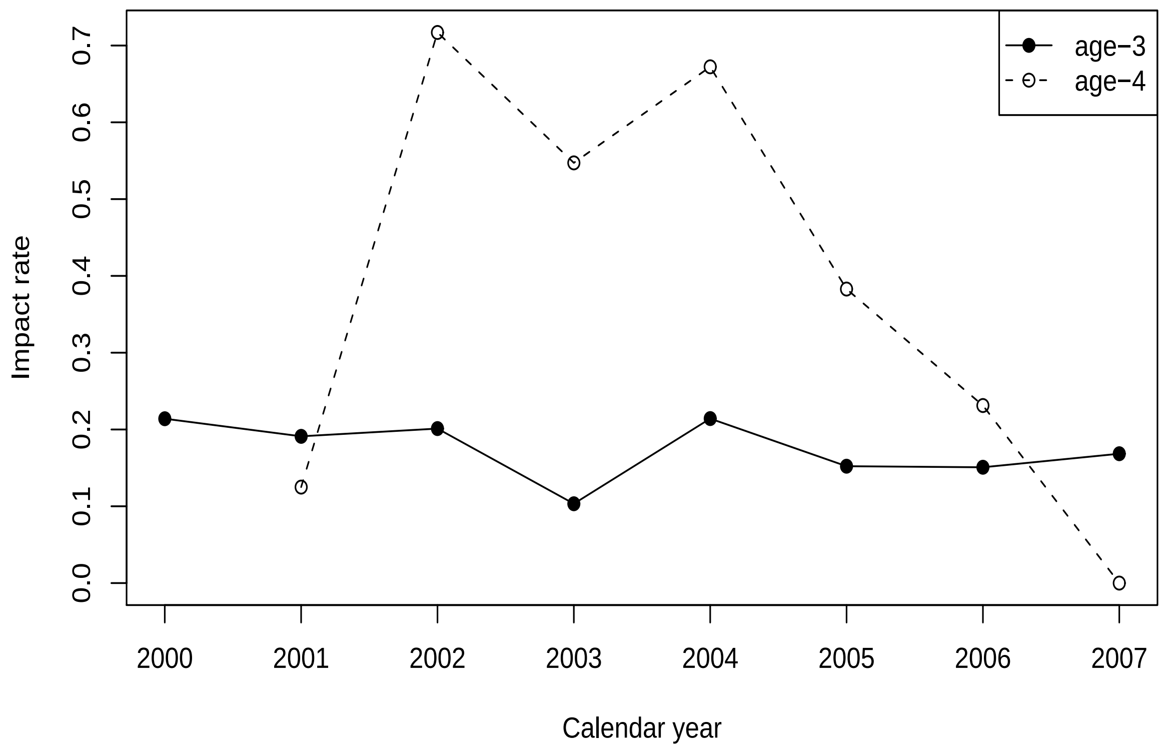

Figure 15: Age specific ocean impact rates by fishing year.

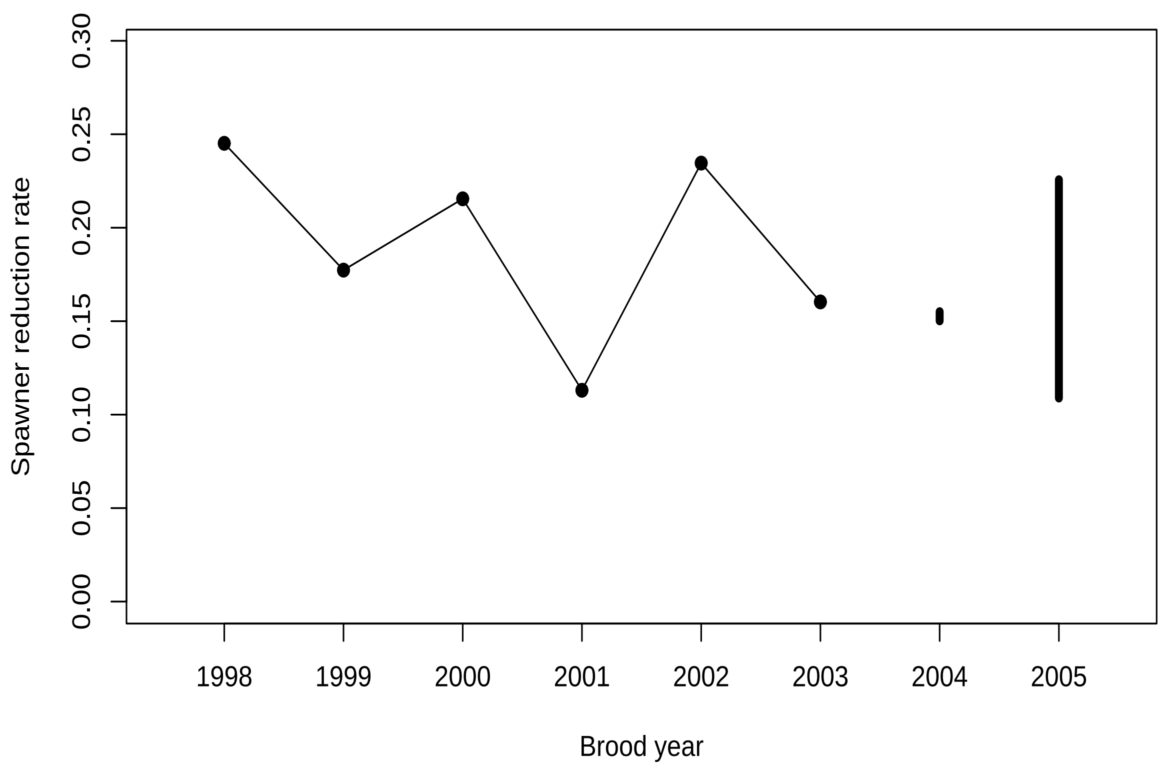

Figure 16: Spawner reduction rates due to ocean salmon fishery impacts by cohort brood year. The uncertainty of the incomplete broods 2004 and 2005 is represented by an estimate range.

Cohort reconstructions rebuild the abundance of winter-run broods back to age-2, March 1. Using the age-2 March abundance and the number of hatchery fish released from LSNFH, it is possible to estimate an early life survival rate (O'Farrell *et al*. 2010). The early life survival rate includes all sources of mortality, both in the river and the ocean from hatchery release to age-2 in the ocean. This survival rate is most likely completely independent of ocean fishery sources of mortality as winter-run prior to age-2 are unlikely to be contacted by ocean fisheries. Estimates of early life survival, and the number of winter-run released from the hatchery, are presented in Figure 17. With the exception of brood year 1999, hatchery release numbers have been fairly consistent. Conversely, early life survival estimates have varied considerably. The highest survival rates occurred for brood years 1999, 2002, and 2003. The relatively high survival rates for the 2002 and 2003 broods coincided with relatively high levels of hatchery releases. These broods in turn incurred the relatively high age-3 ocean impacts observed in 2004 and 2005 (Figure 7; Figure 15). These results suggest that the relatively high age-3 impacts observed in fishing years 2004 and 2005 were the result of relatively good early life survival and relatively large hatchery releases in 2002 and 2003, considering that the age-3 ocean fishery impact rate has varied little over the 2000–2007 period. Conversely, the low survival rates of brood years 2004 and 2005 appear to provide a good explanation for the low abundance of spawner returns observed in 2007 and 2008.

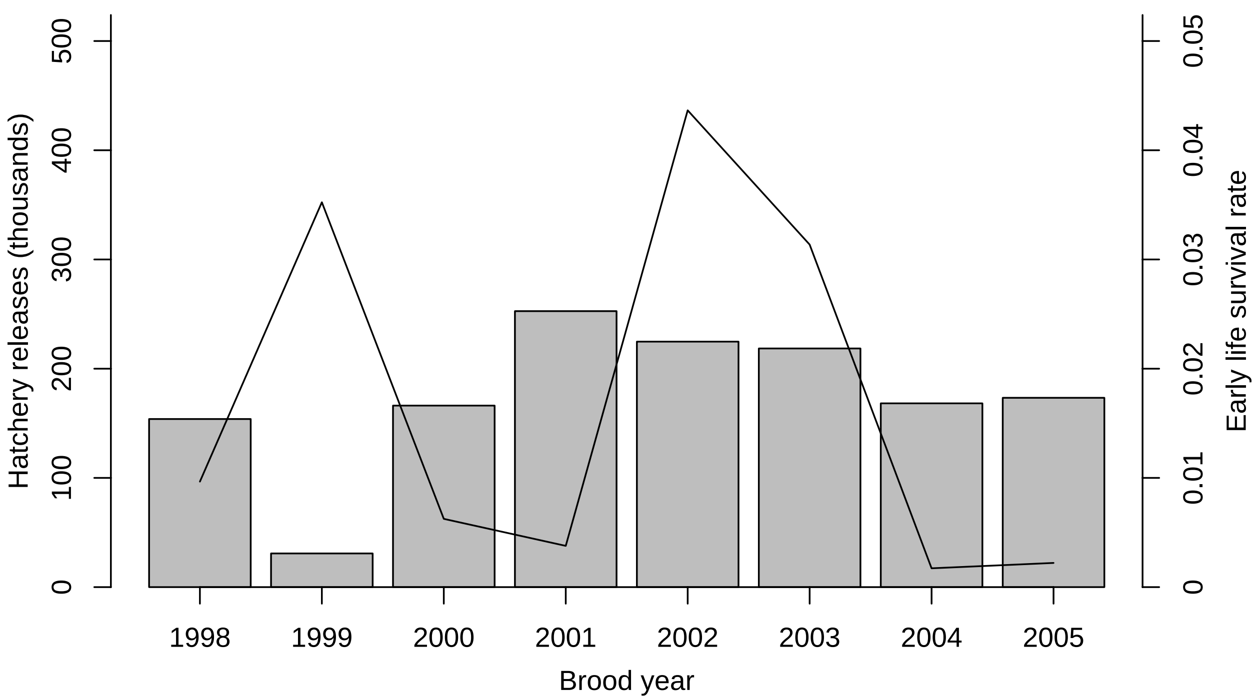

Figure 17. Number of winter-run released from LSNFH hatchery (bars) and estimated early-life survival rate (line); 1998-2005 broods.

B. Response

Winter-run are removed from the population directly through harvest, or indirectly through mortality from release, depredation, or injuries resulting from contact with the fishing gear. These individuals are removed from the population during their residence in the marine environment prior to returning to their freshwater spawning grounds and contributing to the reproductive capacity of the population. This has a direct effect on winter-run by reducing the abundance of the population and growth rate as measured by the returning spawner estimates (cohort replacement rate).

Using the spawner reduction rate estimates, it is possible to estimate what the spawning returns could have been absent fishery impacts (see Appendix C). Estimates of spawner reduction rates are only available beginning with brood year 1998, and this necessarily restricts the time period which can be examined (Figure 18). It is logical to expect that spawning escapement would be higher if impacts, especially those impacts that occur at the stage immediately preceding the return to the spawning grounds, were reduced or eliminated. Moreover, if the ocean fisheries were closed over an extended period of time, there would presumably be additional gains in the offspring resulting from the reproductive potential of "additional" spawners. However, the added gain in reproductive potential over time absent all fishing impacts would not represent an increase in the population growth rate of pre-fishery recruits per spawner. The cohort replacement rate for the "additional" spawning potential is still the same. In fact, this portion of the population growth rate could be reduced if any density dependent processes were operative such as limited spawning habitat capacity, competition for food resources, overlap in breeding efforts on the spawning grounds, etc. The Appendix C model results (Figure 18) suggest that it does not take long for significant increases in these theoretical returns absent fishing to accumulate given conditions that appear to be favorable for winter-run survival (up through 2006).[24] However, the model results also illustrate that the absence of fishery impacts would not have prevented the same magnitude of declines observed in recent years, although it would be expected to provide some buffer against the population falling toward low levels where increased risks extinction become a greater concern.

[24] The results of the model in Appendix C are based on the assumption that density dependant forces would not be a factor to control potential population growth at this magnitude of population size. In reality the limited amount of suitable spawning habitat is largely controlled by temperature regulation below Keswick Dam, and it is possible that the spawning capacity could reach carrying capacity at low spawning escapement levels during drought conditions (B. Oppenheim, personal communication, NMFS, 2010).

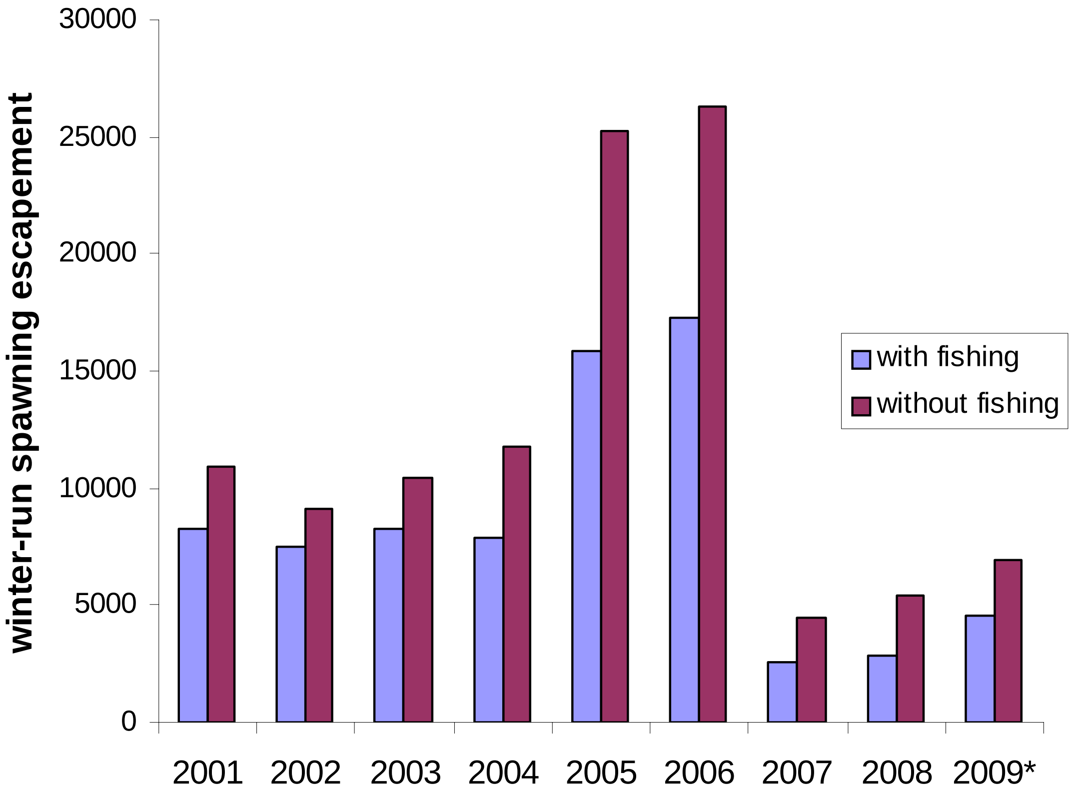

Figure 18: Comparison of observed returns to returns predicted in the absence of fishing impacts. 2009* is based on preliminary return estimates.

C. Risk to populations and ESU

Currently, there is only one extant population of winter-run that spawns in the upper mainstem Sacramento River below the Keswick Dam. The effect of harvest and indirect mortality associated with the salmon ocean fishery reduces the reproductive capability of this population, and subsequently the entire ESU, by 10-25% per brood, when ocean fisheries occur at a level similar to what has been observed for most of the last decade south of Point Arena, California.

There is concern about the relatively high impact rate for age-4 fish and the consequences of this relative to the genetic diversity of winter-run. If age at maturity is strongly related to a genetic component, the removal of older fish at a high rate before they can return to spawn, however few of these individuals in the population there might be, could theoretically reduce the potential for that trait to pass on to successive generation. The change in an average life history trait over time, such as age at maturity, has been suggested as evidence for fisheries induced evolution in some situations (Law 2000; Kuparinen and Merilä 2007; Hard *et al*. 2008). Despite indications that some part of maturity for salmon is genetic, there is also strong evidence that environmental conditions strongly influence development and maturation (Thorpe 2007; Wright 2007). At this point, the interplay between these two forces is not well understood and it has been difficult to separate and identify the source of observed changes in population life history traits (Kuparinen and Merilä 2007; Kuparinen *et al*. 2009).

With respect to winter-run, it is not clear if the predominance of age-3 fish has been evolving over time. The only historical perspective comes from a study of three cohorts in the early 1970s where 25% of tagged winter-run that returned to spawn were 2 years old, 67% were 3 years old, and 8% were 4 years old (Hallock and Fisher 1985). During the time period considered in this analysis (brood years 1998-2004), 7% of tagged winter-run that returned to spawn were age-2, 90% were age-3, and 3% were age-4 (Table 9). Based on the limited historical data and the uncertainty of the genetic/environmental relationship of age at maturity, it is not possible to determine if this is indicative of an evolutionary shift caused by harvest impacts or more reflective of environmental conditions at the respective moments in time.

Table 9. Percentage of spawning return by age for brood years 1998-2004, including total number of expanded tag recoveries and overall percentage by age for all brood years.

	brood year								
age	1998	1999	2000	2001	2002	2003	2004	total	%
2	0.03	0.26	0.10	0.08	0.06	0.06	0.03	489	7.3
3	0.96	0.74	0.88	0.91	0.91	0.91	0.93	6051	90.0
4	0.02	0.01	0.02	0.01	0.03	0.03	0.03	179	2.7
5	0.00	0.00	0.00	0.00	0.00	0.00	na[25]	3	0.0

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of all future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. For the purposes of this analysis, the action area includes the EEZ off the coasts of Washington, Oregon and California and the marine waters, other than internal, of these states. Activities that may occur in these areas will likely consist of state or federal government actions related to ocean use policy and management of public resources, such as fishing or energy development projects. Changes in ocean use policies as a result of government action are highly uncertain and may be subject to sudden changes as political and financial situations develop. Examples of actions that may occur include development of aquaculture projects; changes to state fisheries which may alter fishing patterns or influence the bycatch of ESA-listed salmon, including any actions by the state of California in regards to management of the salmon fishery within state waters; installation of hydrokinetic projects near areas where salmon are known to migrate through or congregate; designation or modification of marine protected areas that include habitat or resources that are known to affect salmon; and coastal development which may alter patterns of shipping or boating traffic. However, none of these potential state, local, or private actions, can be anticipated with any reasonable certainty in the action area at

[25] There is a small potential for age-5 tag recoveries on spawning ground from carcass surveys in 2009. At the time of this opinion, that data was not available for use in this analysis. Given the historical lack of age-5 spawners (a total of 3 for the previous 6 broods), it would seem unlikely that enough age-5 spawners would return in one year to significantly affect the average distribution of age of maturity.

this time. Even if some of the projects were developed with any certainty, the level of direct or indirect effect associate with most of these types of actions appear speculative at this point. Current and continuing non-federal actions that may occur in the action area and may be effecting winter-run are addressed in the environment baseline section.

VII. INTEGRATION AND SYNTHESIS

The cohort reconstruction analysis has indicated that, given the current management structure of the fishery and the protective measures in place to protect winter-run, it is expected that spawning returns of winter-run will be reduced 10-25% per brood from impacts associated with harvest in the ocean salmon fishery, under normal circumstances of the recreational fishery south of Point Arena being open from April to October/November and somewhat more variable timing/effort in the commercial fishery south of Point Arena based on the status of target stocks managed under the FMP. These impacts are going to occur primarily as a result of the removal of age-3 winter-run, almost exclusively in the areas south of Point Arena, California, when fishing activity is permitted in those areas in conjunction with the seasonal and size restrictions of the proposed actions. The results from O'Farrell *et al.* (2010) indicate that the majority of these impacts will be associated with the recreational fishery in this area. The rest of this opinion will be focused on how the ocean salmon fishery conducted with the anticipated level of effects on winter-run when added to the environmental baseline relates to the likelihood of both the survival and recovery of this ESA-listed ESU.

Jeopardy Standard. The "jeopardy" standard has been interpreted in regulation (50 CFR 402.02) as a requirement that Federal agencies ensure that their actions are not likely to result in appreciable reductions in the likelihood of both the survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution. NMFS equates a listed species' probability (or risk) of extinction with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. In the case of listed salmonids, we use the Viable Salmonid Populations (VSP) framework (McElhany *et al.* 2000) as a bridge to the jeopardy standard. A designation of "a high risk of extinction" indicates that the species faces significant risks from internal and external processes that can drive it to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

For salmonids, the four VSP parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed salmonid species (McElhany *et al*. 2000). The VSP parameters of productivity, abundance, and population spatial structure are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for "numbers, reproduction, and distribution." The VSP parameter of diversity relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-levels.

The VSP concept also identifies guidelines describing a viable ESU/DPS. The viability of an ESU or DPS depends on the number of populations within the ESU or DPS, their individual status, their spatial arrangement with respect to each other and to sources of potential catastrophes, and diversity of the populations and their habitat (Lindley *et al.* 2007). Guidelines describing what constitutes a viable ESU are presented in detail in McElhany *et al*. (2000). More specific recommendations of the characteristics describing a viable Central Valley salmon population are found in Table 1 of Lindley *et al.* (2007), reproduced as Table 4 in this opinion.

A. Ocean salmon fishery and winter-run ESU

Within the confines of the VSP approach and the viability criteria of Lindley *et al.* (2007), the effects of the ocean salmon fishery are primarily related to the abundance and population growth or productivity of winter-run. It appears from the results of the cohort reconstruction analysis that ocean fishery impacts have remained fairly consistent (approximately a 20% reduction in a brood's eventual spawner returns) regardless of the spawning abundance of winter-run or the specific annual ocean fishery regulations over that last decade. There is little evidence to indicate that spatial structure is being affected by the reduction of spawning returns, because there is very little diversity currently in the spatial structure of this ESU. From the point of view of recovery goals and criteria identified by NMFS, the ocean salmon fishery is not restricting winter-run from developing new populations. Until such time that in-river passage barriers and other impediments to increased spatial structure and diversity are reduced to a point where additional populations of winter-run are present, the ocean salmon fishery only affects the spawning returns of the one extant population. It is possible that the genetic diversity of this population of winter-run is being affected by virtue of disproportionate harvest of older fish. While the fact that age-3 fish currently dominate the returning spawners does suggest that evolutionary forces have been acting on this run, the available information does not allow for a conclusive determination of how fishing has impacted age at maturity. This is an area of research where the theoretical basis and empirical results need to be more closely analyzed.

In order to assess the impact of the fishery on population growth and abundance, it is necessary to consider the status of winter-run during the time period for which the estimates of fishing impacts are available. In Figure 19, the recent spawner returns of winter-run and corresponding cohort replacement rates are provided. It is important to note that the carcass survey derived estimates of spawner returns took the place of RBDD derived estimates of spawner returns beginning in 2001. It is generally acknowledged that a carcass survey derived estimate tends to be higher than the RBDD derived estimate, although the carcass survey estimates are considered more accurate than previous methods. While the change in methods to the carcass surveys from using RBBD counts estimates does add an element of uncertainty to direct historical comparisons, it is still apparent that spawning returns were increasing beginning in the late 1990s and through 2006. This was most likely the result of a combination of factors including conservation actions taken to promote spawning habitat, favorable conditions in the marine environment, and initial actions taken to reduce and limit incidental take in the ocean and river fisheries. Looking specifically at the last decade, it is clear that this winter-run population (and consequently the entire ESU) is capable of positive growth (cohort replacement rates greater than 1.0) while sustaining the 10-25% reduction in the cohort spawning returns due to ocean fishery impacts, up to spawning returns of at least 15,000 individuals, during times of favorable or improving conditions like those which appear to have occurred for the most part over the last 15 years. However, the last 3 years (essentially 1 generation of winter-run) have seen a dramatic reduction in spawning returns and cohort replacement rates. This has occurred despite the fact that fishing pressure was not present in 2008 and 2009, although some small level of impact from fishing in 2007 was likely felt by fish that may have returned in 2008 or possibly 2009 (*i.e.* age-2 fish caught in 2007 that may have returned as age-3 or age -4).

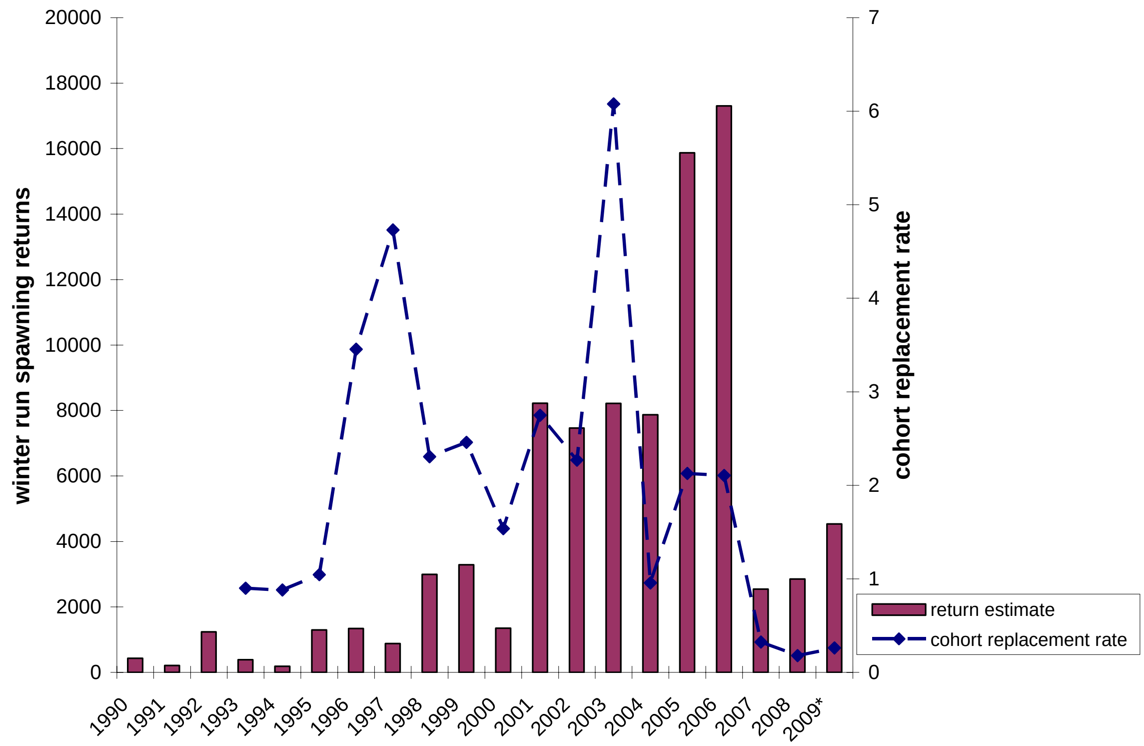

Figure 19: Winter run spawning returns and cohort replacement rates. Carcass survey estimates began in 2001. *2009 is preliminary estimate.

Overall, the long term average growth rate of the population remains positive using the natural log of 3-yr running sum estimates of returns[26] (λ=1.17 since 1992; λ=1.13 since 2000) (Dennis *et al.* 1991; Morris and Doak 2002; Holmes and Fagan 2002). However, the long term trend in spawning returns are somewhat complicated by the change in the escapement estimation methods to carcass survey estimates in 2001. Although it is clear that one complete generation has experienced a dramatic reduction in returns, it is not yet

[26] Annual growth rate = $\ln R_{t+1}/\ln R_t$

possible to conclude whether or not the recent observed declines of the last three years are indicative of a systemic decline in productivity or more reflective of temporary adjustments according to natural variation in the ecosystem.

Although the recent declines in winter-run returns are unlikely to be related to the ocean salmon fishery, which was closed in 2008 and 2009, NMFS must consider the likely outcome of the future operations of the fishery given the current status of the ESU. A reduction of 10-25% of each brood's spawning potential will affect winter-run spawning abundance in the short term, and perhaps over the long term (see Figure 18). If population growth is measured by changes in abundance, then effects on abundance may be expected to affect growth.[27] In the case of winter-run for most of the last decade, these two criteria (both in terms of the VSP concept and population criteria in the *Draft Recovery Plan*) for the extant population were not at high risk for extinction despite the consistent pressure from the fishery documented in this opinion. While abundance and growth have recently declined, the impacts from the fishery were also diminished during this time. This is due to fishery management under the FMP and the reduction of effort in the southern portion of the fishery in response to the status of SRFC. Although the exact timing and extent of declines for both winter-run and SRFC were not identical, there does appear to have been a concordant relationship between the two with respect to early life survival for brood years 2004 and 2005 (Figure 11; O'Farrell *et al*. 2010; Lindley *et al*. 2007). As a result, management of the ocean salmon fishery during a time when SRFC has declined has minimized fishing effort in the southern portion of the fishery, which has minimized impacts to winter-run at a time when winter-run spawning returns have also decreased significantly.

Based on this recent history it would be appropriate to conclude that the ocean fishery is constructed in a manner that has worked to protect winter-run during a time period of decline, which is the critical point for when concerns about reductions in spawning potential would arise. According to Lindley *et al*. 2007 and Allendorf *et al*. 1997, salmon populations face increased risk of extinction associated with significant declines or reduced population sizes. As stated previously, during periods where environmental and man-made conditions allowed the winter-run population to grow, fishing impacts do not appear to have reduced the likelihood of the ESU surviving and recovering. However, there is uncertainty in the immediate and long term future of this stock. The sudden decline observed in the last 3 years raises the concern that the stock is not replacing itself and the resiliency of the ESU is being compromised. The factors that are most likely acting as the agents in this case are not the result of fishing, but more likely due to poor early life survival resulting from a combination of conditions in the freshwater and marine environment. As the understanding of the specific mechanics of this system and the relative status of all parameters involved are not well understood, it is not clear how winter-run are going to respond going forward, regardless if impacts to the stock from ocean salmon fisheries are realized or not.

[27] After a variable impact such as fishing is removed, with all other things being equal, cohort replacement rates should remain the same.

If the status of winter-run were relatively well-linked to the status of other stocks managed under the FMP, management of the ocean salmon fishery should work coincidentally to help benefit winter-run and minimize fishery impacts. For example, if the same environmental conditions that supported increased spawner returns of winter-run also supported increased returns of SRFC and KRFC, it is reasonable to expect that current management constraints in the FMP to protect these stocks would also benefit winter-run. However, if SRFC or KRFC stocks didn't respond to the environment in the same manner as winter-run, then it would be expected that the status of these stocks would diverge. An example of this would be a situation where winter-run were doing well but SRFC or KRFC were not, and the southern portion of the ocean fishery was being constrained by a weaker stock. In this case it would appear that the risk of fishing impacts occurring at a rate that would reduce the likelihood of survival and recovery of the species is very small.[28] In fact, the underlying relationships of covariation and correlation between different populations of Chinook salmon have yet to be well described. There are a suite of possible factors involved including the extent of conservation measures being implemented for winter-run in their freshwater habitats, or variation in the exposure or response to different environmental conditions that may be faced by different salmon ESUs given different run timings and maturation rates.

A potential scenario that would cause concern would be incongruity in the relative strength of winter-run and other stocks such that both SRFC and KRFC were doing well enough to support significant levels of fishing effort in the southern fisheries, while the winter-run population was depressed and declining. At that point fishery impacts on winter-run could be expected to be maximized and spawner reduction rates could reach relatively high levels, and might increase beyond what has been observed in the ocean fishery without any further controls beyond the current protective measures. Additionally, at lower population sizes, impact rates consistent with what has been observed in the past become more of a concern due to the uncertainty of how other factors are contributing to population declines and the response of this species to adult mortalities resulting from impacts from the ocean salmon fishery. If, during years of reduced and declining winter-run spawning returns, impacts from the fishery were anticipated to continue at or exceed levels that may be expected under the proposed action (impacts consistent with what was observed for the most part from 2000-2007), these losses to the ESU will further reduce potential spawner returns and growth of a population at increased risk of extinction.

Ultimately, the concern associated with whether fishing impacts commensurate with a spawning reduction rates averaging about 20%, and up to 25%, are increasing the extinction risk for winter-run comes down to the status of winter-run at the time when impacts are expected to be realized. It may be possible to quantify the appropriate or maximum allowable level of impact to allow for recovery given certain conditions or scenarios related to population or ecological parameters, or specify overall long term targets that account for a range of variables. This type of analysis has been done for a number of salmonid ESUs in the Pacific Northwest, including Oregon Coast coho, Lower Columbia River Chinook, and Puget Sound Chinook. However, analytical tools that have

[28] This is essentially what has occurred during the last ten years.

been evaluated and accepted by NMFS are not currently in place to provide that level of information for use with winter-run in this opinion. Up to this point, NMFS has relied primarily on qualitative assessments of impacts to winter-run from the ocean fishery in terms of retrospective analyses of impact effects and forecasting future impact levels as a result of management actions. Until such time as other quantitative tools are available, NMFS continues to rely on a qualitative assessment and has determined that the level of fishing impact that is not likely to appreciably reduce the likelihood of survival and recovery of the species in the wild during periods of growth or stability for winter-run is likely to reduce appreciably reduce the likelihood of survival and recovery of the species in the wild during periods of decline.

VIII. CONCLUSION

As required by section 7 of the Endangered Species Act (ESA), federal agencies must ensure that their actions are not likely to jeopardize any listed species or result in the destruction or adverse modification of designated critical habitat. In the current consultation, NMSF has analyzed the proposed operation of the fishery as described in the biological assessment. This analysis is intended to consider the impacts to ESA-listed species over multiple years of fishing operations.

NMFS reasons that if the status of winter-run remains generally positive, similar to what was observed for most of the last two decades (assumed to be primarily related to improving and more favorable conditions in the ocean and freshwater environment), impacts from the salmon ocean fishery, consistent with the fishery operation since 2000 and what would be anticipated under the proposed action, would not be expected to negatively affect the abundance and population growth capability of this ESU at a level that would appreciably increase the risk of extinction. However, during times of generally negative patterns in spawner returns or other indications that the status of winter-run is deteriorating, fishing impacts at or above those observed in the past decade are likely to increase the probability of extinction of the ESU through losses in population abundance, impacts on diversity, and reductions in population growth rate.

The primary concern is that the current proposed action does not include measures that would avoid, reduce, or even constrain the fishery's impacts to winter-run during a time when the species' status is declining or is facing increased extinction risks. Without any explicit means to further constrain impacts after consideration of winter-run status in the fishery management process, the potential exists for total spawner reduction rates associated with the ocean salmon fishery to approach, and possibly exceed, 25% during periods of time when risks of extinction are significantly increased due to other factors. Therefore, NMFS finds it reasonable to conclude that the proposed operation of the fishery with impacts at a level that could be expected without any consideration for additional action based on the current status of winter-run has not ensured that the fishery is not likely to appreciably reduce the likelihood of survival and recovery.

Therefore, after reviewing the best available scientific and commercial data, the current status of the winter-run ESU, the environmental baseline for the action area, and the effects of the proposed action, it is NMFS' biological opinion that the proposed action is likely to jeopardize the continued existence of the Sacramento River winter Chinook ESU.

IX. REASONABLE AND PRUDENT ALTERNATIVE

A. Approach to the RPA

If NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify or destroy its critical habitat, the ESA requires NMFS to suggest those reasonable and prudent alternatives (RPAs) that it believes would enable the project to go forward in compliance with the ESA. By regulation, an RPA is defined as "alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the [NMFS] Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat" (50 CFR 402.02).

NMFS approach to developing an RPA to the proposed action is to address the foundation of the jeopardy conclusion, which is the lack of explicit controls in the ocean salmon fishery management process to constrain and reduce impacts when the status of winter-run is declining or unfavorable, and the extinction risks are increased. In essence, the RPA is that NMFS must consider and implement what fishery measures may be necessary given certain conditions, namely a declining status of winter-run spawning returns and indications that the population is not replacing itself given the current environmental conditions. If these conditions are not evident, the measures implemented by the 2004 biological opinion and proposed again as protective measures as part of this consultation will remain the consultation standards of the ocean salmon fishery relative to winter-run, and no additional management action may be required. As stated in the opinion, when the status of winter-run is favorable, the anticipated impacts on winter-run under these already existing protective measures are not likely to jeopardize the continued existence of the species.

B. RPA

The overall objective of the RPA is that NMFS must consider the current status of winter-run as part of the annual preseason management process and apply as necessary fishery management actions that are designed to prevent fishery impacts from exceeding levels that would be expected to reduce the species' likelihood of survival and recovery given the species current status. In order to incorporate this consultation standard into the ocean salmon fishery management process, NMFS (in coordination with the PFMC) must develop a management framework for winter-run that meets the overall objective of this RPA, and that also provides a methodology that is practical given the Salmon FMP, the ocean salmon fishery management process, and the extent of information that may be available for consideration on a timely basis. This framework must be implemented as the consultation standard of the ocean salmon fishery for winter-run before NMFS issues ESA guidance to the PFMC for the 2012 fishing season, or no later than March 1, 2012.

The development of this overall framework will rest upon using the best information and analytical tools that are available. While the specific details of the framework are not yet established, it is evident that the framework must contain certain specific elements that can be translated into fishery management activity:

- Thresholds related to the status of winter-run must be established. These thresholds should define criteria that identify when the status of winter-run is at varying stages of risk related to various levels of fishing impacts. Thresholds should be measurable and determinable on a regular basis.
- Given these established threshold criteria, fishery management objectives with regard to fishery impacts on winter-run must be established. These objectives must relate to impact targets that are readily measureable and regularly monitored for performance.
- In order to meet the management objectives, additional analytical tools and assessment models will need to be created that can incorporate the objectives into the overall fishery management process and used to evaluate various management schemes. These tools should also be used in the ongoing assessment of the performance of the framework for managing fishery impacts to winter-run.

C. RPA Rationale

In general, NMFS believes that when Sacramento River winter Chinook returns are low or declining, fishing impacts, as measured by the age-3 impact rates and total spawner reduction rates, may need to be reduced from the level that would be expected given no additional management constraints in order to avoid the likelihood of jeopardizing the ESU. Such impact rate restrictions would be in addition to the protective measures of season, size limit, and gear restrictions outlined in the proposed action. The purpose of the RPA is to establish a long term management framework structure that allows NMFS to consider the status of winter-run on a regular basis under a defined set of criteria which will help guide the establishment of fishery management objectives that will ensure the ocean salmon fishery is not likely to jeopardize winter-run. At this time, the specific thresholds that would trigger the need for reducing impacts, the objectives or impact targets that are acceptable given various conditions, and the tools needed to incorporate these criteria into the fishery management process are not available. It is expected that additional analytical effort will be required before this framework can be finalized.

Although the details of the RPA framework have not been developed, NMFS has identified some concepts that represent a foundation for building this approach. One fundamental concept expected to apply to this long term framework is that not all situations indicating decline are equal. For example, a population experiencing a relatively small decline in spawning returns compared to its parental brood from a relatively high level of return is not reflective of the same compromised status or extinction risk as a population experiencing a relatively large decline from a relatively low level of spawning return. One other important principle is that winter-run spawning returns are so dominated by age-3 fish that the population status as indicated by 3-yr cohort replacement rates provides a measure to help track the capability of this population to survive and recover. The following criteria are examples of primary measures that could be used to assess the status of winter-run based on information that is readily available.

Criteria 1: absolute spawning return estimates
Criteria 2: growth rate as measured by cohort replacement rate

Until more quantitative analytical work is completed, NMFS is operating under the assumption that the status of winter-run can be measured by the annual estimates of spawning return and the trend in the 3-yr cohort replacement rates of winter-run. A cohort replacement of 1.0 represents essentially 0 growth or decline. It may also be possible to include other indicators or measures in the status assessment. Based on the principles mentioned above, the RPA framework is likely to take a tiered approach to assessment of criteria designed to address the status of winter-run in a manner that can be incorporated into the annual preseason planning process. Based on the assessment, management action can be designed to meet specific objectives, such as impact rate targets, that adaptively address the current status of winter-run. Once in place, this framework will become the consultation standard for winter-run and the ocean salmon fishery. After this framework has been implemented, NMFS anticipates it will be possible to redefine and modify status criteria and fishery management objectives within the framework, and improve or develop new tools necessary to achieve those objectives, over time as new or better information becomes available.

As part of the implementation of the requirements of this biological opinion, NMFS would prefer to have a clearly defined management framework for use by NMFS and the PFMC to address winter-run impacts by the 2011 preseason planning process. However, due to the complexity of the issues and the analytical processes that are involved, NMFS acknowledges the possibility that a long term framework consistent with this RPA may not be fully developed in time for the 2011 preseason management process. In that case, NMFS will have to approach the jeopardy standard of this opinion for the 2011 ocean salmon fishery season in a similarly conservative manner as the interim RPA for the 2010 ocean salmon fishery season was constructed.

D. Interim RPA

Without the details of a framework in place, NMFS must take interim actions that will ensure that incidental take of winter-run in the ocean salmon fishery is not likely to jeopardize the ESU (develop an interim RPA). A quantitative evaluation of what the appropriate fishery impact rate should be or precisely how much impacts need to be reduced given increased extinction risks associated with population decline is not available at this time. As stated previously, in the past NMFS has not developed quantitative models to assess the effect of the ocean salmon fishery or estimate future impacts to winter-run. Consequently, in the interim of more quantitative analysis, NMFS must rely on a more qualitative approach in considering how to address the current status of winter-run.

1. Rationale for Interim RPA Standards and 2010 Fishing Season ESA Guidance

For purposes of the 2010 fishing year, NMFS determined that impacts from the fishery needed to be constrained from reaching the levels estimated during the years of 2000 to 2007 (age-3 impacts rates up to 0.21; total spawner reduction rates up to 0.25), due to the significant decline in abundance of winter-run spawning returns since 2006. It is evident from spawning return estimates that the last three years have represented very poor cohort replacement and suggests that forces or environmental conditions are acting to negatively influence survival at some point(s) along the life-cycle of these fish in a manner that is not consistent with what had happened in the previous decade. The level of this decline and the apparent magnitude of these influences over such a short period of time places winter-run at a high risk of extinction. Without a full understanding of the root causes or the ability to predict the trajectory of the population, NMFS must conclude that conservative action is necessary to minimize additional impacts to the extinction risk of winter-run in the immediate future. As such, steps must be taken to constrain impacts from the ocean salmon fishery against reaching total spawner reduction rates of 20% or more until there is an indication that the status of this species is improving.

The recent cohort reconstruction analysis suggested that the core results remain consistent with the 2004 biological assessment. In particular, ocean fishery impacts occur primarily on age-3 fish and are mostly the result of recreational fisheries south of Point Arena. In looking at how to reduce impacts, the information contained in the cohort reconstruction analysis was used to develop ideas for how to modify the fishery in order to achieve a reduction in fishery impacts.

A key issue for NMFS in developing the winter-run ESA guidance to the PFMC for developing recommendations for the 2010 fishing year in the interim of a developed management framework for winter-run was the consideration of what level of impact reduction is required to satisfy the jeopardy standard. Without any established quantitative standards or models that could be incorporated into this process, NMFS was forced to rely on more qualitative standards such that reductions: 1) be demonstrable and significant in accordance with the current status of winter-run; and, 2) be reasonably certain to occur considered against likely scenarios.

As mentioned earlier in the Effects Analysis, the results of the cohort reconstructions indicate that recreational fishing in the months of June and July have produced the strongest relationship between increasing fishing effort and increasing fishery impacts in SF and MO[29] in recent years. A significant positive relationship between effort and impacts also occurred in the months of April, May, and August, but to varying degrees based on the area and relative effort levels that have occurred. Even at reasonably low

[29] South of Sur (SS) will not be referenced as historical fishing effort south of Point Sur is very small (Figure 9), and has only recently been considered a separate area from Monterey (MO) in salmon management.

levels of effort during June and July (average effort in SF in July is nearly double that of any month anywhere else south of Point Arena), winter-run impact rates are likely to be substantial in both SF and MO. As a result, it would be possible to significantly reduce winter-run impacts by eliminating recreational fishing effort in these areas during those months.

Based on the information available, it was not possible to estimate the absolute value of closing the recreational fishery for any given month in any area. The data in Appendix B indicates that considerable inter-annual variation in age-3 impacts per fishing effort is possible. Using the slopes of these graphs, NMFS determined that the most efficient way to constrain impacts in any one season would be to restrict the potential for high levels of effort south of Point Arena (SF, MO, and SS) in either June or July. In order to ensure a demonstrable reduction in impacts without any way to further analyze the effects of sporadic or short-term openings of the recreational fishery during any month, it is necessary to close the fishery for the entire month. However, there is concern that a closure would cause effort in the recreational fishery in the months on either end of a closure in June or July to increase, which could lead to higher levels of fishery impacts during those months. There is a potential that the reduction savings in June or July could be mostly, or nearly entirely, offset by increased effort in other months. Considering the relatively severe concern over the current status of winter-run based on three consecutive years of poor cohort replacement, NMFS determined that it would be necessary to close the recreational fishery in a month adjacent to either June or July to ensure that fishery impacts are significantly constrained. While a recreational fishery closure in June and July would likely produce the largest benefit for winter-run, NMFS concluded that any 2 month closure that included either June or July would be sufficient to meet the jeopardy standard (*i.e*. a closure in May and June or July and August would meet the jeopardy standard).

NMFS also considered modifications to the minimum size limit in order achieve a reduction in fishery impacts. The information contained in the size-at-age model used in the cohort reconstruction suggests that almost all age-3 winter-run are larger than the 20 inch size limit that has been in place in the recreational fishery south of Point Arena (Figure 13). However, this model also suggest significant portions of age-3 winter-run would be eligible for release if the minimum size limit were higher, depending the month in question. Due to the anticipated growth during the calendar year, the average size of fish increases by month. An initial examination of this size-at-age model suggested that 24 inches was likely the smallest size limit that could implemented that would make a significant difference on the impact to age-3 fish in the recreational fishery, as the average size of winter-run reaches and surpasses 24 inches during the early summer period when fishery impacts would be most expected[30].

As part of this analysis, it was possible to look at the length data from winter-run CWT recoveries to look at the historical pattern of size distribution across the calendar year (Figure 20). In general, these results do match up with the size-at-age model. They

[30] It is important to remember that average size by definition implies that 50% of fish will be less than the average – 50% will be greater than the average, given the normal distribution of this model.

illustrate that significant portions of age-3 winter-run that were harvested in the recreational fishery south of Point Arena when the size limit was 20 inches would have been released with a larger minimum size limit of 24 inches, but this proportion decreases as the year progresses. This data suggests that anywhere from 20-70% of winter-run that would be retained with a 20 inch limit would be released with a 24 inch limit, depending on the timing when impacts occur. It is important to remember that mortalities associated with release would still be expected to occur. Unfortunately there is no tool currently available to assess the absolute benefits in terms of impact reduction that the larger size limit would have for winter-run. It may be possible to combine the elements of size-at-age, post release mortality, and impacts per effort in specific areas during specific months, in a model that could more precisely estimate the impact reduction of various size limits. Until that capability is developed, NMFS has determined that the additive value of reducing winter-run harvest associated with a 24 inch size limit across the season would ensure a demonstrable and significant constraint on fishery impacts that would be sufficient to meet the jeopardy standard.

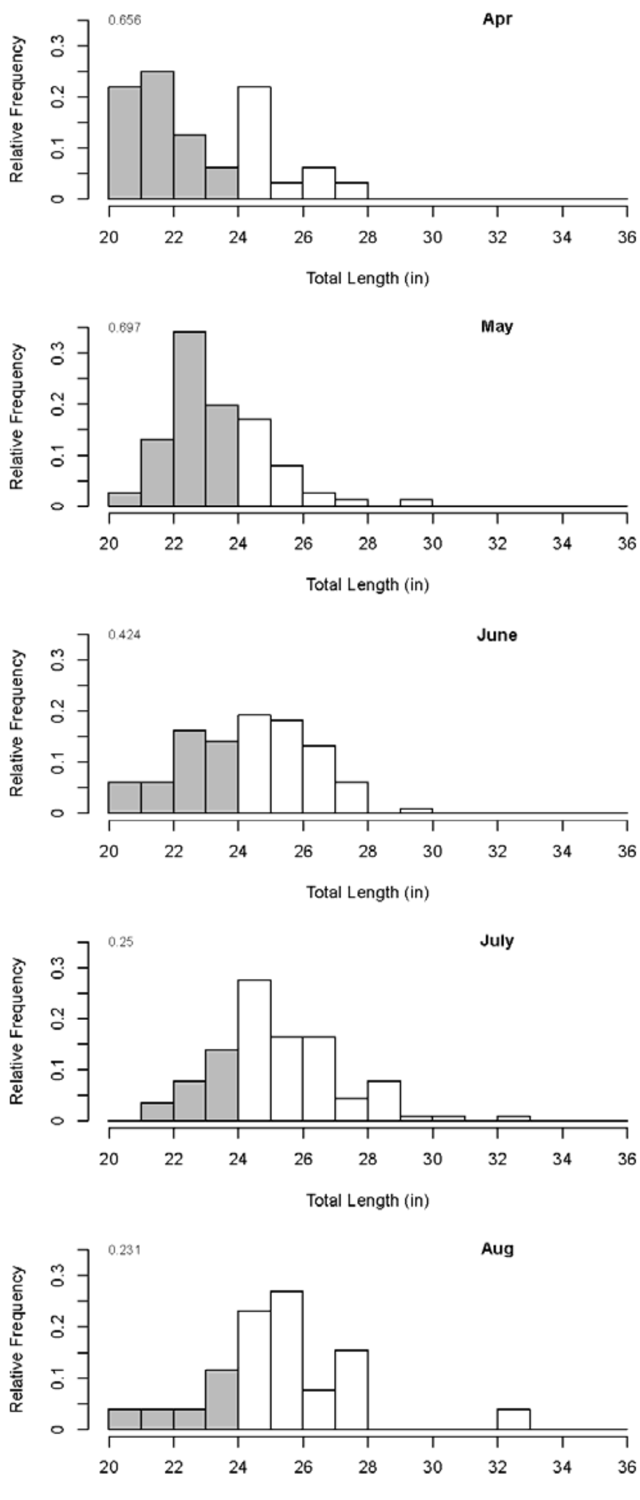

Figure 20: Frequency distribution of size by month (total length in inches) from CWT recoveries of age-3 winter-run in the recreational fishery south of Point Arena (SF, MO, and SS) from 2000-2007. The total % of the recoveries for each month is provided in the top left corner of the graph.

In light of these results, NMFS provided two recommended actions in the ESA guidance letter to the PFMC, dated March 2, 2010, that it believed will sufficiently constrain fishery impacts in the 2010 fishing year:

> (1) for the recreational fishery south of Point Arena, increase the minimum size limit to 24 inches for the entire year; or
>
> (2) for the recreational fishery south of Point Arena, close the fishery for at least two consecutive months (any consecutive 61 day period) at some point from May 1 through August 31. This closure should apply to all areas south of Point Arena simultaneously.

During the March 2010 PFMC meeting, several management options pertaining to this guidance were presented to NMFS. In the interest of providing more flexibility to NMFS and the PFMC in designing the 2010 salmon fishing season, further consideration was given to two additional options.

> (3) use the following combination of options 1 and 2 above:
> Close the **San Francisco** management area for 2 consecutive months (as described in #2) and implement the minimum size limit (described in #1, as revised) in the **Monterey** management area.[31]
>
> (4) for the recreational fishery south of Point Arena, increase the minimum size limit to 24 inches at the beginning of the season through August 31, and continue a minimum size limit of no less than 20 inches throughout September, October, and November.

The combination of the original recommendations as an additional option (3) is based on the available information that suggests either of the first two guidance recommendations will be effective in each area. The important points are that impacts would be constrained in May and June in the San Francisco area, and impacts will be constrained by size limit restrictions throughout the fishing season in Monterey, where fishing effort is greatest in the early part of the fishing year at a time when size limits would be expected to be most effective at limiting winter-run impacts. Although it is not currently possible to quantify impact reduction from either measure separately by area, NMFS concludes that this combination meets the same qualitative standard as the two original guidance options originally provided.

Further analysis of the size of age-3 winter-run exposed to the recreational fishery south of Point Arena based on CWT recoveries (data not shown) during September, October, and November and the low level of fishery impacts on winter-run that is expected at that time of the year (Appendix B), the additional benefit of extending the 20 inch size limit past August appears to be minimal. There have been very few recoveries of age-3 fish in the recreational fishery during those months, which is indicative of the fact that impacts to winter-run are generally not expected at any significant level during that time. Based

[31] The implication is that Monterey includes the South of Sur area.

on these limited tag recoveries, the probability of catching an age-3 winter-run that is less than 24 inches is very small. Following the same qualitative criteria that have been used in this opinion, NMFS determined that prescribing a 24 inch size limit in September, October, or November does not add a demonstrable and significant contribution to reducing or constraining fishery impacts, based on the available information.

2. 2010 Ocean Salmon Fishing Season RPA

In April, 2010, the PFMC provided recommendations to NMFS for the 2010 ocean salmon fishery management. With respect to the recreational fishery south of Point Arena, the 2010 season recommendation (beginning May 1) limits effort to Thursday through Monday from May 1 to September 6. The minimum size limit for Chinook in all areas south of Point Arena is 24 inches total length. A very limited commercial fishing season (a total of 8 days in July) and sufficient impacts to allow experimental GSI sampling from May through September have also been recommended to NMFS.

The use of a 24 inch minimum size limit in the recreational fishery meets the jeopardy standard under the interim rationale provided above. In addition, the recreational season recommended to NMFS by PFMC is restricted to only four days a week and will end in early September. This is a reduction in fishing opportunity compared to typical recreational fishing seasons associated with an open season under the proposed action, although it is not ultimately clear how much fishing effort would be limited by having a recreational fishery that is focused on weekend effort versus effort that could occur all weeklong. Regardless of the magnitude of this impact, NMFS concludes that impacts to winter-run are expected to be constrained and reduced sufficiently to ensure that the ocean salmon fishery is not likely to jeopardize the continued existence of winter-run in 2010 based on the use of the 24 inch size restriction.

3. 2011 Ocean Salmon Fishing Season RPA without Framework Implementation

In the event that the framework called for in the RPA is not implemented before the 2011 management process is complete, NMFS will have to approach the jeopardy standard of this biological opinion for the 2011 ocean salmon fishery season in a similarly conservative manner as the interim RPA for the 2010 ocean salmon fishery season was constructed. Based on the information that is currently available on the status of winter-run, NMFS would maintain the same level of concern regarding the apparent decline in this ESU over the last generation. The cohort that would be expected to be the primary recipient of impacts in 2011 would be the 2009 spawning cohort. Although the absolute abundance of this spawning cohort was higher than the two previous years (2007 and 2008), it represents a replacement rate of only about 25% of its parental spawning cohort. As a result, without any additional information, NMFS shall consider the same guidance options for the recreational fishery as those presented in this opinion as options for developing the 2010 ocean salmon fishery season as sufficient to meet the interim consultation standards of this biological opinion to constrain the 2011 ocean salmon fishery. However, NMFS will consider any new information that may become available before the 2011 ocean salmon fishery season is set, including updated estimates of spawning returns in 2010 and any additional analysis resulting from the effort to develop the long term management framework required under this opinion, in establishing or refining the interim consultation standards for the fishery in 2011.

X INCIDENTAL TAKE STATEMENT

Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to engage in any such conduct." Harm is further defined to include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patters, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as "take that is incidental to, and not the purpose of, carrying out of an otherwise lawful activity." Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action, is not considered to be prohibited under the ESA, provided that such taking is in compliance with the terms and conditions of the incidental take statement.

Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA, and the proposed action may incidentally take individuals of a listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. It also states that reasonable and prudent measures, and terms and conditions to implement the measures, be provided that are necessary to minimize such impacts.

The measures described below are non-discretionary, and must be undertaken by NMFS so that they become binding conditions of any permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. NMFS has a continuing duty to regulate the activity covered by this incidental take statement. If NMFS fails to implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NMFS must document the progress of the action and its impact on the species as specified in the incidental take statement (50CFR § 402.14(i)(3)).

A. Amount or Extent of Take

The proposed action of authorization of the ocean salmon fisheries pursuant to the Pacific Coast Salmon Fishery Management Plan in conjunction with additional protective measures designed to protect Sacramento River winter Chinook, including seasonal and size restrictions for the commercial and recreational fishery, is likely to result in incidental take of this ESA-listed endangered ESU.

1. Incidental Take Prior to RPA Framework Development

2010 Ocean Salmon Fishery

The incidental take of winter-run will occur as a result of catch and retention, or mortalities resulting from catch and release, or other encounters with fishing gear. Take will occur on all winter-run captured in the commercial and recreational fisheries, as well as the GSI project, within the seasonal time and areas restrictions set by NMFS in 2010, although winter-run CWTs are typically only recovered in areas south of Point Arena. Mortality will be expected in the form of retention from all winter-run 27 inches or larger captured in the commercial fishery (the 2010 regulation south of Horse Mountain) and all winter-run 24 inches or larger captured in the recreational fishery. Additional mortality is expected on certain percentages of fish released, based on the type of capture method employed. In the recreational fishery, release mortalities estimates are 14 or 42%, depending on the method of capture (troll versus hook). In the commercial troll fishery (and GSI), the mortality estimate is 26%. An additional 5% mortality estimate for all contacts in all fishery activities is expected due to drop off mortality or depredation.

Based on the Reasonable and Prudent Alternative provided for fishing season 2010, NMFS expects that the incidental take of winter-run in the ocean salmon fishery will be constrained from the proposed action by requiring the 24 inch minimum size limit for the entire 2010 season in the recreational fishery south of Point Arena. As a result, NMFS anticipates that the incidental take of winter-run in 2010 will be significantly reduced in terms of age-3 impact and total spawner reduction rate estimates compared to what occurred in fishing season 2000-2007, and what could be expected without any additional restrictions beyond the same seasonal and size limit restrictions that have been implemented in the past. What could be expected without the constraints of the RPA includes estimates of age-3 impacts up to .21, and total spawner reduction rates estimates up to .25. The available data from historical recoveries of CWTs in the recreational fishery suggests the retention of winter-run from May through August (early September closure of the recreational fishery) will be reduced anywhere from 20-70% given the use of a 24 inch size minimum versus a 20 inch size minimum in the recreational fishery south of Point Arena, depending on the timing of winter-run impacts (Figure 20). The survival rate of winter-run captured in the recreational fishery that are less than 24 inches, but greater than 20 inches (fish that would not have otherwise been released but for the RPA), represents the estimate of reduced impact as a result of the 2010 RPA.

2011 Ocean Salmon Fishery without Framework Implementation

NMFS anticipates the capture and mortality of winter-run as part of the 2011 fishery. Although the fishing season is not yet defined, NMFS anticipates that the take would be measured similarly as described for the 2010 fishing season with modifications for any variables in the specifics of the 2011 season.

Based on the Reasonable and Prudent Alternative provided for fishing season 2011 without implementation of a management framework, the incidental take of winter-run in the ocean salmon fishery will be constrained by the use of one of the management measures considered for the 2010 season in the recreational fishery south of Point Arena. As a result, NMFS expects that the incidental take of winter-run in 2010 will be significantly reduced in terms of age-3 impact and total spawner reduction rate estimates compared to what occurred in fishing season 2000-2007, and what could be expected without any additional restrictions beyond the same seasonal and size limit restrictions that have been implemented in the past. What could be expected without the constraints of the RPA includes estimates of age-3 impacts up to .21, and total spawner reduction rates estimates up to .25.

2. Incidental Take Beyond 2011 Fishing Season

Over the long term, in cases where additional protective measures triggered by the status of winter-run are not needed, NMFS expects the annual impact rates of age-3 winter-run to remain consistent and average about .17 over time. NMFS anticipates that the incidental take of winter-run will produce spawner reduction rates that will fluctuate more than age-3 impact rates on an annual basis, but will ultimately average about 20% (.20) over time. Unless or until these expected impact levels are modified by the implementation of the RPA framework or future analysis, NMFS considers these estimates to be anticipated incidental take during periods when the consultation standards are the basic protective measures of season and minimum limits that have been implemented in the past.

According to the RPA of this opinion, there are situations and conditions when the incidental take of winter-run should be reduced from the extent that would be expected to occur without additional controls to the fishery. NMFS expects that in times when the status of winter-run is deteriorating or the population is reduced to low levels, age-3 impact rates and total spawner reduction rates attributable to the ocean salmon fishery should be constrained to appropriate levels as a result of management action taken during the preseason salmon fishery management process. These impact levels will be specified in the RPA framework as it is developed and finalized. As long as the framework is consistent with the objectives of the RPA in this biological opinion, NMFS will modify this incidental take statement to reflect the anticipated levels of incidental take once the framework is developed.

B. Effect of the Take

In the accompanying opinion, NMFS determined that the incidental take associated with the proposed action, in conjunction with the RPA, is not likely to jeopardize the continued existence of Sacramento River winter Chinook.

C. Reasonable and Prudent measures

NMFS believes the following reasonable and prudent measures, as implemented by the terms and conditions are necessary and appropriate to minimize impacts to Sacramento River winter-run as a result of incidental take in the ocean salmon fishery. The measures described below are non-discretionary and must be undertaken for the exemption in section 7(o)(2) to apply. If NMFS fails to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. Thus, the following reasonable and prudent measures must be implemented in order to authorize the ocean salmon fishery under the Pacific Salmon FMP in a manner which may result in the incidental take of winter-run.

1. In-season management actions taken during the course of the fisheries shall be consistent with the harvest objectives and other management measures established in accordance with the salmon FMP that were subject to review with this biological opinion.

2. Incidental harvest impacts of Sacramento River winter Chinook shall be monitored on an annual basis using the best available measures. Although NMFS is the Federal agency responsible for ensuring that this reasonable and prudent measure is carried out, it is the states, tribes, and U.S. Fish and Wildlife Service (USFWS) that conduct monitoring and reporting of catch and other data necessary to complete analyses of impacts.

D. Terms and conditions

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

1. The following term and condition implements reasonable and prudent measure No. 1.

   1A. NMFS shall confer with the affected states and tribes, and the PFMC chair, as appropriate, to ensure the inseason management actions taken during the course of the fisheries are consistent with the objectives of the Reasonable and Prudent Alternative and the take specified in the Incidental Take Statement of this biological opinion.

2. The following term and condition implements reasonable and prudent measure No. 2.

   2A. NMFS shall ensure that the catch and effort and the implementation of other management measures under the Pacific Coast Salmon FMP by the PFMC, states, and tribes is monitored at levels that are at least comparable to those used in recent years. Catch monitoring programs shall be stratified by gear, time, and management area.

   2B. NMFS, in cooperation with the affected states and tribes, the PFMC chair, and USFWS, as appropriate, shall ensure that fisheries are sampled for stock composition, including the collection of coded-wire-tags in all fisheries.

Additionally, surveys of spawning populations and collection of CWTs shall be conducted at a level sufficient to provide the data needed to complete estimates of impacts to ESA-listed salmon ESUs.

2C. NMFS, in cooperation with the affected states and tribes, the PFMC chair, and USFWS, as appropriate, will ensure that post-season estimates of age-3 ocean impact rates and updates of spawner reduction rate estimates are developed on an annual basis, as cohort reconstructions are completed. The Sustainable Fisheries Division, NMFS Southwest Region, will provide such estimates.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purpose of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS believes the following conservation recommendation is consistent with these obligations, and therefore should be implemented by NMFS.

1. NMFS, in collaboration with the PFMC, states, and tribes, should continue to develop improvements in gear technologies and fishing methods to reduce the mortality of ESA-listed species.

2. NMFS, in collaboration with the PFMC, states, and tribes, should continue to improve the knowledge of ocean rearing and migration patterns, as well as the relationships between ocean conditions and survival of salmon in the marine environment to better understand how ESA-listed and non-ESA listed salmon respond to variables in the marine environment. Use of this knowledge could assist in the development of more efficient tools to manage the impacts of fisheries on ESA-listed stocks.

3. NMFS, in cooperation with PFMC and other affected interests, should work cooperatively to develop and implement a more ecosystem-based management approach that integrates harvest, hatchery, habitat, and water management, in consideration of ocean conditions and climate change, which reflects the complex influences of individual environmental components upon each other and the system as a whole.

XI. REINITIATION OF CONSULTATION

This completes the formal consultation on the authorization of the ocean salmon fisheries beginning May 1, 2010, developed in accordance with the Pacific Coast Fisheries Management Plan and additional protective measures proposed, by NMFS, as it affects Sacramento River winter Chinook. 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, or is expected to be exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is modified in a manner that causes an effect to listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action (50 CFR § 402.16). In instances where the amount or extent of take defined in the incidental take statement is exceeded, consultation shall be reinitiated immediately.

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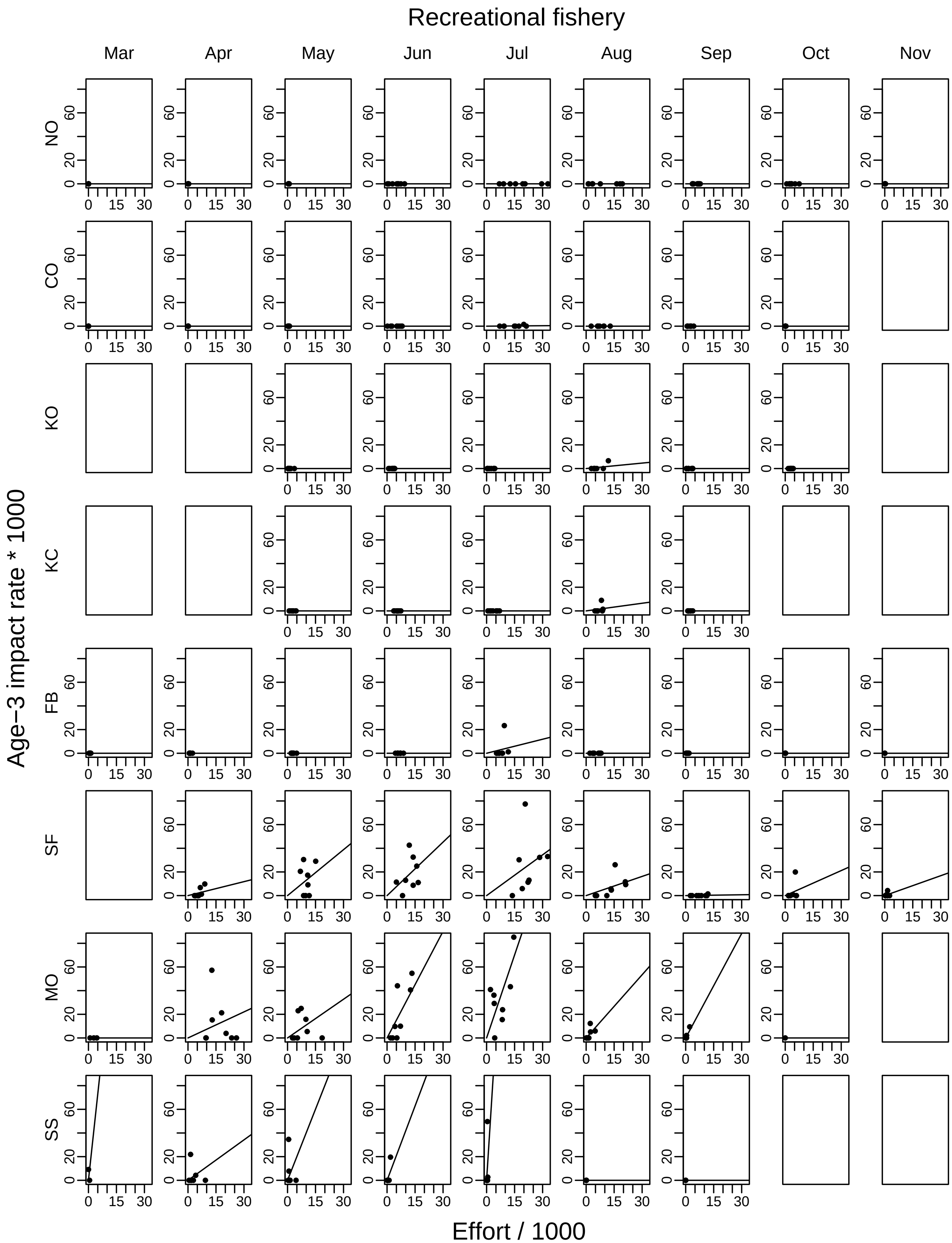
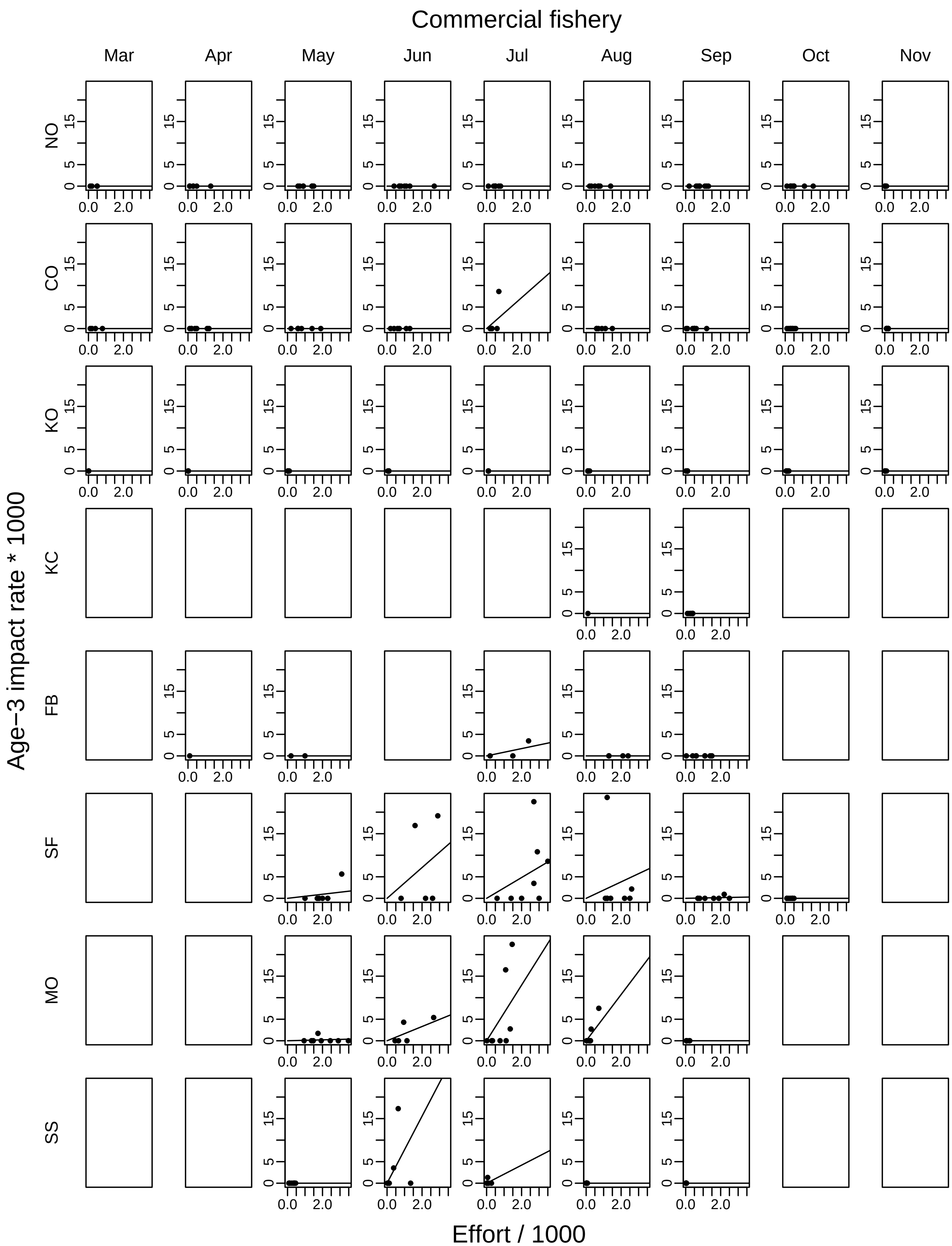
Appendix A. Table of consultation history

Year	Measures to minimize Impacts on SRWR Chinook	Time in Effect
1990	The opinion required that future fisheries not exceed those observed in 1990. The recreational season south of Point Arena, which traditionally ran from February 15 through November 15, was shortened by two weeks at both ends of the season to provide more opportunity for maturing fish to exit the ocean. The state of California also implemented a conservation control zone that closed the fishery outside of Golden Gate from November 1 through April 30. A proposal for an early opening (prior to May 1) of the commercial fishery south of Point Arena was also disallowed. (NMFS 2004a)	NMFS required the PFMC report to NMFS annually on the impact of ocean fisheries to SRWR Chinook chinook thus providing the opportunity for accumulating additional information and making adjustments as necessary. This established the expectation that fisheries would be managed adaptively in response to new information. (NMFS 2004a)
1996 and the 1997 amendment	Required constraints on ocean harvest sufficient to produce a 31% increase in the SRWR Chinook adult replacement rate relative to the mean rate observed between 1989-1983 (NMFS 2004b) Required that the ocean fishery be managed so that there was an 80% probability that the 3-year adult replacement rate was at least 1.0 (i.e., the population would remain stable or exhibit positive growth). Given the variability in the adult replacement rate observed between 1989 and 1993, the criterion was met if the adult replacement rate was increased by 31%. (NMFS 2004a) Implemented through a variety of seasonal restrictions and changes in minimum size limits and evaluated by the WCOHM	Through the 2001 salmon seasons; after which time NMFS was required to reassess the need for restrictions on ocean harvest to protect SRWR Chinook
2002	Time and area restrictions Extended most the protection of the 1997 opinion; required that the duration and timing of the 2002 and 2003 fishing seasons south of Point Arena, CA, not change substantially relative to the 2000 and 2001 fishing seasons (NMFS 2004b)	2002 and 2003 fishing seasons
2004	Time and area restrictions, similar to the 2002 opinion but the 2004 opinion allowed the opening date of the recreational fishery between Point Arena and Pigeon Point to advance by about 2 weeks and the minimum size limit during the month of April to decrease from 24 to 20 inches. It allowed the recreational season between Point Arena and Pigeon Point to open no earlier than the first Saturday of April (rather than the Saturday nearest April 15), and close no later than the second Sunday in November (rather than the Sunday nearest November 7). NMFS concluded that the effects on SRWR Chinook mortality of the additional fishing effort and lower minimum size amounted to less than a 6% increase in the	May 1, 2004 to April 30, 2010

	impact rate and that it would unlikely have a measurable effect on the rate of recovery of SRWR Chinook, based on the data at the time. (NMFS 2004b)	

Appendix B. Age-3 impact rates vs effort by time and area




Commercial fishery
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
NO
CO
KO
KC
FB
SF
MO
SS
Age−3 impact rate * 1000
Effort / 1000

Appendix C. Projecting the impact of harvest on returns

A two-part method was used to make this projection. First, determine what the escapement would have been in a particular year had the fishery been closed (only in the previous year) based on the observed spawner reduction rate, and compute the corresponding absent-fishing cohort replacement rate. Second, assume the fishery had been completely closed since year 2000, and apply the absent-fishing cohort replacement rates sequentially to escapement to account for the enhanced production from the additional spawners. The method details are as follows.

1. Assume that the brood spawner reduction rate is an adequate approximation of the escapement reduction rate three years hence (escapement year = brood year + 3). This assumption is reasonable given that age-3 fish constitute the majority of the spawning escapement in any given calendar year. Spawner reduction rate estimates are thus available for calendar years 2001–2008 (O'Farrell et al. 2010). Although the fishery was closed in 2008, assume a spawner reduction rate of 0.01 for the 2009 escapement year to acknowledge the possibility of some small impact on winter-run from the limited fishing opportunity allowed off Oregon in 2008. Together, this provides a set of spawner reduction rates, SRR(t), t = 2001–2009.

2. From the observed escapements, E(t), t = 1998–2009, calculate the observed cohort replacement rates as CRR(t) = E(t) / E(t-3), t = 2001–2009.

3. Calculate the spawner impacts due to the fishery, SI(t) = E(t) * [SRR(t) / (1-SRR(t)], t = 2001–2009.

4. Assuming the fishery was closed only in year (t-1), project what the escapement would have been as E.0(t) = E(t) + SI(t), t = 2001–2009, and compute the corresponding absent-fishing cohort replacement rate, CRR.0(t) = E.0(t) / E(t-3), t = 2001–2009.

5. Assume the fishery was completely closed beginning in 2000. Project the escapement, E.0+(t), as:

    a. E.0(t), t = 2001–2003
    b. E.0(t-3) * CRR.0(t), t = 2004–2006
    c. E.0+(t-3) * CRR.0(t), t = 2007–2009

	FISHERY OPEN				FISHERY CLOSED ONLY IN YEAR (t-1)		FISHERY CLOSED 2000–2009
Year	Escapement	Cohort Replacement Rate	Spawner Reduction Rate	Spawner Impacts	Escapement	Cohort Replacement Rate	Escapement
(t)	E(t)	CRR(t)	SRR(t)	SI(t)	E.0(t)	CRR.0(t)	E.0(t)
1998	2992						
1999	3288						
2000	1352						
2001	8224	2.75	0.25	2672	10896	3.64	10896
2002	7464	2.27	0.18	1609	9073	2.76	9073
2003	8218	6.08	0.22	2257	10475	7.75	10475
2004	7869	0.96	0.11	1002	8871	1.08	11753
2005	15875	2.13	0.23	4866	20741	2.78	25211
2006	17304	2.11	0.16	3303	20607	2.51	26268
2007	2542	0.32	0.15	458	3000	0.38	4481
2008	2850	0.18	0.17	573	3423	0.22	5435
2009*	4537	0.26	0.01	46	4583	0.26	6957