UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

May 25, 2021

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act, we announce the availability for review of the Draft Environmental Assessment (DEA) for Amendment 21 to the Pacific Coast Salmon Fishery Management Plan (FMP). The National Marine Fisheries Service (NMFS) will also publish a Notice of Availability for the DEA and the amendment in the Federal Register.

The proposed action is to amend the FMP to include management measures to allow increased access to prey and foraging opportunities for Southern Resident killer whales.

The document is accessible electronically through the following website: https://www.fisheries.noaa.gov/west-coast/laws-and-policies/west-coast-region-national-environmental-policy-act-documents.

Additionally, this DEA, the Federal Register notice, and amendment documents provided by the Pacific Fishery Management Council will be accessible electronically through the following website upon publication of the Federal Register notice: *https://www.fisheries.noaa.gov/action/amendment-21-pacific-coast-salmon-fishery-management-plan*.

Written comments may be submitted to NMFS via the Federal eRulemaking portal at www.regulations.gov as described in the Federal Register notice. The public comment period on the DEA will be concurrent with the 60-day public comment period for the Notice of Availability, specified in the Federal Register notice. Complete instructions for submitting comments will be provided in the Federal Register notice.

Thank you in advance for your input and assistance in finalizing the Environmental Assessment.

Sincerely,

Barry A. Thom
Regional Administrator

DRAFT

ENVIRONMENTAL ASSESSMENT

AMENDMENT 21

TO THE

PACIFIC COAST SALMON FISHERY MANAGEMENT PLAN:

SALMON FISHERY MANAGEMENT MEASURES TO ALLOW FOR PREY AVAILABILITY AND FORAGING OPPORTUNITIES FOR SOUTHERN RESIDENT KILLER WHALES

(REGULATORY TRACKING IDENTIFIER NUMBER: 0648-XA696)

May 2021

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

ACRONYM LIST

CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRC	Columbia River Control
CYER	Calendar Year Exploitation Rate
DPS	Distinct Population Segment
EEZ	Exclusive Economic Zone
EJ	Environmental Justice
EO	Executive Order
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fishery Management Plan
FR	Federal Register
FRAM	Fishery Regulation Assessment Model
KMZ	Klamath Management Zone
KRFC	Klamath River Fall Chinook
MMPA	Marine Mammal Protection At
MSA	Magnuson-Stevens Fishery Management and Conservation Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOF	North of Cape Falcon
NRKW	Northern Resident Killer Whale
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish and Wildlife
PFMC	Pacific Fishery Management Council
PST	Pacific Salmon Treaty
RA	Risk Assessment
ROA	Range of Alternatives
RRFC	Rogue River Fall Chinook
SEAK	Southeast Alaska
S_{MSY}	Maximum Sustainable Yield
SOF	South of Cape Falcon
SRFC	Sacramento River Fall Chinook
SRKW	Southern Resident Killer Whale
SSC	Science and Statistical Committee
STT	Salmon Technical Team
SWFSC	Southwest Fisheries Science Center
TS	Time Step
TS1	Time Step 1, October through April
TS2	Time Step 2, May through June
TS3	Time Step 3, July through September
WDFW	Washington Department of Fish and Wildlife
Workgroup	SRKW ad hoc Workgroup

1.0 Introduction

Ocean salmon fisheries in Federal waters of the exclusive economic zone (EEZ), 3-200 nautical miles off the West Coast states of California, Oregon, and Washington, are managed by the Council. Under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Council has developed, and NOAA's National Marine Fisheries Service (NMFS) has approved, the Pacific Coast Salmon Fishery Management Plan (FMP) (PFMC 2016a), which sets out the framework under which the fisheries are managed. Approval of an FMP, or an FMP amendment, requires that NMFS, as delegated by the Secretary of Commerce, make a determination that the FMP or amendment is consistent with the MSA and other applicable law, which includes the Endangered Species Act (ESA). Southern Resident killer whales (SRKW) are an ESA-listed Distinct Population Segment classified as endangered under the ESA (70 FR 69903, November 18, 2005).

At its April 2019 meeting, the Council established the SRKW ad hoc Workgroup (Workgroup) to address the effects on SRKW of implementing the FMP in 2019 and beyond. The purpose the Council tasked the Workgroup with was to reassess the effects of Council-managed ocean salmon fisheries on SRKW and if needed, develop a long-term approach that may include proposed conservation measure(s) or management tool(s) that limit Council salmon fishery impacts to Chinook salmon prey availability for SRKW relative to implementing the FMP. The Workgroup included representatives from West Coast tribes; the states of California, Oregon, Washington, and Idaho; the PFMC; NMFS' West Coast Region, Northwest Fisheries Science Center, (NWFSC) and Southwest Fisheries Science Center; (SWFSC); and the U.S. Coast Guard.

In 2020, at its September meeting, the Council received recommendations from the Workgroup (PFMC September 2020 meeting, Agenda item H.3.a, SRKW Workgroup Report 1) and adopted a range of alternative management measures for public review. The Council adopted a final preferred alternative at the November 2020 Council meeting.

This draft EA is being prepared using the 1978 Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA regulations was September 14, 2020. This review began on July 14, 2020 and the agency has decided to proceed under the 1978 regulations.

1.1 Background

The Council manages ocean salmon fisheries primarily for Chinook and coho salmon and, to a lesser extent, pink salmon, sockeye salmon, chum salmon, and steelhead. Species other than Chinook and coho salmon are rarely caught in Council-managed ocean salmon fisheries (PFMC 2016a).

The Council manages salmon fisheries for commercial, recreational, and tribal harvest in the EEZ. The Council's FMP describes conservation and allocation objectives for the fishery, and procedures for developing and implementing annual fishing regimes. The Council develops annual management measures that consider anticipated fishery impacts on Council-managed salmon stocks in Council-area salmon fisheries as well as salmon fisheries in Alaska, British Columbia, and shoreward of the EEZ on the West coast to meet conservation objectives in the FMP and ensure spawners from each stock reach their natal streams to reproduce.

The SRKW Ad Hoc Workgroup

In order to assist NMFS with reassessing the effects of PFMC ocean salmon fisheries on SRKW, in light of the current status and information available through 2020, the Workgroup met numerous times during the course of 2019 and early 2020 in order to develop its analysis, and all meetings were open to the public. A detailed list of Workgroup meetings and presentations can be found online at: https://www.fisheries.noaa.gov/west-coast/southern-resident-killer-whales-and-fisheries-interaction-workgroup. The Workgroup analyzed fisheries under the jurisdiction of the Council, as described in Table 1-1. For a more in depth description of these fisheries, see the NMFS 2021 Biological Opinion (NMFS 2021) visit the Council's website.

Table 1-1. Summary of PFMC Salmon Fishery Areas

PFMC Salmon Fishery	Description
North of Falcon Salmon Fisheries	The North of Cape Falcon (NOF) management area encompasses the Washington coast and northern Oregon. Harvest allocation and seasons may vary among the four ocean subareas, which include Marine Area 1 (Columbia River subarea - Leadbetter Point to Cape Falcon, OR), Marine Area 2 (Westport subarea - Queets River to Leadbetter Point, WA), Marine Area 3 (La Push subarea - Cape Alava to Queets River, WA) and Marine Area 4 (Neah Bay subarea - U.S./Canada border to Cape Alava, WA)
South of Falcon to California Border Salmon Fisheries	Oregon Coast: This area includes the major management areas of Oregon (Cape Falcon to Humbug Mt.) and the Oregon portion of the Klamath Management Zone (KMZ; Humbug Mt. to the OR/CA border).

PFMC Salmon Fishery	Description
California Coast	California coast fisheries are managed within four major catch/port areas (north to south): (1) the California portion of the Klamath Management Zone (CA-KMZ), which historically extended from the OR/CA border to Horse Mountain[a], (2) Fort Bragg (Horse Mountain to Point Arena), (3) San Francisco (Point Arena to Pigeon Point), and (4) Monterey (Pigeon Point to the U.S./Mexico border).

a - The southern boundary of the CA-KMZ was located at Horse Mountain, California (40°05'00" N. lat.) from the late 1980s to 2020. The Council moved the boundary north to 40°10'00" N. lat. under Amendment 20 to the Pacific Coast Salmon FMP, which was adopted by the Council in September 2020.

The Workgroup began by collecting and summarizing information related to:

- spatial and temporal overlap between Council salmon fisheries and SRKW;
- the Council's Salmon Technical Team (STT) report (see Agenda Item D.8.a, Supplemental STT Report 2 from the Council's 2019 March meeting) regarding which FMP Chinook salmon stocks are represented in Council salmon fishery models in order to compare them against a priority stock list developed by NMFS and the Washington Department of Fish and Wildlife (NOAA and WDFW 2018) for the purposes of prioritizing salmon restoration work. The STT did not attempt to evaluate stock priorities against other already established rankings; and
- other NMFS and independent analyses of prior salmon fishery/SRKW evaluations.

In its final report to the Council, the Workgroup described the SRKW geographic distribution and diet by season (focusing on coastal waters from central California to southeast Alaska). It also reviewed three threats outlined in NMFS' 2008 SRKW Recovery plan: (1) prey limitation, (2) contaminant accumulation, and (3) impacts from sound and vessels (NMFS 2008). However, the Workgroup's review focused on prey abundance as affected by ocean salmon fisheries managed by the Council since that is where the Council has direct management jurisdiction.

The Workgroup report also described the spatial and temporal overlap of the Council-area ocean salmon fisheries and SRKW (PFMC 2020a) and trends in fishery prey removal. The Workgroup's conclusions are described in more detail below, but they generally concluded that Chinook salmon abundance in northern areas would likely be more consistently important to SRKW than Chinook salmon abundance in southern areas.

SRKW occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (refer to (PFMC

2020a) for more a more detailed description). Although SRKW seasonal movements are somewhat predictable, there can be large inter-annual variability in the SRKW spatial distribution. SRKW are highly mobile and can travel up to approximately 86 miles (160 km) in a single day (Erickson 1978; Baird 2000), with seasonal movements likely tied to the migration of their primary prey, salmon. Over the last several years, for example, many social groups of the SRKW population have not spent much time in inland waters of Washington and British Columbia during the summer relative to their historical occurrence.(Olson et al. 2018).

In general, SRKW may be present in Washington coastal waters at nearly any time of year, and in other coastal waters more often than previously believed (Hanson et al. 2017) indicating overlap with Council-managed salmon fisheries could occur each month of open season. More specifically, the spatial data off Washington showed K/L pods occurred almost exclusively on the continental shelf, with a continuous high use area between Grays Harbor and the Columbia River and off Westport (PFMC 2020a). The spatial data in Oregon coastal waters suggests overlap of SRKW and the Council-managed salmon fisheries may be more likely to occur from March through May when salmon fisheries are open. However, their predictive use is uncertain and while the limited spatial distribution data seems to suggest that SRKW distribution off the Oregon coast has a seasonal component, there is considerable year-to-year variation. In California coastal waters, these types of spatial data are similarly limited but suggest there may be overlap in some years with the Council-managed salmon fisheries from April, May, and October. The Workgroup (PFMC 2020a) described high use foraging areas along with the currently known temporal patterns for use of these areas, which may prove useful for qualitative assessment, but given the low amount and quality of SRKW spatial data, the Workgroup focused on abundance of Chinook salmon.

The proportion of estimated ocean adult Chinook salmon abundance in the EEZ removed by Council-area ocean salmon fisheries generally declined during the period the Workgroup had data for, between 1992 and 2016. This is likely due to changes to the fishery management framework for a variety of reasons including addressing changes in the MSA and its implementing regulations, new scientific information and methodology relevant to stocks in the fishery, and the listing of a number of salmon species under the ESA.

In this EA, NMFS will utilize the methodology the Workgroup developed as the basis for our analysis, and therefore briefly review that here. Similar to previous evaluations of the interaction between salmon fisheries and the SRKW population, the Workgroup examined correlative relationships between SRKW demography and indices of Chinook salmon abundance.

In trying to quantify effects on SRKW due to Chinook salmon removals in Council-area ocean salmon fisheries, the Workgroup approached its analysis in four steps:

Step I.	Develop annual indices of adult (age-3+) Chinook salmon abundance by ocean area and three seasonal breakpoints, called timesteps
Step II	Relate these indices of Chinook salmon abundance to measures of SRKW population demographics
Step III	Estimate reductions in Chinook salmon abundance by time and area that are attributable to Council-area ocean salmon fisheries
Sept IV.	Estimate the changes in predicted population demographic rates that the statistical relationships fitted in step II predict for the reductions in abundance estimated in step III.

Details for this methodology and criteria are described in (PFMC 2020a).

In contrast with earlier evaluations, the Workgroup developed a new model of Chinook salmon distribution to quantify Chinook salmon abundance by ocean area and time of year rather than by stock or groups of stocks (PFMC 2020a). The resultant statistical relationships were weaker than those found in previous studies, and the Workgroup was unable to develop a robust model that can predict or characterize these complex relationships.

SRKW are observed in the North of Cape Falcon (NOF) area in all seasons (the NOF area is described in Table 1-1). This is also where the Workgroup found the strongest relationships between Chinook salmon abundance and SRKW demography. Therefore, SRKW may be impacted by reduced prey availability in this area to some unknown degree, and there is potential for temporal and spatial overlap between SRKW and salmon fisheries in this area every year. SRKW also occur off Oregon and California coastal waters and likely have some potential temporal and spatial overlap with salmon fisheries in this area; however, less frequently than in NOF waters. Due to salmon migration, salmon fisheries South of Cape Falcon (SOF) (described in Table 1-1) in Oregon coastal waters can also affect the abundance of Chinook salmon in the NOF area, and vice versa. SRKW occurrence in waters off the California Coast (described in Table 1-1) are primarily during the winter when Council-managed fisheries do not occur. Infrequently, SRKW have also been detected during the months of April, May, and October when the salmon fishery in SOF is just beginning or very near the end and harvest is relatively low. Salmon fisheries off California primarily

affect Chinook salmon stocks with southerly distributions but also have impacts on Chinook salmon abundance NOF, though at lower levels than Oregon and NOF fisheries.

We acknowledge that the greatest percent reductions in Chinook salmon abundance due to salmon directed fisheries occur in waters south of Cape Falcon (SOF; Oregon and California), particularly in California coastal waters, but there is less justification overall to conclude that Chinook salmon abundance in SOF areas is consistently important to SRKW. SRKW presence SOF is less frequent than their presence in NOF, and may primarily occur only in a season (winter/spring) during which there is little direct effect of the salmon fishery on Chinook salmon abundance. In addition, the maturation schedule for Sacramento River fall-run Chinook salmon (SRFC), the primary stock in this area, also limits the carryover effect (reduction in Chinook salmon that would be available the following spring) of salmon fisheries in California on Chinook salmon abundance during times of the year when the whales are present.

While SRKW overlap in time and space more consistently with fisheries in NOF, compared to SOF, Council-managed salmon fisheries NOF have a relatively small impact (1.2 to 7.7 percent reduction to the modeled ocean abundance) on the overall Chinook salmon abundance and the overall percentage of the abundance harvested in Council-managed salmon fisheries has decreased over the time series examined (1992-2016) (PFMC 2020a). The Workgroup stressed that assessment of relative importance of Chinook salmon abundance in different areas would need to be revisited if new data indicates more consistent presence of SRKW in southern waters at other times of the year. However, for purposes of their reporting to the Council, the Workgroup developed a range of alternative management approaches that includes the use of abundance thresholds and responsive measures focused in NOF (see September 2020, Agenda Item H.3.a SRKW Workgroup Report 1).

1.2 Proposed Action

The Proposed Action is to limit Council-managed salmon fishery impacts on the availability of Chinook salmon as prey for endangered SRKW. This action would be implemented as Amendment 21 to the FMP.

1.3 Purpose and Need

The purpose of the Proposed Action is to limit impacts of the Council-managed salmon fisheries on SRKW by limiting the extent to which they reduce Chinook salmon prey availability for SRKW.

The need for the Proposed Action is to ensure that the fisheries will not jeopardize the survival and recovery of SRKW through their effects on Chinook salmon prey availability.

1.4 Scope of Action

The scope of this action is limited to Council-managed salmon fisheries in the EEZ. Under the MSA, NMFS considers Council recommendations for FMP amendments and regulations implementing the FMP, and determines whether these recommendations are consistent with the MSA and other applicable law including the ESA. While the Council and NMFS' authority to manage fisheries under the MSA is generally limited to fisheries in federal waters, the Council may make recommendations to NMFS or other entities regarding other actions outside the EEZ as they relate to factors that affect salmon and SRKW.

The FMP guides management of salmon fisheries in the EEZ for salmon of U.S. and Canadian origin, except in the case of species which 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). The FMP covers the coastwide aggregate of natural and hatchery salmon encountered in ocean salmon fisheries, but only has management objectives and allocation provisions for Chinook or king salmon (*Oncorhynchus tshawytscha*), coho or silver salmon (*O. kisutch*), and pink salmon (*O. gorbuscha*). Catches of other salmon species in council-managed fisheries are inconsequential (low hundreds of fish or less each year) to very rare (PFMC 2016b).

1.5 Analysis Area

For the purposes of this draft EA, the analysis area encompasses the waters of the U.S. Pacific Coast Region EEZ, which are directly affected by the action, and the coastal waters of the states of Washington, Oregon, and California (Figure 1-1). Coastal state managed waters are incorporated since management of fisheries in the EEZ affects the number of fish returning to state waters, thus the availability of prey to SRKW in state waters adjacent to the EEZ, and the coastal states typically mirror or coordinate with federal regulations.

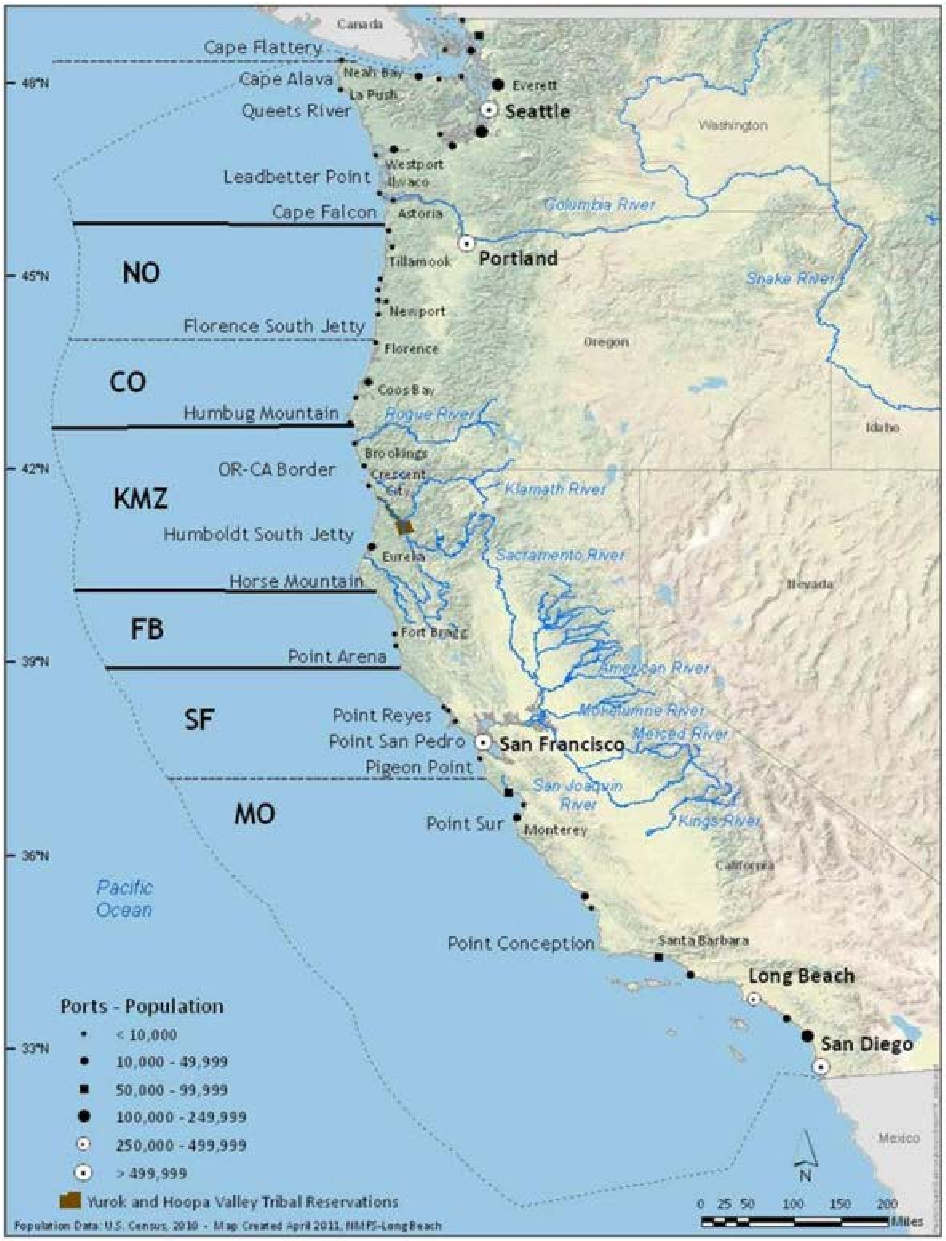

Figure 1-1. Map of major management boundaries in common use since 2000. North Oregon (NO), Central Oregon (CO), Klamath Management Zone (KMZ), Fort Bragg, San Francisco (SF) Monterey.

Although the analysis area encompasses the area shown in Figure 1-1, each alternative may impact only a portion of this analysis area.

1.6 Public Involvement

The alternatives analyzed in this document were developed through an interactive Council process. This process involved discussion at 10 Council meetings, and 15 meetings of the Workgroup. All these meetings were open to the public and announced in the *Federal Register.* These meetings were streamed

live online and opportunity for public comment was provided. Meeting dates and FR notices are listed in Table 1-2.

Table 1-2. Meetings of the Pacific Fishery Management Council and the SRKW Workgroup during development of the alternatives analyzed in this draft EA.

Pacific Fishery Management Council Meetings	FR Notice	SRKW Workgroup Meetings	FR Notice
March 6, 2019	84 FR 28; 02/11/2019	May 23-24 2019 Workgroup Meeting	84 FR 19766; 05/06/2019
April 9-16, 2019	84 FR 11057; 03/25/2019	July 2, 2019 Webinar	84 FR 27599; 06/13/2019
June 19-25, 2019	84 FR 26755; 05/29/2019	July 23-24, 2019 Workgroup Meeting	84 FR 27599; 06/13/2019
September 11-18, 2019	84 FR 42900; 08/19/2019	August 6, 2019 Webinar	84 FR 33756; 07/15/2019
November 14-20, 2019	84 FR 57703; 10/28/2019	September 24, 2019 Webinar	84 FR 4485; 08/27/2019
March 3-9, 2020	85 FR 7922; 02/12/2020	October 8-9, 2019 Workgroup Meeting	84 FR 47257; 09/09/2019
April 4-10, 2020	85 FR 15433; 03/18/2020	October 29, 2019 Webinar	84 FR 54892; 10/11/2019
June 10-19, 2020	85 FR 31160; 05/22/20202	December 10, 2019 Webinar	84 FR 61596; 11/13/2019
September 8-11 & 14-18, 2020	85 FR 51415; 08/20/2020	January 8-9, 2020 Workgroup Meeting	84 FR 67435; 12/10/2019
November 9-10; 12-13 & 16-20	85 FR 67338; 10/22/2020	February 6, 2020 Webinar	85 FR 3895; 01/23/2020
		April 28, 2020 Webinar	85 FR 18920; 04/03/2020
		June 1, 2020 Webinar	85 FR 28614; 05/13/2020
		June 30, 2020 Webinar	85 FR 28614; 05/13/2020
		August 3-4, 2020 Webinar	85 FR 43541; 07/17/2020
		September 29, 2020 Webinar	85 FR 56585; 09/14/2020

2.0 Description of Alternatives

The Workgroup provided three broad recommendations for Council consideration and NMFS' consultation: (1) Management Strategy Alternatives, (2) Re-evaluate Conservation Objectives for Chinook Stocks, and (3) Improve Stock Assessment Analytic Methods. Each recommendation provides a different method for modifying salmon abundance. Under each recommendation, the Workgroup provided one or more alternatives.

Alternatives the Council considered but excluded from further analysis are listed in Section 2.5. Each selected alternative is analyzed in Section 4.0, Environmental Consequences. Refer to the Workgroup's Range of Alternatives and Recommendations (from September 2020, Agenda Item H.3.a SRKW Workgroup Report 1) for further details regarding the development of alternatives.

The alternatives analyzed in this draft EA encompass the range of alternatives (ROAs) the Council adopted under Recommendation 1 from the Workgroup at its September 2020 meeting. The Council considered four alternatives in selecting its preferred alternative:

- Alternative 1 – No-Action - Status Quo Fishery Management Plan Implementation.
- Alternative 2 – Abundance Threshold Alternative of 966,000 Chinook salmon.
- Alternative 3 – Abundance Threshold Alternative of 1,144,000 Chinook salmon.

2.1 Alternative 1 – No-Action - Status Quo Fishery Management Plan Implementation

Under the No-Action alternative, the Council and NMFS would continue managing salmon fisheries in the EEZ consistent with the FMP, including existing harvest control rules and reference points on an annual basis. As described in the FMP, fisheries would continue to be managed consistent with biological opinions analyzing the effects of the fisheries on ESA-listed salmon, including the reasonable and prudent alternatives, and terms and conditions in the incidental take statements issued in conjunction with those opinions. Salmon fisheries would also continue to be managed consistent with the Pacific Salmon Treaty (PST) and tribal fishing rights.

To implement the FMP each year, the Council and its STT go through an extensive pre-season salmon management process resulting in a set of annual management measures that govern the year's fisheries. Annual salmon abundance forecasts are inserted into salmon fishery management and harvest models to predict the effects of fishery proposals (quotas, seasons, time, area, and gear restrictions) as they relate to management objectives and that year's stock specific abundances.

The pre-season evaluation of the proposed salmon fishing regime must meet the conservation objectives and annual catch limits described in the FMP (usually spawning escapement goals or exploitation rate ceilings) and limits required for consistency with the ESA and PST. Fishery performance is evaluated in each year and adjustments are made where appropriate in subsequent seasons.

2.2 Alternative 2 – Abundance Threshold Alternative of 966,000 Chinook salmon (Preferred Alternative)

Alternative 2 would establish a threshold, or floor, for low pre-fishing Chinook salmon abundance in the NOF area, below which management action would be triggered. This alternative also includes a review schedule for possible updates to model parameters if new science becomes available.

Under Alternative 2, Council-managed salmon fisheries would continue to be managed consistent with the current requirements of the FMP and other laws as described for Alternative 1, but would also be managed to be responsive to the needs of the ESA-listed SRKW population.

The threshold would be compared to the preseason estimate of abundance starting on October 1 (timestep[1] 1, TS1) defined as projections for the NOF area prior to fisheries occurring (hereafter referred to as "TS1 projected abundance"). The TS1 projections would be obtained by taking a weighted sum across modeled stocks of the stock-specific preseason projections of total ocean abundance on October 1. The weights are the estimated proportions of each stock's ocean abundance in the NOF area according to the time-invariant distribution estimates for that time period obtained from the Shelton et al. (2019) model, or the proxies identified in the Workgroup report (PFMC 2020a) for stocks not included in Shelton et al. (2019).

The NOF abundance threshold under this alternative follows NMFS' recommendations for addressing effects to SRKW for the 2020 fisheries (described further in the NMFS (2021) biological opinion and February 2020 guidance letter (Agenda Item E.5.b, Supplemental NMFS Report 1, March 2020) and is equal to the arithmetic mean of the seven lowest years of TS1 starting abundance (1994 – 1996, 1998 – 2000 and 2007, updated for validated run size abundance estimates[2]), when the SRKW's status was poor

[1] Timesteps are seasonal breakpoints which fishery aggregates data for modeling purposes. See Appendix A for further explanation.

[2] For 2020 fisheries, NMFS recommended a threshold of approximately 972,000 Chinook that was based on the arithmetic mean of the seven lowest years of TS1 starting abundance (1994 – 1996, 1998 – 2000, and 2007) from Appendix E Table 2 of the Workgroup's Risk Assessment (PFMC 2020a) which are based on model runs that assume "zero PFMC" fishing. The threshold identified here in Alternative 2 of approximately 966,000 Chinook (Alternative 3.1.2.c in the Workgroups ROA) is based on the same years, however the abundances used were those resulting from actual post-season model runs rather than "zero PFMC" fishing scenario.

for the majority of the years. When the lowest seven years of the estimated Chinook salmon abundance NOF were examined (1994 – 1996, 1998 – 2000, and 2007), there is a general mix of SRKW status, with two relatively good status years (1994 and 2007) and the remaining consecutively low abundance years had fair or poor SRKW status.

Both resident killer whale populations (SRKW and Northern Resident killer whale, NRKW) appear to have constrained body growth for most of these years. The smaller growth in body size in whales was concurrent with an almost 20 percent decline from 1995 to 2001 (from 98 whales to 81 whales) in the SRKW population (NMFS 2008). During this period of decline, multiple deaths occurred in all three pods of the SRKW population and relatively poor survival occurred in nearly all age classes and in both males and females. The Northern Resident killer whales also experienced population declines during the late 1990s and early 2000s. Hilborn et al. (2012) stated that periods of decline across killer whale populations "suggest a likely common causal factor influencing their population demographics." During this same general period of time of declining body size in whales, and declining resident killer whale populations, all three SRKW pods experienced substantially low social cohesion (Parsons et al. 2009). This temporal shift in SRKW social cohesion may reflect a response to changes in prey. Although both intrinsic and extrinsic factors can affect social cohesion, the most important extrinsic factors for medium and larger terrestrial carnivores are the distribution and abundance of prey (Parsons et al. 2009). Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success.

This alternative uses a threshold based on just a single year's abundance. However, it may be that multiple consecutive years of low abundance are important to consider because improved fitness and body condition over multiple years potentially increases the likelihood of a whale's reproductive success. Improved fitness and body condition over multiple years potentially increases the likelihood of a whale's reproductive success. The gestational period for killer whales is approximately 17 to 18 months (Duffield et al. 1995; Robeck 2016) and calves can nurse for several years before becoming fully weaned, although weaning can be variable among individuals (Mongillo et al. (2012). During these life stages, food consumption in the adult female killer whale may increase to compensate for the increased energetic costs (Noren 2011). Because SRKW integrate their prey over long periods and likely require more food consumption during certain life stages, it may be that multiple consecutive years of low abundance are important to consider. However, an annual measure of when a threshold is triggered has the potential to be more conservative than using a multi-year geometric mean since the geometric mean abundance might remain above the threshold even if the current year's abundance was below it. Conversely, a single year

of low abundance, particularly one that is far below the threshold, would affect a geometric mean for multiple years, potentially causing it to remain below the threshold even if the current year's abundance was above it. Therefore this draft EA evaluates both options separately (e.g., an annual measure vs. a multi-year geometric mean) in order to compare the outcomes of their use.

This alternative establishes a threshold that, when triggered, would require additional management action beyond that in place in Alternative 1. Under Alternative 2 the Council would implement the management measures specified in Section 2.2.1, below, for Council salmon fisheries (this includes salmon fisheries in Washington, Oregon, and California waters) when the annual preseason TS1 NOF abundance was forecasted to be less than 966,000 Chinook salmon. We round values calculated to the nearest thousand for ease of readability and given the qualitative basis for each subsequent alternative.

2.2.1 List of management responses under Alternative 2

In their ROA, the Workgroup provided a list of management responses that could be implemented in years where the TS1 projected abundance falls below the identified threshold (Section 3.1.2.e of Agenda Item H.3.a SRKW Workgroup Report 1 from the September 2020 PFMC meeting). The suite of management responses included:

1. Further limit NOF non-treaty Chinook salmon quotas,
    a. Aggregate run size v. quota regressions – Non-treaty quota limits would be defined using a regression relationship between NOF TS1 abundance and non-treaty Chinook salmon quotas. This would ensure that fisheries in years of low abundance could not have disproportionately high removals from the aggregate abundance relative to other years in the data series.
2. Attain NOF non-treaty quota incrementally over time (spring/summer split) – NOF troll fisheries occur during spring/summer seasons with a specified split of quota, which is typically two-thirds of the quota allocation going to the May-June time period. Under this alternative, catch (quota) would be limited in spring (May through June) to potentially benefit whales. It is likely that changes to the fishery structure in May and June would provide a greater benefit to SRKW than changes in later months as the likelihood of SRKW presence and feeding in the NOF area is higher in the winter and spring than the summer months. Under this management response no more than 50 percent of Chinook salmon troll quotas would be assigned to the spring time period.
3. Closure of NOF Area Control Zones –control zones in the NOF area would be closed to fishing consistent with implementation that has occurred over the past five years (2016 – 2020).

Specifically, the Cape Flattery Control Zone[3] would be closed to non-treaty commercial troll fisheries year-round, the Columbia River Control Zone would be closed to non-treaty commercial troll and recreational fisheries year-round, and the Grays Harbor Control Zone would be closed to non-treaty commercial troll and recreational fisheries beginning the second Monday in August through the remainder of the fishery. In addition, spatial and temporal expansions would occur as described below:

a. Columbia River Control (CRC) Zone[4] - as it has in the past five years, the CRC would be closed to non-treaty commercial troll and recreational fisheries year-round inside from Buoy 10 out to the end of each Jetty (Buoy 4 to Buoy 7). In addition, under this management response, the CRC Zone would be expanded to extend to a line running northwest/southeast between Buoy 1 and Buoy 2 from January 1 - June 15. This location coincides with a known SRKW 'hotspot' (area they are frequently detected or sighted as described above) so closing it likely provides some benefit to SRKW.

b. Grays Harbor Control Zone[5] – as it has in the past five years, this control zone would be closed to non-treaty troll and recreational fishing beginning on the second Monday in August. This area would be additionally closed from January 1 - June 15. This location coincides with a known SRKW 'hotspot' (in winter/spring months).

4. NOF non-treaty start/end time adjustments – NMFS' draft proposed SRKW critical habitat designation identifies two areas in Washington and Oregon north of Cape Meares with prey as an essential feature for both areas (Figure 2-1). SRKW usage of Area 1 (between the 6.1 and 50-meter isobaths) is recognized to occur at a higher frequency than usage of Area 2 (between the 50 and 200-meter isobaths). The Workgroup discussed delaying the fishery start in Area 1 as the primary objective under this approach given the majority of data sample collection occurred

[3] The area from Cape Flattery (48º23'00" N. lat.) to the northern boundary of the U.S. EEZ; and the area from Cape Flattery south to Cape Alava (48º10'00" N. lat.) and east of 125º05'00" W. long. (as described in 2020 annual management measures).

[4] An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat.,124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long.), and then along the north jetty to the point of intersection with the Buoy #10 line; and, on the south, by a line running northwest/southeast between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line. (as described in 2020 annual management measures).

[5] The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 55'36" N. lat., 124°10'51" W. long.). (as described in 2020 annual management measures).

there; however, in areas NOF the offshore boundary is relatively far from shore and there was concern that forcing the fishery offshore into Area 2 would effectively make the fishery inaccessible for some vessels and create safety concerns for all vessels, particularly early in the season. As a result, the Workgroup felt that for areas NOF, a delayed opening of the entire fishery might be preferable to closure of fishery inshore of the 50-meter isobath. Because SRKW use of ocean waters is believed to be more prevalent earlier in the season, this management response would delay fishery start dates until either June 1 or June 15.

5. In Oregon coastal waters south of Cape Falcon:
   a. Delay opening Oregon SOF Troll (Cape Falcon to Humbug Mountain) until April 1;
   b. Close the Oregon Klamath Management Zone (KMZ) beginning October 1 through March 31 of the following year; and/or
   c. Close the area between Cape Falcon and Cape Meares in SRKW proposed Critical Habitat Area 1 (see Figure 2-1, SRKW Area 1) through either June 1 or June 15, aligning with the date identified in response 4 above (delayed opening of non-treaty fisheries in NOF areas).
6. When Chinook salmon abundance in NOF waters is critically low, there may be insufficient foraging opportunities for SRKWs. NMFS assumes that when prey is insufficient in NOF areas, the whales will need to expand their search into other areas. Although Chinook salmon abundance SOF may not be consistently important to SRKW as suggested in NOF, SRKW require healthy Chinook salmon stocks throughout their geographic range. In an effort to reduce the likelihood of direct overlap of the fisheries and SRKWs and reduce competition for prey to benefit SRKWs, management responses in California coastal waters could include:
   a. Beginning October 1 through March 31 of the following year close the CA Monterey (Pigeon Point to U.S./Mexico border) and the CA KMZ (OR/CA border to Horse Mountain) fishing areas,
   b. As in the past five years, the Klamath River Control Zone[6] would be closed to salmon fishing. In addition, the closed area would be expanded to 6 miles beyond the northern and southern boundaries of the recently closed area and 12 miles seaward of the western boundary of the recently closed area. The State of California would also ensure closure of other CA control zones are in effect year-round (Smith, Eel, Klamath Rivers).

[6] The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately 6 nautical miles north of the Klamath River mouth); on the west by 124°23'00" W. long. (approximately 12 nautical miles off shore); and on the south by 41°26'48" N. lat. (approximately 6 nautical miles south of the Klamath River mouth). (from 2020 annual management measures).

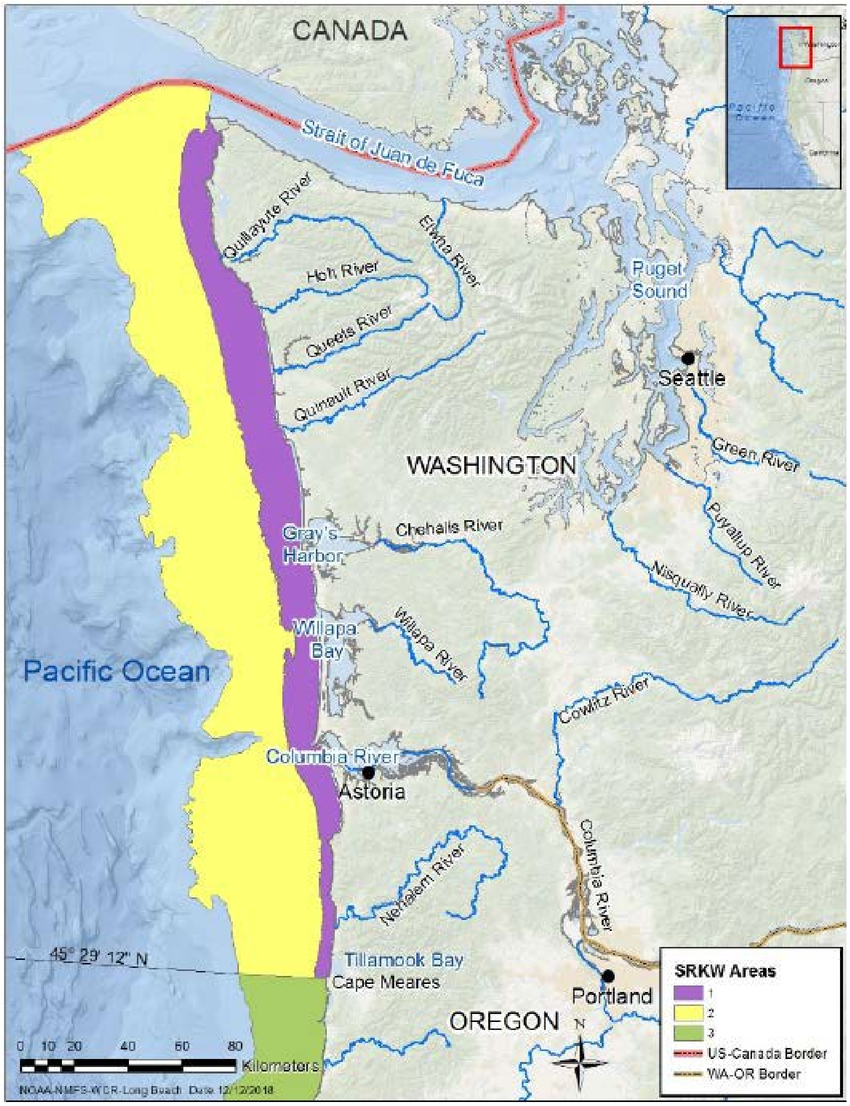

Figure 2-1. Southern Resident Killer Whale Proposed Critical Habitat Areas. Area 1 (purple) shows the Coastal WA/N. OR Inshore Area. Area 2 (yellow) shows the Coastal WA. N. OR Offshore Area. Area 3 (green) shows the Central/S. OR Coast Area. Derived from NMFS Proposed Critical Habitat designation biological report (NMFS 2019).

The Workgroup's ROA includes responses in which control zones would be closed to fishing consistent with implementation that has occurred over the past five years (2016 – 2020), with additional spatial and temporal expansions specifically to benefit SRKW. However, portions of the existing and expanded control zones occur in state waters, 0-3 miles offshore, and are thus outside the Council and NMFS' jurisdiction under the MSA. To the extent they have not already done so to fully implement the Workgroup's responses, the states would need to close the portions of the control zones located in state waters through state regulation. The federal action here is to close the portions of the control zones that lie

in the EEZ. However, the effects of the alternatives discussed in this document include effects from complimentary state closures of the portions of the control zones in state waters. This analytical approach is necessary because data attributing catch to the EEZ or state waters are unavailable and it reflects the relationship between the state and federal actions.

The goal of management response(s) under Alternative 2 would be to benefit SRKW across their coastal geographic range while still providing some fishing opportunity in years when Chinook salmon abundance falls below a defined threshold. For Alternative 2, in years where the TS1 NOF abundance is projected to be below the identified threshold of approximately 966,000 Chinook salmon, Table 2-1 depicts the management responses identified in the above list which would be implemented. Note that while the Workgroup's ROA did not specify whether implementation of responses would be mandatory or discretionary in years when abundance falls below the threshold, under Alternative 2, as recommended by the Council and as described here, implementation of the described responses included under this alternative would be mandatory if the abundance threshold was met. Under Alternative 2 management response 4 (delayed opening date for non-treaty NOF fisheries) and response 5c (closure of the proposed SRKW critical habitat area 1 between Cape Falcon and Cape Meares prior to the opening date identified in response 4) are not implemented as identified in Table 2-1 by the missing "X"s in the right hand column.

Table 2-1. List of SRKW Workgroup management responses implemented in Alternative 2.

Management Response	Description	Implemented in Alternative 2
1a	Further limit NOF non-treaty Chinook salmon quotas	X
2	Attain NOF non-treaty quota incrementally over time	X
3a	Closure of Columbia River Control Zone including spatial expansion from Jan 1 – Jun 15	X
3b	Closure of Grays Harbor Control Zone including temporal expansion	X
4	NOF non-treaty start/end time adjustments	
5a	Delay opening OR SOF Troll until April 1	X
5b	Close OR KMZ October 1 through March 31	X
5c	Cape Falcon to Cape Meares closure	
6a	Close CA KMZ and Monterey areas October 1 through March 31	X
6b	Close Klamath River Control Zone including expansion	X

2.3 Alternative 3 – Abundance Threshold Alternative of 1,144,000 Chinook salmon

Similar to Alternative 2, Alternative 3 is intended to be responsive to the needs of the ESA-listed SRKW population through implementation of an abundance threshold and required management responses in years where predicted abundance fell below the threshold. However, in Alternative 3 the threshold is based on the maximum TS1 starting abundance observed during the mid to late 90s (1995 – 2000) which is approximately 1,144,000 adult Chinook salmon. These years incorporate successive years in which SRKW would have experienced low prey abundances. As described in Alternative 2, there is evidence SRKW and other killer whale populations (*e.g*., NRKWs) that are known to consume Chinook salmon may have experienced adverse effects (e.g. declining body size in whales, declining resident killer whale populations, and substantially low social cohesion in all three SRKW pods as described under Alternative 2) from low prey availability in the mid to late 1990s likely due to common factors affecting changes in the prey populations (NMFS 2008; Towers et al. 2015).

We considered increasing the threshold by the median estimated NOF forecast error as described in the Workgroup's ROA (*i.e.*, the point estimate abundance multiplied by 1.08), but explain here why we decided against doing so. As described above, the threshold value is determined based on historical estimates of postseason abundance. In practice, however, during the preseason salmon fishery planning process, the abundance status in a given year would be determined by comparing the preseason forecasted NOF TS1 abundance against the threshold value. The Workgroup conducted an analysis comparing postseason and preseason abundances and concluded that the median ratio between postseason terminal run size and preseason forecast was 0.93, meaning that over-forecasting occurred more than half of the time (Section 3.1.2.a of Agenda Item H.3.a SRKW Workgroup Report 1 from the September 2020 PFMC meeting). As a result, the Workgroup recommended considering applying an adjustment of 1.08 (inverse of 0.93) to the postseason-derived threshold value for compatibility with preseason abundance estimates. For this EA, however, in order to assess the potential effects of each alternative, we conduct a retrospective analysis based on historical postseason abundances, under the assumption that the range of abundances experienced over the past 25 years is likely representative of the range of abundances we expect to see in future years. Thus, since we are comparing the threshold to postseason estimates of abundance (as opposed to preseason estimates), there is no need to apply the forecast error adjustment to the threshold. Alternative 3 still establishes a threshold of the highest value from among the ROA.

Also incorporated into Alternative 3 is the use of a running two-year geometric mean to establish the required trigger for management action. This allows us to compare the use of a single year trigger in Alternative 2. Under Alternative 3, management action is required in a given year if the geometric mean

of the NOF TS1 abundance in that year and the NOF TS1 abundance from the previous year falls below the threshold of 1,144,000 adult Chinook salmon. We use a geometric mean of multiple years rather than using just a single annual value since one low abundance year could affect the geometric mean for multiple years, increasing the chance that "responses" would remain in place for multiple years once triggered, especially if abundance was far below the threshold in one year. We selected a length of two years for the geometric mean (as opposed to something longer) in an effort to preserve the length of the retrospective time series used in this analysis. When utilizing a geometric mean in a data set, for every additional year added to the length of time in the geometric mean, the usable time series is shortened by one year. For example, with a retrospective time series that begins in 1992, the first year that can be assessed when using a two-year geometric mean is 1993 (mean of 1992-1993). The initial year in the time series (1992) could not be assessed because information from 1991 would be required. Using a three-year geometric mean further exacerbates this effect on the data, and the first year that could be assessed is 1994 (mean of 1992-1994). Therefore, we chose to use a two-year geometric mean to assess successive year occurrence of low Chinook salmon abundance. Because improved fitness and body condition over multiple years potentially increases the likelihood of a whale's reproductive success and fitness as described in Alternative 2, Alternative 3 also considers multiple consecutive years of low abundance.

Under Alternative 3, if the recent two-year geometric mean (current year and previous year) of NOF preseason TS1 projected Chinook salmon abundance falls below the threshold of 1,144,000, then the suite of responses in Section 2.3.1 would be implemented when structuring salmon seasons.

2.3.1 List of management responses under Alternative 3

Similar to Alternative 2, the Workgroup's ROA did not specify whether implementation of responses would be mandatory or discretionary in years when abundance falls below the threshold, but under Alternative 3, as considered by the Council and as described here, implementation would be mandatory. Under this Alternative, the Council would implement all six of the potential management responses identified in the Workgroup's ROA that are specified in Section 2.2.1 (Table 2-2). Under Alternative 3, in addition to all of the management responses implemented in Alternative 2, management responses 4 (delayed opening date for non-treaty NOF fisheries) and 5c (closure of the proposed SRKW critical habitat area 1 between Cape Falcon and Cape Meares prior to the opening date identified in response 4) are included. For these additional responses, we selected the most harvest restrictive option, which was to delay NOF non-treaty fishery openings and implement the area closure from Cape Falcon to Cape Meares in SRKW critical habitat area 1 until June 15.

Table 2-2. List of SRKW Workgroup management responses implemented in Alternative 3.

Management Response	Description	Implemented in Alternative 3
1a	Further limit NOF non-treaty Chinook salmon quotas	X
2	Attain NOF non-treaty quota incrementally over time	X
3a	Closure of Columbia River Control Zone including spatial expansion from Jan 1 – Jun 15	X
3b	Closure of Grays Harbor Control Zone including temporal expansion	X
4	NOF non-treaty start/end time adjustments (opening delayed until June 15)	X
5a	Delay opening OR SOF Troll until April 1	X
5b	Close OR KMZ October 1 through March 31	X
5c	Close SRKW Critical Habitat Area 1 from Cape Falcon to Cape Meares (until June 15)	X
6a	Close CA KMZ and Monterey areas October 1 through March 31	X
6b	Close Klamath River Control Zone including expansion	X

2.4 Alternatives considered but not further analyzed

The Council also considered additional alternatives that either did not differ substantially from each other or from the Alternatives described above for the purposes of this analysis, in terms of the values for the least harvest restrictive alternative (Alternative 1) to the most harvest restrictive alternative (Alternative 3) categories for threshold occurrence, and the number of years that would trigger a required management response. These alternatives are summarized in Table 2-3 and described further in the Workgroup's Range of Alternatives and Recommendations (from September 2020, Agenda Item H.3.a SRKW Workgroup Report 1).

Table 2-3. List of alternatives analyzed, and considered by the Council but not forwarded further for analysis with accompanying rationale.

Alternative	Included in Analysis			Not analyzed in This Document			
	Alternative 1 – Least Restrictive	**Alternative 2**	**Alternative 3– Most restrictive**	**Threshold based on 1994**	**Threshold based on 3 year arithmetic mean**		**Establishing a Tiered Response**
Estimated Threshold (Number of Fish)	None	966,000	1,144,000	813,000	874,000		
Application	None	Annual	Two-year geometric mean			Three-year geometric mean	
Reason Excluded from Further Analysis	N/A	N/A	N/A	Similar to Alternative 1	Effects already captured in analyzed alternatives	Reduced data set would not best analyze effects	Effects already captured in analyzed alternatives

The Council decided to exclude these from further analysis for the following reasons:

- a threshold based on the year with the lowest modeled abundance (1994); result: approximately 813,000 adult Chinook salmon, or adjusting this for a forecast error value;
    - the occurrence of the lowest observed modeled abundance occurs only one time in the dataset (see Appendix Table A-1). If we anticipate that Chinook salmon abundance moving forward reflects abundances in specific periods from the past, then a single occurrence of a threshold value does not inform a contrast across the ROA from Alternative 1. Given in our assessment NMFS assumes that the range of abundances experienced over the past 25 years is likely representative of the range of abundances we expect to see in future years, setting a low abundance threshold where actions would occur largely outside the range of the retrospective abundances would likely not be different than that which is analyzed under Alternative 1. Therefore, we do not view this threshold alternative different than Alternative 1 and expect a similar effects to SRKW.
- A threshold based on arithmetic mean of lowest three abundance years; result: approximately 874,000 adult Chinook salmon, or adjusting this for a forecast error value;
    - the justification and rationale used for choosing the three years to represent this TS1-projected abundance threshold is not clear. This threshold averages random non-successive years and the Workgroup's analysis (PFMC 2020a) indicating that a one-year lag of Chinook salmon abundance is likely more important to affecting the SRKW population. Therefore, this threshold use of three non-consecutive years does not appear strongly supported by the results of the Workgroup nor addresses NMFS concerns raised in NMFS 2020 guidance letter (from March 2020 Council meeting, E.5.b, Supplemental NMFS Report 1: Guidance Letter). However, this threshold is between the level of Alternative 1 and Alternative 2, and therefore its effects are captured within the range of the analysis in this EA.
- utilizing a running three-year geometric-mean of TS1-projected abundance;
    - as described above, using an elongated geometric-mean reduces the data set available for evaluation above in Section 2.3, under our description of Alternative 3; and,
- establishing a tiered response. Here one set of management responses would be implemented in the first low abundance year, with additional management responses implemented in the event that additional consecutive low abundance years occur.

- Informing a decision to hold back any particular management responses in the first year when a potential additional year of low NOF TS1 abundance might be triggered requires comparing responses against each other. Given we compare Alternative 2 and 3 to each other and not just against the No-Action alternative, we believe this, along with evaluating a geometric-mean in Alternative 3, eliminates the need for an additional alternative that specifically evaluates a tiered response and provides the necessary information to compare how additional responses would affect the environment.

Based on the rationale described in this section, analysis of the Alternatives described in Table 2-3 would not inform a decision much differently from the range chosen in this EA. While they were not included in the analysis for the reasons discussed above, choosing any one of them will result in effects within the range analyzed in this EA, relative to the magnitude of the threshold value.

In addition, the ROAs the Council adopted for evaluation at their September 2020 Council meeting included reviewing escapement goals for KRFC and SRFC salmon and develop an age-structured stock assessment for the SRFC stock using cohort reconstruction methods. This contemplated a future action that the Council could initiate, but would not in and of itself be an action within the meaning of NEPA.

The current SRFC conservation objective is a range of 122,000 to 180,000 hatchery and natural-area adult spawners. It was adopted as a proxy for maximum sustainable yield in 1984; however, much has changed in the Sacramento Basin since that time. Consideration should be given to estimating productivity of natural-area spawners and development of management objectives for this component of the SRFC stock, as has previously been recommended by California Hatchery Scientific Review Group (2012), (Lindley et al. 2009), and the Council (PFMC 2019b). Consideration should also be given to development of sub-basin specific escapement goals. For example, natural-area juvenile production above Red Bluff Diversion Dam is maximized at escapement levels of approximately 80,000 females (PFMC 2019b). Analyses such as this applied across other portions of the Sacramento Basin could be useful in the development of new conservation objectives. Munsch (2020) found that aggregate fall, winter, and spring run natural-origin production was maximized at substantially higher multi-run natural-area spawner abundances than the current fall-run target for natural areas and hatcheries combined, but did not account for hatchery contributions to total production and did not restrict the analysis specifically to fall run. In addition, some consideration may need to be given to how water temperature and flow impact the potential productivity of freshwater habitat such that management goals set would be attainable under climate effects and water operations in the Sacramento Basin. Munsch (2020) also found a strong

relationship between flow and natural-origin production. Appropriate adjustments to this escapement objective stand to benefit the productivity of this stock and the organisms that depend on it for prey, including SRKW.

3.0 Affected Environment

This section describes the affected environment and Table 3-1 identifies resources NMFS identified in the initial scoping that would be affected by the Proposed Action and are, therefore, analyzed in Section 4.0.

Table 3-1. Affected environment resources identified in initial scoping for the Proposed Action.

Affected Environment Resources	
Water Quality	
Fish and Fisheries Resources	
	• Salmon species • Fisheries
Protected Resources	
	• Marine mammals
Socioeconomics	
Cultural Resources	
Environmental Justice	

Section 3.0, Affected Environment, describes the current status of the natural, built, and human resources that have the potential to be affected by the alternatives under consideration for salmon harvest in the analysis area. Effects of each alternative are analyzed for each of these identified resources in Section 4.0, Environmental Consequences. Resources that were determined to not be impacted by the alternatives will not be analyzed in this draft EA and are not included in this affected environment section.

3.1 Water Quality

Good water quality supports SRKW's ability to successfully forage, grow, and reproduce. Clean water is essential to the SRKW conservation, especially given their present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) which includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. The absence of harmful contaminants is a habitat feature essential for the species' recovery (NMFS 2008; 2021).

A variety of factors influence off shore water quality, including commercial/industrial/domestic waste discharges, poor agricultural and forest practices, storm water runoff, improper disposal of household hazardous wastes, failing septic systems, improper use of pesticides, and atmospheric deposition. However, this draft EA and the subsequent analysis in Section 4 focuses only on the water contaminants that could be related to the Proposed Action and the action alternatives. Contaminants that could vary based on the implementation of the Proposed Action or action alternatives are pollutants associated with

the commercial and recreational fishing vessels of Council fisheries; therefore, the number of commercial and recreational fishing vessels within the analysis area may impact water quality and SRKW health.

Lundin et al. (2018) suggest that combustion of fuel from boat motors could pose a risk to water quality and SRKW health; however, they found low concentrations of the measured polycyclic aromatic hydrocarbons (<10 parts per billion, wet weight) in whale fecal samples collected in inland waters of Washington between 2010 and 2013. Very little information exists on vessel impacts on water quality relative to marine mammal habitat.

It is worth noting that the number of Council commercial and recreational salmon fishing vessels operating under the current status is relatively small compared to the number of shipping, additional fishing, recreational and other vessels in the analysis area.

Exposure to oil spills also poses additional direct threats as well as longer term population level impacts; therefore, the absence of these chemicals is of the utmost importance to SRKW conservation and survival. Oil spills can also have long-lasting impacts on other habitat features. While oil spill risk exists throughout the SRKW's coastal and inland range, there is no evidence that this risk would change from the Proposed Action evaluated in this draft EA.

For more information on pollutants and poor water quality relative to SRKW, see NOAA Technical Memorandum NMFS-NWFSC-135 (Mongillo et al. 2016).

3.2 Fish & Fisheries

There are many species of fish inhabiting the analysis area. However, since the Proposed Action and the alternatives could impact salmon and steelhead on the West Coast, the affected environment section and subsequent analysis focuses on salmon and steelhead, and narrows it further based on consideration discussed below.

3.2.1 Salmon and Steelhead

Six species of anadromous Pacific salmon (*Oncorhynchus* spp.) occur within the analysis area: Chinook salmon (*O. tshawytscha*), coho (O. *kisutch*), chum (O. *keta*), sockeye (O. *nerka*), pink (O. *gorbuscha*), and steelhead (O. *mykiss*). Of these species, three are rarely, if ever, encountered in the Council-managed salmon fisheries, and are not managed under the FMP (chum, sockeye, and steelhead). Pink salmon are occasionally taken in ocean salmon fisheries, but are not generally targeted. Chinook and coho salmon are the primary target species in the Council-managed salmon fisheries. Salmon fisheries affecting Chinook

salmon are the only fisheries that would be impacted by the Proposed Action, therefore only Chinook salmon are reviewed from here on in this document.

The Council manages several stocks of Chinook salmon under the FMP. In the ocean, stocks of Chinook salmon comingle which results in mixed-stock fisheries. Non-target Chinook salmon stocks will be encountered in mixed-stock fisheries. The Council's STT models the degree to which non-target Chinook salmon stocks are impacted by proposed fisheries, and the Council uses tools such as harvest restrictions, time and area closures, and fisheries targeting externally marked Chinook salmon to limit impacts to non-target Chinook salmon stocks. There are several subspecies of Chinook salmon that are listed as threatened or endangered under the ESA. Salmon species are listed under the ESA as unique populations called Evolutionarily Significant Units (ESUs) (salmon) (McElhany et al. 2000). Table 3-2 lists the nine ESA-listed Chinook salmon (*O. tshawytscha*) ESUs in the analysis area as well as their listing status, with dates and links to each population's recovery plan and five-year review.

Table 3-2. Listing Status of ESA-Listed Chinook Salmon Evolutionary Significant Units

Listed Entity	Listing Status	Links
Chinook Salmon ESUs		
Upper Willamette River Chinook Salmon ESU	ESA-Listed as Threatened on March 24, 1999 (64 FR 14308) and June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802) Critical Habitat designated September 2, 2005	Webpage Link Five Year Review Link Recovery Plan Link
Snake River Spring/Summer-run Chinook Salmon ESU	ESA-Listed as Threatened on April 11, 1992 (57 FR 14653) and June 28, 2005 (70 FR 37159; updated April 14, 2014 (79 FR 20802) Critical Habitat designated October 25, 1999 (64 FR 57399)	Webpage Link Five Year Review Link Recovery Plan Link
Snake River Fall-run Chinook Salmon ESU	ESA-Listed as Threatened on April 22, 1992 (57 FR 14653) and June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802) Critical Habitat designated December 28, 1993 (58 FR 68543)	Webpage Link Five Year Review Link Recovery Plan Link
Puget Sound Chinook Salmon ESU	ESA-Listed as Threatened on March 24, 1999 (64 FR 14308) and June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802) Critical Habitat designated September 2, 2005	Webpage Link Five Year Review Link Recovery Plan Link
Lower Columbia River Chinook Salmon ESU	ESA-Listed as Threatened on June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802) Critical Habitat designated September 2, 2005	Webpage Link Five Year Review Link Recovery Plan Link
Sacramento River Winter-run Chinook Salmon ESU	ESA-Listed as Threatened on August 4, 1989 (54 FR 32085) and on November 5, 1990 (55 FR 46515) Critical Habitat designated June 16, 1993 (58 FR 33212)	Webpage Link Five Year Review Link Recovery Plan Link
Central Valley Spring-run Chinook Salmon ESU	ESA-Listed as Threatened on September 16, 1999 (64 FR 50394) and updated on June 28, 2005 (70 FR 37204). Critical Habitat designated September 2, 2005 (70 FR 37159)	Webpage Link Five Year Review Link Recovery Plan Link

Listed Entity	Listing Status	Links
California Coastal Chinook Salmon ESU	ESA-Listed as Threatened on September 16, 1999 (64 FR 50394) and June 28, 2005 (70 FR 37159); updated April 14, 2014 Critical Habitat designated September 2, 2005 (70 FR 37159)	Webpage Link Five Year Review Link Recovery Plan Link
Upper Columbia River Spring-run Chinook Salmon ESU	ESA-Listed as Endangered on March 24, 1999 (64 FR 14308) and June 28, 2005 (70 FR 37159); updated April 14, 2014 (79 FR 20802) Critical Habitat designated September 2, 2005 (70 FR 37159)	Webpage Link Five Year Review Link Recovery Plan Link

A list of the salmon stocks and stock complexes managed in the ocean salmon fisheries is provided in the FMP (PFMC 2016a). A description of the historical baseline for salmon stocks managed under the FMP is presented in the Review of 2019 Ocean Salmon Fisheries (PFMC 2020b). Both of these documents are incorporated herein by reference. For more information about ESA-listed salmon and steelhead, visit NMFS' website.

NMFS has issued biological opinions on the impacts of Council-managed salmon fisheries on ESA-listed salmon. The Council designs the annual management measures for the fishery to ensure fishery impacts to ESA listed stocks do not exceed any limits described in the proposed actions or ITSs for these biological opinions. Effects to those ESA-listed salmon by the Proposed Action would be unchanged or smaller than previously analyzed in biological opinions and NEPA documents, since no alternative relaxes current restrictions, instead each alternative imposes further fishery constraints; therefore, individual ESUs of ESA-listed Chinook salmon will not be discussed in Section 4.0.

3.2.1.1 Chinook Salmon Abundance

The abundance and availability of Chinook salmon in the analysis area (the EEZ along the coastal waters of Washington through California) is important to SRKW health. For the purposes of this draft EA, the current status of Chinook salmon abundance within the analysis area is presented in units of number of fish (ages 3 – 5), with annual estimates between the years 1993 and 2016 presented in Appendix A. To describe the current environment, we assume that abundances in the past 25 years likely represent the range of abundances we would expect to see in future years. This draft EA presents abundance and catch from this period (1993 to 2016) since SRKW are a long-lived species.

The modeling scenarios for Alternatives 2 and 3 were built from the No-Action Alternative that would continue using existing harvest control rules and reference points as defined in the FMP on an annual basis. The effect of the FMP's implementation on the environment was evaluated using a retrospective analysis (see Appendix A). We used a retrospective analysis to look at past Chinook salmon abundances

to assess what may happen in the future under the Alternatives. The assumption here is that the range of abundances experienced over the past 25 years is likely representative of the range of abundances we expect to see in future years. Alternatives 2 and 3 each have different management responses as well as differences in the frequency in which these responses would be implemented, through the application of different threshold values, and are therefore compared to each other. We are unable to quantitatively capture effects for some responses under each of the Alternatives, and instead provide qualitative assessments.

The retrospective analysis used for analyzing the effects of the Proposed Action relies on a review of past circumstances to develop an understanding of the likely influence of implementing the FMP on the environment in the future. Actual outcomes will depend on year-specific circumstances related to individual salmon stock abundance, the combined abundances of stocks in particular fisheries, and how salmon fisheries are actually managed in response to these circumstances. We conducted the analysis primarily using the FMP's described Fishery Regulation Assessment Model (FRAM), which is the tool used for assessing NOF Chinook salmon fisheries by the Council and is described in more detail below.

We analyze from the year 1993, since this is the oldest complete data set used in analyses, up through 2016, the most recent complete data set available. These years are broken down into three equal periods to correspond with the last ESA consultation NMFS completed for SRKW in 2009 and to take account of the PST fishing regime that governed between 2000 and 2009 and the 2009-2019 PST fishing regime. Additionally, many of the Chinook salmon ESA-listings, as depicted in Table 3-2, occurred prior to 2000. Therefore each period, 1993 to 2000, 2001 to 2008, and 2009 to 2016, represent different, distinct periods in salmon management and are important for describing the current and future environment of Chinook salmon and salmon fisheries affecting them. Table 3-3 depicts the pre-fishery TS1 abundances of Chinook salmon estimated to have occurred in each area for the three periods, while Table 3-4 provides estimates of the resulting abundances that occurred after fisheries happened in each subsequent TS. The pre-fishing average annual abundances within these three periods in Table 3-3 also provide a range in scenarios to assess the Alternatives. For instance, because these periods had a range of relatively low, medium, and high average abundances, we can assess how the Alternatives may effect SRKW at different prey abundance levels moving forward.

Table 3-3. Average Annual Chinook salmon abundance at the beginning Time Step (TS) 1 in Washington, Oregon, and California (from Appendix A).

Catch Area	Season	Time Period		
		1993-2000	2001-2008	2009-2016
Washington	TS1 (Oct-Apr)	1,005,071	1,618,426	1,778,529
Oregon	TS1 (Oct-Apr)	1,207,998	1,565,108	1,625,533
California	TS1 (Oct-Apr)	800,238	841,005	621,032

*Footnotes: Washington abundances correspond with Council NOF area, Oregon abundances correspond with OR coastal waters (Cape Falcon, OR to Horse Mountain, CA), and California abundances correspond to all waters couth of Horse Mountain, CA.

Table 3-4. Average Chinook salmon abundance after fishery removals in each TS (season) in Washington, Oregon, and California (from Appendix A).

Catch Area	Season	Time Period		
		Abundance 1993-2000	Abundance 2001-2008	Abundance 2009-2016
Washington	TS1 (Oct-Apr)	979,163	1,575,319	1,759,133
	TS2 (May-Jun)	453,127	718,399	873,282
	TS3 (Jul-Sep)	459,671	810,789	1,096,082
Oregon	TS1 (Oct-Apr)	1,181,570	1,513,869	1,608,645
	TS2 (May-Jun)	677,291	874,923	900,031
	TS3 (Jul-Sep)	616,849	785,842	884,908
California	TS1 (Oct-Apr)	773,517	811,642	611,457
	TS2 (May-Jun)	540,955	618,531	438,933
	TS3 (Jul-Sep)	287,516	350,098	234,277

*Footnotes: Washington abundances correspond with Council NOF area, Oregon abundances correspond with OR coastal waters (Cape Falcon, OR to Horse Mountain, CA), and California abundances correspond to all waters couth of Horse Mountain, CA.

3.2.1.2 Chinook Salmon Fisheries

As described in Section 3.2.1, the Proposed Action and the alternatives would impact Chinook salmon on the West Coast. We have reviewed Chinook salmon catch above in Section 3.2.1.1.

Changes to Council Chinook salmon fishery management and implementation could impact the current status of fisheries and catch within the analysis area. The Proposed Action only restricts salmon fisheries affecting Chinook salmon, as they are of primary importance to SRKW (NOAA and WDFW 2018). As such, we focus only on Chinook salmon fisheries when describing the affected environment and subsequent analysis of alternatives.

Table 3-5 displays the current status of Chinook salmon catch as the average amount of catch by season and annually across the West Coast states of Washington (North of Falcon area), Oregon, and California. It is important to note that catches reported here are catches that occur within the specified area, however, due to the mobile nature of fish, they will ultimately affect Chinook abundances in other areas. Thus, differences in abundance noted in a specific area (Table 3-4) cannot be fully explained by the estimates of catch in that area.

Analysis of how the Alternatives would influence the status of fisheries is described in Section 4. More detailed annual breakdowns of Chinook salmon catch are available in Appendix A. Figure 3-1 indicates that when plotting the abundances from Table 3-3 against the catches in Table 3-5 , while catch has generally increased over the time periods in the analysis, the abundances have risen more than the catch.

Table 3-5. Average Chinook salmon catch by TS (season) in Washington, Oregon, and California (from Appendix A).

Catch Area	**Season**	**Time Period**		
		Catch 1993-2000	**Catch 2001-2008**	**Catch 2009-2016**
Washington	TS1 (Oct-Apr)	2,130	3,570	2,194
	TS2 (May-Jun)	15,290	45,121	51,640
	TS3 (Jul-Sep)	13,596	57,705	61,345
	Annual (Oct-Sep)	31,017	106,396	115,179
Oregon	TS1 (Oct-Apr)	16,451	51,563	11,816
	TS2 (May-Jun)	51,419	72,014	32,489
	TS3 (Jul-Sep)	74,280	108,619	51,342
	Annual (Oct-Sep)	142,149	232,195	95,647
California	TS1 (Oct-Apr)	44,347	21,054	10,264
	TS2 (May-Jun)	284,094	135,417	63,130
	TS3 (Jul-Sep)	232,427	195,019	83,947
	Annual (Oct-Sep)	560,868	351,489	157,341

*Footnotes: Washington catch amounts correspond with PFMC NOF fisheries, Oregon catch amounts correspond to Council fisheries between Cape Falcon, OR and Horse Mountain, CA, and California catch amounts correspond to fisheries south of Horse Mountain, CA.

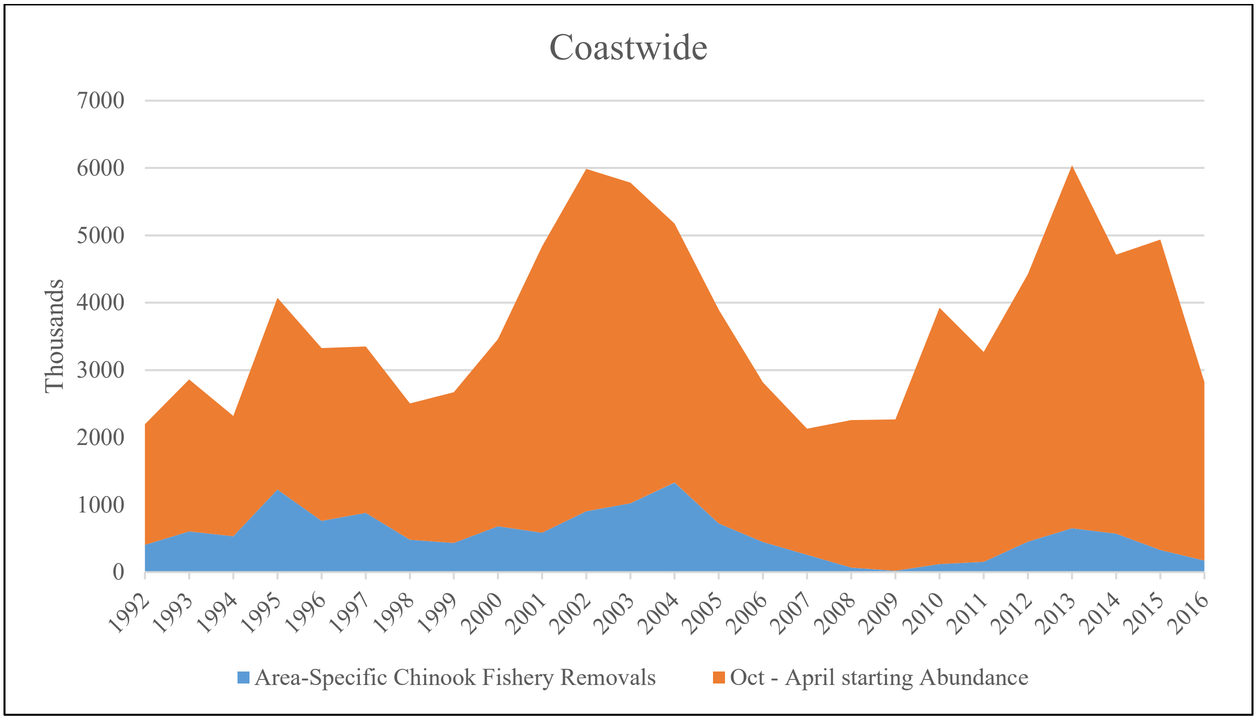

Figure 3-1. Coastwide (EEZ) 1992-2016 trends in annual abundance (estimated annually to be present on October 1) and reductions in abundance attributable to Council-managed salmon fisheries (from October through the following September). Note that this does not include abundance outside the EEZ, nor the modeled reduction in abundance outside the EEZ owing to Council salmon fisheries within the EEZ impacting fish that would have moved between areas (reproduced from (PFMC 2020a)).

The level of fishery mortality to Chinook salmon has changed over time, and has generally been reduced as a proportion of abundance from 1992-2016 relative to implementing changes to harvest control rules and ESA limitations on the fisheries. By dividing the estimated end of year abundance without the fishery by the estimated end of year abundance with the fishery, we calculate the percent of potential ending abundance that remains after Council-managed salmon fisheries have occurred. When plotted by year for coastwide EEZ abundance, the percent of potential abundance that is remaining after ocean fisheries occurred is increasing over time – meaning fisheries have been taking a lower proportion of the available abundance over time (Figure 3-2). The trend line depicted in Figure 3-2 is not intended to reflect any particular level of significance, but is simply to demonstrate the trend.

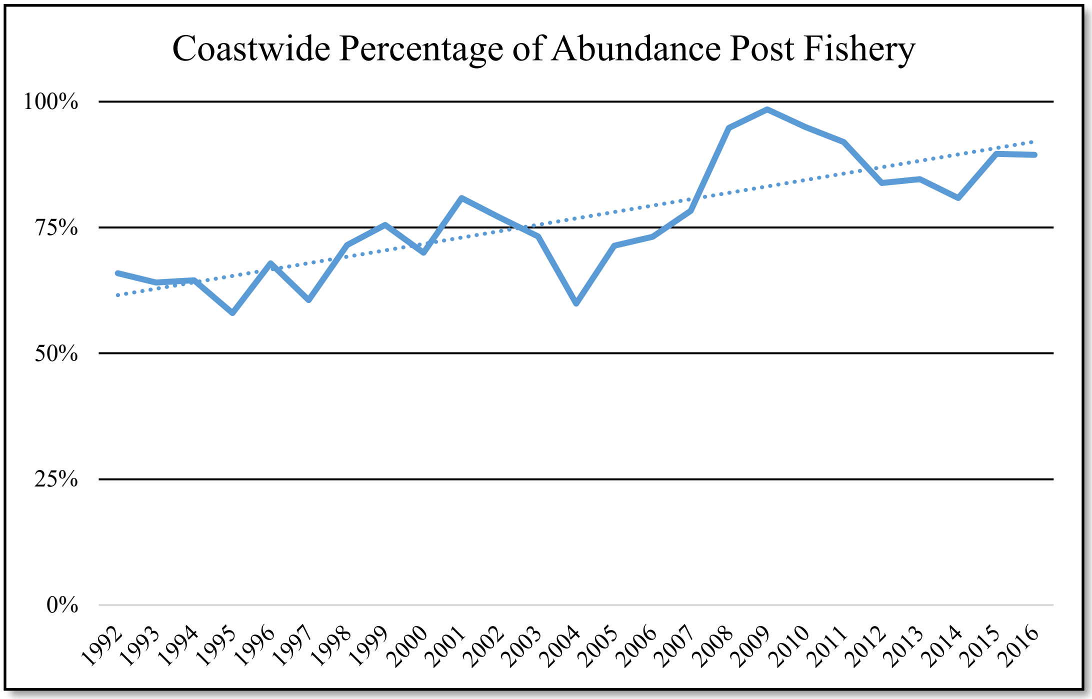

Figure 3-2. Coastwide (EEZ) 1992-2016 trend in percent of Chinook salmon adult abundance remaining after PMFC ocean salmon fisheries (from October through the following September) (reproduced from (PFMC 2020a)).

3.3 Marine Mammals

There are many species of marine mammal inhabiting the analysis area. Marine mammal species that may co-occur with Council-managed salmon fisheries include: California sea lion, (*Zalophus californianus*), Guadalupe fur seal (*Arctocephalus philippii townsend*), Harbor seal (*Phoca vitulina*), Steller sea lions (*Eumetopias jubatus*), southern and northern sea otters (*Enhydra lutris*), Dall's propoise (*Phocoenoides dalli*), Harbor porpoise (*Phocoena phocoena*), Northern right whale dolphin (*Lissodelphis borealis*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Striped dolphin (*Stenella coeruleoalba*), Long-beaked (*Delphinus capensis*) and Short-beaked (*Delphinus delphis*) common dolphin, Bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), Pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), short-finned pilot whale (*Globicephala macrorhynchus*), blue whale (*Balaenoptera musculus*), sperm whale (*Physeter microcephalus*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata scammoni*), sei whale (*Balaenoptera borealis*), and three ecotypes of killer whales (*Orcinus orca*) - offshore killer whales, Bigg's (transient) killer whales, and SRKW. Among these, California sea lion are known to potentially interact with salmon fisheries at very low levels.

The non-ESA listed marine mammal species that are known to interact with ocean salmon fisheries are California sea lion and harbor seals. Populations of both these species are at stable and historically high levels. Moreover, the proposed action and alternatives do not alter the existing fisheries in any way that would change the interactions with these marine mammals. Therefore, impacts to non-ESA listed marine mammals are not expected to be significant, and there is no discernible difference between the effects of the alternatives on these resources.

Among the ESA-listed marine mammals, only the SRKW is known to interact with Pacific salmon. Given this, and since the Proposed Action and the alternatives are focused on adjustments to salmon fisheries for the benefit of SRKW, the affected environment section and subsequent analysis focuses on SRKW.

3.3.1 Southern Resident Killer Whales

The status of SRKW throughout their range was most recently described in the Workgroup's report (PFMC 2020a) and the most recent PFMC biological opinion (NMFS 2021). This section summarizes the SRKW status described by these documents, both incorporated by reference here within, and if possible, updated with newly available data.

The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA, completed in 2016, concluded that SRKW should remain listed as endangered and included more recent information on the population, threats, and new research results and publications (NMFS 2016). The population has relatively high mortality and low reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2019).

The limiting factors described in the final recovery plan include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008).

3.3.1.1 Abundance, Productivity, and Trends

Since the early 1970s, annual summer censuses in the Salish Sea using photo-identification techniques have occurred (Bigg et al. 1990). The population of SRKW was at its lowest known abundance in the early 1970s (68 animals) and at its highest recorded abundance since the 1970s in 1995 (98 animals). The historical estimated abundance of the SRKW population is 140 animals (NMFS 2008). The 2020 summer census number was 72 whales (one whale is missing and presumed dead since the 2019 summer census) and two new calves have been born following the census count (NMFS 2021). The population

experienced a period of growth between 2001 and 2006 and 2014, but has generally been declining in recent years (see Figure 3-3).

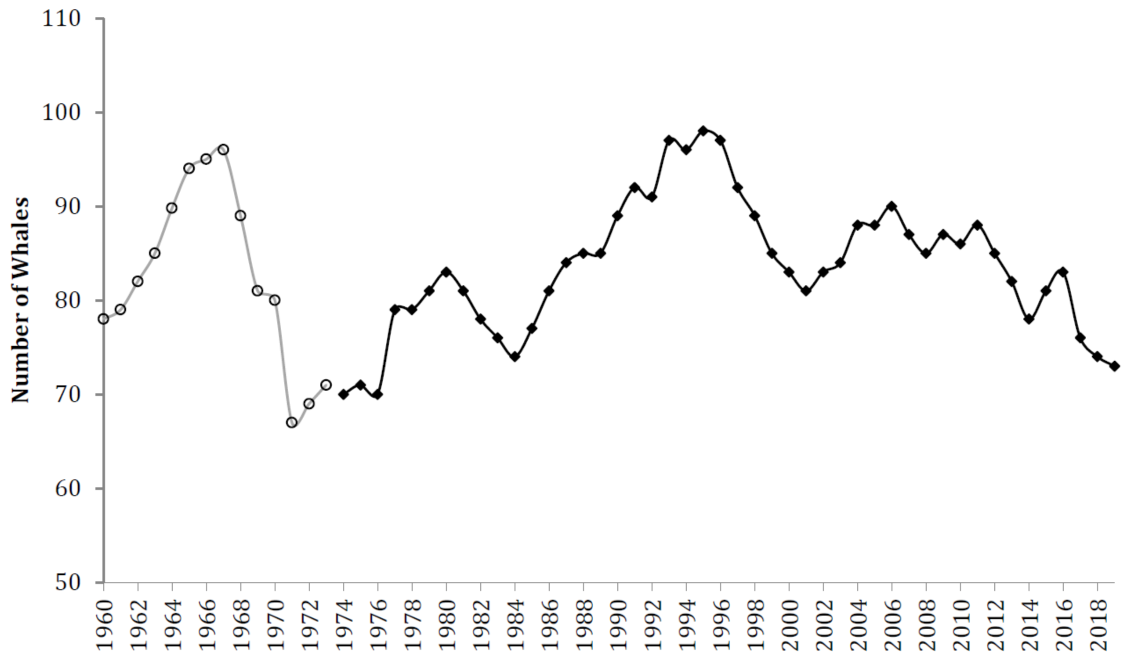

Figure 3-3. Population size and trend of Southern Resident killer whales, 1960-2019. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2019 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpublished data) and NMFS (2008). Data for these years represent the number of whales present at the end of each calendar year.

Based on an updated pedigree from new genetic data, many of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. The fitness effects of this inbreeding remain unclear and are an effort of ongoing research (Ford et al. 2018).

Seasonal mortality rates among SRKW and NRKW may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring and standings data. Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer season, and multiple new calves have been documented in winter months that have not survived the following summer season (Center for Whale Research unpublished data). Stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004).

The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the population viability analyses conducted for the 2004 Status Review for SRKW and the 2011 science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). According to the updated analysis, the model results now suggest a downward trend in population size projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. The downward trend is in part due to the changing age and sex structure of the population. If the population of SRKW experiences demographic rates (e.g. fecundity and mortality) that are more similar to 2016 than the recent 5-year average (2011 through 2016), the population will decline faster as shown in Figure 3-4 (NMFS 2016).

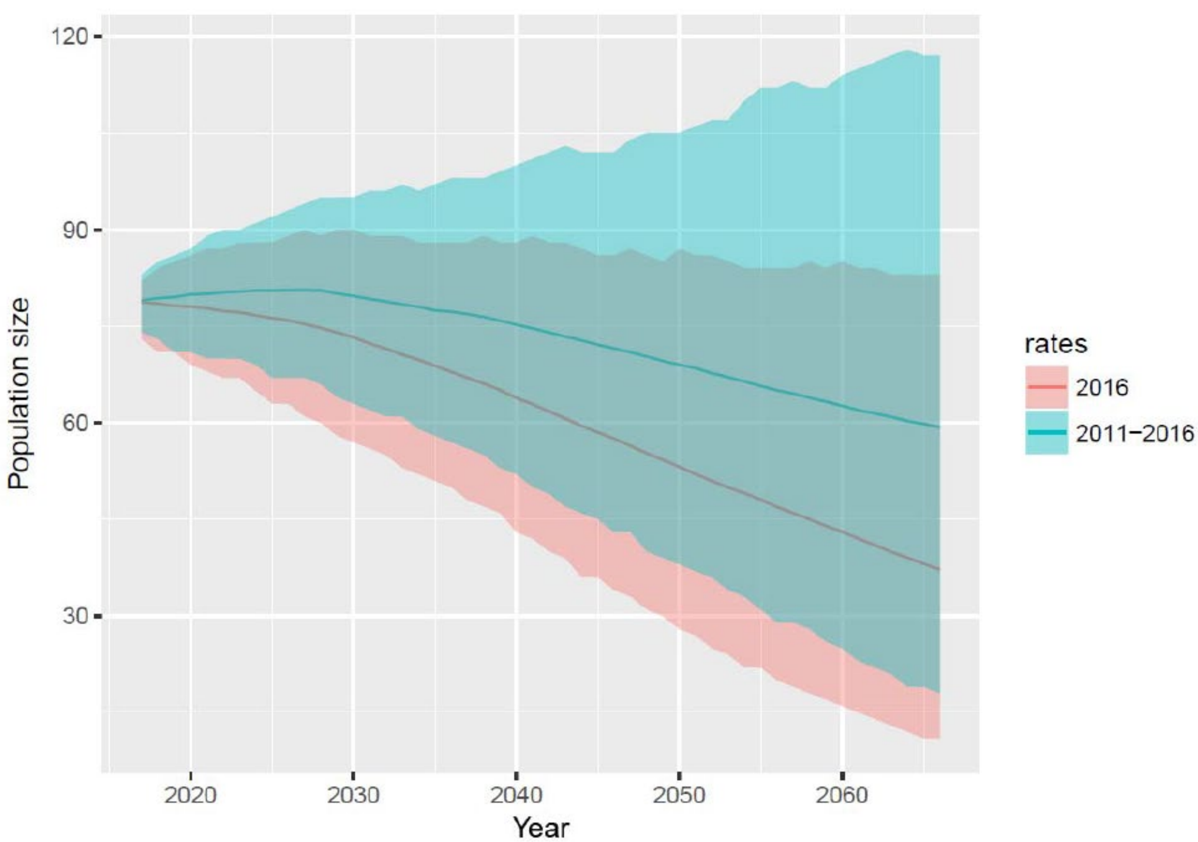

Figure 3-4. Southern Resident killer whale population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (Figure 2, NMFS (2016)).

3.3.1.2 Geographic Range and Distribution

As described in Section 1.2 Background, SRKW currently occur throughout the coastal waters off Washington, Oregon, and Vancouver Island, Canada and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008; Ford et al. 2017; Carretta et al. 2019)(see Figure 3-5). SRKW are highly mobile and travel with seasonal movements likely tied to the migration of salmon, their primary prey. During the spring, summer, and fall months, SRKW typically spent a substantial amount of the time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Krahn et al. 2002; Hauser et al. 2007). During fall and early winter, SRKW and J pod in particular expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Osborne 1999; Hanson et al. 2010; Ford et al. 2016). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010).

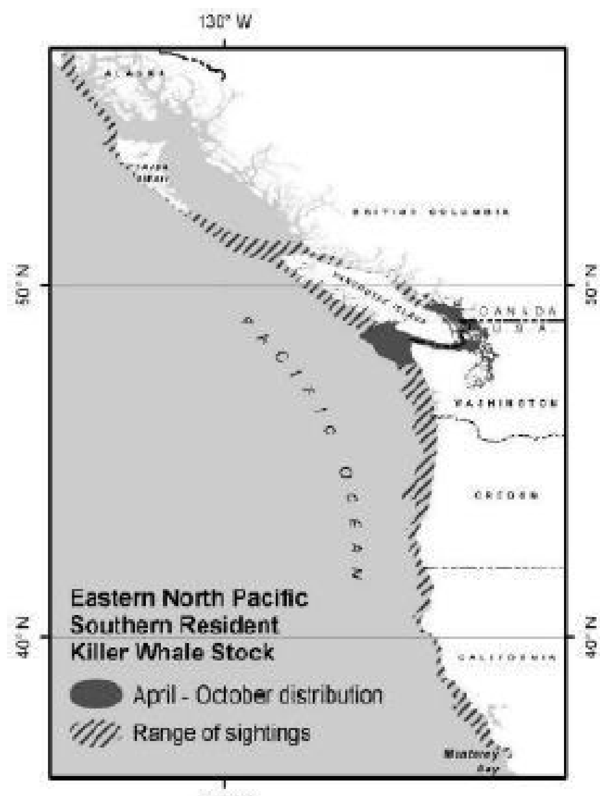

Figure 3-5. Approximate April – October distribution of SRKW (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. (2019)).

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted have provided an updated estimate of the whales' coastal range that extends

from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. Since 1975, confirmed and unconfirmed opportunistic SRKW sightings from the general public or researchers have been collected off British Columbia, Washington, Oregon, and California. Together, these SRKW sightings have confirmed their presence as far north as Chatham Strait, southeast Alaska and as far south as Monterey Bay, California (NMFS 2019).

As part of a collaborative effort between NWFSC, Cascadia Research Collective and the University of Alaska, satellite-linked tags were deployed on eight male SRKW (three tags on J pod members, two on K pod, and three on L pod) from 2012 to 2016 in Puget Sound or in the coastal waters of Washington and Oregon (Table 3-6). The tags transmitted multiple locations per day to assess winter movements and occurrences of SRKW (Hanson et al. 2017).

Over the course of the study, the satellite tagging resulted in data ranges from 3 days to 96 days of duration, depending on the tag, of monitoring with deployments occurring from late December to mid-May (Table 3-6). The winter locations of the tagged whales included inland and coastal waters. The inland waters range occurs across the entire Salish Sea, from the northern end of the Strait of Georgia and Puget Sound, and coastal waters from central west coast of Vancouver Island, British Columbia to northern California (Hanson et al. 2017). J pod had high use areas (defined as 1 to 3 standard deviations), or "hot spots", in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30 percent of their time there (Figure 3-6). K/L pods occurred almost exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a continuous high use area between Grays Harbor and the Columbia River, spending approximately 53 percent of their time there (Figure 3-7) (Hanson et al. 2017; Hanson et al. 2018). The tagging data provide general information on the home range and overlap of each pod from 2012 to 2016.

Satellite tagging can also provide details on preferred depths and distances from shore. Approximately 95 percent of the SRKW locations were within 34 km of the shore and 50 percent of these were within 10 km (Hanson et al. 2017). Only 5 percent of locations were greater than 34 km away from the shore, but no locations exceeded 75 km. Most locations were in waters less than 100m in depth.

Table 3-6. Satellite-linked tags deployed on Southern resident killer whales 2012 to 2016 (Hanson et al. 2018). This was part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

Whale ID	Pod Association	Date of Tagging	Duration of signal contact (days)
J26	J	20 Feb. 2012	3
L87	J	26 Dec. 2013	31
J27	J	28 Dec. 2014	49
K25	K	29 Dec. 2012	96
L88	L	8 Mar. 2013	8
L84	L	17 Feb. 2015	93
K33	K	31 Dec. 2015	48
L95	L	23 Feb. 2016	3

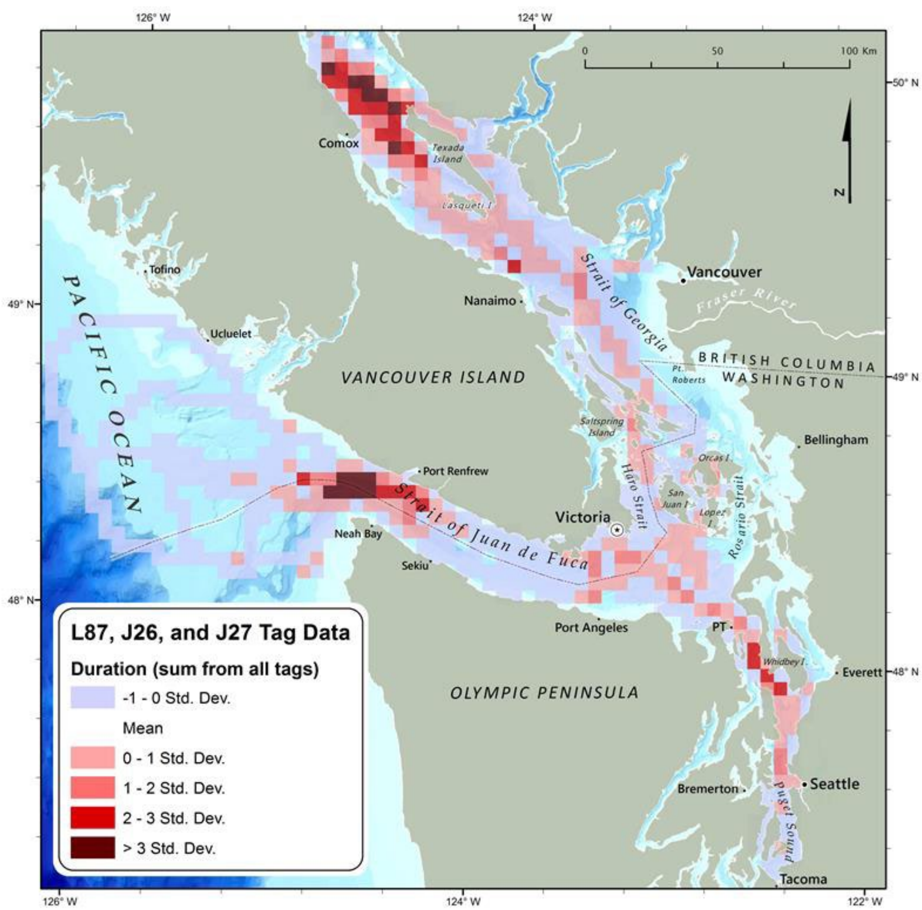

Figure 3-6. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). “High use areas”, or “hot spots”, are illustrated by the 0 to >3 standard deviation pixels.

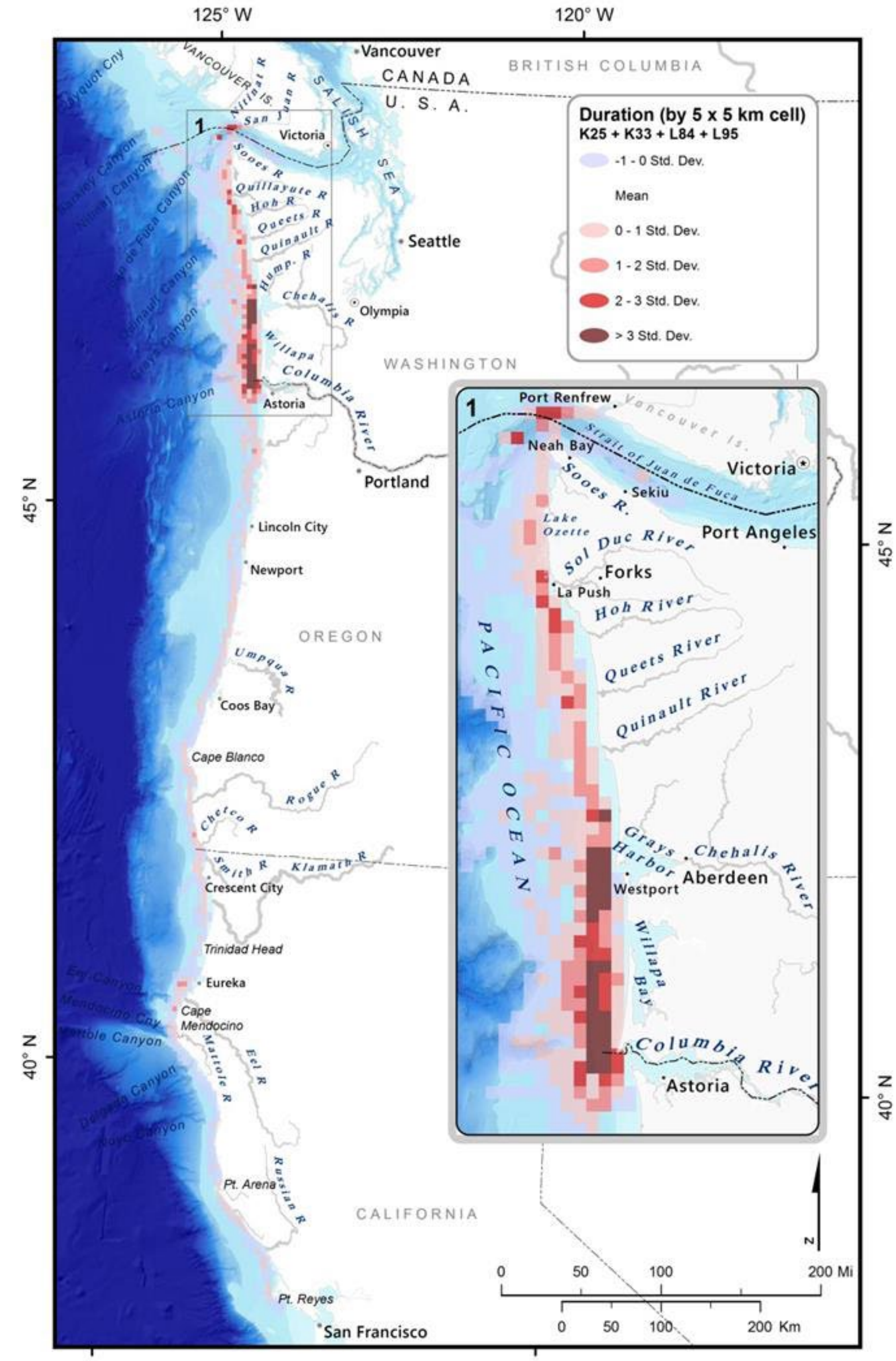

Figure 3-7. Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas", or "hot spots", are illustrated by the 0 to >3 standard deviation pixels.

Passive acoustic recorders were deployed off the coasts of California, Oregon and Washington in most years since 2006 to assess their seasonal uses of these areas via the recording of stereotypic calls of the SRKW (Hanson et al. 2013; Emmons et al. 2019). Passive aquatic listeners were originally deployed from 2006 to 2008. Since 2008, four to seventeen ecological acoustic recorders have been deployed. From 2006 to 2011, passive acoustic listeners and recorders were deployed in areas thought to be of frequent use by SRKW based on previous sightings, where enhanced productivity was expected to be concentrated, and in areas with a reduced likelihood of fisheries interactions (Figure 7; Hanson et al. (2013)). The number of recorder sites off the Washington coast increased from 7 to 17 in the fall of 2014 and locations were selected based on “high use areas” identified in the duration of an occurrence model (Figure 3-9), and sites within the U.S. Navy’s Northwest Training Range Complex in order to determine if SRKW used these areas in other seasons when satellite-linked tags were not deployed (Hanson et al. 2017; Emmons et al. 2019). “High use areas” for the SRKW in winter were determined to be primarily located in three areas 1) the Washington coast, particularly between Grays Harbor and the mouth of the Columbia River (primarily for K/L pods); 2) the west entrance to the Strait of Juan de Fuca (primarily for J pod); and 3) the northern Strait of Georgia (primarily for J pod). It is important to note that recorders deployed within the Northwest Training Range Complex were designed to assess spatial use off Washington coast and thus the effort was higher in this area (i.e. the number of recorders increased in this area) compared to off Oregon and California.

There were acoustic detections off Washington coast in all months of the year (Figure 3-10.), with greater than 2.4 detections per month from January through June and a peak of 4.7 detections per month in both March and April, indicating that the SRKW may be present in Washington coastal waters at nearly any time of year, and in other coastal waters more often than previously believed (Hanson et al. 2017). Acoustic recorders were deployed off Newport, Fort Bragg, and Port Reyes between 2008 through 2013 and SRKW were detected 28 times (Emmons et al. 2019).

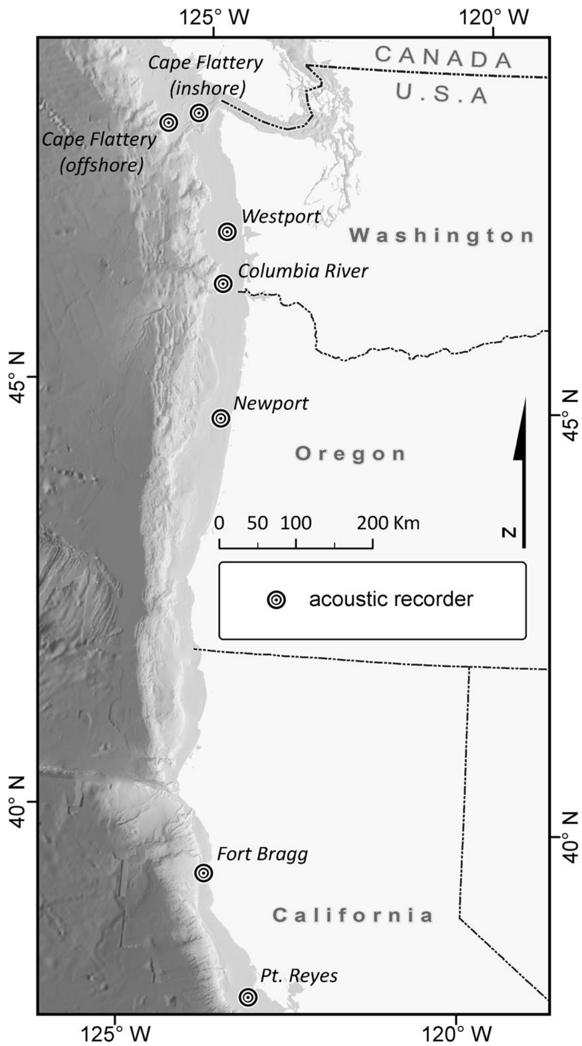

Figure 3-8. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

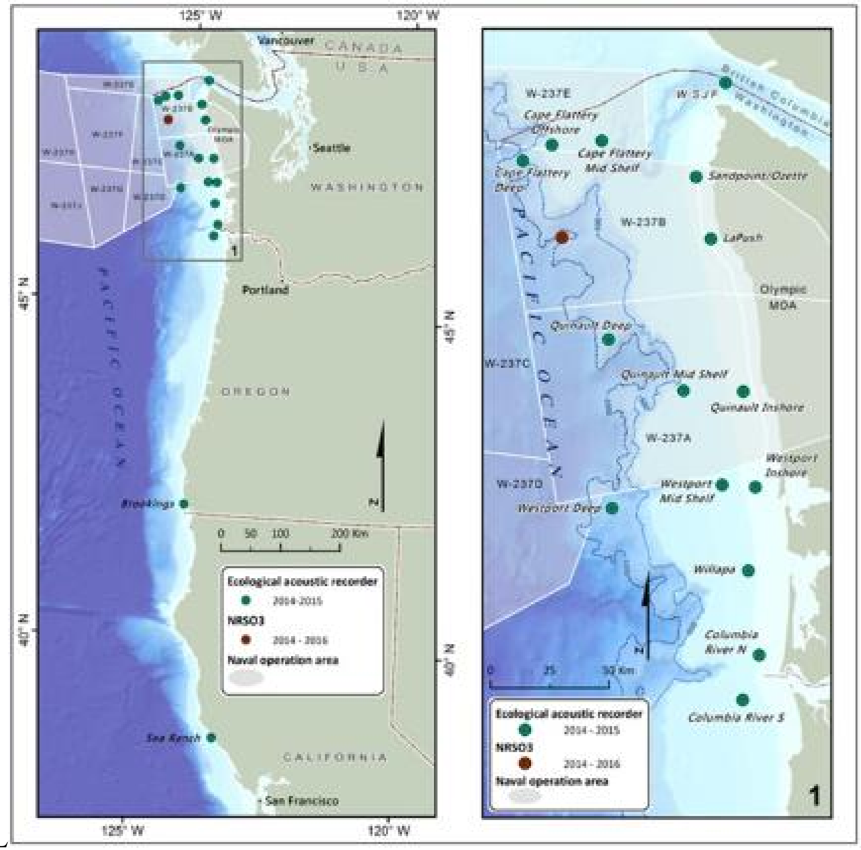

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Figure 3-9. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

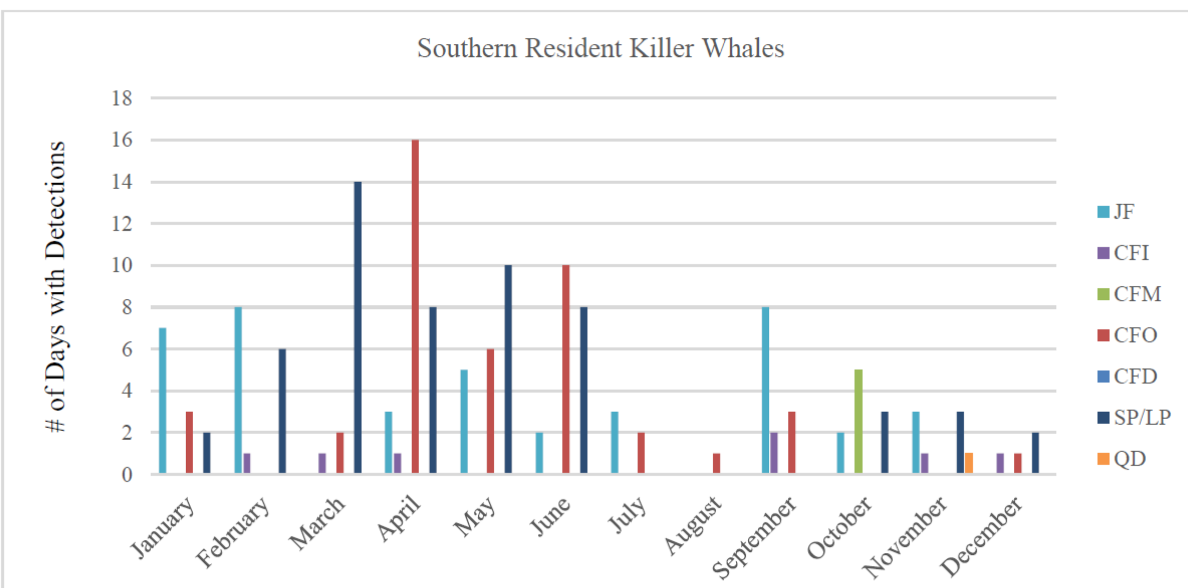

Figure 3-10.A. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep(CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

In a recent study, researchers collected data using an autonomous acoustic recorder deployed at Swiftsure Bank from August 2009 to July 2011 to assess how this area is used by NRKW and SRKW (Riera et al. 2019) (Figure 3-11). SRKW were detected on 163 days with 175 encounters (Riera et al. 2019). All three pods were detected at least once per month except for J pod in January and November and L pod in March. K and L pods were heard more often (87 percent of calls and 89 percent of calls, respectively), between May and September (Figure 3-12). J pod was heard most often during winter and spring (76 percent of calls during December and February through May; (Riera et al. 2019)). K pod had the longest encounters in June, with 87 percent of encounters longer than 2 hours occurring between June and September. L pod had the longest encounters in May, with 79 percent of encounters longer than two hours occurring during the summer (May through September). The longest J pod encounters were during winter, with 72 percent of encounters longer than 2 hours occurring between December and May (Riera et al. 2019).

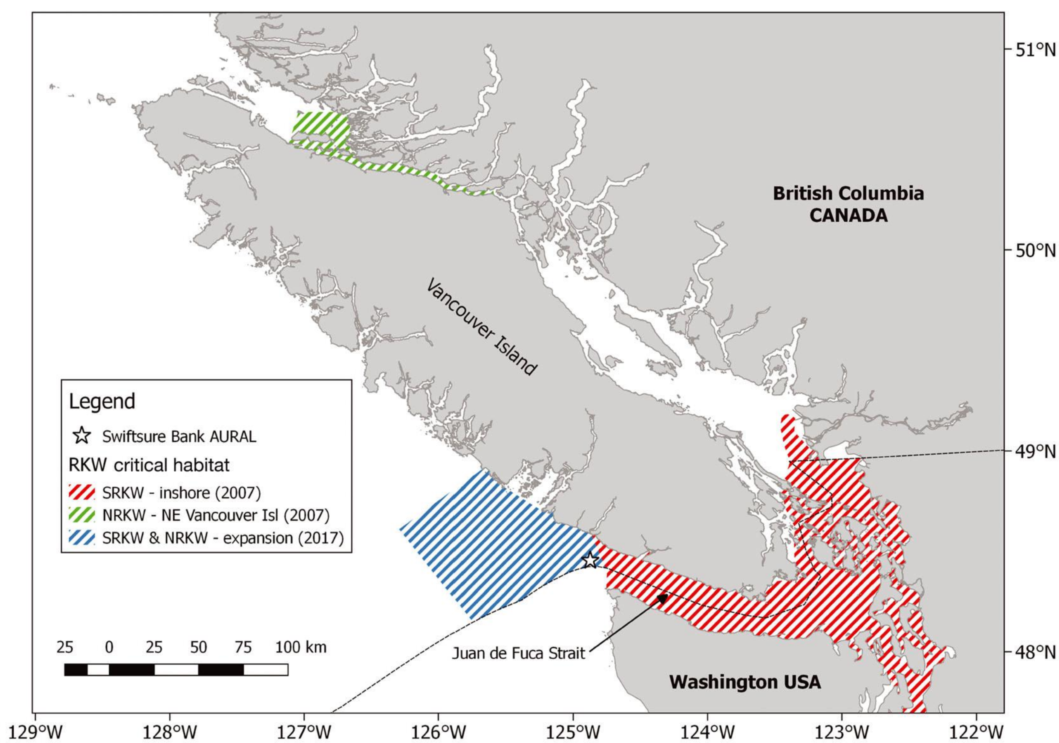

Figure 3-11. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (NE Vancouver Island) and 2007 Southern Resident killer whale critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

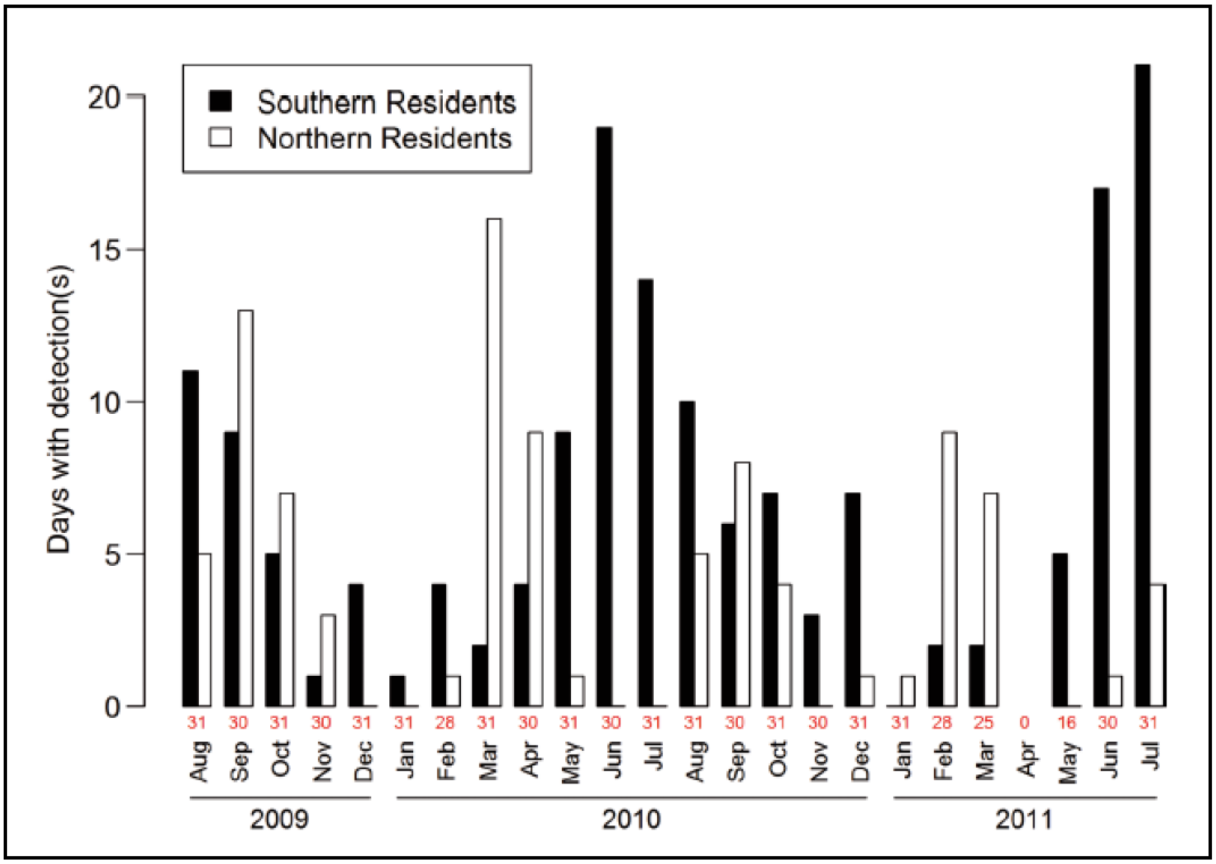

Figure 3-12. Number of days with acoustic detections of SRKW at Swiftsure Bank from August 2009 – July 2011. Red numbers indicate days of effort (Riera et al. 2019).

3.3.1.3 Limiting Factors and Threats

Several factors identified in the recovery plan for SRKW may be limiting recovery. The recovery plan identified three major threats including (1) the quantity and quality of prey, (2) toxic chemicals that accumulate in top predators, and (3) impacts from sound and vessels. Oil spills and disease as well as the small population size are also risk factors. It is likely that multiple threats are acting together to impact SRKW. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (Lacy et al. (2017)) and available data suggest that all of the threats are potential limiting factors (NMFS 2008).

We review SRKW diet and foraging activities spatially and temporally below given the data suggest some general patterns.

May - September

Scale and tissue sampling from May to September in inland waters of Washington and British Columbia, Canada indicate that the SRKW's diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016). Genetic analysis of the Hanson et al. (2010) samples from 2006-2010 indicate that when SRKW are in inland waters from May to September, they primarily consume Chinook stocks that originate from the Fraser River (80 – 90 percent of the diet in the Strait of Juan de Fuca and San Juan Islands; including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), and to a lesser extent consume stocks from Puget Sound (North and South Puget Sound) and Central British Columbia Coast and West and East Vancouver Island. This is not unexpected as all of these stocks are returning to streams proximal to these inland waters during this timeframe. Few diet samples have been collected in summer months outside of the Salish Sea.

DNA quantification methods are also used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to SRKW in the early to mid-summer months (May-August) using DNA sequencing from SRKW feces collected in inland waters of Washington and British Columbia. Salmon and steelhead made up greater than 98 percent of the inferred diet, of which almost 80 percent were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters of Washington and British Columbia in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40 percent of the diet in September in inland waters, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Less than 3 percent each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September) in inland waters.

October - December

Prey remains and fecal samples collected in U.S. inland waters during October through December indicate Chinook and chum salmon are primary contributors of the whale's diet during this time (NWFSC unpublished data). Diet data for the Strait of Georgia and coastal waters is limited.

January – April

Observations of SRKW overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and fewer fecal samples collected in coastal waters, recent data indicate that salmon, and Chinook salmon in particular, remain an important dietary component when the SRKW occur in outer coastal waters during these timeframes. Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson et al. in prep). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples. A total of 55 samples were collected from northern California to northern Washington (Hanson et al. in prep). Results of the 55 available prey samples indicate that, as is the case in inland waters, Chinook are the primary species detected in diet samples on the outer coast, although steelhead, chum, lingcod, and halibut were also detected in samples. Despite J pod utilizing much of the Salish Sea, including the Strait of Georgia, in winter months (Hanson et al. 2018), few diet samples have been collected in this region in winter.

The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. west coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (Hanson et al. in prep). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 55 diet samples collected from SRKW in coastal areas.

Increased Chinook abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKW and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010; Hanson et al. in prep). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural-origin fish are underway. Although hatchery production has contributed some offset to the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to SRKW because it is uncertain whether a hatchery dominated mix of stocks is

sustainable indefinitely and because hatchery fish can differ relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing.

Nutritional Limitation and Body Condition

When prey is scarce or in low density, SRKW likely spend more time foraging than when prey is plentiful or in high density. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition, can lead to reduced body size of individuals and to lower reproductive or survival rates in a population (Trites and Donnelly 2003). During periods of nutritional stress and poor body condition, cetaceans lose adipose tissue behind the cranium, displaying a condition known as "peanut-head" in extreme cases (Pettis et al. 2004; Bradford et al. 2012; Joblon et al. 2014). Between 1994 and 2008, 13 SRKW were observed from boats to have a pronounced "peanut-head"; and all but two subsequently died (Durban et al. 2009; Center for Whale Research unpublished data). Since 2008, NOAA's SWFSC has used aerial photogrammetry to assess the body condition and health of SRKW, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in "peanut-head" that is observable from boats. Annual aerial surveys of the population from 2013 through 2017 (with exception of 2014) have detected declines in condition before the death of seven SRKW.

None of the whales that died were subsequently recovered, and therefore definitive cause of death could not be identified. Both females and males across a range of ages were found in poor body condition.

3.3.1.4 Status of SRKW Critical Habitat

Critical habitat for the Southern Resident killer whale DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. Based on the natural history of SRKW and their habitat needs, NMFS identified the following physical or biological features essential to conservation: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

In 2006, few data were available on SRKW distribution and habitat use in coastal waters of the Pacific Ocean. Since the 2006 designation, additional effort has been made to better understand the geographic range and movements of SRKW. For example, opportunistic visual sightings, satellite tracking, and passive acoustic research conducted since 2006 have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska (NMFS 2020).

On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,627 square miles (40,473 square kilometers) of marine waters between the 6.1-meter depth contour and the 200-meter depth contour from the U.S./Canada border south to Point Sur, California (Figure 3-13). In the proposed rule (84 FR 49214), NMFS states that the "proposed areas are occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." The three physical or biological features essential to conservation in the 2006 designated critical habitat were also identified for the six new areas along the U.S. West Coast.

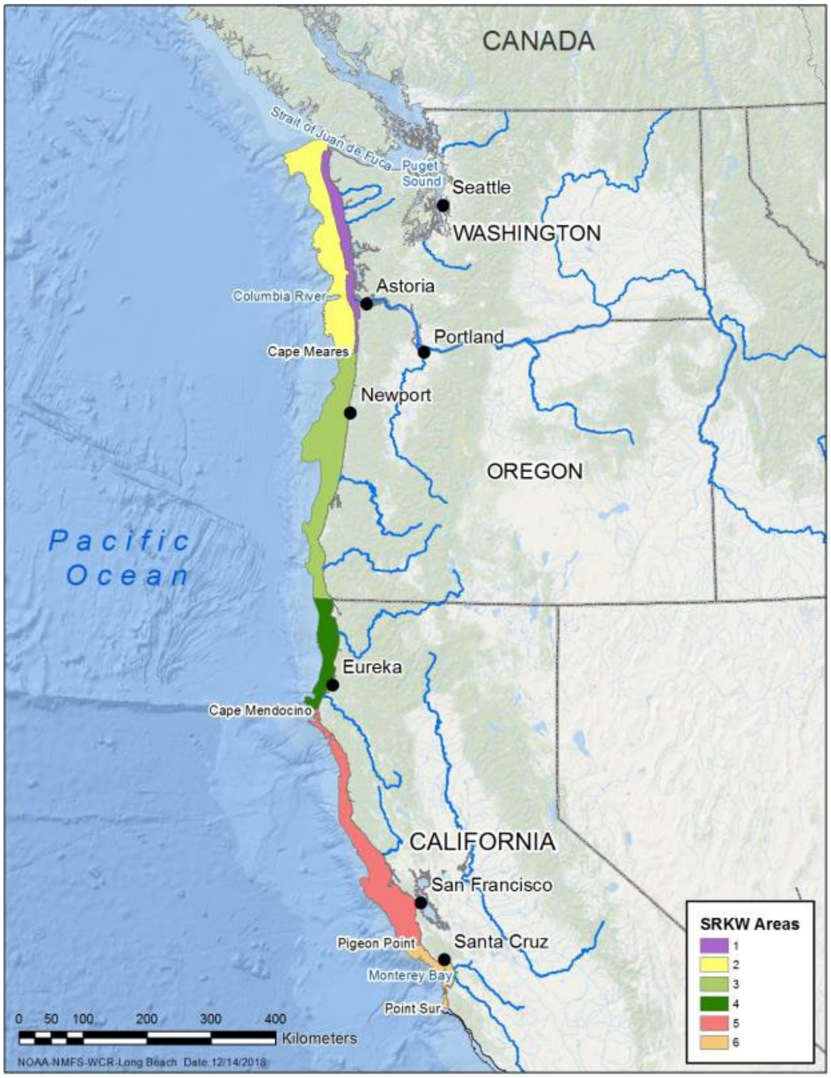

Figure 3-13. Specific areas containing essential habitat features (reproduced from NMFS (2019)).

Water Quality

Water quality supports SRKW's ability to forage, grow, and reproduce free from disease and impairment. Water quality is essential to the SRKW conservation, given their present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) that includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. The absence of contaminants or other agents of a type and/or amount that would inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and recovery of the SRKW population is a habitat feature essential for the species' recovery. Water quality in Puget

Sound, in general, is degraded as described in the Puget Sound Partnership 2018-2022 Action Agenda and Comprehensive Plan (Puget Sound Partnership 2018). For example, toxicants in Puget Sound persist and build up in marine organisms including SRKW and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. Water quality varies in coastal waters from Washington to California. For example, as described in NMFS (NMFS 2019), high levels of DDTs have been found in SRKW, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano et al. 2014).

The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2017, the Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as the performance measures from 2007 to 2017 (WDOE 2017).

Prey Quantity, Quality, and Availability

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

Contaminants and pollution also affect the quality of SRKW prey in Puget Sound and in coastal waters of Washington, Oregon, and California. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKW. Chemical contamination of prey is a potential threat to SRKW critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. The size of Chinook salmon is also an important aspect of prey quality (i.e., SRKW primarily consume large Chinook salmon) so changes in Chinook salmon size may affect the quality of this component critical habitat. In addition, vessels and

sound may reduce the effective zone of echolocation and reduce availability of fish for the whales in their critical habitat (Holt 2008).

Passage

Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whale passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior (review in NMFS (2010), Ferrara et al. (2017)).

For the purposes of this draft EA, changes to Council fishery management and implementation could impact the current status of marine mammals within the analysis area. Analysis of how the Proposed Action and each of the action alternatives will influence the current status of marine mammals is described in Section 4.

3.4 Socioeconomics

Federal agencies are required to assess impacts of major Federal actions on the human environment. Within the human environment, socioeconomic impacts could occur under implementation of the alternatives analyzed in this draft EA.

One quantitative measure that can help describe the current status of the socioeconomic environment is annual income generated by ocean salmon fisheries, a metric that is tracked in yearly reports by the PFMC (PFMC 2013; 2016b; 2017; 2018; 2019a; 2020b). NMFS determined the years 2010 through 2019 sufficiently represent the current status of the socioeconomic environment for this metric, and represents a range that will likely be experienced in the near future, therefore fully informing the decision of selecting a preferred alternative from the ROAs the Council adopted for public review. Ocean salmon income impacts within the analysis area for 2010 through 2019 are presented in Table 3-7 and Figure 3-14. Since 2010, the median coastal community socioeconomic environment was valued at $58.8 million dollars, with an arithmetic mean of $61.8 million dollars. Changes to the amount of Chinook salmon harvest through the implementation of the Proposed Action may cause a change to the values presented in Table 3-7. The analysis of each alternative on the socioeconomic affected environment is presented in Section 4.

Table 3-7. West coast (WA, OR, CA) income impacts from recreational and commercial ocean salmon fisheries from 2010 through 2019 (PFMC 2017).

Year	West Coastal Income Impacts of Ocean Salmon Fisheries (WA, OR, and CA) (Millions of Dollars in 2016)
2010	$25.5
2011	$31.9
2012	$55.8
2013	$79.3
2014	$112.1
2015	$80.4
2016	$48.6
2017	$50.9
2018	$61.8
2019	$71.7

*Footnotes

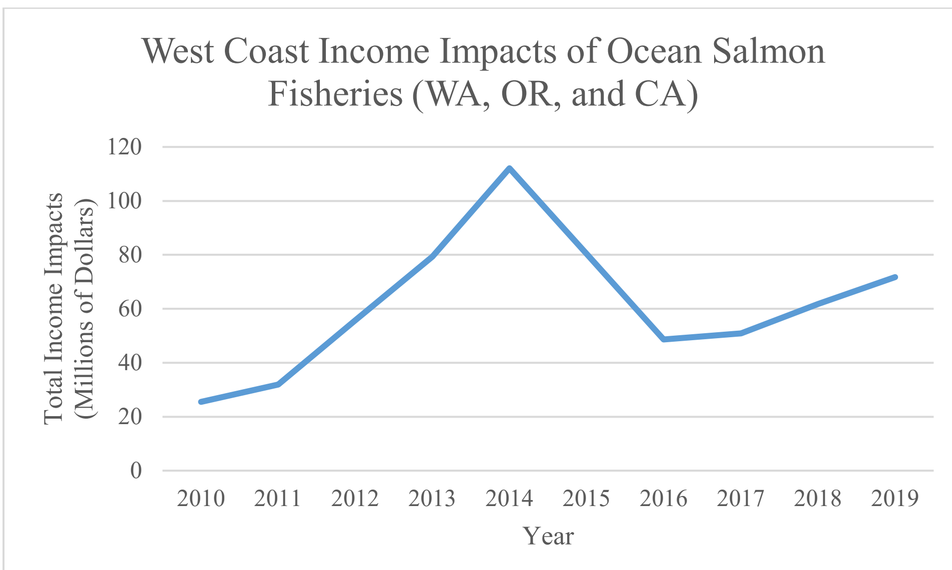

Figure 3-14. West Coast Income Impacts of Ocean Salmon Fisheries (WA, OR, and CA) from 2010 through 2019.

Economic impacts restricting ocean salmon harvests may allow increased opportunities for inside harvest and escapement but are outside the scope of this analysis. The implementation of the Proposed Action or the alternatives may impact the income of Council-managed salmon fisheries, or may redistribute the geography or timing of these incomes. The analysis of these potential redistributions may be unable to be quantified, but possibilities are analyzed in Section 4.

3.5 Cultural Resources

Cultural resources are an aspect of a cultural system that is valued by or significantly representative of a culture, or that contains significant information about a culture. Cultural resources can also be identified as sites, structures, or objects listed or eligible for listing in the National Register of Historic Places. As the Proposed Action does not involve and is not expected to impact any listed or eligible items in the National Register of Historic Places, the focus of this section will be the current status of salmon as a cultural resource for Native American Tribes. Initial scoping of the Proposed Action indicated potential effects from changes to tribal fisheries, but the range of alternatives adopted by the Council were absent tribal fishery changes. We still chose to analyze this resource based on scoping, and subsequent analysis of salmon as a cultural resource can be found in Section 4.

Salmon and SRKW are an important part of Native American tribal culture and have been since time immemorial. Salmon provide cultural, ceremonial, and subsistence benefits to tribal communities on the West Coast. There are 151 Federally-recognized tribes and many other non-Federally-recognized tribes in the West Coast Region, many of which utilize salmon for occasions including but not limited to ceremonies, celebrations, funerals and as part of their cultural identity.

3.6 Environmental Justice

Several laws and policies mandate attention to impacts on human communities, including Executive Order (EO) 12898. This EO directs agencies to determine whether the Proposed Action disproportionately affects low income and minority populations. Typically, census data are used to document the occurrence and distribution of these groups. In addition, the pertinent rights of Indian tribes should also be considered in this environmental justice (EJ) analysis.

The analysis of environmental justice impacts considers potential adverse effects under the alternatives on physical, biological, cultural, human, and socioeconomic resources in the analysis area. Unlike effects on other resource topics (e.g., fish, marine mammals, birds) analyzed in this draft EA, EJ is not a stand-alone topic and examines interactions between low-income and minority communities, and tribal communities with other resources presented in this draft EA.

Based on consideration of potential effects for the alternatives on communities and the human environment, it was concluded that the EJ analysis should focus on potential adverse effects associated with two of the resource categories from Section 3.0:

1. Cultural Resources

2. Socioeconomics

Section 4.0 will determine if there are disproportionate impacts in any of these resource categories on the low-income, minority, and/or tribal EJ populations identified in this section, below.

3.6.1 Determination of Environmental Justice Populations

3.6.1.1 Tribal Environmental Populations

In addition to any identifiable low-income and/or minority populations, Environmental Protection Agency guidance considers Native American tribal communities to be EJ populations that must be examined for disproportional impacts under the Proposed Action (see Section 4.6 for environmental consequences on EJ populations) (EPA 1998).

The applicable current status of tribal communities is described throughout section 3. In Section 4, the environmental justice evaluation for Native American tribes will examine changes to the current status of the two resource categories identified above; (1) Cultural Resources and (2) Socioeconomics.

3.6.1.2 Non-tribal Environmental Justice Populations

The Council on Environmental Quality (CEQ) established guidance on defining minority and low-income areas in the *Environmental Justice Guidance under the National Environmental Policy Act* (Council on Environmental Quality 1997). CEQ's guidance states the following:

> Minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis. … The selection of the appropriate unit of geographical analysis may be a governing body's jurisdiction, and neighborhood, a census tract, or other similar unity that is chosen so as not to artificially dilute or inflate the affected minority population (Council on Environmental Quality 1997).

CEQ guidelines do not specify the percentage considered meaningful in the case of low-income populations (NMFS 2017).

Commercial and recreational fishing populations have the potential to be impacted by the Proposed Action. However, after NMFS examined these fishing populations to determine if there are any EJ communities; making a determination that either commercial or recreational fishing populations should be

designated as an EJ population was too speculative and therefore we did not separate them or classify them as EJ communities in this analysis.

3.6.2 Summary

For the purposes of this draft EA, Native American Tribes along the West Coast that utilize salmon were identified as EJ populations. As described in Section 3.6.1.2, while commercial and recreational fishermen were considered in determining EJ populations, socio-demographic information concerning these specific groups is too limited to determine key EJ characteristics. Table 3-8 summarizes the EJ communities and resources considered in this draft EA.

Table 3-8. Environmental justice communities and resources considered in this draft EA.

Resource Category	**American Indian Tribes**		**Commercial and Recreational Fishing Populations**	
	Considered	Evaluated in Section 4	Considered	Evaluated in Section 4
Cultural Resources	✓	✓	×	×
Socioeconomics	✓	✓	✓	×

4.0 Environmental Impacts of Alternatives

This section will analyze the environmental impacts of the alternatives on the resources described in Section 3.0, for which there are identifiable impacts. The Proposed Action will have no impact on fish and fisheries other than salmon. In addition to non-ESA-listed salmon, the Proposed Action may have impacts on ESA-listed SRKW and the socioeconomic environment, which are discussed in the following subsections.

4.1 Alternative 1 – No Action - Status Quo Fishery Management Plan Implementation

4.1.1 Water Quality

Based on the Review of 2019 Ocean Salmon Fisheries (PFMC 2020b), there were a total of 20,100 vessel-days fished in the West Coast non-Indian commercial troll salmon fishery in 2019. This is 64 percent greater than in 2018 (12,300), 81 percent greater than in 2017 (11,200), and 52 percent greater

than in 2016 (13,200) (PFMC 2020b). We expect the range over these years for levels of effort in the non-Indian commercial troll salmon fishery to be maintained under Alternative 1.

The preliminary number of vessel-based ocean salmon recreational angler trips taken on the West Coast in 2019 was 263,600, an increase of 26 percent from 2018, 51 percent above the number taken in 2017, 16 percent above the 2014-2018 average of 226,800 (PFMC 2020b). We expect the range over these years for levels of participation in the recreational salmon fishery to be maintained under Alternative 1.

This level of participation is unlikely to affect the water quality of the Pacific Ocean through fuel or oil from fishing boat motors leaking and negatively affecting water quality under Alternative 1 given the area over which the fishery occurs relative to the sizes and numbers of total vessels participating throughout the EEZ. However, relative to each of the other Alternatives the effect to water quality is greatest under this Alternative. The effects from this Alternative on water quality likely would be too small for effects on water quality to be significant.

4.1.2 Fish & Fisheries

Although the Council-managed salmon fisheries, by their very nature, harvest fish from a mix of salmon stocks, they are managed to meet conservation objectives for individual stocks. For example, if one stock in the mix of stocks in the ocean is assessed to be compatible with relatively high fishing pressure, but another weaker stock requires a lower fishing pressure, then the ocean fishery is managed to target the limiting rate for the weaker stock and leave some of the harvestable fish from the stronger stock uncaught. We expect this to continue under Alternative 1. While we described levels of catch that occurred under past fishery regimes in Table 3-5, the Council has implemented a multitude of regulation changes to protect ESA-listed Chinook salmon stocks between 1993 and 2016 (PFMC 2020b) with each additional listing and has updated conservation objectives, and improved technical tools and management models over that time. Additionally, a newly renegotiated PST Agreement requires further constraints on Chinook salmon fisheries in the analysis area. Table 4-1 presents estimates of catch that would have occurred in Council salmon fisheries applying contemporary Chinook salmon conservation requirements through a retrospective analysis to past abundance levels. Negative values indicate a reduction in catch that would result from applying the current suite of salmon management constraints relative to what actually occurred. The ability to retrospectively apply similar analyses to OR and CA fisheries was not possible, but similar effects are expected. Therefore, Alternative 1 represents a more conservative management framework than reflected in the data series described in Section 3.2 for Chinook salmon. The No-action Alternative (Alternative 1) would result in no change to the FMP. Therefore, salmon

fishery impacts on Chinook salmon species, both ESA-listed and non-listed stocks would be consistent with those in recent years.

Table 4-1. Average Chinook Salmon catch by TS (season) in Washington, Oregon, and California if applying 2020 management regime retrospectively (Alternative 1) (from Appendix A).

Catch Area	Season	Time Period					
		Catch 1993-2000	Diff. from historical actual	Catch 2001-2008	Diff. from historical actual	Catch 2009-2016	Diff. from historical actual
Washington	TS1 (Oct-Apr)	1,582	-548	2,265	-1,305	1,891	-303
	TS2 (May-Jun)	10,879	-4,411	38,642	-6,479	44,514	-7,126
	TS3 (Jul-Sep)	10,000	-3,596	50,312	-7,393	56,932	-4,413
	Annual (Oct-Sep)	22,462	-8,555	91,219	-15,177	103,337	-11,842
Oregon	TS1 (Oct-Apr)	16,451	0	51,563	0	11,816	0
	TS2 (May-Jun)	51,419	0	72,014	0	32,489	0
	TS3 (Jul-Sep)	74,280	0	108,619	0	51,342	0
	Annual (Oct-Sep)	142,149	0	232,195	0	95,647	0
California	TS1 (Oct-Apr)	44,347	0	21,054	0	10,264	0
	TS2 (May-Jun)	284,094	0	135,417	0	63,130	0
	TS3 (Jul-Sep)	232,427	0	195,019	0	83,947	0
	Annual (Oct-Sep)	560,868	0	351,489	0	157,341	0

*Footnotes: Washington catch amounts correspond with Council NOF fisheries, Oregon catch amounts correspond to Council fisheries between Cape Falcon, OR and Horse Mountain, CA, and California catch amounts correspond to fisheries south of Horse Mountain, CA.

4.1.3 Marine Mammals

Ocean salmon fisheries employ hook-and-line gear and are classified under the MMPA as Category III (86 FR 3028, January 14, 2021), indicating there is no record of substantive impacts on marine mammals (MMPA 118(c)(1)) from gear interactions. Although there are documented cases of pinnipeds preying on hooked salmon, these interactions are uncommon in Council-area fisheries in the EEZ. Because the gear type used by the fisheries, hook and line gear, are the same for Alternative 1-3 we do not expect substantive impacts on marine mammals from gear interactions for any of the alternatives. Therefore, the No-action Alternative would have neither a positive nor negative impact on pinnipeds, compared to the other analyzed alternatives.

4.1.3.1 Southern Resident Killer Whales

We expect the effect from gear interactions to SRKW under Alternative 1 to be the same as described for all marine mammals above. Effects on SRKW from prey reductions that occurred from Council-managed salmon fisheries are described in the Workgroup's risk assessment evaluating the FMP's impacts on SRKW (PFMC 2020a). We incorporate this document herein by reference, summarize effects retrospectively of what would have occurred under Alternative 1 and what may occur in the future under Alternative 1. Again, this is because the range of abundances experienced over the past 25 years is likely representative of the range of abundances we expect to see in future years. Table 4-2 summarizes effects on Chinook salmon abundance moving forward under Alternative 1 assuming similar pre-fisheries abundance levels as those estimated in the past (refer to Table 3-3 for estimates of past average annual abundance levels by period).

Under Alternative 1, existing harvest control rules and reference points are designed to ensure that impacts to individual Chinook stocks are sustainable and do not jeopardize listed Chinook ESUs, as consistent with the FMP, but no additional consideration of low Chinook abundance relative to SRKW would be included under this Alternative. Thus impacts to overall Chinook salmon abundance, relevant to prey availability to SRKW, may not be responsive to fluctuations in overall abundance, as opposed to individual stock abundance, under Alternative 1and it represents the largest negative impact to SRKW among the ROAs. Under Alternative 1, the fisheries would be managed consistent with the FMP, but would not be managed to be specifically responsive to the needs of the ESA-listed SRKW population. The largest number of Chinook overall would be removed by the fisheries under Alternative 1.

SRKW are observed in the North of Cape Falcon (NOF) area in all seasons (PFMC 2020a). This is also where the strongest links between Chinook salmon abundance and SRKW demography were found by the

Workgroup (PFMC 2020a). Therefore, we expect SRKW may be impacted by reduced prey availability in this area to some unknown degree, and there is potential for overlap with salmon fisheries in this area every year. SRKW also occur off Oregon coastal waters (Cape Falcon, OR to Horse Mountain, CA) and likely therefore have some potential overlap with the fisheries in this area; however, SRKW have been observed or detected less frequently than in NOF waters. Due to fish movement north and south along the coast, fisheries in Oregon coastal waters can also affect the abundance of Chinook salmon in the NOF area, and vice versa (Weitkamp 2010; Shelton et al. 2019). SRKW also occur in waters off the coast of California and do so primarily during the winter (PFMC 2020a). SRKW have also been detected during the months of April, May, and October when the fishery in this same geographic area is just beginning or very near the end and harvest is relatively low. Fisheries off California primarily affect Chinook stocks with southerly distributions but also have impacts on Chinook salmon abundance NOF, though at lower levels compared to Oregon and NOF fisheries.

We expect the level of impact on Chinook salmon abundance under Alternative 1 to be similar to those experienced in recent years. The Workgroup report (PFMC 2020a) concluded that in recent years, while salmon fisheries reduced potential prey availability for SRKW, negative impact from these fisheries on SRKW was reduced as fishing occurred in dispersed geographic areas throughout the West coast EEZ and the quantities of Chinook salmon removed as prey were not at a level which resulted a meaningful reduction on prey. Therefore, we expect that the salmon fisheries affecting the levels of Chinook salmon are not likely to significantly impact SRKW through prey removal. Estimates of post-fishery Chinook salmon abundance by TS under this Alternative are presented in Table 4-2. Every instance, except one, shows an increase in abundance when comparing Alternative 1 to what occurred retrospectively. The increases to abundances (Table 4-2) are noticeably larger than the reductions to catches (Table 4-1). This is a result of applying contemporary fishery management measures to all fisheries (not just Council fisheries, i.e., Southeast Alaska, British Columbia, Puget Sound), as these fisheries also impact Chinook salmon abundances in coastal areas. However, similar to the past, we expect multiple years with relatively low Chinook salmon abundance levels to occur in the future.

NMFS is particularly concerned about conditions in years with critically low Chinook salmon abundance throughout SRKW' geographic range that may represent a higher risk condition. Additional prey reductions from fisheries have potential effects on SRKW's energetics, health, reproduction, and survival during years with critically low Chinook salmon abundance. Because SRKW are already stressed due to the cumulative effects of multiple stressors that could be additive or synergistic, and because we expect their status to continue to be poor in the future, reductions in Chinook salmon abundance in low

abundance years likely have a greater physiological effect, which may have negative implications for SRKW vital rates and population viability (e.g., NAS (2017)). For Alternative 1, we expect no change in prey accessibility or foraging opportunities and similar impacts of fisheries in years where abundance presents high risk conditions.

Alternative 1 includes no specific fishery response to years where levels of Chinook abundance pose high risk conditions for SRKW. Thus, under this alternative, it is more likely in some years, there may be insufficient foraging opportunities compared to what would occur under Alternatives 2 and 3. As described under Alternatives 2 and 3, in years in the past with relatively low abundance Chinook salmon abundance, low SRKW survival, body condition and social cohesion had occurred. It is possible these trends could occur again, however, there is no quantitative tool to predict this, especially given the non-stationary and non-linear nature of the relationship between whales and their primary prey. Under Alterative 1, there would likely continue to be similar spatial and temporal overlap between the fisheries and SRKW and potential competition for prey resources, but as mentioned above, we expect this would occur at levels not considered significant.

Table 4-2. Average Chinook salmon abundance after fishery removals, by TS (season), in Washington, Oregon, and California if applying 2020 conservation regime retrospectively (Alternative 1) (from Appendix A).

Catch Area	**Season**	**Time Period**					
		Abundance 1993-2000	**Diff. from historical actual**	**Abundance 2001-2008**	**Diff. from historical actual**	**Abundance 2009-2016**	**Diff. from historical actual**
Washington	TS1 (Oct-Apr)	988,509	9,346	1,585,369	10,051	1,760,845	1,712
	TS2 (May-Jun)	458,000	4,873	731,690	13,291	877,236	3,954
	TS3 (Jul-Sep)	488,533	28,862	846,713	35,924	1,111,859	15,777
Oregon	TS1 (Oct-Apr)	1,182,071	502	1,518,261	4,392	1,609,776	1,131
	TS2 (May-Jun)	677,509	217	882,146	7,223	902,216	2,186
	TS3 (Jul-Sep)	628,419	11,569	801,480	15,638	891,397	6,489
California	TS1 (Oct-Apr)	773,746	229	812,734	1,092	611,799	342
	TS2 (May-Jun)	540,941	-14	620,396	1,865	439,504	571
	TS3 (Jul-Sep)	289,110	1,594	351,680	1,581	234,868	592

*Footnotes: Washington abundances correspond with Council NOF area, Oregon abundances correspond with OR coastal waters (Cape Falcon, OR to Horse Mountain, CA), and California abundances correspond to all waters south of Horse Mountain, CA.

4.1.4 Socioeconomics

Under the No-action Alternative, the economic impacts on fishery-dependent communities from the ocean salmon fisheries would not change from what has been experienced in the recent past. The No-Action Alternative would likely result in fishery participation levels similar to those described above; and utilizing catch as an indicator of regional socioeconomic effects we expect the levels to remain similar to those experienced contemporarily as described in Table 4-1. The 2009 to 2016 catches correspond to our socioeconomic effect expectations; utilizing this period from Table 3-7, we expect income impacts of the fishery across all states to range from a low of $25.5 million to a high of $112.1 million dollars when accounting for variability due to changes in salmon abundance. The magnitude of economic benefits to fishery-dependent communities would continue to vary year-to-year, but is not likely to be significant.

4.1.5 Cultural Resources

Under the No-Action Alternative, effects on cultural resources would remain unchanged. Salmon and SRKW would continue to provide cultural, ceremonial, and in the case of salmon, subsistence benefits to tribal communities on the West Coast.

4.1.6 Environmental Justice

There would be no differential impact to minority populations, low-income populations, or Indian tribes under the No-Action Alternative.

4.2 Alternative 2 (Preferred Alternative)

4.2.1 Water Quality

Effects on Water Quality under Alternative 2 relative to the No-Action Alternative are likely to be neutral to slightly positive to the environment in areas that close for fishing, but are also likely too small to be significant. Relative to Alternative 3, Alternative 2 will not have discernable alternate effects, as geographic areas closed to fishing are similar in location and duration. Vessel participation levels will likely not change compared to the other Alternatives, but spatially redistribute during periods when management measures, such as area closures, restrict salmon fishing.

4.2.2 Fish & Fisheries

Effects on Fish and Fisheries under Alternative 2 relative to the No-Action Alternative will be slightly positive on the environment as salmon go uncaught, but have negative socioeconomic impacts on fisheries as catch is reduced. Reduced catch would result from enacting management measures described in Section 2.2.1 under Alternative 2. Alternative 2 would introduce further fishery restrictions from those currently defined in the FMP. This may reduce impacts on ESA-listed salmon compared with the status

quo, as additional restrictions are implemented based on the aggregate abundance of all Chinook salmon stocks in the NOF area, and are not stock specific. This is because Chinook salmon abundance also drives access to other species of salmon, and is considered when planning all salmon fisheries. Under Alternative 2, fisheries would continue to be managed consistent with biological opinions analyzing the effects of the fisheries on ESA-listed salmon, including the reasonable and prudent alternatives, and terms and conditions in the incidental take statements issued in conjunction with those opinions. Alternative 2 would add additional fishery restrictions, amounting to lower biological impacts on Chinook salmon than the No-Action alternative. Alternative 2 would reduce harvest in the ocean salmon fisheries less often than Alternative 3 but more often than the No-Action Alternative. The threshold of 966,000 TS1 NOF requires abundance management responses to be implemented in three out of 24 years (1994, 1998, and 2007) if applied retrospectively between 1993 and 2016 (Table 4-3). The reductions in fishing quotas in combination with enacting the suite of responses described in Alternative 2 (refer to Section 2.2.1 for details) result in the reduced catches estimated below in Table 4-4. For the three stratifications of the 24 years in the data set, two of the three events requiring a management response occurred in the 1992-2000 period. This explains why Table 4-4 indicates the largest reductions occur in this period. Inversely, because Table 4-3 indicates 2009-2016 did not contain a NOF TS1 abundance that fell below the threshold, Table 4-4 shows no difference from Alternative 1 since no management responses additionally employed specifically for SRKW would have been necessary. Because our retrospective analysis helps us predict impacts of the Alternatives moving forward, future years that have average abundance levels similar to that estimated for 1992-2000 would have more protections because they are years of low abundance, whereas, in the future when levels are above the threshold and considered relatively high, there would be no additional protective measures, similar to the retrospective time period between 2009 – 2016 that had pre-fishery abundances above the threshold. We do not expect these effects to be significant.

Table 4-3. Postseason estimates of TS1 (October 1) Chinook salmon abundance in the NOF area and whether a given year was above or below the Alternative 2 abundance threshold of 966,000 (reproduced from Appendix A, rounded to nearest 1,000).

Year	NOF TS1 Abundance	Threshold Determination
1992	1,038,000	ABOVE
1993	1,080,000	ABOVE
1994	813,000	BELOW
1995	1,023,000	ABOVE
1996	1,035,000	ABOVE
1997	1,144,000	ABOVE
1998	861,000	BELOW

Year	NOF TS1 Abundance	Threshold Determination
1999	1,047,000	ABOVE
2000	1,037,000	ABOVE
2001	1,922,000	ABOVE
2002	2,135,000	ABOVE
2003	1,961,000	ABOVE
2004	1,970,000	ABOVE
2005	1,479,000	ABOVE
2006	1,279,000	ABOVE
2007	947,000	BELOW
2008	1,254,000	ABOVE
2009	1,063,000	ABOVE
2010	1,941,000	ABOVE
2011	1,523,000	ABOVE
2012	1,553,000	ABOVE
2013	2,440,000	ABOVE
2014	1,976,000	ABOVE
2015	2,293,000	ABOVE
2016	1,439,000	ABOVE

Table 4-4. Average Chinook salmon catch by TS (season) in Washington, Oregon, and California if applying Alternative 2 retrospectively (from Appendix A).

Catch Area	Season	Time Period								
		Catch 1993-2000	Diff. from Alt 1	Diff. from Alt 3	Catch 2001 - 2008	Diff. from Alt 1	Diff. from Alt 3	Catch 2009-2016	Diff. from Alt 1	Diff. from Alt 3
Washington	TS1 (Oct-Apr)	1,582	0	0	2,265	0	0	1,891	0	0
	TS2 (May-Jun)	10,560	-319	3,333	38,360	-282	866	44,514	0	0
	TS3 (Jul-Sep)	10,320	319	-3,333	50,594	282	-866	56,932	0	0
	Annual (Oct-Sep)	22,462	0	0	91,219	0	0	103,337	0	0
Oregon	TS1 (Oct-Apr)	16,446	-5	10	51,560	-3	1	11,816	0	0
	TS2 (May-Jun)	51,419	0	0	72,014	0	0	32,489	0	0
	TS3 (Jul-Sep)	74,280	0	0	108,619	0	0	51,342	0	0
	Annual (Oct-Sep)	142,145	-5	10	232,193	-3	1	95,647	0	0
California	TS1 (Oct-Apr)	42,106	-2,241	4,234	21,054	0	99	10,264	0	0
	TS2 (May-Jun)	284,094	0	0	135,417	0	0	63,130	0	0
	TS3 (Jul-Sep)	232,427	0	0	195,019	0	0	83,947	0	0
	Annual (Oct-Sep)	558,627	-2,241	4,234	351,489	0	99	157,341	0	0

*Footnotes: Washington catch amounts correspond with Council NOF fisheries, Oregon catch amounts correspond to Council fisheries between Cape Falcon, OR and Horse Mountain, CA, and California catch amounts correspond to fisheries south of Horse Mountain, CA.

4.2.3 Marine Mammals

We expect no difference in effects on marine mammals, other than SRKW, from Alternative 2 from any of the other alternatives as the same number of vessels would participate in the fishery, and therefore the same gear interactions would occur. As discussed under the No Action Alternative, we do not expect any significant effects on marine mammals.

4.2.3.1 Southern Resident Killer Whales

We expect effects from Alternative 2 to be positive for SRKW, which may benefit from prey availability and accessibility increases from the potentially reduced direct overlap and competition between the fisheries and SRKW under this Alternative relative to Alternative 1, as Table 4-5 indicates increased abundance by the positive numbers in the columns comparing the two alternatives. These benefits would also only occur during years when management measures required by the Proposed Action were enacted. Any effects of Alternative 2on SRKW would not be significant. The benefits of increased prey availability and accessibility would occur during low Chinook salmon abundance when SRKW may be at higher risk. As described in Section 2.2, Alternative 2 includes a less restrictive threshold compared to Alternative 3, which would therefore be triggered at lower Chinook salmon abundance and would be triggered less often, and is done on an annual basis, which does not include the potential for a low abundance year to influence multiple years of management responses.

We explain above in Section 4.1.3.1 that at low Chinook salmon abundance, risk to SRKW may increase. Management responses under Alternative 2 would ensure that fisheries in years of low abundance could not have disproportionately high removals, and the responses adjust timing and areas for fisheries would be expected to reduce overlap of SRKW with the fisheries. The management responses are focused on seasonal movements and hot spots (see Figure 3-6 and Figure 3-7) for SRKW, with positive qualitative effects if implemented relative to the No-Action Alternative (Table 4-6). The management responses would potentially increase Chinook salmon abundance and reduce spatial/temporal overlap with the whales in both NOF and SOF areas with the intent of making prey more available and accessible across SRKW' geographic range. Improved availability and accessibility to prey as compared to Alternative 1 would support successful foraging, and contribute to SRKW's energetics, health, reproduction, and survival during low Chinook salmon abundance conditions as triggered by the threshold. Alternative 2 would also support the need for whales to have healthy available Chinook salmon stocks across their geographic range. As indicated by the negative numbers in the columns comparing Alternatives 2 and 3, Table 4-5 indicates this effect is less under Alternative 2 relative to Alternative 3. This is an expected result since it results in less frequent restrictions when retrospectively compared against Alternative 3

(Table 4-3). The results in Table 4-5 depict a majority of the overall resulting TS3 abundances post fishing increasing relative to the No-Action Alternative and decreasing from Alternative 3 and that the largest level of this effect occurs when retrospectively comparing the 1993-2000 period across alternatives. In two instances (WA and OR, TS3, 2001 – 2008) the abundance decreases by a small amount relative to the No-Action Alternative and increases by a small amount relative to Alternative 2. This is likely due to the effect of differing stock composition of non-treaty NOF troll catches between the spring and summer time periods, as different stocks have different distribution estimates for the proportion of the abundance that occurs in the NOF area during a given time period.

Again, because our retrospective analysis helps us predict impacts of the Alternatives moving forward, future years that have average abundance levels similar to that estimated for 1992-2000 would have more restrictions because they are years of low abundance, whereas, in the future when levels are above the threshold and considered relatively high, there would be no additional protective measures or restrictions for SRKW, similar to the retrospective time period between 2009 – 2016 that had pre-fishery abundances above the threshold.

Table 4-5. Average Chinook salmon Abundance after fishery removals, by TS (season), in Washington, Oregon, and California if applying Alternative 2 retrospectively (from Appendix A).

Catch Area	**Season**	**Time Period**								
		Abundance 1993-2000	**Diff. from Alt 1**	**Diff. from Alt 3**	**Abundance 2001 - 2008**	**Diff. from Alt 1**	**Diff. from Alt 3**	**Abundance 2009-2016**	**Diff. from Alt 1**	**Diff. from Alt 3**
Washington	TS1 (Oct-Apr)	988,764	255	-489	1,585,370	0	-11	1,760,845	0	0
	TS2 (May-Jun)	458,183	183	-863	731,757	67	-272	877,236	0	0
	TS3 (Jul-Sep)	488,632	98	-19	846,703	-10	71	1,111,859	0	0
Oregon	TS1 (Oct-Apr)	1,182,824	753	-1,466	1,518,268	8	-33	1,609,776	0	0
	TS2 (May-Jun)	678,153	644	-1,574	882,187	41	-182	902,216	0	0
	TS3 (Jul-Sep)	628,988	569	-961	801,473	-7	21	891,397	0	0
California	TS1 (Oct-Apr)	774,877	1,131	-2,169	812,737	3	-49	611,799	0	0
	TS2 (May-Jun)	542,233	1,292	-2,577	620,408	12	-96	439,504	0	0
	TS3 (Jul-Sep)	290,418	1,308	-2,524	351,680	1	-53	234,868	0	0

*Footnotes: Washington abundances correspond with Council NOF area, Oregon abundances correspond with OR coastal waters (Cape Falcon, OR to Horse Mountain, CA), and California abundances correspond to all waters south of Horse Mountain, CA.

Table 4-6. Table capturing summary of alternative comparisons for effect to SRKW (+ means increase in protections/improvements for the whales; = means no change in protections/improvements for the whales).

SRKW Protections	**Alt. 1**	**Alternative 2 compared to Alternative 1**							
Threshold implementation	X	**+ Threshold 966,000, lower threshold w/ potential to trigger less often compared to Alt. 2; less restrictive than Alt. 3 more restrictive than Alt. 1**							
Responses enacted		**1.a**	**2**	**3a, 3b**	**5a**	**5b**	**6a**	**6b**	**6c**
Reduced spatial/temporal overlap	=	=	+	+	+	+	+	+	=
Increased chinook salmon abundance	=	+ =	+ =	=	=	=	=	=	=
Increased chinook availability NOF	=	+ =	+	+	=	=	=	=	=
Increased chinook availability SOF	=	=	=	=	+	+	+	+	=
Support nutrition/body condition/fitness	=	+	+	+	+	+	+	+	=

Numeric values represent the responses enacted under each Alternative, described in detail in Section 2.3.1.

1.a. NOF non-treaty Chinook quotas	5.a SOF delay OR troll until April 1	6.a Closure of Monterey Oct 1 – March 31
2. Spring Quota split	5.b Closure of KMZ Oct 1 – March 31	6.b Extend Klamath Control Zone 6 miles seaward
3.a, 3.b NOF control zones closures	5.c Closure of Cape Falcon to Cape Meares Jan 1 – June 15	6.c Closure other control zones
4. NOF season time adjustments		

4.2.4 Socioeconomics

We expect socioeconomic effects to be negative relative to the No-action Alternative under Alternative 2, as catches would be restricted across the fishery resulting in decreases shown in Table 4-4. This Alternative allows more catch to occur in TS2 in the WA catch area, as shown in Table 4-4 when compared to Alternative 3. This is because the date restriction delaying the fishery opening until June 15 is relaxed; however, catch levels still decrease relative to Alternative 1. The negative socioeconomic effect relative to Alternative 3 is smaller as indicated by the positive values in the difference from Alternative 3 column in Table 4-4, meaning more catch occurs under this alternative when comparing the two action alternatives against each other. This illustrates the effect of relaxing the date restriction in response 4. However, we do not have data sufficient to calculate differences from Table 3-7 in expected relative income resulting from these expected effects. We do expect the magnitude on economic benefits to fishery-dependent communities would continue to vary year-to-year, but is not likely to be significant.

4.2.5 Cultural Resources

Under Alternative 2, effects on cultural resources would remain unchanged from the No-Action alternative, and therefore not significant. Salmon and SRKW would continue to provide cultural, ceremonial, and in the case of salmon, subsistence benefits to tribal communities on the West Coast. There are no changes to tribal fisheries under Alternative 2.

4.2.6 Environmental Justice

We could not detect differential impacts on minority populations, low-income populations, or Indian tribes under Alternative 2.

4.3 Alternative 3

4.3.1 Water Quality

Effects on Water Quality under Alternative 3 relative to the No-Action alternative are likely to be neutral to slightly positive to the environment in areas that close for fishing, but are likely too small to be significant. Relative to other alternatives, Alternative 3 will not have discernable alternate effects. Vessel participation levels will likely not change, but spatially redistribute during periods when management measures, such as area closures, restrict salmon fishing. This would constrict areas vessels could access, but the additional geographic area closed relative to accessible fishing area is small enough we do not anticipate changes to participation levels under similar conditions in any year and all the non-salmon fishery related vessel traffic that would still be moving through the area.

4.3.2 Fish & Fisheries

Effects on Fish and Fisheries under Alternative 3 relative to the No-Action Alternative will be slightly positive on the environment as salmon go uncaught but negative to fisheries as catch is reduced, but are not likely to be significant. Relative to the other Alternatives these effects will be largest under Alternative 3. Table 4-7 demonstrates how this Alternative would have restricted the fisheries more often when compared to Alternative 1 or 2 using the retrospective years, as abundance would have been below the threshold of 1,144,000 TS1 NOF abundance during 10 out of 24 years (1993-2000, 2007-2008) if applied retrospectively between 1993 and 2016. This is seven years more than the three years where additional management measures would be required under Alternative 2. We would assume moving forward that a similar number of years would include management measures. Implementing the entire suite of responses described in the Description of Alternatives (refer to Section 2.3.1 for details) would result in the reduced catches estimated below in Table 4-8 off OR and CA.

Table 4-7. Postseason estimates of TS1 (October 1) Chinook salmon abundance in the NOF area, running two-year geometric mean, and whether a given year was above or below the Alternative 3 abundance threshold of 1,144,000 (reproduced from Appendix A, rounded to nearest 1,000).

Year	NOF TS1 Abundance	2-yr Geometric Mean	Threshold Determination
1992	1,038,000	NA	NA
1993	1,080,000	1,058,000	BELOW
1994	813,000	937,000	BELOW
1995	1,023,000	912,000	BELOW
1996	1,035,000	1,029,000	BELOW
1997	1,144,000	1,088,000	BELOW
1998	861,000	993,000	BELOW
1999	1,047,000	949,000	BELOW
2000	1,037,000	1,042,000	BELOW
2001	1,922,000	1,412,000	ABOVE
2002	2,135,000	2,026,000	ABOVE
2003	1,961,000	2,047,000	ABOVE
2004	1,970,000	1,966,000	ABOVE
2005	1,479,000	1,707,000	ABOVE
2006	1,279,000	1,376,000	ABOVE
2007	947,000	1,100,000	BELOW
2008	1,254,000	1,089,000	BELOW
2009	1,063,000	1,154,000	ABOVE
2010	1,941,000	1,436,000	ABOVE
2011	1,523,000	1,719,000	ABOVE
2012	1,553,000	1,538,000	ABOVE
2013	2,440,000	1,947,000	ABOVE
2014	1,976,000	2,196,000	ABOVE
2015	2,293,000	2,129,000	ABOVE
2016	1,439,000	1,816,000	ABOVE

The analysis indicates implementing the responses under Alternative 3 shift catch from TS2 in WA to TS3 under this Alternative relative to Alternative 1. This is largely due to the delay of opening the fishery until June 15, which pushes the majority of catch that would have occurred prior to June 15 into the July – September time step (TS3). The modeling results in no net change to the total catch occurring per year as indicated by the annual difference from Alternative 1 in Table 4-8. This temporal shift effect in WA is larger in Alternative 3 (Table 4-8), when compared to Alternative 2 (Table 4-4) because management responses required under Alternative 3 (details in Section 2.3.1) indicate a hard delay of the fishery start date until June 15. The effects on OR and CA are solely confined to TS1 (Table 4-8) but do result in overall lower catches, as those effects are carried through by enacting seasonal closures.

Similar to Alternative 2, across the three stratifications of the 24 years in the data set, a management response would be required in two of the periods across the data set (Table 4-7). This explains why Table 4-8 demonstrates catch reductions occurring in both the 1993-2000 and 2001-2008 periods. Conversely, as indicated in Table 4-7 there were no years in the 2009 – 2016 period where the two-year geometric mean NOF TS1 abundance fell below the threshold. Therefore, Table 4-8 shows no difference from Alternative 1 in this period since no additional management responses employed specifically for SRKW would have been necessary because the pre-fisheries abundance levels were above the threshold. While more frequent than Alternative 2, this result across three separate decades is no different for Alternative 3 when comparing the periods that would reduce catch in Table 4-4 and Table 4-8.

Table 4-8. Average Chinook salmon catch by TS (season) in Washington, Oregon, and California if applying Alternative 3 retrospectively (from Appendix A).

Catch Area	Season	Time Period								
		Catch 1993-2000	Diff. from Alt 1	Diff. from Alt 2	Catch 2001-2008	Diff. from Alt 1	Diff. from Alt 2	Catch 2009-2016	Diff. from Alt 1	Diff. from Alt 2
Washington	TS1 (Oct-Apr)	1,582	0	0	2,265	0	0	1,891	0	0
	TS2 (May-Jun)	7,227	-3,653	-3,333	37,494	-1,148	-866	44,514	0	0
	TS3 (Jul-Sep)	13,653	3,653	3,333	51,460	1,148	866	56,932	0	0
	Annual (Oct-Sep)	22,462	0	0	91,219	0	0	103,337	0	0
Oregon	TS1 (Oct-Apr)	16,436	-15	-10	51,559	-4	-1	11,816	0	0
	TS2 (May-Jun)	51,419	0	0	72,014	0	0	32,489	0	0
	TS3 (Jul-Sep)	74,280	0	0	108,619	0	0	51,342	0	0
	Annual (Oct-Sep)	142,135	-15	-10	232,191	-4	-1	95,647	0	0
California	TS1 (Oct-Apr)	37,872	-6,475	-4,234	20,955	-99	-99	10,264	0	0
	TS2 (May-Jun)	284,094	0	0	135,417	0	0	63,130	0	0
	TS3 (Jul-Sep)	232,427	0	0	195,019	0	0	83,947	0	0
	Annual (Oct-Sep)	554,393	-6,475	-4,234	351,390	-99	-99	157,341	0	0

*Footnotes: Washington catch amounts correspond with Council NOF fisheries, Oregon catch amounts correspond to Council fisheries between Cape Falcon, OR and Horse Mountain, CA, and California catch amounts correspond to fisheries south of Horse Mountain, CA.

4.3.3 Marine Mammals

We expect no difference to marine mammals, other than SRKW, from Alternative 3 from any of the other alternatives as the same number of vessels would participate in the fishery, using the same gear type (hook and line gear), and therefore we expect interactions remaining unchanged from the effects expected under Alternative 1. As discussed under the Alternative 1, we do not expect any significant effects on marine mammals.

4.3.3.1 Southern Resident Killer Whales

We expect effects from Alternative 3 to be positive for SRKW, which may benefit from increased prey availability and accessibility under this alternative relative to Alternatives 1 and Alternative 2. However, we do not expect effects from Alternative 3 to be significant. Alternative 3 results in a greater number of years that require a management response when viewed retrospectively (Table 4-7). This means moving forward we would also expect a greater number of years that would require a response compared to Alternative 2. The increased accessibility to prey from effects from Alternative 3 result from a potential reduction in direct overlap and competition for resources between the fisheries and SRKW during years of relatively low Chinook salmon abundance. We explain above in Section 4.1.3.1 that at low Chinook salmon abundances, risk to SRKW likely increases. As described in Section 2.3.1 Alternative 3 includes the most restrictive threshold and incorporates a two-year geometric mean. Management responses would ensure that NOF fisheries in years of low abundance could not have disproportionately high removals and the management responses that adjust timing and area changes for fisheries are intended to reduce overlap between the fisheries and SRKW seasonal movements and hot spots (see Figure 3-6 and Figure 3-7). The management responses would potentially increase Chinook salmon abundance and reduce spatial/temporal overlap with SRKW in both NOF and SOF areas making prey more available and accessible. Given the potential that SRKW may increase their search area for better foraging opportunities in years with low Chinook salmon abundance, having responses implemented in both NOF and SOF would support Chinook salmon prey availability across SRKW's geographic range. Table 4-9 indicates improved availability and accessibility to prey as compared to Alternatives 1 and 2 would support successful foraging, and contribute to SRKW energetics, health, reproduction, and survival during high risk conditions as triggered by the threshold. However, the data are too limited to estimate the extent of the reduction of the effects on SRKW demographics in a quantitative manner, hence why qualitative protections or improvements for the whales based on the individual management responses are included in.Table 4-9, which indicates Alternative 3 has more positive impacts compared to Alternative 2.

Table 4-10 depicts resulting post-fishery abundances by TS, which indicate almost all abundances increasing relative to the No-Action Alternative, with the highest increases occurring when comparing to the 1993-2000 period. In two instances (WA and OR, TS3, 2001 – 2008) the abundance decreases by a small amount relative to the No-Action Alternative. This is likely due to the effect of differing stock composition of non-treaty NOF troll catches between the spring and summer time periods, as different stocks have different distribution estimates for the proportion of the abundance that occurs in the NOF area during a given time period. Similar to Alternative 2, implementation of the threshold under Alternative 3 would not have triggered a management response between 2009 and 2016 (Table 4-7), and therefore the abundances remain similar to Alternative 1 during this period, demonstrated in Table 4-10.

Table 4-9. Table capturing summary of alternative comparisons for effect to SRKW (+ means increase in protections/improvements for the whales; = means no change in protections/improvements for the whales).

SRKW Protections	Alt. 1	Alternative 3 compared to Alternative 1										Alternative 3 compared to Alternative 2									
Threshold implementation	X	**++ Threshold of 1,144,000, higher threshold with potential to trigger actions more often compared to Alternative 2; most restrictive**																			
Responses enacted		**1.a**	**2**	**3a, 3b**	**4**	**5a**	**5b**	**5c**	**6a**	**6b**	**6c**	**1.a**	**2**	**3a, 3b**	**4**	**5a**	**5b**	**5c**	**6a**	**6b**	**6c**
Reduced spatial/temporal overlap	=	=	++	++	++	++	++	++	++	++	=	=	=	=	+	=	=	+	=	=	=
Increased chinook salmon abundance	=	++ =	++ =	=	=	=	=	=	=	=	=	= =	= =	=	+	=	=	+	=	=	=
Increased chinook availability NOF	=	++ =	++	++	++	=	=	=	=	=	=	= =	=	=	+	=	=	+	=	=	=
Increased chinook availability SOF	=	=	=	=	=	++	++	++	++	++	=	=	=	=	=	=	=	+	=	=	=
Support nutrition/body condition/fitness	=	++	++	++	++	++	++	++	++	++	=	=	=	=	+	=	=	+	=	=	=

Numeric values represent the responses enacted under each Alternative, described in detail in Section 2.2.1.

1.a. NOF non-treaty Chinook quotas	5.a SOF delay OR troll until April 1	6.a Closure of Monterey Oct 1 – March 31
2. Spring Quota split	5.b Closure of KMZ Oct 1 – March 31	6.b Extend Klamath Control Zone 6 miles seaward
3.a, 3.b NOF control zones closures	5.c Closure of Cape Falcon to Cape Meares Jan 1 – June 15	6.c Closure other control zones
4. NOF season time adjustments		

Table 4-10. Average Chinook salmon abundance after fishery removals, by TS (season), in Washington, Oregon, and California if applying Alternative 3 retrospectively (from Appendix A).

Catch Area	Season	Time Period								
		Abundance 1993-2000	Diff. from Alt 1	Diff. from Alt 2	Abundance 2001-2008	Diff. from Alt 1	Diff. from Alt 2	Abundance 2009-2016	Diff. from Alt 1	Diff. from Alt 2
Washington	TS1 (Oct-Apr)	989,253	744	489	1,585,381	11	11	1,760,845	0	0
	TS2 (May-Jun)	459,045	1,046	863	732,028	339	272	877,236	0	0
	TS3 (Jul-Sep)	488,651	117	19	846,632	-81	-71	1,111,859	0	0
Oregon	TS1 (Oct-Apr)	1,184,290	2,219	1,466	1,518,301	40	33	1,609,776	0	0
	TS2 (May-Jun)	679,727	2,219	1,579	882,369	223	182	902,216	0	0
	TS3 (Jul-Sep)	629,949	1,530	961	801,452	-27	-21	891,397	0	0
California	TS1 (Oct-Apr)	777,046	3,300	2,169	812,786	52	49	611,799	0	0
	TS2 (May-Jun)	544,810	3,869	2,577	620,504	108	96	439,504	0	0
	TS3 (Jul-Sep)	292,942	3,832	2,524	351,733	54	53	234,868	0	0

*Footnotes: Washington abundances correspond with Council NOF area, Oregon abundances correspond with OR coastal waters (Cape Falcon, OR to Horse Mountain, CA), and California abundances correspond to all waters south of Horse Mountain, CA.

4.3.4 Socioeconomics

We expect socioeconomic effects to be negative, but not significant, under Alternative 3 relative to the No-action Alternative, since catches are restricted or delayed across the fishery as indicated in Table 4-8. While, these levels appear to be small, we also expect lower overall revenue for participants in the fishery as delaying openings would prohibit bringing fish to market until later in the year, very likely depressing the price fishermen would have been paid for salmon caught earlier in the calendar year and less overall opportunity to catch the quota or in fishing days. Again, similar to Alternative 2, we do not have data sufficient to calculate differences from Table 3-7 in expected relative income as a result of these expected effects, but expect the magnitude on economic benefits to fishery-dependent communities would continue to vary year-to-year.

4.3.5 Cultural Resources

Under Alternative 3, effects on cultural resources would remain unchanged from the No Action alternative, and therefore are not significant. Salmon and SRKW would continue to provide cultural, ceremonial, and in the case of salmon, subsistence benefits to tribal communities on the West Coast. There are no changes to tribal fisheries under Alternative 3.

4.3.6 Environmental Justice

We could not detect differential impacts on minority populations, low-income populations, or Indian tribes under Alternative 3.

4.4 Summary

Effects to the environment from implementing the alternatives has a general trend across all alternatives regarding their effects to the environment based on past patterns of effects from implementing the FMP. If we anticipate that Chinook salmon abundance moving forward reflects abundances in specific periods from the past, we can evaluate the potential for effects on fisheries and SRKW in future years:

- In a retrospective analysis, management responses under the thresholds under either Alternative 2 or Alternative 3 would have historically been applied most frequently between the 1992-2000 period, since this period exhibited the lowest pre-fisheries Chinook salmon abundance levels during the 24-year period between 1992 and 2016. Management responses would have been applied the least number of times between 2009-2016, as this was the period that experienced the highest levels of Chinook salmon abundance in the NOF area for TS1 (Table 4-4 and Table 4-7). This is consistent across all alternatives, and was not influenced by annually applying a threshold or calculating a threshold using a geometric mean but is simply a result of the abundances that

occurred prior to fishing in this period. No fishery responses would have been implemented between 2009 and 2016 under either Alternative 2 or Alternative 3 since all NOF TS1 Chinook salmon abundances in this period were above the thresholds in these alternatives (Table 4-4 and Table 4-7). Moving forward, this means we would assume Chinook salmon abundance levels would sometimes be relatively low, similar to that observed in 1992-2000, and would require the mandatory restrictions in the alternatives along with Chinook salmon specific conservation measures.

- applying Alternative 1 retrospectively would have constrained catch from what occurred historically (Table 4-1) in the NOF area. Again, anticipating Chinook salmon abundance will exhibit similar variation into the future, we anticipate Alternative 1 would increase Chinook salmon abundances available to SRKW compared to historical management regimes in the relative manner Table 4-2 demonstrates, but provides the smallest benefit of the Alternatives analyzed in this draft EA to SRKW, as no additional measures to address potential fishery overlap, either spatially or temporally are enacted, and no additional measures are implemented to address high risk conditions. Alternative 1 (the No-Action Alternative) has no anticipated additional effects on the ocean salmon fishery. We would expect no change in prey accessibility or foraging opportunities beyond levels expected under the current management regime, and no potential mitigation for high risk conditions for SRKW. Under Alterative 1, there would likely continue to be similar spatial and temporal overlap between the fisheries and SRKWs and potential competition for prey resources even in high risk years.
- applying Alternative 2 retrospectively with current FMP limits would reduce catch in OR and CA relative to what actually occurred, but as explained in Section 4.1.2 this is not adjusted for contemporary management, but we expect similar effects given the results in WA. Catch in WA does not appear to be reduced, but would be transferred to later in the season from what occurred historically (Table 4-4). These effects are less negative to the fishery relative to what occurs under Alternative 3, and would occur less frequently than Alternative 3 would require. However, this alternative does provide a benefit to SRKW by increasing prey availability and accessibility from the potentially reduced direct overlap and competition between Council managed salmon fisheries and SRKW under this Alternative relative to Alternative 1 (Table 4-6). These benefits of increased Chinook salmon prey availability and accessibility would occur during low Chinook salmon abundance when SRKW may be at higher risk. Alternative 2 enacts fishery closures temporally in SOF areas, and also addresses potential fishery overlap by enacting area closures where SRKW are known to occur (Figure 3-7 and Figure 3-9) similarly to Alternative 3, and each

of this effects are more beneficial to the SRKW than Alternative 1 (Table 4-6). Into the future the framework of Alternative 2 would provide a suite of management responses across the EEZ, supporting the need for SRKW to have healthy available Chinook salmon stocks across their geographic range, when the ocean exhibits poor Chinook salmon survival as demonstrated during the period of 1992-2000, but still accounts for potential more sudden downturns that might occur over a more stable period in Chinook salmon abundance demonstrated between 2001 and 2008.

- applying Alternative 3 retrospectively in conjunction with current FMP limits would reduce catch in OR and CA relative to what actually occurred rather than adjusting for Alternative 1 contemporary management, as explained in Section 4.1.2, while catch in WA would be transferred to later in the season from what occurred historically (Table 4-8). This Alternative would have the largest negative socioeconomic effects on the fishery from reductions in catch relative to all other alternatives, and would occur most frequently under Alternative 3. This alternative provides the largest benefit among all alternatives analyzed in this draft EA to SRKW with the largest increases in Chinook salmon abundances (Table 4-9 and Table 4-10), enactment of fishery closures temporally in SOF areas, and addresses potential fishery overlap by enacting area closures where SRKW are known to occur (Figure 3-7 and Figure 3-9) most frequently. Into the future Alternative 3 could disproportionately affect the fishery for the longest period of time during poor ocean conditions for Chinook salmon, as demonstrated between 1992 and 2000. Improved availability and accessibility to prey as compared to Alternatives 1 and 2 would support successful foraging, and contribute to SRKW energetics, health, reproduction, and survival during high risk conditions as triggered by the threshold.

5.0 Cumulative Effects

This chapter discusses the cumulative effects of the alternatives described in Chapter 2, Description of Alternatives, and analyzed in Chapter 4, Environmental Consequences, along with other past, present, and reasonably foreseeable future actions, considered against the existing condition of the affected environment (Chapter 3, Affected Environment). Cumulative effects are the effects "on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7).

5.1 Past, Present, and Reasonably Foreseeable Actions and Conditions

Chapter 3, Affected Environment, describes existing conditions for each resource and environmental justice and reflects the effects of past actions and present conditions. As described, past actions that contributed to the present condition of resources considered in this draft EA primarily include vessel operation, fishery management and fisheries. The following subsections describe the reasonably foreseeable actions and conditions related to these factors.

5.1.1 Climate Change

The changing climate is recognized as a long-term trend that is occurring throughout the world. These changes will affect the human environment and biological ecosystems within the analysis area (Ecology 2012; Mauger et al. 2015; NWFSC 2015; King County 2016; Krosby et al. 2016). Changes to organisms and their habitats are likely to include shifts in timing of life history events, changes in growth and development rates, and changes in habitat and ecosystem structure (Johannessen and Macdonald 2009; Littell et al. 2009; Krosby et al. 2016). The most heavily affected ecosystems and human activities along the Pacific coast are likely to be near areas having high human population densities and along the continental shelves off Oregon and Washington (Halpern et al. 2009).

The potential impacts of climate and oceanographic change on whales and other marine mammals would likely involve effects on habitat availability and food availability. Although few predictions of impacts on SRKWhave been made, it seems likely that any changes in weather and oceanographic conditions resulting in effects on salmon populations would have consequences for the whales. SRKW might shift their distribution in response to climate-related changes in their salmon prey.

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (ISAB 2007; Lindley et al. 2007; Crozier et al. 2008; Moyle et al. 2013; Wainwright and Weitkamp 2013).

In the marine ecosystem, salmon may be affected by warmer water temperatures, increased stratification of the water column, intensity and timing changes of coastal upwelling, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (ISAB 2007; Mauger et al. 2015). Salmon marine migration patterns could be affected by climate-induced contraction of thermally suitable habitat. Northward range shifts are a climate response expected in many marine species, including salmon (Cheung et al. 2015). However, salmon populations are strongly differentiated in the northward extent of their ocean migration, and hence would likely respond individualistically to widespread changes in sea surface temperature.

Prey species such as salmon are most likely to be affected through changes in food availability and oceanic survival (Benson and Trites 2002), with biological productivity increasing during cooler periods and decreasing during warmer periods (Hare et al. 1999; NMFS 2008). Also, range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "The Blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Pearcy 2002; Fisher et al. 2015).

The frequency of these extreme climate conditions associated with El Niño events or "blobs" are predicted to increase in the future with climate change (greenhouse forcing) (Di Lorenzo and Mantua 2016) and therefore, it is likely that long-term anthropogenic climate change would interact with inter-annual climate variability. Evidence suggests that 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 a local scale, provides an indication of the role they play in salmon survival in the ocean.

The predictions of climate change and effects described above are based on models used to estimate effects of climate change under a wide range of change scenarios (from low to high changes) (Mauger et al. 2015). In the near term (next 15 to 20 years), the actual effects and pace of climate change will become clearer as evidence of change accumulates. However, the effects of climate change are likely to be less pronounced in the near term compared to the long-term projections, and annual weather patterns (variation in seasonal temperatures and precipitation) in the near term may mask long-term trends (Ecology 2012).

5.1.2 Water Quality

Impacts of the Proposed Action on the salmon fishery and fish resources will vary year-to-year, depending on the forecast abundance of salmon in a particular year. Forecasts will largely determine the

duration and extent of salmon fisheries in that year, which will affect the level of participating vessels and subsequent future effects to water quality. Taking the expected impacts of the Proposed Action into account in addition to past, present, and reasonably foreseeable future actions, including climate change effects, no significant cumulative impacts are expected on water quality.

5.1.3 Fish & Fisheries

Taking the expected impacts of the Proposed Action into account in addition to past, present, and reasonably foreseeable future actions, including climate change, effects of all Alternatives on fish species and fisheries assume salmon abundance levels would sometimes be relatively low, similar to those observed in 1992-2000 and discussed in sections above.

We also anticipate that state fisheries managers would take action to close the state waters portions of the control zones as described in Section 2.2.1. As explained above, we analyzed the state management measures (area closures in state waters) in low abundance years in conjunction with the effects of the federal action, but still do not expect the inclusion to reach a level that would be cumulatively significant.

This would require additional mandatory restrictions in the Alternatives in those years that could benefit salmon species into the future, and at the same time negatively affect fisheries through reduced catch, but both at a level not expected to be cumulatively significant.

5.1.4 Marine Mammals

Ocean salmon fisheries will continue to be evaluated on an annual basis under section 118 of the MMPA and categorized in terms of level of incidental mortality and serious injury of marine mammals. As stated in section 4.1.3, ocean salmon fisheries off the West Coast states are currently in Category III—i.e., remote likelihood of or no known incidental mortality and serious injury of marine mammals and we do not expect significant cumulative effects to marine mammals from the Proposed Action.

5.1.4.1 Southern Resident Killer Whales

Taking the expected impacts of the Preferred Alternative into account in addition to past, present, and reasonably foreseeable future actions, the Preferred Alternative would provide a suite of management responses across the EEZ. No significant cumulative effects are expected in the future. The preferred alternative would support the need for SRKW to have healthy available Chinook salmon stocks across their geographic range, when the ocean exhibits poor Chinook salmon survival. Our analysis demonstrates this pattern of poor Chinook survival occurred during the period of 1992-2000, but the framework of salmon fishery restrictions in the preferred alternative leading to increased Chinook prey

for SRKW would also account for potential more sudden downturns that might occur over a more stable period in Chinook salmon abundance, such as was demonstrated between 2001 and 2008, which was a stable period with a single sudden downturn year (2007).

5.1.5 Socioeconomics

Future effects of the No-action Alternative would not change fishery management areas nor how commercial and recreational fishery participants conduct their fishing activities. The Preferred Alternative would likely result in somewhat negative economic effects in the long-term, in years when salmon abundance was very low and restricted catch and open areas, but any effects of the alternatives on socioeconomics would not be cumulatively significant.

The proposed action implements fishery closure zones and restrictions under specific environmental conditions, but does not implement ocean salmon fisheries. Ocean salmon fisheries are set each year through a separate action to establish annual management measures that are consistent with current stock abundance forecasts and which meet FMP and ESA-requirements to manage ocean salmon fishery impacts on salmon stocks. As previously described, the Proposed Action would be evaluated for its enactment every year, in conjunction with these other requirements, and our analysis indicates effects from the Preferred Alternative from implementing its mandatory measures during years of low abundances would have occurred in just three of the past season setting processes between 1992 and 2016 if applied retrospectively. Under the conditions where the threshold is triggered in Alternative 2 abundances are more indicative of poor ocean conditions for salmon survival, and therefore fisheries in these conditions are likely already constrained. Socioeconomic impacts, therefore, are more strongly affected by salmon abundance and are already coupled to expectations of decreases under conditions when abundances are low.

5.1.6 Cultural Resources

Effects on cultural resources would remain unchanged into the future. Salmon and SRKW would continue to provide cultural, ceremonial, and in the case of salmon, subsistence benefits to tribal communities on the West Coast. There are no changes to tribal fisheries under any of the alternatives, and we do expect cumulatively significant effects to cultural resources.

5.1.7 Environmental Justice

We could not detect differential cumulative impacts on minority populations, low-income populations, or Indian tribes under any of the alternatives.

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Appendix A: Description of modeling methods and results

Historical Postseason Data

Modeling Approach:

To estimate Chinook ocean abundances by region and time period we employed the same methodologies developed by the Pacific Fishery Management Council's (PFMC) Ad-Hoc Southern Resident Killer Whale Workgroup (Workgroup) and detailed in their Risk Assessment (PFMC 2020a). Throughout the development of their Risk Assessment, the Workgroup used 1992 – 2016 postseason data from the Fishery Regulation Assessment Model (FRAM) for stocks originating north of and including the Elk River in Oregon. The predominant Chinook salmon stocks originating south of the Elk River are Sacramento River Fall Chinook (SRFC), Klamath River Fall Chinook (KRFC), and Rogue River Fall Chinook (RRFC). Abundance and harvest estimates specific to these stocks were derived outside of FRAM, synthesized with FRAM-based information for all other stocks, then apportioned into ocean spatial regions based on distribution parameters derived from the Shelton et al. model (2019) to provide pre-fishery and post-fishery estimates of Chinook salmon abundance. Abundance estimates resulting from this analysis using 1992 – 2016 postseason data, in addition to Council area fishery catches, are provided below for the North of Falcon (Table A-1), Oregon Coast (Table A-2), and California Coast (Table A-3) areas. It is important to note that catches reported here are catches that occur within the specified area, however, due to the mobile nature of fish, they will ultimately affect Chinook abundances in other areas. Thus, differences in abundance noted in a specific area cannot necessarily be explained by the estimates of catch in that area.

Modeling Results:

Table A-1. Annual postseason estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the North of Falcon area (U.S./Canada border to Cape Falcon, OR). TS1 = October – April, TS2 = May – June, TS3 = July – September.

	NOF Estimated Chinook Abundance				NOF Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,079,615	1,045,887	465,670	421,539	9,682	37,971	31,326	78,979
1994	813,488	791,792	398,440	381,223	1,660	4,562	8	6,230
1995	1,023,198	991,387	484,698	467,373	1,113	698	9,688	11,499
1996	1,035,307	1,007,331	500,518	575,165	3,436	3,447	9,068	15,951
1997	1,144,316	1,118,131	487,710	478,690	520	14,751	10,008	25,279
1998	861,061	842,182	402,509	422,992	113	15,560	7,347	23,020
1999	1,046,805	1,034,290	485,256	506,302	362	29,752	27,073	57,187
2000	1,036,780	1,002,303	400,214	424,082	156	15,580	14,251	29,987
2001	1,921,684	1,886,315	785,169	902,696	1,374	33,964	46,885	82,223
2002	2,135,437	2,100,170	935,690	1,058,489	773	84,177	97,780	182,730
2003	1,961,415	1,898,643	894,305	1,020,144	309	54,998	86,399	141,706
2004	1,969,915	1,902,000	892,940	1,021,764	1,655	53,443	70,372	125,470
2005	1,479,393	1,413,182	684,366	756,839	15,618	52,702	74,385	142,705
2006	1,279,110	1,244,013	565,725	620,038	4,141	32,092	36,797	73,030
2007	946,536	921,998	405,130	408,658	2,815	26,056	22,136	51,006
2008	1,253,914	1,236,229	583,863	697,682	1,878	23,535	26,888	52,301
2009	1,062,589	1,050,785	498,243	592,216	846	17,701	20,787	39,334
2010	1,941,237	1,923,323	879,789	1,057,980	1,912	57,336	69,900	129,148
2011	1,522,915	1,506,132	707,861	859,299	3,138	33,396	58,983	95,517
2012	1,553,167	1,535,600	720,402	848,117	1,311	65,091	70,297	136,699
2013	2,440,330	2,425,163	1,346,850	1,848,496	2,139	60,051	63,861	126,051
2014	1,976,374	1,947,350	976,470	1,195,113	4,156	73,302	85,569	163,026
2015	2,292,952	2,264,874	1,172,537	1,541,178	3,626	76,927	90,231	170,784
2016	1,438,666	1,419,840	684,106	826,257	425	29,319	31,131	60,876
93-00	1,005,071	979,163	453,127	459,671	2,130	15,290	13,596	31,017
01-08	1,618,426	1,575,319	718,399	810,789	3,570	45,121	57,705	106,396
09-16	1,778,529	1,759,133	873,282	1,096,082	2,194	51,640	61,345	115,179

Table A-2. Annual postseason estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the Oregon Coast area (Cape Falcon, OR to Horse Mountain, CA). TS1 = October – April, TS2 = May – June, TS3 = July – September.

	OR Estimated Chinook Abundance				OR Council Area Fishery Catch			
Year	**TS1_Pre**	**TS1_Post**	**TS2_Post**	**TS3_Post**	**TS1**	**TS2**	**TS3**	**TS1-TS3**
1993	1,103,808	1,076,103	609,778	505,616	19,978	37,217	47,508	104,703
1994	888,401	871,832	508,804	429,196	7,112	28,739	3,050	38,901
1995	1,766,135	1,728,726	971,407	898,743	10,248	57,259	146,979	214,486
1996	1,372,109	1,333,995	781,725	747,121	31,622	82,145	107,511	221,278
1997	1,224,879	1,188,842	664,482	570,735	22,542	75,481	81,658	179,681
1998	969,254	948,404	559,423	527,556	27,314	77,486	31,716	136,516
1999	910,163	900,726	555,032	499,820	6,618	32,206	40,157	78,981
2000	1,429,234	1,403,928	767,678	756,009	6,170	20,821	135,658	162,649
2001	1,825,119	1,791,073	1,054,382	1,016,176	37,604	115,207	164,883	317,694
2002	2,383,448	2,339,287	1,338,929	1,273,186	38,119	102,785	159,966	300,870
2003	2,464,999	2,343,655	1,362,746	1,267,897	157,107	117,639	148,760	423,506
2004	1,963,439	1,858,565	1,014,353	777,684	100,520	79,531	211,936	391,987
2005	1,455,466	1,394,863	821,110	704,062	46,420	120,957	116,106	283,483
2006	900,401	873,859	511,834	422,206	19,779	20,980	22,540	63,299
2007	780,594	768,884	459,880	415,212	10,205	19,001	44,425	73,631
2008	747,397	740,763	436,148	410,313	2,749	9	335	3,093
2009	929,392	925,050	522,959	557,548	937	9	1,147	2,093
2010	1,524,308	1,515,300	834,547	872,854	558	18,615	11,051	30,224
2011	1,282,449	1,269,999	720,673	720,030	7,010	21,158	15,881	44,049
2012	1,928,808	1,912,534	1,122,087	1,119,588	7,403	40,445	71,592	119,440
2013	2,412,252	2,392,429	1,379,332	1,294,757	18,499	38,651	125,573	182,723
2014	1,889,278	1,855,918	1,049,349	951,864	26,783	89,911	114,792	231,486
2015	2,029,652	2,004,269	1,038,573	1,060,517	20,694	37,341	43,997	102,032
2016	1,008,122	993,660	532,725	502,105	12,640	13,782	26,706	53,128
93-00	1,207,998	1,181,570	677,291	616,849	16,451	51,419	74,280	142,149
01-08	1,565,108	1,513,869	874,923	785,842	51,563	72,014	108,619	232,195
09-16	1,625,533	1,608,645	900,031	884,908	11,816	32,489	51,342	95,647

Table A-3. Annual postseason estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the California Coast area (Horse Mountain, CA to U.S./Mexico border). TS1 = October – April, TS2 = May – June, TS3 = July – September.

	CA Estimated Chinook Abundance				**CA Council Area Fishery Catch**			
Year	**TS1_Pre**	**TS1_Post**	**TS2_Post**	**TS3_Post**	**TS1**	**TS2**	**TS3**	**TS1-TS3**
1993	606,752	583,250	400,827	156,469	29,093	167,304	188,476	384,873
1994	564,663	547,951	381,494	164,809	28,383	208,258	231,370	468,011
1995	1,222,002	1,170,998	768,200	338,347	96,480	546,871	428,429	1,071,780
1996	837,097	799,878	573,729	304,019	65,754	267,794	192,290	525,838
1997	910,480	872,450	602,694	312,760	60,262	345,034	299,580	704,876
1998	630,715	615,038	452,482	259,701	18,561	154,715	170,912	344,188
1999	674,586	666,843	522,273	353,591	13,379	171,260	158,201	342,840
2000	955,612	931,728	625,942	410,434	42,866	411,512	190,159	644,537
2001	1,011,524	990,501	825,012	556,049	28,035	104,586	141,672	274,293
2002	1,381,624	1,346,335	1,062,986	693,191	48,701	231,609	270,861	551,171
2003	1,286,377	1,227,765	938,777	543,712	14,870	208,687	348,164	571,721
2004	1,069,442	1,001,954	666,373	246,330	34,951	310,566	321,511	667,028
2005	881,144	851,129	649,768	360,739	19,018	127,479	310,776	457,273
2006	494,826	480,637	376,667	191,815	16,187	48,634	90,016	154,837
2007	366,515	360,340	257,723	115,524	5,543	51,772	77,149	134,464
2008	236,585	234,478	170,946	93,427	1,124	0	0	1,124
2009	274,777	273,529	195,768	103,466	0	0	0	0
2010	457,383	452,582	332,804	191,205	5,265	3,038	20,874	29,177
2011	459,597	453,521	332,603	183,756	5,522	20,274	80,101	105,897
2012	904,642	892,060	675,721	386,297	20,361	106,415	164,068	290,844
2013	1,126,427	1,112,585	800,713	437,983	19,223	183,519	169,980	372,722
2014	801,326	782,300	556,717	265,200	16,311	81,138	125,431	222,880
2015	590,492	578,361	381,118	184,138	9,207	78,097	58,936	146,240
2016	353,611	346,717	236,023	122,166	6,224	32,556	52,188	90,968
93-00	800,238	773,517	540,955	287,516	44,347	284,094	232,427	560,868
01-08	841,005	811,642	618,531	350,098	21,054	135,417	195,019	351,489
09-16	621,032	611,457	438,933	234,277	10,264	63,130	83,947	157,341

Alternative 1 – No-Action, Status Quo Scenario

Modeling approach:

To estimate fishery catches and resulting Chinook abundances that would occur under Alternative 1, the no-action alternative, we conducted a retrospective analysis based off of the postseason information in the previous section, under the assumption that Chinook abundances over the past 24 years are reflective of what we would expect to see in future years. For fisheries from Southeast Alaska (SEAK) to Cape Falcon, OR we modified the postseason fishery data in an effort to ensure compliance with some of the key contemporary conservation requirements that currently drive fishery planning. The ability to retrospectively apply similar analyses to fisheries South of Falcon fisheries was not possible.

1. *Aggregate Abundance Based Management (AABM) fisheries* – The 2019 Pacific Salmon Treaty (PST) Agreement identifies total allowable catch (TAC) limits for those fisheries that fall under the AABM regime, which include fisheries in SEAK (troll, net, sport), Northern British Columbia (troll and sport), and West Coast Vancouver Island (troll an sport). The allowable catches for each of these fisheries is derived based on an annual preseason Abundance Index (AI) that is derived from annual calibration of the PST Chinook Model. For this retrospective analysis, a set of AABM fishery inputs was developed for 1993 – 2016 that reflects the fishery limits contained in the 2019 PST Agreement. A time series of model derived AIs was compiled for each AABM fishery. For 1999 onward the preseason AIs were used, derived from the projections produced by the given year's calibration of the PSC Chinook model. Prior to 1999, however, preseason AIs do not exist, therefore postseason AIs were used, as produced by the 2020 calibration of the PSC Chinook model (old base period). These AIs were translated into TACs using tiers from Table 2 (for SEAK) and the equations in Appendix C (for NBC and WCVI) of Chapter 3, Annex IV, Article XV of the 2019 PST Agreement (PST 2020). Next in order to account for management error, an adjustment factor was applied to these TACs that was based on the mean and standard deviation of the observed management error specific to each fishery (defined as observed catch / preseason TAC, Table A-4). For example, if a fishery on average caught only 80 percent of what it was allowed, the TAC would be reduced similarly. Finally, these resulting TACs were allocated into gear and time step specific quotas using observed proportions from the validation runs.

Table A-4. Abundance Index, Total Allowable Catch (TAC), and management error adjusted TAC for Southeast Alaska (SEAK) all gear, Northern British Columbia (NBC) troll and sport, and West Coast Vancouver Island (WCVI) troll and sport fisheries.

	Abundance Index			Total Allowable Catch			TAC with Management Error		
Year	SEAK	NBC	WCVI	SEAK	NBC	WCVI	SEAK	NBC	WCVI
1993	1.58	1.35	0.70	266,585	178,000	91,700	266,585	124,600	86,547
1994	1.46	1.18	0.52	205,165	153,400	68,100	191,516	135,621	60,674
1995	1.03	0.95	0.42	140,323	123,500	47,200	140,323	117,325	40,200
1996	0.96	0.95	0.50	111,833	123,500	65,500	106,139	103,565	64,845
1997	1.22	1.09	0.58	205,165	141,700	76,000	203,113	111,097	68,064
1998	1.14	0.97	0.57	140,323	126,100	74,700	140,323	85,748	74,700
1999	1.15	1.12	0.60	140,323	145,600	78,600	140,323	131,040	77,822
2000	1.14	1.00	0.54	140,323	130,000	70,800	140,323	97,017	70,800
2001	1.14	1.02	0.66	140,323	132,600	86,500	140,323	107,406	86,500
2002	1.74	1.45	0.95	266,585	192,700	135,400	249,482	181,867	135,400
2003	1.79	1.48	0.85	266,585	197,100	111,400	266,585	147,825	84,847
2004	1.88	1.67	0.90	334,465	243,600	117,900	325,436	170,174	104,931
2005	2.05	1.69	0.88	334,465	246,600	115,300	334,465	231,804	115,300
2006	1.69	1.53	0.75	266,585	223,200	98,300	266,585	220,968	91,078
2007	1.60	1.35	0.67	266,585	178,000	87,800	266,585	153,861	79,020
2008	1.07	0.96	0.76	140,323	124,800	99,600	135,792	117,409	88,644
2009	1.33	1.10	0.72	205,165	143,000	94,300	205,165	111,540	94,300
2010	1.35	1.17	0.96	205,165	152,100	136,800	205,165	127,764	124,953
2011	1.69	1.38	1.15	266,585	182,400	192,100	247,314	164,160	172,890
2012	1.52	1.32	0.89	266,585	173,600	116,600	261,253	159,299	89,782
2013	1.20	1.10	0.77	140,323	143,000	100,900	140,323	135,891	90,968
2014	2.57	1.99	1.20	372,921	290,300	200,400	372,921	206,113	197,948
2015	1.45	1.23	0.85	205,165	160,400	111,400	190,620	158,796	82,903
2016	2.06	1.70	0.89	334,465	248,000	116,600	306,172	201,645	114,268

2. *Individual Stock Based Management (ISBM) fisheries* – All non-AABM fisheries within the Treaty area are designated as ISBM fisheries under the 2019 PST Agreement. These fisheries are evaluated relative to 2009-2015 calendar year exploitation rate (CYER) averages specific to stocks listed in Attachment I in Chapter 3, Annex IV, Article XV of the 2019 PST Agreement (PST 2020). The limit varies by stock, ranging from 100 percent of the 2009-2015 average CYER to 85 percent of the 2009 – 2015 average, and applies in years when a stock does not meet its management objective, or in all years for stocks without management objectives. For many stocks, the Agreement requires no reduction beyond the 2009 – 2015 CYER average, or the management objectives are likely to be met. For other stocks, however, reductions will need to occur relative to the 2009 – 2015 base period.
    a. *Canadian ISBM* – To best reflect a likely implementation of the 2019 Agreement, inputs were initially derived for all Canadian ISBM fisheries using 2009 – 2015 average rates (fishery scalers) from the postseason FRAM runs, as these rates should represent the average scenario that occurred during the CYER base years. Further, to meet Canadian ISBM obligations on U.S. Puget Sound stocks (87.5 percent of 2009 – 2015 CYER average) a 12.5 percent reduction was applied to the 2009 – 2015 average fishing rates for Canadian sport fisheries

that occur in the Strait of Juan de Fuca and north and south Strait of Georgia. To meet Canadian ISBM obligations on Canadian stocks, it was assumed that fishery modifications will occur in terminal areas, thus, no modifications were made to marine fisheries.

b. *U.S. ISBM* – For the purposes of informing this modeling exercise, stocks with U.S. ISBM fishery obligations were divided into three groups: (1) Canadian stocks, (2) Puget Sound Stocks, and (3) WA/OR coastal and Columbia River stocks.

    i. Canadian stocks included in Attachment I include Cowichan, Nicola, and Harrison. Management objectives are included for Cowichan and Harrison, however, neither of these stocks has a strong record of achieving its goal. Currently there is no management objective for Nicola. This means that the obligations for U.S. fisheries on these stocks (95 percent of the 2009 – 2015 average CYER) are likely to apply. To address these obligations in the retrospective modeling, a 5 percent reduction was applied to fishery inputs for tribal and non-tribal North of Falcon (NOF) troll fisheries, tribal and non-tribal net fisheries in commercial management areas 7 and 7A, 7B, and 7C, and sport fisheries in Marine Area 7. During the CYER base period of 2009 – 2015, these fisheries accounted for the majority of U.S. fishery impacts on the Cowichan (indicator for Lower Georgia Strait; 96 percent of total U.S. impacts), Nicola (indicator for Fraser Early; 92 percent of total U.S. impacts), and Harrison (indicator for Fraser Late, 76 percent of total U.S. impacts).

    ii. Puget Sound stocks included in Attachment I include Nooksack Spring, Skagit Spring, Skagit Summer/Fall, Stillaguamish, and Snohomish. Of these, Nooksack Spring, Stillaguamish, and Snohomish do not have identified management objective, thus the CYER limit (100 percent of 2009-2015 CYER average) applies in all years. To meet U.S. ISBM obligations on these stocks, all fisheries within Puget Sound were modeled using the 2009 – 2015 average fishery scalers from the validation runs.

    iii. Attachment I includes a variety of stocks originating from the WA and OR coasts and the Columbia River. Most of these stocks have a management objective and have a strong record of meeting their objectives. Those that don't are generally exposed to notable terminal fisheries. Thus for the purposes of this retrospective modeling exercise, it was assumed that, for WA/OR coastal and Columbia river stocks without management objectives and in situations where the remaining stocks were not expected to meet their objectives, fishery modifications would be made in terminal areas in order to ensure that U.S. ISBM obligations were met. As a result, no modifications were made to U.S. ocean fishery inputs (beyond those noted in the bullets above) to address U.S. ISBM obligations.

3. In addition to fishery limitations set forth within the 2019 PST Agreement, NOF Chinook fisheries are often restricted by ESA-related total exploitation rate limits on Lower Columbia River (LCR) natural tule Chinook. Annual total exploitation rate limits on LCR natural tule Chinook are determined annually based on an abundance-based management framework. The framework includes four tiers, where the total exploitation rate limit in a given year is set based on the forecasted abundance of the Lower River Hatchery (LRH) tule Chinook salmon stock in that year. A time series of exploitation rate limits was determined for 1992 – 2016 based on the historical forecasted LRH abundances in each year, compiled from Table I-1 of the PFMC's annual Preseason Report I document (e.g., PFMC 2020c). These limits were then compared to model predicted exploitation rates resulting from model runs that had incorporated modifications described in (1) and (2) above to address to the limits set forth in the 2019 PST agreement. To account for fishery impacts occurring in

the Columbia River we used postseason harvest rates on LRH tule Chinook for 1992 – 2016. In years where the predicted exploitation rate on LCR natural tules exceeded the limit, proportional reductions were applied to catches in all Council area NOF fisheries (tribal and non-tribal commercial and recreational) in addition to in-river fisheries until the limit was no longer exceeded.

Two other considerations that can limit NOF Chinook fisheries are coho (Queets, LCN) and Puget Sound Chinook. While these were not taken into consideration for this modeling exercise, they would only result in further reductions to fishery catches, suggesting that, if anything, the fishery catches modeled in this scenario could occasionally be higher than feasible based on other fishery limitations. Chinook salmon abundance estimates resulting from this Alternative 1 modeling scenario, in addition to Council area fishery catches, are provided below for the NOF (Table A-5), Oregon Coast (Table A-6), and California Coast (Table A-7) areas.

Modeling Results:

Table A-5. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the North of Falcon area (U.S./Canada border to Cape Falcon, OR) under Alternative 1. TS1 = October – April, TS2 = May – June, TS3 = July – September.[1]

	NOF Estimated Chinook Abundance				NOF Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,079,615	1,061,937	486,170	511,146	5,841	23,433	19,830	49,103
1994	813,488	802,582	408,430	436,601	1,577	4,361	8	5,946
1995	1,023,198	1,006,464	496,827	494,802	1,057	663	9,327	11,047
1996	1,035,307	1,014,426	477,586	573,297	3,264	3,277	8,645	15,186
1997	1,144,316	1,128,605	498,251	505,577	494	14,014	9,779	24,287
1998	861,061	848,005	404,810	443,061	97	13,419	6,445	19,962
1999	1,046,805	1,035,243	486,579	505,608	279	22,901	21,271	44,451
2000	1,036,780	1,010,808	405,346	438,175	50	4,966	4,697	9,712
2001	1,921,684	1,894,877	791,165	915,345	1,305	32,284	45,925	79,514
2002	2,135,437	2,106,416	944,590	1,089,659	639	80,980	94,960	176,579
2003	1,961,415	1,909,224	917,867	1,078,953	250	52,386	83,841	136,476
2004	1,969,915	1,916,594	912,934	1,078,388	1,513	50,806	68,192	120,512
2005	1,479,393	1,432,143	706,407	809,351	7,200	24,353	35,318	66,871
2006	1,279,110	1,252,543	574,809	649,210	3,541	27,746	32,382	63,669
2007	946,536	928,243	415,158	433,144	1,888	18,056	15,694	35,638
2008	1,253,914	1,242,915	590,586	719,651	1,784	22,521	26,186	50,492
2009	1,062,589	1,052,065	501,775	602,673	798	16,838	20,509	38,145
2010	1,941,237	1,926,009	884,429	1,069,775	1,724	49,725	68,232	119,681
2011	1,522,915	1,505,449	705,270	864,110	2,926	29,377	57,291	89,595
2012	1,553,167	1,536,242	721,358	846,905	1,224	54,012	67,261	122,497
2013	2,440,330	2,425,504	1,348,584	1,860,605	1,913	54,518	60,885	117,317
2014	1,976,374	1,949,905	984,907	1,228,151	2,936	51,705	63,537	118,178
2015	2,292,952	2,272,003	1,187,176	1,593,213	3,358	72,179	87,396	162,933
2016	1,438,666	1,419,581	684,390	829,440	248	27,760	30,345	58,354
93-00	1,005,071	988,509	458,000	488,533	1,582	10,879	10,000	22,462
01-08	1,618,426	1,585,369	731,690	846,713	2,265	38,642	50,312	91,219
09-16	1,778,529	1,760,845	877,236	1,111,859	1,891	44,514	56,932	103,337

1 - these values are reflective of historical management for SOF fisheries, not contemporary management.

Table A-6. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the Oregon Coast area (Cape Falcon, OR to Horse Mountain, CA) under Alternative 1. TS1 = October – April, TS2 = May – June, TS3 = July – September.[1]

	OR Estimated Chinook Abundance				OR Council Area Fishery Catch			
Year	**TS1_Pre**	**TS1_Post**	**TS2_Post**	**TS3_Post**	**TS1**	**TS2**	**TS3**	**TS1-TS3**
1993	1,103,808	1,077,107	615,513	542,693	19,978	37,217	47,508	104,703
1994	888,401	872,857	511,468	456,011	7,112	28,739	3,050	38,901
1995	1,766,135	1,729,329	974,126	907,530	10,248	57,259	146,979	214,486
1996	1,372,109	1,332,017	766,071	742,938	31,622	82,145	107,511	221,278
1997	1,224,879	1,189,615	667,543	580,294	22,542	75,481	81,658	179,681
1998	969,254	948,934	560,324	538,173	27,314	77,486	31,716	136,516
1999	910,163	900,300	555,261	498,794	6,618	32,206	40,157	78,981
2000	1,429,234	1,406,410	769,762	760,915	6,170	20,821	135,658	162,649
2001	1,825,119	1,793,224	1,056,810	1,020,041	37,604	115,207	164,883	317,694
2002	2,383,448	2,341,174	1,343,081	1,286,420	38,119	102,785	159,966	300,870
2003	2,464,999	2,349,682	1,377,016	1,295,368	157,107	117,639	148,760	423,506
2004	1,963,439	1,866,922	1,026,727	805,113	100,520	79,531	211,936	391,987
2005	1,455,466	1,402,943	833,091	726,998	46,420	120,957	116,106	283,483
2006	900,401	878,281	516,904	434,622	19,779	20,980	22,540	63,299
2007	780,594	770,871	464,159	424,234	10,205	19,001	44,425	73,631
2008	747,397	742,988	439,379	419,040	2,749	9	335	3,093
2009	929,392	925,504	524,621	561,556	937	9	1,147	2,093
2010	1,524,308	1,516,401	837,241	878,771	558	18,615	11,051	30,224
2011	1,282,449	1,270,724	719,516	721,782	7,010	21,158	15,881	44,049
2012	1,928,808	1,912,785	1,122,211	1,118,392	7,403	40,445	71,592	119,440
2013	2,412,252	2,393,091	1,380,228	1,298,882	18,499	38,651	125,573	182,723
2014	1,889,278	1,856,972	1,054,019	965,448	26,783	89,911	114,792	231,486
2015	2,029,652	2,008,604	1,046,980	1,082,652	20,694	37,341	43,997	102,032
2016	1,008,122	994,126	532,914	503,690	12,640	13,782	26,706	53,128
93-00	1,207,998	1,182,071	677,509	628,419	16,451	51,419	74,280	142,149
01-08	1,565,108	1,518,261	882,146	801,480	51,563	72,014	108,619	232,195
09-16	1,625,533	1,609,776	902,216	891,397	11,816	32,489	51,342	95,647

1 - these values are reflective of historical management for SOF fisheries, not contemporary management.

Table A-7. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the California Coast area (Horse Mountain, CA to U.S./Mexico border) under Alternative 1. TS1 = October – April, TS2 = May – June, TS3 = July – September.[1]

	CA Estimated Chinook Abundance				CA Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	606,752	583,630	402,140	161,407	29,093	167,304	188,476	384,873
1994	564,663	548,324	382,134	167,953	28,383	208,258	231,370	468,011
1995	1,222,002	1,171,267	768,828	339,935	96,480	546,871	428,429	1,071,780
1996	837,097	799,410	569,455	304,239	65,754	267,794	192,290	525,838
1997	910,480	872,752	603,441	313,967	60,262	345,034	299,580	704,876
1998	630,715	615,295	452,757	260,595	18,561	154,715	170,912	344,188
1999	674,586	666,839	522,334	353,551	13,379	171,260	158,201	342,840
2000	955,612	932,453	626,437	411,234	42,866	411,512	190,159	644,537
2001	1,011,524	991,099	825,639	556,719	28,035	104,586	141,672	274,293
2002	1,381,624	1,346,911	1,064,079	694,495	48,701	231,609	270,861	551,171
2003	1,286,377	1,229,178	942,451	546,226	14,870	208,687	348,164	571,721
2004	1,069,442	1,003,836	669,547	248,887	34,951	310,566	321,511	667,028
2005	881,144	853,018	652,838	362,941	19,018	127,479	310,776	457,273
2006	494,826	481,849	378,002	193,049	16,187	48,634	90,016	154,837
2007	366,515	360,939	258,828	116,678	5,543	51,772	77,149	134,464
2008	236,585	235,042	171,782	94,440	1,124	0	0	1,124
2009	274,777	273,660	196,185	103,927	0	0	0	0
2010	457,383	452,927	333,512	191,657	5,265	3,038	20,874	29,177
2011	459,597	453,764	332,337	183,903	5,522	20,274	80,101	105,897
2012	904,642	892,084	675,739	386,319	20,361	106,415	164,068	290,844
2013	1,126,427	1,112,806	800,957	438,452	19,223	183,519	169,980	372,722
2014	801,326	782,643	557,911	266,417	16,311	81,138	125,431	222,880
2015	590,492	579,603	383,306	186,092	9,207	78,097	58,936	146,240
2016	353,611	346,901	236,087	122,178	6,224	32,556	52,188	90,968
93-00	800,238	773,746	540,941	289,110	44,347	284,094	232,427	560,868
01-08	841,005	812,734	620,396	351,680	21,054	135,417	195,019	351,489
09-16	621,032	611,799	439,504	234,868	10,264	63,130	83,947	157,341

1 - these values are reflective of historical management for SOF fisheries, not contemporary management.

Alternative 2 – Abundance threshold (2020 NMFS Guidance)

Threshold Assessment:

Under Alternative 2 a low abundance threshold of 966,169 is established for the October 1 starting abundance in the NOF area, based on the mean of the seven lowest years observed between 1993 and 2016 (1994 – 1996, 1998 – 2000, and 2007). Additional management action becomes required when the predicted October 1 starting abundance in the NOF area falls below this threshold. Using postseason data from 1992 through 2016, the abundance fell below the threshold in 3 out of 24 years (1993 – 2000 and 2007 – 2008; Table A-8.).

Table A-8. Postseason estimates of October 1 Chinook abundance in the North of Falcon area and whether a given year was above or below the Alternative 2 abundance threshold of 966,169.

Year	NOF Oct 1 Abundance	Threshold Determination
1992	1,037,717	ABOVE
1993	1,079,609	ABOVE
1994	813,496	BELOW
1995	1,023,196	ABOVE
1996	1,035,299	ABOVE
1997	1,144,311	ABOVE
1998	861,060	BELOW
1999	1,046,803	ABOVE
2000	1,036,777	ABOVE
2001	1,921,698	ABOVE
2002	2,135,440	ABOVE
2003	1,961,412	ABOVE
2004	1,969,918	ABOVE
2005	1,479,392	ABOVE
2006	1,279,105	ABOVE
2007	946,551	BELOW
2008	1,253,919	ABOVE
2009	1,062,578	ABOVE
2010	1,941,244	ABOVE
2011	1,522,917	ABOVE
2012	1,553,163	ABOVE
2013	2,440,331	ABOVE
2014	1,976,380	ABOVE
2015	2,292,946	ABOVE
2016	1,438,662	ABOVE

Modeling Approach:

To assess the effects of Alternative 2 on Chinook abundance and on Council area fishery catches, we modified the Alternative 1 model runs to simulate implementation of the management responses identified in section 2.2.1 of the main document, where possible, in years of low abundance as identified

above. The modeling approach for Alternative 2 was identical to that of Alternative 3 (see description below) with the exception of different years identified as low abundance (Table A-8 and Table A-12Table A-0-8), and the elimination of management responses 4 (delayed opening of non-treaty NOF fisheries) and 5.c (closure of proposed SRKW Critical Habitat Area 1 between Cape Falcon and Cape Meares commensurate with the timing of the non-treaty NOF fishery delay). Chinook abundance estimates resulting from this Alternative 2 modeling scenario, in addition to Council area fishery catches, are provided below for the NOF (Table A-9), Oregon Coast (Table A-10), and California Coast (Table A-11) areas.

Modeling Results:

Table A-9. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the North of Falcon area (U.S./Canada border to Cape Falcon, OR) under Alternative 2. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	NOF Estimated Chinook Abundance				NOF Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,079,615	1,061,937	486,170	511,146	5,841	23,433	19,830	49,103
1994	813,488	802,582	408,430	436,601	1,577	4,361	8	5,946
1995	1,023,198	1,008,413	497,876	495,593	1,057	663	9,327	11,047
1996	1,035,307	1,014,426	477,586	573,297	3,264	3,277	8,645	15,186
1997	1,144,316	1,128,605	498,251	505,577	494	14,014	9,779	24,287
1998	861,061	848,005	405,173	443,017	97	10,863	9,001	19,962
1999	1,046,805	1,035,339	486,631	505,647	279	22,901	21,271	44,451
2000	1,036,780	1,010,808	405,346	438,175	50	4,966	4,697	9,712
2001	1,921,684	1,894,877	791,165	915,345	1,305	32,284	45,925	79,514
2002	2,135,437	2,106,416	944,590	1,089,659	639	80,980	94,960	176,579
2003	1,961,415	1,909,224	917,867	1,078,953	250	52,386	83,841	136,476
2004	1,969,915	1,916,594	912,934	1,078,388	1,513	50,806	68,192	120,512
2005	1,479,393	1,432,143	706,407	809,351	7,200	24,353	35,318	66,871
2006	1,279,110	1,252,543	574,809	649,210	3,541	27,746	32,382	63,669
2007	946,536	928,243	415,691	433,064	1,888	15,800	17,950	35,638
2008	1,253,915	1,242,918	590,589	719,654	1,784	22,521	26,186	50,492
2009	1,062,589	1,052,065	501,775	602,673	798	16,838	20,509	38,145
2010	1,941,237	1,926,009	884,429	1,069,775	1,724	49,725	68,232	119,681
2011	1,522,915	1,505,449	705,270	864,110	2,926	29,377	57,291	89,595
2012	1,553,167	1,536,242	721,358	846,905	1,224	54,012	67,261	122,497
2013	2,440,330	2,425,504	1,348,584	1,860,605	1,913	54,518	60,885	117,317
2014	1,976,374	1,949,905	984,907	1,228,151	2,936	51,705	63,537	118,178
2015	2,292,952	2,272,003	1,187,176	1,593,213	3,358	72,179	87,396	162,933
2016	1,438,666	1,419,581	684,390	829,440	248	27,760	30,345	58,354
93-00	1,005,071	988,764	458,183	488,632	1,582	10,560	10,320	22,462
01-08	1,618,426	1,585,370	731,757	846,703	2,265	38,360	50,594	91,219
09-16	1,778,529	1,760,845	877,236	1,111,859	1,891	44,514	56,932	103,337

Table A-10. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the Oregon Coast area (Cape Falcon, OR to Horse Mountain, CA) under Alternative 2. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	OR Estimated Chinook Abundance				OR Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,103,808	1,077,107	615,513	542,693	19,978	37,217	47,508	104,703
1994	888,401	872,857	511,468	456,014	7,112	28,739	3,050	38,901
1995	1,766,135	1,735,072	978,856	911,973	10,214	57,259	146,979	214,452
1996	1,372,109	1,332,017	766,071	742,938	31,622	82,145	107,511	221,278
1997	1,224,879	1,189,615	667,543	580,294	22,542	75,481	81,658	179,681
1998	969,254	948,934	560,515	538,062	27,314	77,486	31,716	136,516
1999	910,163	900,580	555,493	499,012	6,615	32,206	40,157	78,978
2000	1,429,234	1,406,410	769,762	760,915	6,170	20,821	135,658	162,649
2001	1,825,119	1,793,224	1,056,810	1,020,041	37,604	115,207	164,883	317,694
2002	2,383,448	2,341,174	1,343,081	1,286,420	38,119	102,785	159,966	300,870
2003	2,464,999	2,349,682	1,377,016	1,295,368	157,107	117,639	148,760	423,506
2004	1,963,439	1,866,922	1,026,728	805,114	100,520	79,531	211,936	391,987
2005	1,455,466	1,402,943	833,091	726,998	46,420	120,957	116,106	283,483
2006	900,401	878,281	516,904	434,622	19,779	20,980	22,540	63,299
2007	780,594	770,871	464,435	424,118	10,205	19,001	44,425	73,631
2008	747,400	743,049	439,431	419,102	2,726	9	335	3,070
2009	929,392	925,504	524,621	561,556	937	9	1,147	2,093
2010	1,524,309	1,516,401	837,241	878,772	558	18,615	11,051	30,224
2011	1,282,449	1,270,724	719,516	721,782	7,010	21,158	15,881	44,049
2012	1,928,808	1,912,785	1,122,211	1,118,392	7,403	40,445	71,592	119,440
2013	2,412,252	2,393,091	1,380,228	1,298,882	18,499	38,651	125,573	182,723
2014	1,889,278	1,856,972	1,054,019	965,448	26,783	89,911	114,792	231,486
2015	2,029,652	2,008,604	1,046,980	1,082,652	20,694	37,341	43,997	102,032
2016	1,008,122	994,126	532,914	503,690	12,640	13,782	26,706	53,128
93-00	1,207,998	1,182,824	678,153	628,988	16,446	51,419	74,280	142,145
01-08	1,565,108	1,518,268	882,187	801,473	51,560	72,014	108,619	232,193
09-16	1,625,533	1,609,776	902,216	891,397	11,816	32,489	51,342	95,647

Table A-11. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the California Coast area (Horse Mountain, CA to U.S./Mexico border) under Alternative 2. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	CA Estimated Chinook Abundance				CA Council Area Fishery Catch			
Year	**TS1_Pre**	**TS1_Post**	**TS2_Post**	**TS3_Post**	**TS1**	**TS2**	**TS3**	**TS1-TS3**
1993	606,752	583,630	402,140	161,407	29,093	167,304	188,476	384,873
1994	564,663	548,324	382,134	167,953	28,383	208,258	231,370	468,011
1995	1,222,002	1,179,893	778,644	349,913	79,496	546,871	428,429	1,054,796
1996	837,097	799,410	569,455	304,239	65,754	267,794	192,290	525,838
1997	910,480	872,752	603,441	313,967	60,262	345,034	299,580	704,876
1998	630,715	615,295	452,796	260,591	18,561	154,715	170,912	344,188
1999	674,586	667,260	522,815	354,040	12,433	171,260	158,201	341,894
2000	955,612	932,453	626,437	411,234	42,866	411,512	190,159	644,537
2001	1,011,524	991,100	825,639	556,719	28,035	104,586	141,672	274,293
2002	1,381,624	1,346,911	1,064,079	694,495	48,701	231,609	270,861	551,171
2003	1,286,377	1,229,178	942,452	546,226	14,870	208,687	348,164	571,721
2004	1,069,442	1,003,836	669,547	248,887	34,951	310,566	321,511	667,028
2005	881,145	853,018	652,838	362,941	19,018	127,479	310,776	457,273
2006	494,826	481,849	378,002	193,049	16,187	48,634	90,016	154,837
2007	366,515	360,939	258,898	116,672	5,543	51,772	77,149	134,464
2008	236,587	235,067	171,806	94,452	1,124	0	0	1,124
2009	274,777	273,660	196,185	103,927	0	0	0	0
2010	457,383	452,927	333,512	191,657	5,265	3,038	20,874	29,177
2011	459,597	453,764	332,337	183,903	5,522	20,274	80,101	105,897
2012	904,642	892,084	675,739	386,319	20,361	106,415	164,068	290,844
2013	1,126,427	1,112,806	800,957	438,452	19,223	183,519	169,980	372,722
2014	801,326	782,643	557,911	266,417	16,311	81,138	125,431	222,880
2015	590,492	579,603	383,306	186,092	9,207	78,097	58,936	146,240
2016	353,611	346,901	236,087	122,178	6,224	32,556	52,188	90,968
93-00	800,238	774,877	542,233	290,418	42,106	284,094	232,427	558,627
01-08	841,005	812,737	620,408	351,680	21,054	135,417	195,019	351,489
09-16	621,032	611,799	439,504	234,868	10,264	63,130	83,947	157,341

Alternative 3 – Abundance threshold (most restrictive)

Threshold Assessment:

Under Alternative 3 a low abundance threshold of 1,144,311 is established for the October 1 starting abundance in the NOF area, based on the maximum observed value between 1995 and 2000. Additional management action becomes required when the recent 2-year geometric mean of October 1 starting abundance in the NOF area falls below this threshold. Using postseason data from 1992 through 2016, the 2-year geometric mean abundance fell below the threshold in 10 out of 24 years (1993 – 2000 and 2007 – 2008; Table A-12). We are unable to assess 1992 due to lack of 1991 data necessary to calculate the 2-year geometric mean.

Table A-12. Postseason estimates of October 1 Chinook abundance in the North of Falcon area, running 2-year geometric mean, and whether a given year was above or below the Alternative 3 abundance threshold of 1,144,311.

Year	NOF Oct 1 Abundance	2-yr Geometric Mean	Threshold Determination
1992	1,037,717	NA	NA
1993	1,079,609	1,058,456	BELOW
1994	813,496	937,154	BELOW
1995	1,023,196	912,341	BELOW
1996	1,035,299	1,029,230	BELOW
1997	1,144,311	1,088,441	BELOW
1998	861,060	992,633	BELOW
1999	1,046,803	949,400	BELOW
2000	1,036,777	1,041,778	BELOW
2001	1,921,698	1,411,514	ABOVE
2002	2,135,440	2,025,752	ABOVE
2003	1,961,412	2,046,577	ABOVE
2004	1,969,918	1,965,661	ABOVE
2005	1,479,392	1,707,127	ABOVE
2006	1,279,105	1,375,608	ABOVE
2007	946,551	1,100,335	BELOW
2008	1,253,919	1,089,448	BELOW
2009	1,062,578	1,154,291	ABOVE
2010	1,941,244	1,436,219	ABOVE
2011	1,522,917	1,719,405	ABOVE
2012	1,553,163	1,537,966	ABOVE
2013	2,440,331	1,946,852	ABOVE
2014	1,976,380	2,196,138	ABOVE
2015	2,292,946	2,128,787	ABOVE
2016	1,438,662	1,816,253	ABOVE

Modeling Approach:

To assess the effects of Alternative 3 on Chinook salmon abundance and on Council area fishery catches, we modified the Alternative 1 model runs to simulate implementation of the management responses

identified in Section 2.3.1 of the main document, where possible, in years of low abundance as identified above.

1. *Further limit NOF non-treaty Chinook salmon quotas* – this management response was implemented by applying a limit to NOF non-treaty Chinook quotas (including both commercial and recreational) in low abundance years that was based on a regression relationship between October 1 NOF abundance and the non-treaty quota in a given year (Figure A-1). The non-treaty NOF quota exceeded the regression-based limit in three of the 10 years of low abundance, however, in all three of those years the actual landed catch was less than the regression-based quota (Table A-13). Thus, no fishery modifications were needed to implement this management response in the simulation modeling, as actual catches in all years fell within the allowable limits.

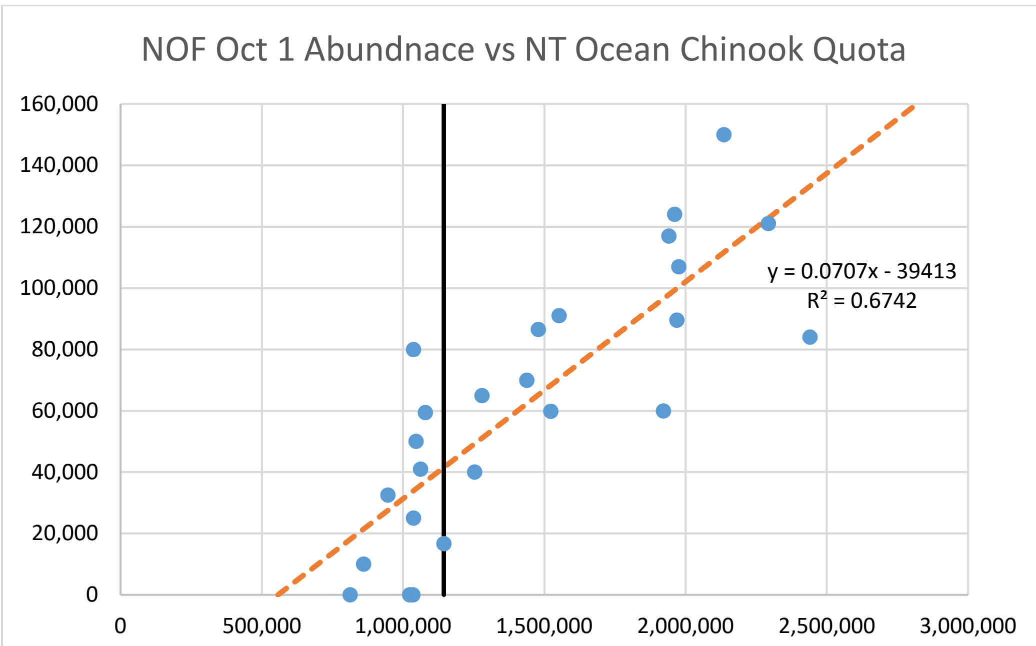

Figure A-1. Regression relationship between non-treaty North of Falcon Chinook quotas and postseason estimates of October 1 Chinook abundance in the North of Falcon area. The orange dashed line represents the regression line and the horizontal black line represents the abundance threshold of 1,144,311.

Table A-13. Chinook salmon abundances, non-treaty NOF quotas, regression-based quota limits, and actual catch in non-treaty NOF fisheries for 1992-2016. Years highlighted are those identified as low abundance under this alternative, while those in bold indicate years where the actual quota exceeded the regression-based limit.

Year	NOF Oct 1 Abundance	Non-Treaty Quota	Regression-based Quota	Non-Treaty Actual Catch
1992	***1,037,717***	***80,000***	***33,999***	***42,511***
1993	***1,079,609***	***59,400***	***36,962***	***27,800***
1994	813,496	0	18,137	0
1995	1,023,196	0	32,971	621
1996	1,035,299	0	33,828	205
1997	1,144,311	16,700	41,539	10,276
1998	861,060	10,000	21,501	7,192
1999	***1,046,803***	***50,000***	***34,641***	***23,040***
2000	1,036,777	25,000	33,932	7,224
2001	1,921,698	60,000	96,534	50,780
2002	***2,135,440***	***150,000***	***111,655***	***138,078***
2003	***1,961,412***	***124,000***	***99,344***	***102,798***
2004	1,969,918	89,500	99,946	71,737
2005	***1,479,392***	***86,500***	***65,244***	***40,242***
2006	***1,279,105***	***65,000***	***51,075***	***33,723***
2007	***946,551***	***32,500***	***27,549***	***17,845***
2008	1,253,919	40,000	49,293	28,818
2009	***1,062,578***	***41,000***	***35,757***	***25,708***
2010	***1,941,244***	***117,000***	***97,917***	***87,058***
2011	1,522,917	59,800	68,323	56,450
2012	***1,553,163***	***91,000***	***70,463***	***69,855***
2013	2,440,331	84,000	133,224	67,988
2014	***1,976,380***	***107,000***	***100,403***	***70,534***
2015	2,292,946	121,000	122,798	103,871
2016	***1,438,662***	***70,000***	***62,363***	***36,379***

2. *Attain NOF non-treaty quota incrementally over time* – this management response was implemented by limiting the proportion of total non-treaty NOF commercial troll catch that occurs in the spring time period (May-June) to 50 percent. In years of low abundance where the proportion of total non-treaty NOF commercial troll catch was greater than 50 percent, this was accomplished by transferring catch from the May-June time period into to the July-September time period until the proportion in spring was no more than 50 percent. It is important to note that, in years where this response was required, it was implemented after consideration of response (4) below, as that response had the potential to affect the spring/summer distribution of non-treaty NOF commercial troll catch.
3. *NOF area control zones* – while the actions associated with this management response are understood to provide a benefit to SRKW in the form of reduced fishery removals and, in turn, increased Chinook abundance in areas of importance to SRKW foraging, the effects are not quantifiable using existing models and assessment methods, as they occur at too fine a spatial scale. Given the mobility of fishing fleets, we do not expect that this action would result in an overall reduction to effort and catch, rather a spatial shift of effort and catch from one area to another within the larger fishery strata that are represented in the model.
4. *NOF non-treaty start/end time adjustments* – this management response called for delaying the opening of non-treaty NOF fisheries until June 15. To implement this, we used monthly catches as

reported in appendix tables A.13 and A.18 of the PFMC's Review of 2019 Ocean Salmon Fisheries (PFMC 2020b) and additional information provided by WDFW (pers. Comm. W. Beeghley, WDFW, Table A-14) on daily non-treaty commercial troll catches during June for 1992 – 2016 to determine the proportion of June catch each year that occurred before June 15. With this information we were able to determine the amount of catch in each non-treaty NOF fishery that occurred prior to June 15. In the majority of years, recreational fisheries did not occur prior to June 15. In years where recreational catch did occur in June, the WDFW sport fishing regulations for that year were referenced to determine what proportion of the effort occurred prior to June 15. In implementing this management response we assumed that it would not result in an overall reduction to catch, thus in years of low abundances where implementation of this response was required, we transferred any catch that occurred prior to June 15 to after June 15 based on proportions of existing catches in Alternative 1.

Table A-14. Proportion of June non-treaty NOF commercial troll catch occurring prior to June 15, by subarea.

Year	Columbia River Subarea	Westport Subarea	La Push and Neah Bay Subareas
1992	1.00	0.72	0.63
1993	1.00	0.83	0.84
1994	0.00	0.00	0.00
1995	0.00	0.00	0.00
1996	0.00	0.00	0.00
1997	0.00	0.87	0.42
1998	0.00	0.00	1.00
1999	0.00	0.93	0.86
2000	0.00	0.00	1.00
2001	1.00	0.66	0.69
2002	1.00	1.00	0.99
2003	0.93	0.91	0.93
2004	0.00	0.00	0.00
2005	0.81	0.76	0.73
2006	0.99	0.89	0.96
2007	0.89	0.04	0.29
2008	0.70	0.13	0.19
2009	0.27	0.85	0.73
2010	0.75	0.79	0.55
2011	0.89	0.48	0.53
2012	0.43	0.74	0.57
2013	0.69	0.81	0.00
2014	0.62	0.13	0.55
2015	0.00	0.11	0.43
2016	0.27	0.27	0.91

5. *Oregon management responses* – there are three management responses identified by the state of Oregon that would be implemented in years of low abundance under this alternative:
    a. *Delay OR SOF troll until April 1* – this management response would prohibit opening of the commercial troll fishery between Cape Falcon and Humbug Mountain prior to April 1 in years of low abundance. These pre-April fisheries occur infrequently and are generally contingent on favorable abundance forecasts of Sacramento and Klamath fall Chinook. Over

the 1992 – 2016 time period included in this assessment, SOF commercial troll fisheries occurred prior to April 1 from 2002 – 2005, none of which were designated as low abundance years under this Alternative. Thus, no fishery modifications were needed to implement this management response in the simulation modeling.

b. *Close OR Klamath Management Zone (KMZ) from October 1 through the following March 31* – this management response would prohibit both commercial and recreational fishing between Humbug Mountain and the OR/CA border from October 1 in the year a low abundance is projected through March 31 of the following year, with the exception of terminal State fisheries such as those that occur at the mouth of the Chetco River. Implementation of this management response occurred in two parts:
    i. First, to inform modifications to FRAM fishery inputs, we obtained monthly troll and sport catches that occurred in the OR KMZ between October and March in each year from appendix tables A.8 and A.10 of the PFMC's Review of 2019 Ocean Salmon Fisheries (PFMC 2020b). In addition to this, since these monthly estimates include catch that occurs in the terminal State fishery at the mouth of the Chetco River which would not close as part of this management response, catches specific to these fisheries were provided by ODFW (pers. comm. C. Foster, ODFW) and removed from the totals. The remaining non-terminal October – March troll and sport catches in the OR KMZ are then removed from the existing fishery catches that were modeled in Alternative 1.
    ii. The SRFC, KRFC, and RRFC stocks are handled externally to FRAM, using cohort reconstruction methodologies to estimate monthly cohort sizes, as identified in the Workgroup Risk Assessment (PFMC 2020a). To assess the effects of this management response in low abundance years, stock specific estimates of harvest (SRFC) and impacts (KRFC, RRFC) occurring in the OR KMZ between October 1 and March 31 were removed from monthly total harvest/impact estimates (summed across areas and gears) and cohort reconstructions were re-computed with the resulting reduced harvest/impact estimates. Harvest and impacts were provided by the SWFSC (pers. comm. M. O'Farrell, SWFSC) for SRFC and KRFC, respectively, stratified by year, month, gear type, and management area. Rogue River fall Chinook impacts were estimated using monthly KRFC harvest rates as a surrogate.

c. *Closure of proposed SRKW Critical Habitat Area 1 between Cape Falcon and Cape Meares through June 15th* – this management response is intended to be implemented in concert with (4) above. However, similar to (3) above, while the actions associated with this management response are understood to provide a benefit to SRKW in the form of reduced fishery removals (and, in turn, increased Chinook abundance) in areas of importance to SRKW foraging, the effects are not quantifiable using existing models and assessment methods, as they occur at too fine a spatial scale. Given the mobility of fishing fleets, we do not expect that this action would result in an overall reduction to effort and catch, rather a spatial shift of effort and catch from one area to another within the larger fishery strata that are represented in the model.

6. *California management responses* – there are three management responses identified by the state of California that would be implemented in years of low abundance under this alternative:
    a. *Close CA KMZ and Monterey fishing areas from October 1 through the following March 31* – this management response would prohibit commercial and recreational fishing in both the

CA KMZ (OR/CA border to Horse Mountain[7]) and Monterey (Pigeon Point to U.S./Mexico border) from October 1 in the year a low abundance is projected through March 31 of the following year. Similar to (5.b) above, implementation of this management response occurred in two parts:

i. First, to inform modifications to FRAM fishery inputs, we obtained monthly troll and sport catches that occurred in the CA KMZ and Monterey fishing areas between October and March in each year from appendix tables A.3 and A.5 of the PFMC's Review of 2019 Ocean Salmon Fisheries (PFMC 2020b). These catches are then removed from the existing fishery catches that were modeled in the no-action alternative.

ii. The SRFC, KRFC, and RRFC stocks are handled externally to FRAM, using cohort reconstruction methodologies to estimate monthly cohort sizes, as identified in the Workgroup Risk Assessment (PFMC 2020a). To assess the effects of this management response in low abundance years, stock specific estimates of harvest (SRFC) and impacts (KRFC, RRFC) occurring in the CA KMZ and Monterey areas between October 1 and March 31 were removed from monthly total harvest/impact estimates (summed across areas and gears) and cohort reconstructions were re-computed with the resulting reduced harvest/impact estimates. Harvest and impacts were provided by the SWFSC (pers. comm. M. O'Farrell, SWFSC) for SRFC and KRFC, respectively, stratified by year, month, gear type, and management area. Rogue River fall Chinook impacts were estimated using monthly KRFC harvest rates as a surrogate.

b. *Extend the Klamath River Control Zone* - similar to (3) above, while the actions associated with this management response are understood to provide a benefit to SRKW in the form of reduced fishery removals (and, in turn, increased Chinook abundance) in areas of importance to SRKW foraging, the effects are not quantifiable using existing models and assessment methods, as they occur at too fine a spatial scale. Given the mobility of fishing fleets, we do not expect that this action would result in an overall reduction to effort and catch, rather a spatial shift of effort and catch from one area to another within the larger fishery strata that are represented in the model.

c. *Ensure other CA control zones are in effect year-round* - similar to (3) above, while the actions associated with this management response are understood to provide a benefit to SRKW in the form of reduced fishery removals (and, in turn, increased Chinook abundance) in areas of importance to SRKW foraging, the effects are not quantifiable using existing models and assessment methods, as they occur at too fine a spatial scale. Given the mobility of fishing fleets, we do not expect that this action would result in an overall reduction to effort and catch, rather a spatial shift of effort and catch from one area to another within the larger fishery strata that are represented in the model.

Chinook salmon abundance estimates resulting from this Alternative 3 modeling scenario, in addition to Council area fishery catches, are provided below for the NOF (Table A-15), Oregon Coast (Table A-16), and California Coast (Table A-17) areas.

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[7] Note that as part of Amendment 20 of the Pacific Coast Salmon Fishery Management Plan the southern boundary of the California Klamath Management Zone is proposed to shift 5 miles north from Horse Mountain (40° 05' N. lat.) to 40° 10' N. lat.

Modeling Results:

Table A-15. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the North of Falcon area (U.S./Canada border to Cape Falcon, OR) under Alternative 3. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	NOF Estimated Chinook Abundance				NOF Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,079,615	1,061,937	488,207	510,453	5,841	12,652	30,611	49,103
1994	813,488	803,018	408,666	436,780	1,577	4,361	8	5,946
1995	1,023,198	1,008,413	497,876	495,593	1,057	663	9,327	11,047
1996	1,035,307	1,015,612	478,235	573,789	3,264	3,277	8,645	15,186
1997	1,144,316	1,130,555	499,789	506,197	494	10,952	12,841	24,287
1998	861,061	848,344	405,722	443,113	97	8,307	11,557	19,962
1999	1,046,805	1,035,339	488,032	505,294	279	15,544	28,628	44,451
2000	1,036,780	1,010,808	405,837	437,987	50	2,056	7,606	9,712
2001	1,921,684	1,894,965	791,212	915,381	1,305	32,284	45,925	79,514
2002	2,135,437	2,106,416	944,590	1,089,659	639	80,980	94,960	176,579
2003	1,961,415	1,909,224	917,867	1,078,953	250	52,386	83,841	136,476
2004	1,969,915	1,916,594	912,934	1,078,388	1,513	50,806	68,192	120,512
2005	1,479,393	1,432,143	706,407	809,351	7,200	24,353	35,318	66,871
2006	1,279,110	1,252,543	574,809	649,210	3,541	27,746	32,382	63,669
2007	946,536	928,243	416,172	432,783	1,888	14,082	19,669	35,638
2008	1,253,915	1,242,918	592,234	719,328	1,784	17,312	31,395	50,492
2009	1,062,589	1,052,065	501,775	602,673	798	16,838	20,509	38,145
2010	1,941,237	1,926,009	884,429	1,069,775	1,724	49,725	68,232	119,681
2011	1,522,915	1,505,449	705,270	864,110	2,926	29,377	57,291	89,595
2012	1,553,167	1,536,242	721,358	846,905	1,224	54,012	67,261	122,497
2013	2,440,330	2,425,504	1,348,584	1,860,605	1,913	54,518	60,885	117,317
2014	1,976,374	1,949,905	984,907	1,228,151	2,936	51,705	63,537	118,178
2015	2,292,952	2,272,003	1,187,176	1,593,213	3,358	72,179	87,396	162,933
2016	1,438,666	1,419,581	684,390	829,440	248	27,760	30,345	58,354
93-00	1,005,071	989,253	459,045	488,651	1,582	7,227	13,653	22,462
01-08	1,618,426	1,585,381	732,028	846,632	2,265	37,494	51,460	91,219
09-16	1,778,529	1,760,845	877,236	1,111,859	1,891	44,514	56,932	103,337

Table A-16. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the Oregon Coast area (Cape Falcon, OR to Horse Mountain, CA) under Alternative 3. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	OR Estimated Chinook Abundance				OR Council Area Fishery Catch			
Year	TS1_Pre	TS1_Post	TS2_Post	TS3_Post	TS1	TS2	TS3	TS1-TS3
1993	1,103,808	1,077,107	616,769	542,050	19,978	37,217	47,508	104,703
1994	888,401	874,142	512,536	457,017	7,112	28,739	3,050	38,901
1995	1,766,135	1,735,072	978,856	911,973	10,214	57,259	146,979	214,452
1996	1,372,109	1,335,691	769,144	745,870	31,603	82,145	107,511	221,259
1997	1,224,879	1,195,367	672,636	584,566	22,529	75,481	81,658	179,668
1998	969,254	949,948	561,553	538,749	27,314	77,486	31,716	136,516
1999	910,163	900,580	556,318	498,691	6,615	32,206	40,157	78,978
2000	1,429,234	1,406,410	770,005	760,674	6,123	20,821	135,658	162,602
2001	1,825,119	1,793,485	1,057,023	1,020,241	37,595	115,207	164,883	317,685
2002	2,383,448	2,341,174	1,343,081	1,286,420	38,119	102,785	159,966	300,870
2003	2,464,999	2,349,682	1,377,016	1,295,368	157,107	117,639	148,760	423,506
2004	1,963,439	1,866,922	1,026,728	805,114	100,520	79,531	211,936	391,987
2005	1,455,466	1,402,943	833,091	726,998	46,420	120,957	116,106	283,483
2006	900,401	878,281	516,904	434,622	19,779	20,980	22,540	63,299
2007	780,594	770,871	464,702	423,990	10,205	19,001	44,425	73,631
2008	747,400	743,049	440,410	418,865	2,726	9	335	3,070
2009	929,392	925,504	524,621	561,556	937	9	1,147	2,093
2010	1,524,309	1,516,401	837,241	878,772	558	18,615	11,051	30,224
2011	1,282,449	1,270,724	719,516	721,782	7,010	21,158	15,881	44,049
2012	1,928,808	1,912,785	1,122,211	1,118,392	7,403	40,445	71,592	119,440
2013	2,412,252	2,393,091	1,380,228	1,298,882	18,499	38,651	125,573	182,723
2014	1,889,278	1,856,972	1,054,019	965,448	26,783	89,911	114,792	231,486
2015	2,029,652	2,008,604	1,046,980	1,082,652	20,694	37,341	43,997	102,032
2016	1,008,122	994,126	532,914	503,690	12,640	13,782	26,706	53,128
93-00	1,207,998	1,184,290	679,727	629,949	16,436	51,419	74,280	142,135
01-08	1,565,108	1,518,301	882,369	801,452	51,559	72,014	108,619	232,191
09-16	1,625,533	1,609,776	902,216	891,397	11,816	32,489	51,342	95,647

Table A-17. Annual estimates of pre- and post-fishery Chinook abundance and Council fishery catch by time period in the California Coast area (Horse Mountain, CA to U.S./Mexico border) under Alternative 3. TS1 = October – April, TS2 = May – June, TS3 = July – September.

	CA Estimated Chinook Abundance				CA Council Area Fishery Catch			
Year	**TS1_Pre**	**TS1_Post**	**TS2_Post**	**TS3_Post**	**TS1**	**TS2**	**TS3**	**TS1-TS3**
1993	606,752	583,630	402,435	161,372	29,093	167,304	188,476	384,873
1994	564,663	550,255	384,351	170,207	24,618	208,258	231,370	464,246
1995	1,222,002	1,179,893	778,644	349,913	79,496	546,871	428,429	1,054,796
1996	837,097	804,693	575,536	310,376	55,460	267,794	192,290	515,544
1997	910,480	881,385	613,453	324,068	43,321	345,034	299,580	687,935
1998	630,715	616,799	454,567	262,346	15,692	154,715	170,912	341,319
1999	674,586	667,260	523,005	354,030	12,433	171,260	158,201	341,894
2000	955,612	932,453	626,489	411,224	42,866	411,512	190,159	644,537
2001	1,011,524	991,491	826,082	557,169	27,243	104,586	141,672	273,501
2002	1,381,624	1,346,911	1,064,079	694,495	48,701	231,609	270,861	551,171
2003	1,286,377	1,229,178	942,452	546,226	14,870	208,687	348,164	571,721
2004	1,069,442	1,003,836	669,547	248,887	34,951	310,566	321,511	667,028
2005	881,145	853,018	652,838	362,941	19,018	127,479	310,776	457,273
2006	494,826	481,849	378,002	193,049	16,187	48,634	90,016	154,837
2007	366,515	360,939	258,969	116,660	5,543	51,772	77,149	134,464
2008	236,587	235,067	172,060	94,437	1,124	0	0	1,124
2009	274,777	273,660	196,185	103,927	0	0	0	0
2010	457,383	452,927	333,512	191,657	5,265	3,038	20,874	29,177
2011	459,597	453,764	332,337	183,903	5,522	20,274	80,101	105,897
2012	904,642	892,084	675,739	386,319	20,361	106,415	164,068	290,844
2013	1,126,427	1,112,806	800,957	438,452	19,223	183,519	169,980	372,722
2014	801,326	782,643	557,911	266,417	16,311	81,138	125,431	222,880
2015	590,492	579,603	383,306	186,092	9,207	78,097	58,936	146,240
2016	353,611	346,901	236,087	122,178	6,224	32,556	52,188	90,968
93-00	800,238	777,046	544,810	292,942	37,872	284,094	232,427	554,393
01-08	841,005	812,786	620,504	351,733	20,955	135,417	195,019	351,390
09-16	621,032	611,799	439,504	234,868	10,264	63,130	83,947	157,341

Appendix A References

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