Endangered Species Act Section 7(a)(2) Consultation
Biological Opinion

Effects of the Pacific Coast Salmon Plan on the Southern Resident Killer Whale (*Orcinus orca*) Distinct Population Segment

Action Agency: National Marine Fisheries Service

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1 ▪ Introduction and Background

1.1 Background

This document constitutes the National Marine Fisheries Service's (NMFS) biological opinion (Opinion) regarding the effects of proposed Pacific coast ocean salmon fisheries conducted under the Pacific Coast Salmon Plan on the Southern Resident killer whale (*Orcinus orca*) distinct population segment. The fisheries assessed by this Opinion would be conducted in the U.S. Exclusive Economic Zone (EEZ) of the Pacific Ocean. These fisheries are managed under the jurisdiction of the Pacific Fisheries Management Council (PFMC) and target primarily Chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*), although pink salmon (*O. gorbuscha*) are taken incidentally during odd-numbered years (e.g., 2005, 2007). The Opinion was prepared by NMFS in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, et seq.), and implementing regulations found at 50 CFR 402. NMFS is both the action agency and the consulting agency with respect to the Pacific Coast Salmon Plan.

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

Section 7(a)(2) of the Endangered Species Act of 1973, as ammended (16 U.S.C. §1536), requires federal agencies to insure that their actions are not likely to jeopardize the continued existence of any listed species or result in the adverse modification of critical habitat. "Jeopardize the continued existence of" means to engage in an action that would reasonably be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reduccing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

NMFS jeopardy standard is based on an action's effects on the continued existence of threatened or endangered species, which can include true biological species, subspecies, or distinct population segments of vertebrate species. The continued existence of listed species depends on the fate of the populations that comprise them. Thus, the probability of extinction of listed species depends on the probabilities of extinction of the populations that comprise the species. Similarly, the continued existence of a population is determined by the fate of the individuals that comprise it. Populations grow or decline as the individuals that comprise the populations live, die, grow, mature, migrate, and reproduce (or fail to do so).

We identify the probable risks that actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses integrate individual's risks to identify consequences to their representative populations. Our analyses conclude by determining the consequences of population-level risks to the species.

We measure risks to listed individuals by evaluating effects on the individual's "fitness," which includes changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to an action's effects on the environment are likely to have fitness consequences.

The Southern Resident killer whale DPS is a single population. The population is composed of three pods, or groups of related matrilines, that belong to one clan of a common but older maternal heritage (review in NMFS 2008a). The Southern Resident killer whale population is sufficiently small (fewer than 90 whales) and the probability of quasi-extinction is sufficiently likely that all individuals of the three pods are important to the survival and recovery of the DPS. Representation from all three pods is necessary to meet biological criteria for Southern Resident downlisting and recovery (NMFS 2008a). For these reasons, it is NMFS' opinion that any Federal action that is likely to hinder the reproductive success or increase the risk of mortality of a single individual is likely to appreciably reduce the survival and recovery of the DPS. Therefore, effects on the Southern Resident killer whale DPS are informed by evaluating effects on individual whales.

2 ▪ Consultation History

Since 1996, NMFS has issued biological opinions on the effects on salmon and other ESA-listed species of the Pacific Coast Salmon Plan and its implementation through annual regulations (Table 1). Additionally, NMFS has required and the PFMC has adopted Essential Fish Habitat conservation recommendations for the Pacific Coast Salmon Plan, pursuant to section 305(b)(4)(A) of the Magnusun Stevens Act (adopted as part of Amendment 14, September 27, 2000). The Southern Resident killer whale distinct population segment (DPS) was listed as endangered under the ESA on November 18, 2005, and the listing became effective February 16, 2006 (70 FR 69903). Critical habitat was designated for the Southern Resident killer whales on November 29, 2006. Following the species' listing, NMFS conducted consultations to evaluate effects of annual harvest under the Pacific Coast Salmon Plan (in 2006-2007, 2007-2008, and 2008-2009) on the Southern Resident killer whale DPS. In the present opinion on the Plan, NMFS evaluates effects of the Plan itself on Southern Residents, including the likely effects of future harvest regulations adopted under the plan. We do this by evaluating a range of harvest scenarios based on past authorized harvest and salmon stock abundances. Therefore, this opinion will remain effective until re-initiation is deemed necessary, pursuant to the regulations and outlined in Section 13 of the opinion (50 CFR 402.16). NMFS will continue to review the PFMC's management recommendations for annual harvest and assess whether re-initiation is warranted.

The proposed action may affect the following listed species under the jurisdiction of NMFS, which are not currently addressed in existing consultations:

Endangered
Marine Mammals
Southern Resident killer whale
(distinct population segment) *Orcinus orca*

Table 1. NMFS ESA decisions regarding ESUs and DPSs affected by PFMC Fisheries and the duration of the 4(d) Limit determination or biological opinion (BO). Only those decisions currently in effect are included. All decisions concluded the actions did not jeopardize the listed species or adversely modify critical habitat.

Date (Decision type)	Duration	Citation	ESU/DPS considered (critical habitat also considered, where applicable)
March 8, 1996 (BO)	until reinitiated	NMFS 1996	Snake River spring/summer and fall Chinook, and sockeye
April 28, 1999 (BO)	until reinitiated	NMFS 1999	S. Oregon/N. California Coast coho Central California Coast coho Oregon Coast coho
April, 2000 (BO)	until reinitiated	NMFS 2000	Central valley Spring-run Chinook
April, 2001 (4(d) Limit)	until withdrawn	NMFS 2001a	Hood Canal summer-run chum
April, 2001 (BO)	until reinitiated	NMFS 2001b	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead ESUs
April, 2004 (BO)	until 2010	NMFS 2004a	Sacramento River winter-run Chinook
March 4, 2005 (4(d) Limit)	until May, 2010	NMFS 2005a	Puget Sound Chinook
June 13, 2005	until reinitiated	NMFS 2005b	California Coastal Chinook
April 30, 2007	until reinitiated	NMFS 2007	North American Green Sturgeon
April 29, 2008	until May, 2009 for Chinook[1]; until reinitiated for coho and steelhead	NMFS 2008b	Lower Columbia River Chinook Lower Columbia River coho Puget Sound Steelhead
May 19, 2008	until May, 2009	NMFS 2008c	Southern Resident Killer Whales

[1] F/NWR/2009/02074

3 ▪ Proposed Action

NMFS proposes to implement annual regulations for the ocean salmon fishery within the Pacific U.S. EEZ. These ocean fisheries are primarily recreational and commercial troll fisheries that use hook-and-line gear to catch salmon and target coho and Chinook. Pursuant to the Magnuson-Stevens Act, annual management recommendations are developed according to the PFMC's "Pacific Coast Salmon Plan" (Fishery Management Plan, or FMP) and its associated amendments. The regulations apply to the period from May 1 of the current year through April 30 of the following year. The FMP uses catch quotas and landing limits; if the fishery reaches the catch quotas or landing limits before the end of the scheduled open period, the fishery will close. A detailed description of the specific fishery locations and historical catch and effort data is found in the Review of Ocean Salmon Fisheries document available at each year's March PFMC meeting. The PFMC provides its management recommendations to the Secretary of Commerce (Secretary), who implements the measures in the EEZ if they are found to be consistent with the Magnuson-Stevens Act and other applicable law such as the ESA. Because the Secretary, acting through NMFS, has the ultimate authority for the FMP and its implementation, NMFS is both the action agency and the consulting agency with respect to the fishery.

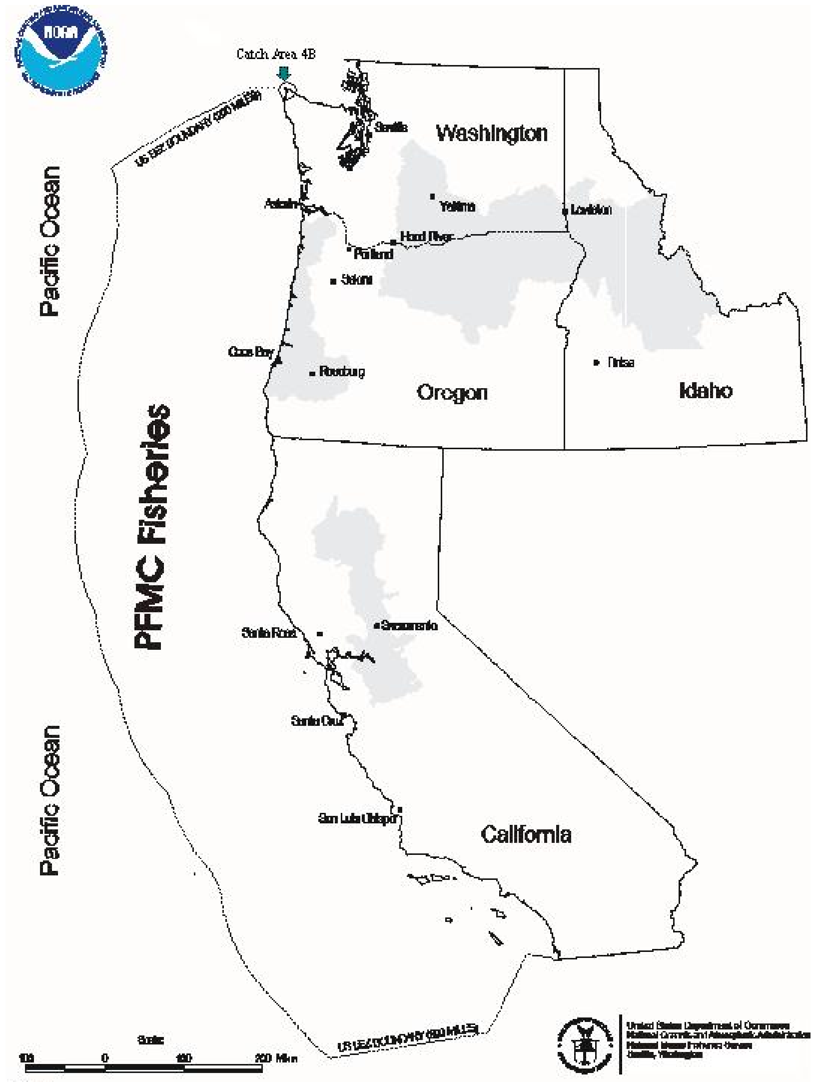
The fishery occurs within the U.S. EEZ off the West Coast including California, Oregon and Washington. Descriptions of open fishing periods and locations for the annual ocean salmon fishery are published at the conclusion of each year's April PFMC meeting (e.g. Preseason Report III, Analysis of Council Adopted Management Measures for 2008 Ocean Salmon Fisheries; PFMC 2009a). The fishing periods and locations may be modified in-season in response to changes in projected salmon abundance, fishing effort or weather conditions in order to assure achievement of the management objectives and consideration for safety concerns.

The PFMC analyzes several management options for the ocean salmon fishery to develop their management recommendations. The analysis includes assumptions regarding harvest of listed salmon species in state marine, estuarine, and freshwater areas. Under the FMP, each salmon stock affected by the fishery is managed subject to a specified conservation objective. For ESA-listed salmon, the conservation objectives are referred to as consultation standards. The FMP requires that NMFS provide consultation standards for each listed species, which specify levels of take that are not likely to jeopardize the continued existence of the species. NMFS provides these standards in its annual guidance letter to the PFMC prior to the start of the annual preseason planning process. NMFS provides the necessary review for these consultation standards through an associated biological opinion (i.e., see Table 1). The FMP requires the PFMC to set management recommendations that meet or exceed NMFS consultation standards. The scope of the EEZ that is open to salmon fishing and the length of time the areas are open in any one year depends on salmon stock abundances in excess of the conservation objectives and the spatial distribution of constraining stocks. This combination of factors affects the amount of prey available to the ESA-listed Southern Resident killer whales, the effect of harvest on the prey available and the potential for interaction between fishing gear and vessels, and the whales.

4 ▪ Action Area

Federal regulations found at 50 CFR 402.02 define "action area" as all areas to be affected directly or indirectly by the Federal actions and not merely the immediate area involved in the action. For the purposes of this consultation, the action area encompasses the waters of the Pacific EEZ (Figure 1), which are directly affected by the action, and the coastal and inland marine waters of the states of Washington, Oregon, and California, which are indirectly affected by the action (i.e., potential reduction in available prey that would have moved into these waters if it had not been caught by the PFMC fisheries).

Figure 1. Map of the Action Area



5 ▪ Status of the Species & Critical Habitat

5.1 Southern Resident Killer Whales

5.1.1 Current Rangewide Status of the Species

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

Abundance, Productivity and Trends

Southern Resident killer whales are a long lived species, with late onset of sexual maturity (review in NMFS 2008a). Females produce a low number of surviving calves over the course of their reproductive life span (an average of 5.3 surviving calves over an average reproductive lifespan of 25 years) (Olesiuk et al. 2005). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg et al. 1990; Baird 2000; Ford et al. 2000). Groups of related matrilines form pods – J, K, and L – which make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of J clan.

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

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

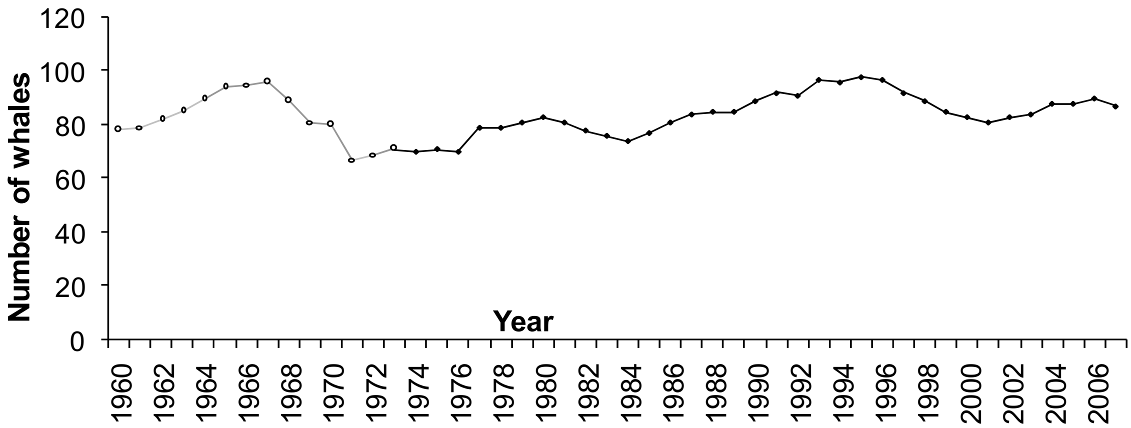


Figure 2. Population size and trend of Southern Resident killer whales, 1960-2008. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2008 (diamonds, black line) were obtained through photo-identification surveys of the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

Range and Distribution

Southern Residents are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia (Figure 3).

Figure 3. Geographic Range (light shading) of the Southern Resident Killer Whale DPS. Source: Wiles 2004.

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

Southern Residents spend considerable time from late spring to early autumn in inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound) (Bigg 1982; Ford et al. 2000; Krahn et al. 2002) (Table 2). Typically, J, K and L pods are increasingly present in May or June and spend considerable time in the core area of Georgia Basin and Puget Sound until at least September. During this time, pods (particularly K and L) make frequent trips from inland waters to the outer coasts of Washington and southern Vancouver Island, which typically last a few days (Ford et al. 2000).

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

The Southern Residents were formerly thought to range southward along the coast to about Grays Harbor (Bigg et al. 1990) or the mouth of the Columbia River (Ford et al. 2000). However, recent sightings of members of K and L pods in Oregon (in 1999 and 2000) and California (in 2000, 2003, 2005, 2006, 2007, 2008, and 2009) have considerably extended the southern limit of their known range (Table 3). There have been 48 verified sightings or strandings of J, K or L pods along the outer coast from 1975 to present with most made from January through April (Table 3). These include 16 records off Vancouver Island and the Queen Charlottes, 17 off Washington, 4 off Oregon, and 11 off central California. Most records have occurred since 1996, but this may be because of increased viewing effort along the coast in recent years. Some sightings in Monterey Bay, California have coincided with large runs of salmon, with feeding witnessed in 2000 (Black et al. 2001). However, when Southern Residents were sighted in Monterey Bay during 2008, salmon runs were expected to be very small. L pod was also seen feeding on unidentified salmon off Westport, Washington, in March 2004 during the spring Chinook run in the Columbia River (M. B. Hanson, pers. obs., in Krahn et al. 2004). Ongoing hydroacoustic research has also documented coastal occurrences, and the results of these studies will improve our understanding of coastal habitat use by Southern Residents.

Table 2. Average number of days spent by Southern Resident killer whales in inland and coastal waters by month, 2003-2007 (Hanson and Emmons, unpubl. Report 2008).

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

Table 3. Known sightings of Southern Resident killer whales along the outer Pacific Ocean coast (NMFS 2008a, NWFSC unpubl. data).

Date	Location	Identification	Source	Comments
British Columbia outer coast				
31 Jan 1982	Barkley Sound, west coast of Vancouver Island	L pod	J. Ford, PBS/DFO	Off shore of Sound
21 Oct 1987	Coal Harbor, north Vancouver Island	Part of L pod	J. Ford, PBS/DFO	Were way up inlet a long distance from open ocean
3 May 1989	Tofino, west coast of Vancouver Island	K pod	WMSA	--
4 July 1995	Hippa Is., south Queen Charlotte Islands	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
May 1996	Cape Scott, north Vancouver Island	Southern Resident	J. Ford PBS/DFO	Carcass found on beach, ID only by genetics
4 Sep 1997	Off Carmanah Point, sw Vancouver Island	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
14 Apr 2001	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
27 Apr 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
12 May 2002	Tofino, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
30 May 2003	Langara Is., Queen Charlotte Islands	L pod	M. Joyce, DFO	
17 May 2004	Tofino, west coast of Vancouver Island	K and L pods	M. Joyce, DFO	

Date	Location	Identification	Source	Comments
9 June 2005	West of Cape Flattery, Washington in Canadian waters	L pod	SWFSC	Whales were exiting the Strait of Juan de Fuca
7 Sep 2005	West of Cape Flattery, Washington in Canadian waters	L pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
18 Mar 2006	North of Neah Bay, Washington in Canadian waters	J pod	NWFSC	Whales were exiting the Strait of Juan de Fuca
8 May 2006	Off Brooks Peninsula, west coast of Vancouver Island	L pod	J. Ford PBS/DFO	
1 Dec 2006	Johnstone Strait	L pod	J. Ford PBS/DFO	
Washington Outer Coast				
4 Apr 1986	Off Westport/Grays Harbor	L pod	J. Ford, PBS/DFO	
13 Sep 1989	West of Cape Flattery	L pod	J. Calambokidis, Cascadia Research	
17 Mar 1996	3 km offshore Grays Harbor	L pod	J. Calambokidis, Cascadia Research	
20 Sep 1996	Off Sand Point (29 km south of Cape Flattery)	L pod	Observed by P. Gearin, NMML	Identified by D. Ellifrit
15 Apr 2002	Long Beach	L60	D. Duffield, Portland State Univ.	Stranded whale identified by K. Balcomb, CWR
11 Mar 2004	Grays Harbor	L pod	B. Hanson, NWFSC	Whales were exiting Strait of Juan de Fuca
13 Mar 2004	Off Cape Flattery	J pod	B. Hanson, NWFSC	

Date	Location	Identification	Source	Comments
22 Mar 2005	Fort Canby-North Head	L pod	J. Zamon, NWFSC	
23 Oct 2005	Off Columbia River	K pod	SWFSC, Cscape	
29 Oct 2005	Off Columbia River	K and L pods	SWFSC, Cscape	
1 Apr 2006	Westport	L pods	PAL	
6 Apr 2006	Westport	K and L pods	Cascadia Research	
13 May 2006	Westport	K and L pods	PAL	
26 May 2006	Westport	K pod	PAL	
29 May 2006	Westport	K pod	PAL	
26 March 2009	Westport	L pod	NWFSC	
27 March 2009	Off the Columbia River	L pod	NWFSC	
Oregon				
Apr 1999	Off Depoe Bay	L pod	J. Ford, PBS/DFO	
Mar 2000	Off Yaquina Bay	L pod	J. Ford, PBS/DFO	Seen week of Mar 20
14 Apr 2000	Off Depoe Bay	Southern Residents	K. Balcomb, CWR	
30 Mar 2006	Off Columbia River	K and L pods	B. Hanson, NWFSC	
California				
29 Jan 2000	Monterey Bay	K and L pods	N. Black, MBWW	Seen and photographed feeding on fish

Date	Location	Identification	Source	Comments
13 Mar 2002	Monterey Bay	L pod	N. Black, MBWW	
16 Feb 2005	Farallon Is	L pod	K. Balcomb, CWR	
26 Jan 2006	Pt. Reyes	L pod	S. Allen	
24 Jan 2007	San Francisco Bay	K pod	N. Black, MBWW	
18 Mar 2007	Fort Bragg	L pod		Reported on CWR website
24-25 Mar 2007	Monterey	K and L pods		Reported on CWR website
30 Oct 2007	Bodega Bay	L pod	Cascadia Research	
27 Jan 2008	Monterey	L pod	N. Black/K. Balcomb	
2 Feb 2008	Monterey	K and L pods	N. Black/K. Balcomb	
5 March 2009	Monterey	L pod	N. Black	

Limiting Factors and Threats

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

Prey

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

Prey Requirements

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

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

Percentage of Chinook

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

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

River of Origin

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

Age and/or Size

The ongoing research discussed above also collected salmon scales from killer whale feeding events and used them to evaluate the age of the salmon consumed, finding that Southern Residents prefer older (hence larger) Chinook (NWFSC unpubl. data). This finding is consistent with that of Ford and Ellis (2006) who also evaluated the age of prey from killer whale feeding events. Ford and Ellis (2006) estimated size selectivity by comparing the age of fish consumed to the age distribution of fish in the area based on catch data obtained from the Pacific Salmon Commission (Table 4; Figure 5 of Ford and Ellis 2006). NMFS' Northwest Fisheries Science Center (NWFSC) evaluated the age of kills relative to the age distribution of Chinook in a fisheries management model, FRAM (Table 4; NMFS 2008d, Ward et al. unpubl. report).

Table 4. Mean abundance by age class (%) and kills by age class

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

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

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

Quantity of Prey

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

Ford et al. (2005) correlated coastwide reduction in Chinook abundance (Alaska, British Columbia, and Washington) with decreased survival of resident whales (Northern and Southern Residents), but changes in killer whale abundance have not been definitively linked to local areas or changes in specific salmon stock groups. Ward et al. (2009) correlated Chinook abundance trends with changes in fecundity of Southern Resident killer whales, and reported the probability of calving increased by 50 percent between low and high Chinook abundance years. Results of this study indicate the Chinook abundance indices from the West Coast of Vancouver Island are an important predictor of the relationship.

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

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

Salmon abundance is also substantially affected by climate variability in freshwater and marine environments, particularly by conditions during early life-history stages of salmon (NMFS 2008e). Sources of variability include inter-annual climatic variations (e.g., El Niño and La Niña), longer term cycles in ocean conditions (e.g., Pacific Decadal Oscillation, Mantua et al.

1997), and ongoing global climate change. For example, climate variability can affect ocean productivity in the marine environment and water storage (e.g. snow pack) and in-stream flow in the freshwater environment. Early life-stage growth and survival of salmon can be negatively affected when climate variability results in conditions that hinder ocean productivity (e.g., Scheurell and Williams 2005) and/or water storage (e.g., ISAB 2007) in marine and freshwater systems, respectively. Severe flooding in freshwater systems may constrain salmon populations (NMFS 2008e). The availability of adult salmon – prey of Southern Residents – may be reduced in years following unfavorable conditions to the early life-stage growth and survival of salmon.

Quality of Prey

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

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

Southern Resident killer whales likely consume both natural and hatchery salmon (Barre 2008). The best available information does not indicate that Southern Residents would be affected differently by consuming natural or hatchery salmon (i.e., no general pattern of differences in size, run-timing, or ocean distribution [e.g., Nickum et al. 2004; NMFS 2008e; Weitkamp and

Neely 2002]).Therefore, there is no scientific evidence to generally distinguish the quality of hatchery salmon from natural salmon as prey of Southern Residents across their range.

Contaminants

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

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

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

Sound and Vessel Effects

Vessels have the potential to affect whales through the physical presence and activity of the vessel, underwater sound levels generated by boat engines, or a combination of these factors. Vessel strikes are rare, but do occur and can result in injury or mortality (Gaydos and Raverty 2007). In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995; Gordon and Moscrop 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior.

Killer whale mortalities from vessel strikes have been reported in both Northern and Southern Resident killer whale populations. Although rare, collisions between vessels and killer whales could result in serious injury. Other impacts from vessels are less obvious, but may adversely affect the health of killer whales. The presence of vessels may alter killer whale behavior, including faster swimming, less predictable travel paths, shorter or longer dive times, moving into open water, and altering normal behavioral patterns at the surface (Kruse 1991; Williams et al. 2002a; Bain et al. 2006; Lusseau et al. 2009, Williams et al. 2009, Noren et al. In press). Research suggests that Southern Residents may expend 10 to 15 percent more energy when vessels are present than they would without vessels present (Bain et al. 2006; Williams et al. 2002a).

Chemicals such as unburned fuel and exhaust may be inhaled or ingested, which could contribute to toxic loads (Bain et al. 2006). Noise from vessel traffic may mask echolocation signals (Bain and Dahlheim 1994; Holt 2008), which reduces foraging efficiency or interferes with communication. The sound from vessels may also contribute to stress (Romano et al. 2003) or affect distribution of animals (Bejder 2006).

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

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. Increased levels of anthropogenic sound from vessels and other sources have the potential to mask echolocation and other signals used by the species, as well as to temporarily or permanently damage hearing sensitivity. Exposure to sound may therefore be detrimental to survival by impairing foraging and other behavior, resulting in a negative energy balance (Bain and Dahlheim 1994; Gordon and Moscrop 1996; Erbe 2002; Williams et al. 2002a, 2002b, 2006; Holt 2008). For example, sounds from vessels have the potential to affect foraging by masking the echolocation and communication signals of the whales (Foote et al. 2004; Holt 2008; Holt et al. 2009). In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop 1996).

Oil Spills

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

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

Extinction Risk

A population viability analysis (PVA) for Southern Residents was conducted by the 2004 biological review team (Krahn et al. 2004). Demographic information from the 1970s to fairly recently (1974-2003, 1990-2003, and 1994-2003) were considered to estimate extinction and quasi-extinction risk. "Quasi-extinction" was defined as the stage at which 10 or fewer males or females remained, or a threshold from which the population was not expected to recover. The model evaluated a range in Southern Resident survival rates, based on variability in mean survival rates documented from past time intervals (highest, intermediate, and lowest survival). The model used a single fecundity rate for all simulations. The study considered seven values of carrying capacity for the population ranging from 100 to 400 whales, three levels of catastrophic event (e.g., oil spills and disease outbreaks) frequency ranging from none to twice per century, and three levels of catastrophic event magnitude in which 0, 10, or 20 percent of the animals died per event. Analyses indicated that the Southern Residents have a range of extinction risk from 0.1 to 18.7 percent in 100 years and 1.9 to 94.2 percent in 300 years, and a range of quasi-extinction risk from 1 to 66.5 percent in 100 years and 3.6 to 98.3 percent in 300 years (Table 5). The population is generally at greater risk of extinction over a longer time horizon (300 years) than over a short time horizon (100 years). There is a greater extinction risk associated with increased probability and magnitude of catastrophic events.

Table 5. Range of extinction and quasi-extinction risk for Southern Resident killer whales in 100 and 300 years, assuming a range in survival rates (depicted by time period), a constant rate of fecundity, between 100 and 400 whales, and a range catastrophic probabilities and magnitudes (Krahn et al. 2004).

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

5.1.2 Current Rangewide Status of Critical Habitat

The final designation of critical habitat for the Southern Resident killer whale DPS was published on November 29, 2006 (NMFS 2006a). Critical habitat consists of three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, 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.

Water Quality

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

Prey Quantity, Quality, and Availability

As discussed above under Limiting Factors and Threats, most wild salmon stocks throughout the Northwest are at fractions of their historic levels. Beginning in the early 1990s, 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California were listed as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. While wild salmon stocks have declined in many areas, hatchery production has been generally strong. Total Chinook abundances coastwide increased significantly from the mid-1990s to the early 2000s, but have declined in the last several years (PFMC 2008).

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

Passage

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

6 ▪ Environmental Baseline

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the broad expanse of the action area considered in this opinion. The status of the species described in Chapter 5 of this opinion is a consequence of those effects. The following discussion summarizes the principal human and natural factors within the action area (other than the proposed action) that are known to affect the likelihood that Southern Resident killer whales will survive and recover in the wild, and the likelihood that their critical habitat will function to support their recovery.

6.1 Natural Mortality

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

In recent years, sighting reports indicate anecdotal evidence of thin killer whales returning to inland waters in the spring. For example in March 2006, a thin female from the Southern Resident population (L54) with a nursing calf was sighted off Westport, WA. The sighting report indicated she had lost so much blubber that her ribs were showing under the skin (Cascadia Research Collective 2008). Current research aims to identify the condition of individual whales, and this information will improve our understanding of the whales' condition (Durban et al. 2008).

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

6.2 Human Related Activities

6.2.1 Entrapment and Entanglement in Fishing Gear

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

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

6.2.2 Prey Availability

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

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

The availability of Chinook to Southern Residents is affected by a number of natural and human actions. The health and abundance of salmon stocks have been negatively affected by altered or degraded freshwater and estuarine habitat (i.e., hydro-power systems, urbanization, forestry and agriculture), poor artificial propagation practices, and overfishing. Adult salmon are affected by fisheries harvest in fresh and marine waters. In addition, climate effects from Pacific decadal oscillation and the El Nino/Southern oscillation conditions and events cause changes in ocean productivity which can affect natural mortality of salmon. Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals (including Southern Resident killer whales). Details regarding baseline conditions of salmon in coastal and inland waters of the action area are described in biological opinions for salmon (biological opinions cited in Table 1).

Harvest actions that have undergone consultation, other than the proposed action, are part of the environmental baseline. Southern Resident killer whales were recently listed under the Endangered Species Act (NMFS 2005c). As a result, NMFS has only recently sought coverage for Southern Resident killer whales in consultations on harvest actions. Following the listing, NMFS conducted annual consultations to evaluate effects of Pacific Coast Salmon Plan fisheries managed by the PFMC (2006-2007, 2007-2008 and 2008-2009, i.e., NMFS 2008f) and the U.S. Fraser Panel fisheries (2007 and 2008, i.e., NMFS 2008g) on Southern Resident killer whales. As described in consultation history, NMFS will consult on a range of Pacific Coast Salmon Plan harvest scenarios based on past authorized harvest levels and salmon stock abundances, which will analyze effects of the FMP on Southern Residents more broadly than consulting on authorization of harvest levels for the current year alone.

NMFS has also consulted on the effects of Columbia River fisheries on Southern Residents as part of the 2008 *U.S. v. Oregon* Agreement (2008-2017; NMFS 2008h), and on the effects of northern U.S. and Canadian fisheries, and general obligations of southern U.S. fisheries (further constrained by other harvest actions and subject to separate section 7 consultations) under the Pacific Salmon Treaty agreement on Southern Residents (new fishing regimes, i.e., amended Chapters 1, 2, 3, 5, and 6 of Annex IV of the Treaty, 2009-2018, NMFS 2008d). Effects of Puget Sound fisheries on Southern Residents will be evaluated by NMFS when consultation is re-initiated on the Puget Sound Harvest Management Plan in 2010 (current ESA Section 4(d) approval for salmon extends through April 30, 2010).

In past harvest opinions, we characterized the short-term and long-term effects on Southern Residents from prey reduction caused by harvest. Effects anticipated on an annual level are considered short-term (i.e., harvested Chinook in a given year). Long-term effects consider the potential for the action to affect viability of prey at the stock or ESU-level over a longer time frame, which puts effects of the action and prey available to Southern Residents in a long-term context. Both components of the analysis are necessary to inform our conclusions for Southern

Residents. The harvest biological opinions referenced above concluded that the harvest actions cause prey reductions, but were not likely to jeopardize the continued existence of ESA-listed Chinook salmon or Southern Residents. In the short term, prey reductions quantified have been small relative to remaining prey available to the whales to meet their prey needs. In the long term, harvest actions have met the conservation objectives of harvested stocks, were not likely to appreciably reduce the survival or recovery of listed Chinook and were therefore not likely to jeopardize the continued existence of listed Chinook.

We have also previously consulted on the effects of hydro-power dams and flood control programs on Southern Residents (NMFS 2008i, NMFS 2008j, NMFS 2008k) in the action area. Biological opinions on the Federal Columbia River Power System and the Willamette Flood Control Program concluded that the actions do not cause prey reductions, were not likely to jeopardize the continued existence of ESA-listed salmonids, and were not likely to adversely affect Southern Resident killer whales. NMFS' biological opinion on the National Flood Insurance Program in Washington State-Puget Sound region concluded that the action was likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU, and that the potential extinction of this ESU as a long-term consequence of the action was also likely to jeopardize the continued existence of Southern Residents. Actions identified as part of the RPA are being implemented over 3 years starting from issuance of the Flood Insurance Program biological opinion.

We used methods to assess Chinook availability by estimating available kilocalories similar to methods used for a recent biological opinion on the Pacific Salmon Treaty (NMFS 2008d). These methods improve on our prior approach, which relied on abundance estimates as a proxy measure of Chinook biomass availability (i.e., NMFS 2008f, 2008g). For the current consultation, methods were developed to estimate the food energy of Chinook available, taking into consideration stock- and age-specific variability in size. Food energy was estimated by converting stock- and age-specific Chinook abundance estimates into kilocalories. Abundance was converted to kilocalories with intermediate steps, using a regression based on individual Chinook length and caloric content (described in more detail below). Available data on whales as well as Chinook stocks limited fine scale stratification temporally and spatially; however, for this analysis we were able to incorporate information on when the whales are in inland waters compared to coastal waters.

Using this information, we evaluate prey available to the whales compared to the whales' needs as a ratio of available Chinook food energy in kilocalories (without the action) to the metabolic needs of the whale population in kilocalories. In addition, we considered a reasonable range of prey size selectivity for Southern Resident killer whales. Our improved ability to estimate food energy available, combined with modeling produced by the NWFSC (described in detail below) provides a range in size selectivity with reasonable bounds on the food energy available to the whales, dependent on their probability of pursuit.

Information on Chinook availability was based on FRAM model runs (review description of the FRAM model in Section7.3, Retrospective Analysis of NMFS 2008d). FRAM provides year-specific ocean abundance estimates based on fishery data from central California to Southeast Alaska (including inland waters of Washington and British Columbia), but the model does not include any Alaskan stocks. All Chinook stocks in the FRAM model travel through the range of Southern Resident killer whales. FRAM includes all listed and non-listed Chinook stocks within the whales' range. FRAM is a single-pool model that does not provide abundance estimates of Chinook within sub regions. However, by using catch distribution patterns from the FRAM base period (1979-1982) when fisheries were broadly distributed across time and area, a method was derived to estimate abundance at a regional scale for inland waters (Strait of Juan de Fuca, east to Georgia Strait in the north, and Puget Sound in the south), and coastal waters (all FRAM fishery regions except inland waters). Regional abundance estimates were derived for two retrospective years that represent a range of high (2002) and low (2008) Chinook abundance and respective harvest levels (Figures 4 and 5 and PSC 2008). For both years, the estimates were specific to time periods in the FRAM model for an annual cycle: October to April, May to June, and July to September. The expected Chinook abundance and fishery structure for 2009 is within the range of Chinook abundance and harvest levels represented by the retrospective years 2008 (low Chinook abundance) and 2002 (high Chinook abundance) (S. Bishop pers. comm, 2/26/2009). The range of high and low years analyzed is expected to represent a reasonable range of abundance and harvest under the FMP in future years.

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

Depending on whether the origin of the stock was coastal or inland waters, the freshwater portion (escapement plus freshwater catch) was placed in its corresponding regional group. The proportions were treated as annual values and applied to each stock-specific cohort in each model run and time period. This method assumes that ocean and inland distributions are the same across time periods, which is not the case in reality (i.e., spawning migration vs. ocean rearing). However, on a crude annual basis this method can show regional differences. Therefore, each stock has a designated distribution of regional occurrence (in inland and coastal waters) according to its annual fishery catch proportion by region and its region of origin (river of origin in inland or coastal waters). Although not a perfect method, this is the best way with the available technical tools to show regional stratification for Chinook abundance and availability to Southern Resident killer whales, given the limitations of FRAM. Note that only pre-terminal fisheries catch data were adjusted to compare Chinook availability with and without the action. Chinook availability was adjusted to reflect harvest levels for northern fisheries (Southeast

Alaska and Canada) designated under the 2008 Pacific Salmon Treaty that are part of the environmental baseline (NMFS 2008d;).

Figure 4. Southern U.S. Coastwide Chinook Terminal Abundance: 1980-2007 (PFMC 2008).

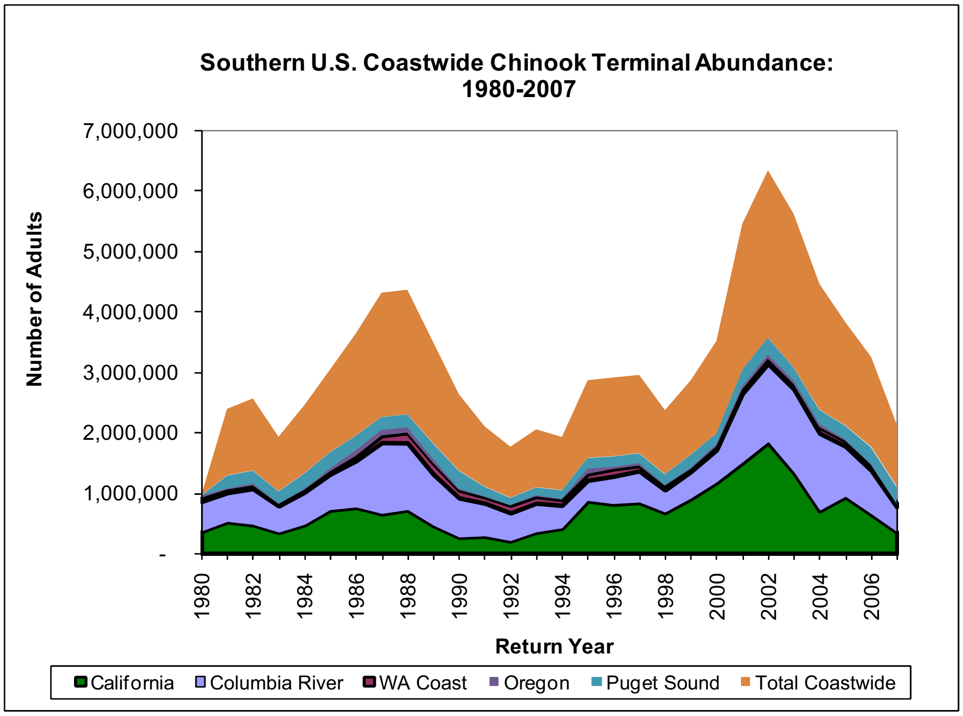
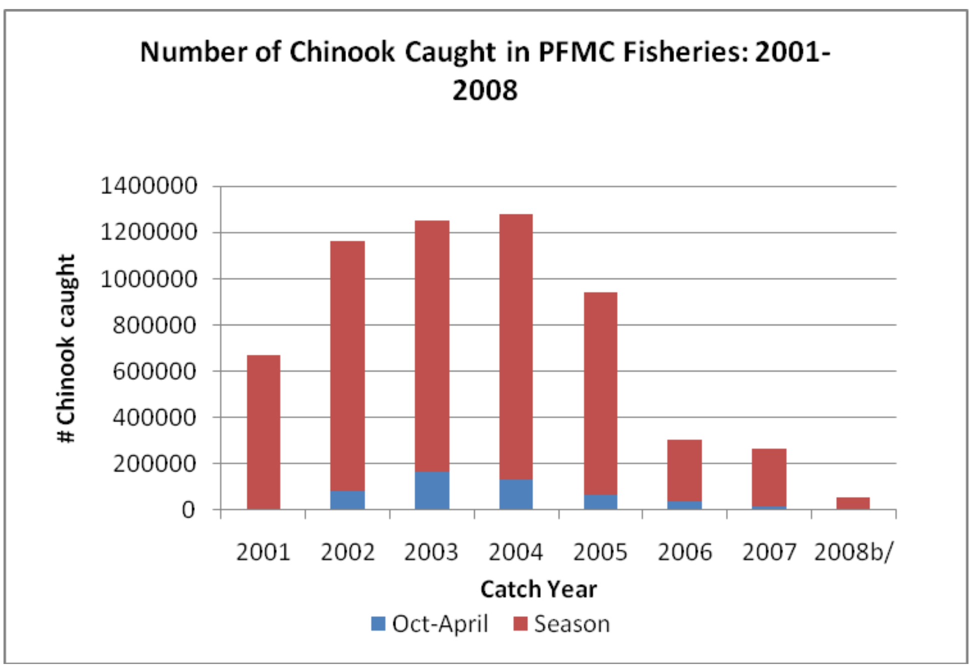


Figure 5. Chinook harvest in FMP fisheries from 2001-2008 (PFMC 2008).



Chinook Food Energy

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

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

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

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

Length to Kilocalorie Regression

The NWFSC developed a regression for Chinook fork-length to kilocalories (Figure 6, O'Neill et al. in prep). NMFS applied the regression to the abundance distributions by age at the sub regional scale (Appendix 1). The regression is based on data available on proximate composition of individual Chinook. Proximate composition (i.e., moisture, protein and lipid content) was determined for composite samples of males or females, each with 2-3 fish per composite (mostly 3 fish per composite). A 100-g subsample of each fish in the composite sample was dried at 105°C until a constant weight was obtained. To create the Chinook composite sample, equal weights of dried tissue (1.5 g) from each fish in the composite were combined. The dried composite tissue sample was then analyzed for protein and nitrogen (N x 6.25) using a LECO nitrogen/protein analyzer whereas total lipid content of the samples was gravimetrically determined on Soxhlet extracted tissues. Carbohydrate was not determined, because only small amounts occur in fish. Wet weight composition of % protein and % lipid for composite samples was calculated from the average % dry weight for that composite sample. From these data, the caloric content of the samples were determined using the following formula: caloric content (in Kcal) = [mass of lipid (g) x 9 Kcal/g] + [mass of protein (g) x 4 Kcal/g].

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

The regression incorporates all available data from the different locations. Puget Sound Chinook contain, on average, lower lipid content than Skeena Chinook so a Puget Sound Chinook of a specific size would have lower Kcal content than a comparable size fish from the Skeena. In general, populations will differ in their lipid content depending upon the length and elevation of their upriver migration. However within a population, lipid content will vary with maturation condition among individuals. Additionally, each data point on the regression represents a composite of 3 fish. Therefore, the fork-length to Kcal relationship for each population may be more variable than is shown in the regression (i.e., more representative of an average value).

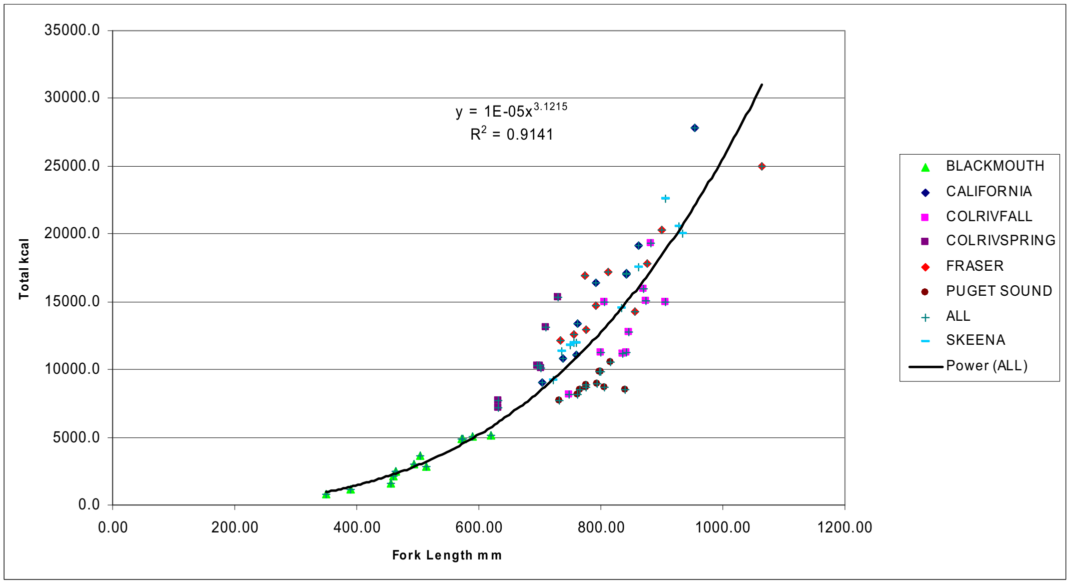


Figure 6. Regression of Chinook fork-length to kilocalories (O'Neil et al. in prep.).

Selectivity Analysis

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

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

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

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

There are potential biases or other issues associated with the different data sources. Issues and biases associated with the whale predation data sources include relatively small sample sizes, particularly when evaluated by age of kills (n= 127, Ford and Ellis 2006; n= 57, NWFSC unpubl. data). The NWFSC data set does not include kills of 2-year old Chinook, which may reflect small sample size as opposed to avoidance of 2-year olds by Southern Residents. Additionally, the two data sets could not be combined to increase sample size, because the studies were conducted in different areas. Depending on the data source used to depict the age distribution of prey available, relative preferences of size and age would be skewed, because of potential difference in the size at age and age distribution per area.

Sampling methods to collect scales from prey remains could also be biased. It is possible that the probability of obtaining scale samples from predation events may improve as the size or age of the Chinook kill increases. For example, if smaller fish tend to be swallowed whole and larger fish tend to be eaten in multiple bites, prey age distribution obtained from sampled scales could be biased toward older (larger) fish. Ford and Ellis (2006) discussed this issue, and concluded that any bias was likely to be small. They did not find behavioral evidence to indicate that the whales consume smaller fish below the surface and larger fish at the surface. In addition, analysis of fecal samples (NWFSC, unpubl. data) is largely consistent with the predominance of Chinook salmon in the whale's diet. Since Chinook salmon are the largest available salmonid, the similarity between the fecal samples and the surface prey remains suggests that the surface remains are not a seriously biased sample of the prey consumed.

The estimates of age composition of available prey are likely to be biased. The data sources from fisheries catch are biased in a different way than data from the FRAM model. The FRAM model estimates are based on the total population available for each FRAM stock. Methods used to develop sub regional abundance estimates are likely less accurate for non-maturing fish than for mature fish, because catch and escapement data that inform FRAM are best represented for mature fish. For inland waters in particular, this likely means that some non-maturing fish that are likely still in the outer ocean are being counted as available to the whales. The CWT data are all based on fishery recoveries, and therefore under represent non-maturing fish, since nearly all fisheries are selective for larger (older) fish. Using the FRAM numbers may therefore tend to overestimate selectivity, while using the CWT data will likely underestimate selectivity, all else being equal.

Despite these caveats, it is reasonable to expect that the whales may be targeting larger (older) fish in preference over smaller (younger) fish, based on the age composition of the prey taken by the whales (Ford and Ellis 2006; NWFSC unpubl. data). The range of selectivity described in Table 6 and Figure 7 is realistic, given the available data (Ward et al. unpubl. Report).

Table 6. Selectivity parameters for two models that represent a reasonable range (low and high) of prey size selectivity, given the available data

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

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

[2] Model representing high selectivity by the whales was based on Chinook kill data from Ford and Ellis (2006), and average age distribution of Chinook available from the FRAM model (Ford-FRAM in Ward et al. unpubl. report).

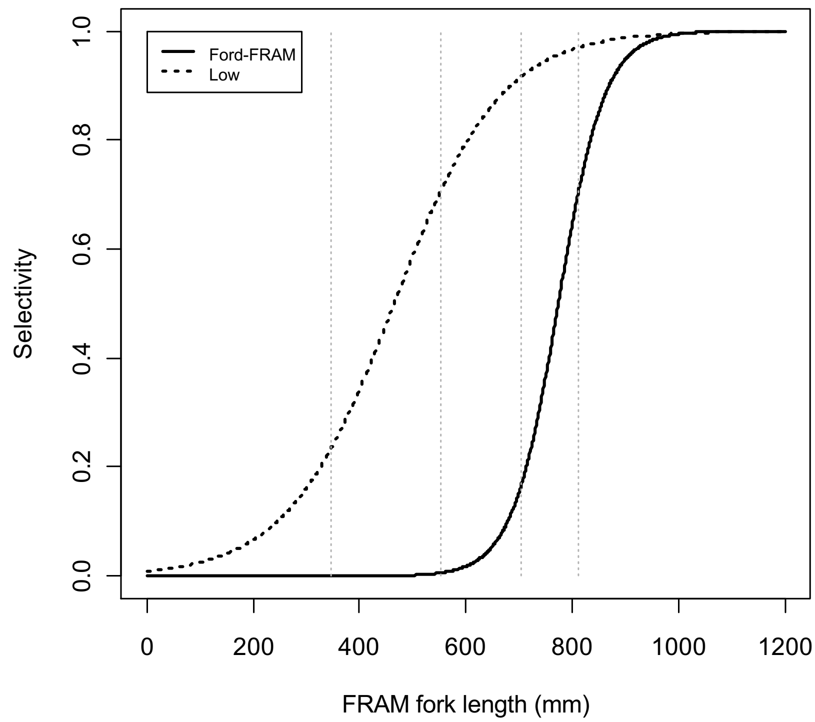


Figure 7. Length-based selectivities for 2 models of Chinook consumption by killer whales: Low selectivity and high selectivity (also called Ford-FRAM). The high selectivity model represents data from Ford & Ellis (2006) combined with average lengths from the FRAM model. Vertical grey lines represent average lengths for Chinook aged 2-5. FRAM lengths vary considerably by stock, with mean lengths of 5-year old Chinook in July-Sept ranging from 727-962mm (Ward et al. unpubl. report).

6.2.2.1 Prey Requirements

We assessed the prey requirements of Southern Resident killer whales by assuming Chinook comprise 86 percent of the killer whales' diet (discussed in Status of the Species) and using estimates of the whales' metabolic needs (informed by Noren, in review), stratified at the same spatial and temporal scale used to depict available Chinook food energy.

Diet Composition

After considering the available information (discussed in Status of the Species) and for purposes of this analysis, we assumed that the entire diet of the Southern Residents consisted of salmon in both inland and coastal waters. This assumption is supported by chemical analyses, which confirm the year-round importance of salmon in the whales' diet (Krahn 2002, 2007). The assumption is conservative, because there are data indicating that the whales consume other fish and squid as prey items in small amounts.

Further, we focused the analysis on Chinook, based on diet sampling that indicates Southern Resident killer whales prefer Chinook from May to September in inland waters (Ford and Ellis 2006; Hanson et al. 2007a; and NWFSC unpubl. data). Considering this information, it is reasonable to expect they may also prefer Chinook when available in coastal waters and at other times of the year (although at least a portion of the population may switch to chum salmon during the fall, based on limited sampling in inland waters). We evaluated scenarios for diet composition, where the percent of Chinook is a range of fixed percents, based on the range of possibilities represented in past studies (~70% Chinook, Ford and Ellis 2006), preliminary data from ongoing research (86% Chinook, NWFSC unpubl. data), and a lower value to represent uncertainty about diet composition in coastal waters (60%).

Metabolic Needs

NWFSC developed a model to estimate the potential range of daily energy expenditure for Southern Resident killer whales for all ages and both sexes (Noren, in review). This information was combined with the population census data to estimate daily energetic requirement for all the members of the Southern Resident DPS based on the sex, age, and estimated body mass of the 85 whales in the population at the end of 2008. Although the model provides a range in daily energy expenditure, the range is meant to represent uncertainty in the calculations. Therefore, 'maximum' should not be interpreted as the maximum needs of the population, but representative of the high end of a typical range in energy requirements. Although based on the best science available, energy requirements depicted from this model may underestimate actual needs of the population.

We further stratified metabolic needs of Southern Residents by region (inland vs. coastal waters). NWFSC provided a compilation of Southern Resident killer whale sightings specific to each pod in inland waters (sighting data from January, 2003 to December, 2007; Hanson and Emmons unpubl. report). The data are based on confirmed sightings made to Orca Network. For the purposes of this analysis, we assumed that Southern Residents occurred west of the Strait of Juan de Fuca (in coastal waters) on days they were not confirmed in inland waters, primarily because the population is highly visible in inland waters. We computed the daily energy requirements by pod based on the age and sex structure of all individuals in each pod, and multiplied the daily energy requirements of each pod by the number of days in a time period that the pod was in inland or coastal waters. Energy requirements were summed across pods by time period, region and for each of three diet composition scenarios (Table 7).

Table 7. Range in energy requirements for Southern Resident killer whales by region (inland and coastal waters), time period, and for three diet composition scenarios. Minimum and maximum levels represent a typical range in energy requirements, informed by a metabolic model (Noren, in review).

Time period	Diet Composition (% Chinook)	Inland		Coastal	
		Minimum Needs (kcal)	Maximum Needs (kcal)	Minimum Needs (kcal)	Maximum Needs (kcal)
Oct-April	86	273,080,348	327,155,665	1,919,261,209	2,299,312,934
	70	222,274,702	266,289,495	1,562,189,356	1,871,533,783
	60	190,521,173	228,248,138	1,339,019,448	1,604,171,814
May-June	86	287,605,061	344,556,559	343,210,198	411,172,613
	70	234,097,143	280,453,013	279,357,138	334,675,383
	60	200,654,694	240,388,297	239,448,975	286,864,614
July-Sept	86	530,333,782	635,350,373	421,059,724	504,437,887
	70	431,667,032	517,145,652	342,723,031	410,588,978
	60	370,000,313	443,267,702	293,762,598	351,933,410

6.2.2.2 Ratio of Prey Available to the Whales' Needs

We compared the food energy of prey available to the whales to the estimated metabolic needs of the whales (Table 8; Appendix 2). To be conservative, we relied on scenarios that assume the whales' diet consists of mostly Chinook. Considering a range of conditions, Southern Residents could need as many kilocalories as their estimated maximum needs (based on the high-end of a typical range in daily needs, Noren, in review) and a diet composed of 86 percent Chinook (Table 8). Ratios indicate prey available is greater than the whales' needs by the magnitude of the value. For example, a ratio of 5.0 indicates that prey availability is 5 times energy needs of the whales.

Table 8. Range in Prey Available Compared to the Whales' Needs Based on Variability in Chinook Returns and the Whales' Selectivity, a High Percent Chinook in the Whales' Diet (86%), and Underestimate of Chinook stocks available (after natural mortality).

Year	Time Period	Area	Ratio Prey Available : Needs	
			Low Selectivity	High Selectivity
Poor Chinook year (2008)	Oct-April	Coastal	4.0	1.0
		Inland	15.6	2.2
	May-June	Coastal	32.8	8.7
		Inland	22.6	3.8
	July-Sept	Coastal	28.9	**6.6**
		Inland	16.0	3.6
Good Chinook year (2002)	Oct-April	Coastal	10.4	2.1
		Inland	21.5	3.7
	May-June	Coastal	82.2	21.3
		Inland	28.9	6.3
	July-Sept	Coastal	71.6	16.3
		Inland	19.9	5.7

The ratios are lowest during the October to April time period in inland and coastal waters, regardless of year. In particular, the ratios during October to April in a poor Chinook abundance year within coastal waters are the lowest range of ratios evaluated, where prey available is as low as 1.0 to 4.0 times the whales' needs, depending on the whales' size selectivity. The ratios are greater during May to June and July to September than during October to April, regardless of year (lower in inland waters but greater in coastal waters during May to June than during July to September).

These low ratios reinforce the need for a better understanding of the whales' prey requirements and preferences temporally and spatially across their range. NMFS is currently engaged in research to improve the available scientific data in these areas. As new data become available, NMFS will continue to revisit how prey quantity affects the status of the species and our baseline estimates of prey available to the whales. Until that information is available, we must rely on incomplete knowledge of the whales' prey requirements and preferences to critically review actions that may affect prey availability.

Based on our most conservative scenarios represented by the "high selectivity" column in Table 8 above, prey available to Southern Resident killer whales is insufficient for the whales' to meet their metabolic needs in coastal and inland waters from October to April in both good and poor Chinook years. It is not reasonable to assume that the Southern Resident population is likely to forage efficiently enough during this time period to catch 100 to 50 percent of the available prey in inland waters (~ corresponding to ratios from 1.0 to 2.1 times needs), or even 50 to 25 percent of available prey in coastal waters (~ corresponding to ratios from 2.2 to 3.7 times needs).

We have limited data to suggest that at least J pod (which represents 30 percent of the Southern Resident population) may switch to a mostly-chum diet during fall in inland waters (as described in Status of the Species, and Hanson et al. 2005, NWFSC unpubl. data). This being the case, some of our conservative assumptions used to develop ratios of prey available to the whales' needs may be overly conservative, particularly for the October to April time period.

For NMFS' recent opinion on the Pacific Salmon Treaty, we evaluated effects of northern U.S. and Canadian fisheries, and general obligations of southern U.S. fisheries (further constrained by other harvest actions and subject to separate section 7 consultations) under the Pacific Salmon Treaty agreement on Southern Residents. Harvest contemplated in this previous consultation incorporated a likely level of harvest for the PFMC fisheries, the proposed action addressed in this opinion, and therefore, is not additive to effects of the action considered currently. The scope of harvest considered and anticipated in the Pacific Salmon Treaty analysis was low during October to April (percent reductions of 0.1 to 0.8 percent, NMFS 2008d), and is not driving the low prey availability contemplated in the environmental baseline for the current consultation.

Chinook harvest in Canada does affect the prey available in the environmental baseline, but Canadian harvest does not come directly under NMFS' section 7 authority. The United States did, however, recently negotiate for harvest reductions on the west coast of Vancouver Island under the Pacific Salmon Treaty agreement (30 percent reduction in sport and troll fisheries off the west coast of Vancouver Island, NMFS 2008d). NMFS will continue to evaluate the effects of Chinook harvest in Canada on prey available to Southern Residents outside of section 7, and will explore what role reductions in Canadian fisheries may have in the recovery of Southern Resident killer whales.

6.2.3 Prey Quality

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

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

6.2.4 Vessel Activities and Sound

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

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

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

6.2.5 Non-Vessel Sound

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

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

6.2.6 Oil Spills

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

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

6.2.7 Scientific Research

Most of the scientific research conducted on Southern Resident killer whales occurs in inland waters of Washington State and British Columbia. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. In 2006, NMFS issued scientific research permits to seven investigators who intend to study

Southern Resident killer whales (NMFS 2006b). Additionally in 2008, NMFS issued another scientific permit to one investigator intending to study Southern Residents (NMFS 2008l). Research activities are typically conducted between May and October in inland waters; however, some permits include authorization to conduct research in coastal waters.

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

6.2.8 Recovery Planning

The final recovery plan for Southern Resident killer whales was issued in January 2008 (NMFS 2008a). To date, recovery planning and implementation has included additional scientific research to better understand threats to recovery, and directed actions to reduce the risk associated with identified threats. Detailed information on recovery implementation, including oil spill response planning and proposed rulemaking for regulations on vessel effects are available at http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Status/Recovery-Implement.cfm . Actions that reduce the risk associated with identified threats will benefit Southern Resident killer whales. Additionally, recovery planning for salmon will benefit Southern Resident killer whales, where actions improve the quantity and quality of prey available to Southern Resident killer whales.

6.3 Summary of Environmental Baseline

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

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

7 ▪ Effects of the Action

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

7.1 Effects of Vessel Operation

There is potential for direct interaction between Southern Resident killer whales and fishing vessels/gear in the whales' coastal range because of overlap in time and space (Table 9). There is no potential for direct interaction between the whales and vessels/gear when the whales occur in inland waters, because the ocean salmon fisheries of the FMP do not occur in inland waters of Washington and British Columbia. Interactions with vessels could occur while vessels are fishing or while they are transiting to and from the fishing grounds. The most likely vessel interaction is disruption of the whales' behavior. Vessel strikes or any potential for entanglement are rare and have not been observed in association with ocean salmon fisheries. As described previously (Environmental Baseline, Section 6.2.1, Entrapment and Entanglement in Fishing Gear), commercial fishers in all categories participating in U.S. fisheries are required to report incidental marine mammal injuries and mortalities. Although unlikely, NMFS will evaluate the need for observers to cover the ocean salmon fisheries of the FMP if fishery interactions with Southern Residents are reported (in accordance with provisions of the MMPA, 50 CFR 229.7).

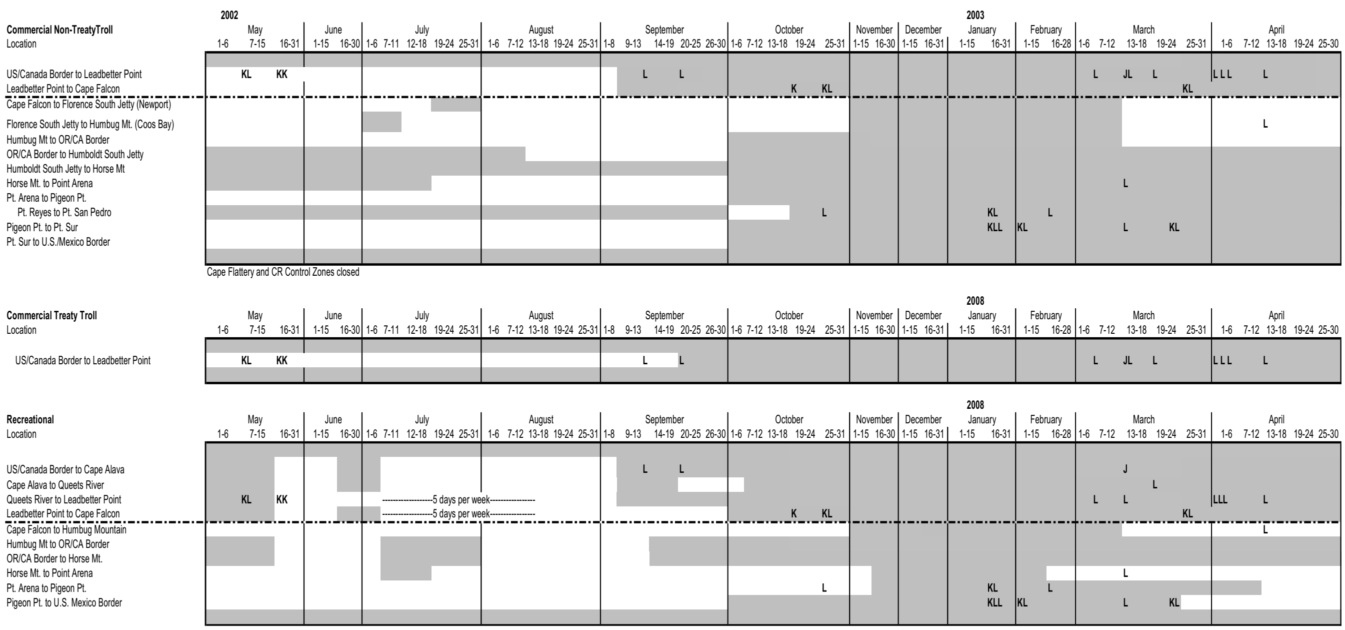
As described in the Environmental Baseline, behavioral responses to vessels could include faster swimming, less predictable travel paths, shorter or longer dive times, moving into open water, and altering normal behavior patterns at the surface (Kruse 1991; Williams et al. 2002a; Bain et al. 2006; Noren, In Press). Research suggests that Southern Residents may expend 10 to 15 percent more energy when vessels are present than they would without vessels present (Bain et al. 2006; Williams et al. 2002a). Sounds from vessels also have the potential to affect foraging by masking the echolocation and communication signals of the whales (Foote et al. 2004; Holt 2008; Holt et al. 2009).

Although vessels generally are a concern for killer whales, fishing vessels operate at slow speeds or in idle when actively fishing, which does not appear to disrupt the whales' behavior (Krahn et al. 2004). When in transit, vessels would likely travel at faster speeds with potential to affect the whales' behavior; however, there are very few past reports of commercial fishing vessels within ½ mile of the whales (Koski 2004, 2005, 2007), probably because fishing vessels do not target whales. Based on this, the low potential for temporal and spatial overlap (Table 9), and relatively small number of fishing vessels participating in the fleet (Figures 8 and 9), there is a low potential for direct interaction between the ocean salmon fisheries of operating under the FMP and Southern Resident killer whales.

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

Table 9. Final fishing regulation schedule for: (a) 2002 (high fishing effort/harvest year) and (b) 2008 (low fishing effort/harvest year) salmon fisheries by month and area. Open fishing periods are indicated in white (PFMC 2002, 2008). Southern Resident killer whale sightings are indicated by pod (K or L).

(a)



(b)

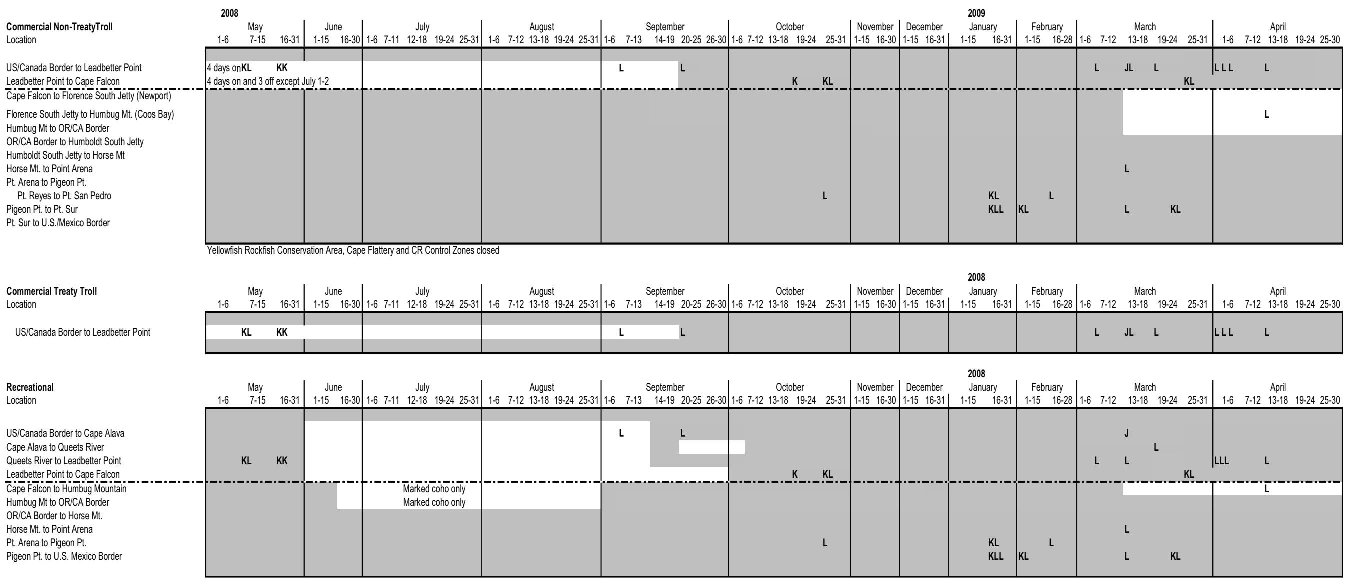

2008
2009
Commercial Non-TreatyTroll
Location
May
June
July
August
September
October
November
December
January
February
March
April
US/Canada Border to Leadbetter Point
Leadbetter Point to Cape Falcon
Cape Falcon to Florence South Jetty (Newport)
Florence South Jetty to Humbug Mt. (Coos Bay)
Humbug Mt to OR/CA Border
OR/CA Border to Humboldt South Jetty
Humboldt South Jetty to Horse Mt
Horse Mt. to Point Arena
Pt. Arena to Pigeon Pt.
Pt. Reyes to Pt. San Pedro
Pigeon Pt. to Pt. Sur
Pt. Sur to U.S./Mexico Border
4 days on
4 days on and 3 off except July 1-2
Yellowfish Rockfish Conservation Area, Cape Flattery and CR Control Zones closed
Commercial Treaty Troll
US/Canada Border to Leadbetter Point
Recreational
US/Canada Border to Cape Alava
Cape Alava to Queets River
Queets River to Leadbetter Point
Leadbetter Point to Cape Falcon
Cape Falcon to Humbug Mountain
Humbug Mt to OR/CA Border
OR/CA Border to Horse Mt.
Horse Mt. to Point Arena
Pt. Arena to Pigeon Pt.
Pigeon Pt. to U.S. Mexico Border
Marked coho only
Marked coho only

Figure 8. Trend in the number of troll vessels landing salmon in the ocean salmon fisheries (PFMC 2008).

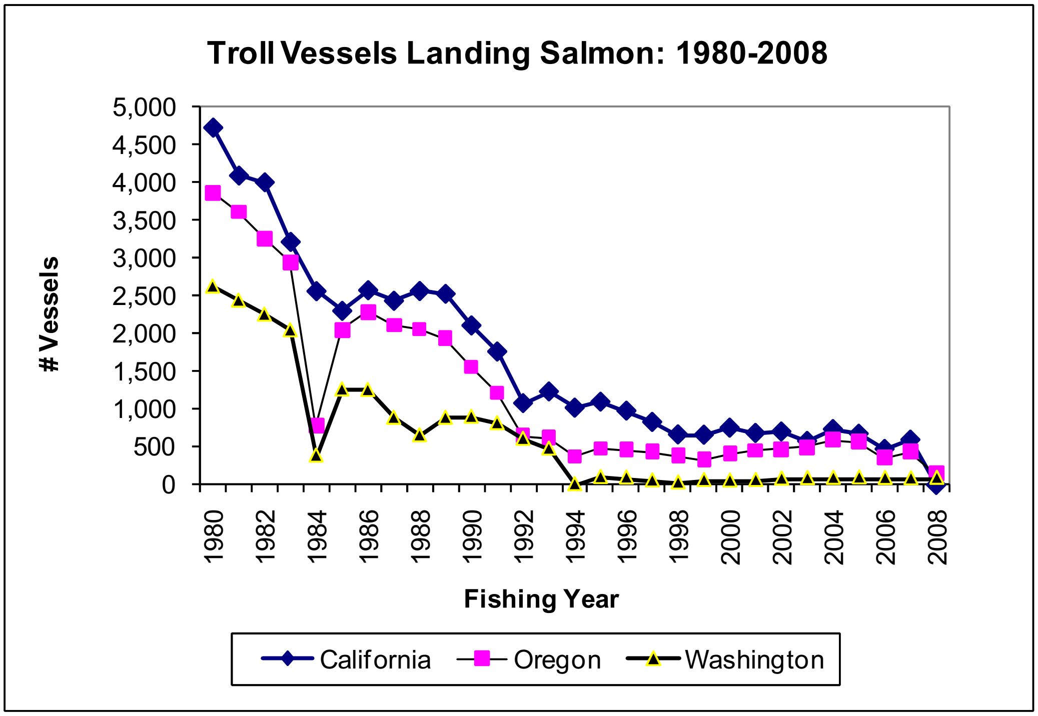
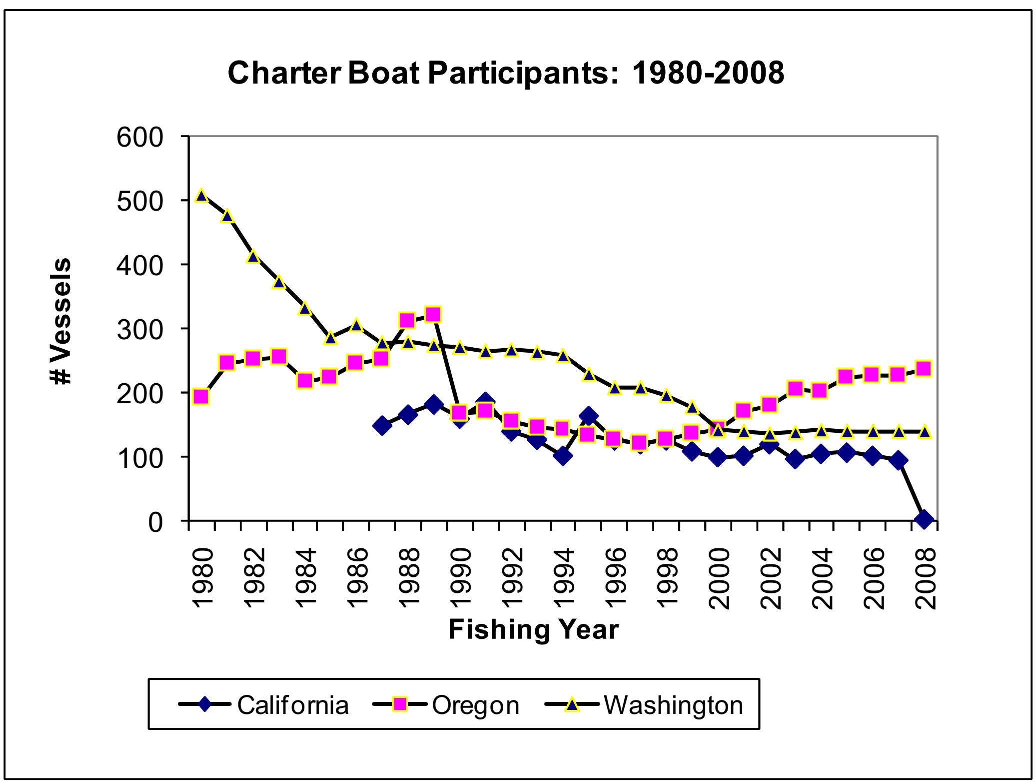


Figure 9. Trend in the number of charter vessels landing salmon in ocean salmon fisheries (PFMC 2008).



7.2 Effects of Prey Reduction

We compared prey available to Southern Resident killer whales with and without the action and found that the action will reduce prey available to Southern Residents in some locations during some time periods. This analysis considers whether effects of that prey reduction may reduce the reproduction, numbers, or distribution of Southern Resident killer whales, pursuant to NMFS jeopardy standard (reviewed in Section 1.2). We evaluated the potential effects of the FMP on Southern Residents based on the best scientific information regarding metabolic needs of the whales, prey availability, and reductions in prey resulting from a range of harvest scenarios that have been previously authorized, and thus are considered likely in the future, under the FMP.

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

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

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

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

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

In order to evaluate how the prey reduction affects Southern Residents, we needed to consider prey reduction specific to the whales' needs, which are dependent on when the whales occur in particular areas of their range. Therefore, the prey reduction was evaluated by time and area, among other factors, based on the available information to stratify the analysis (detailed methods are outlined in the Environmental Baseline).

The percent reduction parameter was evaluated by comparing available food energy with the FMP to the baseline. The prey available: needs parameter was estimated by directly comparing available Chinook food energy (in kilocalories) with the FMP to the metabolic needs of the whale population (in kilocalories) for comparison to the baseline. These estimates also take into account a reasonable range of prey size selectivity for Southern Resident killer whales (as described in the environmental baseline).

7.2.1 Short-Term or Annual Effects

Percent Reduction

Prey reduction caused by the proposed action is measured as the percent reduction in prey available with the action. The range in percent reduction reflects annual and seasonal variability in Chinook abundance, differences by region, and the range in size selectivity of the whales' (Table 10). For example, in 2002 during the May-June time period, in the coastal area and assuming the low selectivity model, the analysis suggests that available prey is reduced by 4.7 percent as a result of fishing (Table 10). Although actual FMP fishing effort only occurs in coastal waters, this effort indirectly affects fish returning to inland waters. Some fish caught in coastal waters would have returned to inland waters in the absence of fishing, documented as prey reduction in inland waters. Percent reductions in coastal waters are greater than in inland waters. Generally, the percent reduction by region is greater in good Chinook abundance years than in poor abundance years. The level of size selectivity also affects the prey reduction caused by the action, where the percent reduction is reduced as the whales' size selectivity increases (i.e., as the whales become more size selective than the fisheries). Additionally, the proposed action causes minimal or no prey reduction during the October to April time period, regardless of year or region (range from 0.0 percent to 0.7 percent reduction; Table 10). The proposed action causes incrementally larger prey reductions during May to June (range from 0.2 percent to 4.7 percent) and July to September (range from 1.1 percent to 11.8 percent) (Table 10) when the majority of FMP fisheries occur.

Remaining Prey-Base Compared to Whales' Needs

We compared the food energy of prey available to the whales with the proposed action to the estimated metabolic needs of the whales (Table 10; Appendix 2). In all cases where a sizeable percent reduction is attributed to the proposed action, the ratios of prey available to the whales' needs without fishing are greater than ratios with fishing. For example in a good year, July-Sept, coastal, with low selectivity, the largest reduction (-11.8 percent) corresponds to a 71.6 ratio without fishing compared to 63.2 with fishing (Table 10).   Small percent reductions (i.e., less than 1 percent), however, result in minimal to no detectable change between the ratios with and without fishing, as in all Oct-April time periods. The ratios are generally greater in good Chinook abundance years than in poor abundance years, with and without fishing. With the exception of the October to April time period, the ratios are greater in coastal waters than in inland waters. In October to April, the ratios are greater in inland waters than in coastal waters. Size selectivity of the whales also affects the ratio values, where the ratios are reduced as the whales' size selectivity increases (i.e., as the whales become more size selective, they are less likely to pursue smaller fish and fewer kilocalories are available to the whales). For example, in a good year, from July-Sept, in coastal waters, the ratio of prey available to needs with fishing is 63.2 with low selectivity and drops to 15.3 with high selectivity.

There is no detectable difference between the ratios with and without fishing regardless of year, region, or selectivity of the whales during October to April (i.e., very little fishing) (Table 10). During May to June, prey available is as low as 3.8 to 22.5 times the whales' prey needs in inland waters, and during July to September as low as 3.6 to 15.8 times needs in inland waters, depending on the whales' size selectivity. For these specific cases, 3.8 to 22.5 times prey needs with fishing are compared to 3.8 to 22.6 times prey needs without fishing, and 3.6 to 15.8 times prey needs with fishing are compared to 3.6 and 16.0 times prey needs without fishing (Table 10). The greatest difference in ratios with and without fishing, and where the ratios are low, occurs during July to September in coastal waters (6.3 to 28.0 times prey needs with fishing compared to 6.6 to 28.9 times prey needs without fishing, corresponding to percent reductions of 3.0 to 3.9 percent).

Overall, the greatest difference in ratios with and without fishing and where the ratios are low occurs during July to September, and the lowest ratios of prey available to the whales' needs occur in October to April, albeit not attributed to harvest during that time period. The FRAM model (as described in section 7.2.1) is not designed to forecast effects of harvest from a previous year (i.e., July to September) on prey available in a subsequent year (i.e., October to April of the following year). Although outside the model capability, we can qualitatively consider the effects of harvest during July to September on prey available to Southern Residents in the subsequent October to April. The FMP Chinook fisheries mostly target and land mature Chinook. Chinook mature at 3-5 years of age (Meyers et al. 2000), and in general, 80 percent of the landed catch is 3-5 year olds (H. Yuen pers. comm., cited in NMFS 2008m), and over 80 percent of Chinook mortalities were 3-5 year olds in July-September for the model years 2002 and 2008 (LaVoy 2009). These mature Chinook would have returned to spawning grounds in freshwater systems in the absence of harvest, and would not be available to Southern Residents in the subsequent year regardless of harvest. Therefore, harvest during July to September has minimal effect on prey available to Southern Residents during October to April of the subsequent year.

Table 10. Range in Percent Reduction and Remaining Prey Base Compared to the Whales' Needs Based on Variability in Chinook Returns and the Whales' Selectivity, a High Percent Chinook in the Whales' Diet (86%), and Underestimate of Chinook stocks available (after natural mortality).

Year	Time Period	Area	Percent Reduction		Ratio Prey Available : Needs (w/ proposed action)		Ratio Prey Available : Needs (baseline)	
			Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity
Poor Chinook year (2008)	Oct-April	Coastal	-0.2%	0.0%	4.0	**1.0**	4.0	1.0
		Inland	0.0%	0.0%	15.6	2.2	15.6	2.2
	May-June	Coastal	-1.4%	-0.6%	32.5	8.7	32.8	8.7
		Inland	-0.5%	-0.3%	22.5	3.8	22.6	3.8
	July-Sept	Coastal	-3.0%	**-3.9%**	28.0	**6.3**	28.9	**6.6**
		Inland	-1.1%	-1.4%	15.8	3.6	16.0	3.6
Good Chinook year (2002)	Oct-April	Coastal	-0.7%	-0.2%	10.4	2.1	10.4	2.1
		Inland	0.0%	0.0%	21.5	3.7	21.5	3.7
	May-June	Coastal	-4.7%	-1.3%	78.3	21.0	82.2	21.3
		Inland	-0.6%	-0.2%	28.8	6.2	28.9	6.3
	July-Sept	Coastal	**-11.8%**	-6.2%	63.2	15.3	71.6	16.3
		Inland	-1.3%	-1.4%	19.6	5.7	19.9	5.7

In addition to reducing prey abundance, fisheries can cause fish to disaggregate, or cause dense schools of fish to scatter (i.e., Brock and Riffenburgh 1960; Dayton et al. 1995). This phenomenon can affect the foraging behavior of marine mammals that target the aggregated prey. With respect to salmon, the effects of disaggregating prey are likely to be short-term and site-specific, with the fish re-aggregating again in the same or different location. While we do not have quantitative information on what effects the fishery may have on salmon aggregations or whether there is any prey density threshold that affects foraging efficiency of killer whales, there is potential for some short-term reduction in the ability of whales to efficiently catch salmon after fishing has occurred in an area.

Data Confidence, Uncertainties, and Assumptions

Section 7 of the ESA requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of threatened and endangered species or destroy or adversely modify their critical habitat, relying on the best scientific data available. Accordingly we highlight our level of confidence in the available data, identify where there is uncertainty in light of data gaps, and identify where we made conservative assumptions in the analysis to estimate effects on prey available to Southern Resident killer whales.

Data Confidence

A variety of data sources and models are used to evaluate the effects of prey reduction, including estimates of the energy requirements of the whales in certain locations at certain times, estimates of the energy available in the form of prey in certain locations at certain times, and estimates of the change in available energy in the form of prey with and without the proposed action. These estimates are based on the best data available, but we have varying levels of confidence in the data and modeling underlying each estimate.

We are highly confident in the age, sex, and lineage of all Southern Residents, informed by a long-term data set of direct observation. Additionally, we are fairly confident in the regional and temporal characterization of the whales' presence in or absence from inland waters, because the population is highly visible and closely observed in inland waters. We are less confident about the metabolic requirements of the population, informed by modeling that uses values not directly based on the Southern Resident population (i.e., literature-based energy relationships, and whale sizes based on captive animals and other killer whale populations).

We are moderately confident of the predominance of salmon in the whales' diet year-round, and the predominance of Chinook in the whales' diet while in inland waters. We are less confident about the proportion of Chinook in the whales' diet in coastal waters, but conclude it is reasonable to assume a preference for Chinook when available.

To estimate Chinook abundance and distribution in marine waters we relied primarily on FRAM, a single pool model that uses catch and escapement data. The model was not designed to be used to estimate regional and seasonal Chinook abundance, as described previously, so several additional assumptions were required to obtain these results. Regarding the FRAM model results, we are moderately confident in the estimates of total adult Chinook abundance in marine areas, but less confident in regional distribution and abundance estimates, particularly related to the distribution of non-mature fish (2-year-olds).

Finally, we have low confidence in the data sources that informed our assumptions about the whales' selectivity of older larger Chinook. The small sample sizes, and potential biases in Chinook age composition estimates, are described in more detail above in the environmental baseline.

Uncertainty

In addition to variable confidence in the available data, there are data gaps which create uncertainty in the analysis. At this time, we do not have data with sufficient detail regarding whale and Chinook distribution in smaller areas or over shorter time frames than in inland or coastal waters at a seasonal level. The action could reduce prey available to the whales in specific places at specific times by a larger percent than is currently estimated by our analysis of broader areas and time frames. Additionally, we do not have any data on the foraging efficiency of Southern Residents. Without this information, we must rely on professional judgment to evaluate whether the ratio of prey available compared to the whales' needs is small or large.

Conservative Assumptions

In light of variable data confidence and uncertainty, we used assumptions to focus our analysis on conservative data scenarios. We conservatively assumed an all salmon diet composed mainly of Chinook in both inland and coastal waters. We also treated small fish as unavailable to the whales. This assumption reduces the food energy available to Southern Residents by as much as an order of magnitude. Additionally, we focused on the high end of metabolic requirements modeled for the population to represent the whales' needs. Further, the estimated available food energy from Chinook salmon is an underestimate, because natural mortality (which includes predation by killer whales) was already accounted for before estimating the energy available to the whales. These conservative assumptions aid in meeting our obligation to insure the proposed action does not appreciably reduce the species ability to survive and recover.

7.2.4 Long-Term Effects

We rely on the salmon determinations to ensure that the proposed action does not appreciably reduce the likelihood of survival and recovery of the Southern Residents in the long term. NMFS has concluded that the action is not likely to appreciably reduce the survival and recovery of Chinook and all other salmon species ESUs affected by the action (summarized in Table 1). Additionally, NMFS found that the actions are not likely to destroy or adversely modify designated critical habitat of any salmon ESUs.

These conclusions on Chinook, other salmon ESUs, and critical habitat were informed by recovery plans, objectives for priority stocks, and/or other considerations specific to individual ESUs, as discussed in the biological opinions and 4(d) determination documents cited in Table 1.

NMFS' opinions on effects of FMP fisheries on salmon also consider the effects of environmental variability on sustainability of salmon stocks (i.e., from ocean conditions or climate effects) and aim to maintain stocks at or above conservation objectives. Although in specific cases, for some years and stocks the conservation objectives are not met, overall NMFS finds that effects to the ESU still meet ESA compliance standards. When necessary to insure that the FMP fisheries do not compromise ESA compliance, regulations for those fisheries have been adjusted to incorporate conservation measures that avoid jeopardy to listed salmonids. For example, in 2008 and the current year, poor performance of Chinook stocks in Central Valley, California were the impetus behind fisheries closures south of Cape Falcon. As a result of the fishery closures the proposed action will not affect escapements of these stocks.

While the salmon harvest is managed to meet objectives to promote recovery of salmon, we are not currently able to evaluate if recovery levels identified for salmon ESUs are consistent with the prey needs and recovery objectives for Southern Resident killer whales. We have no information that suggests identified salmon ESU recovery levels would be insufficient for Southern Resident survival and recovery.

7.3 Effects on Critical Habitat

In addition to the direct and indirect effects discussed above, the action may have effects on critical habitat designated for Southern Resident killer whales. Based on the natural history of the Southern Residents and their habitat needs, 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. NMFS evaluated effects to these features.

NMFS did not use the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02 in this Opinion. Instead, this analysis relies on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation," in section 4 that describe the designation process, and in section 7 that set forth the substantive protections and procedural aspects of consultations, and on agency guidance for application of the "destruction or adverse modification" standard (NMFS 2005d).

FMP fisheries are not expected to have an impact on water quality or passage of the whales. Discharges from fishing vessels can affect water quality and vessels may affect the travel of the whales; however, the FMP fishing fleet operates along the coast, outside of designated critical habitat.

The previous discussion of the effects on whales as a result of prey reduction is also relevant to effects on the prey feature (sufficient quantity, quality and availability of prey) of critical habitat. Effects of the fishery include a potential reduction in prey availability in critical habitat resulting from the harvest of adult salmon. As described previously, the proposed action is expected to result in prey removal that represents short-term or annual reductions of Chinook in designated critical habitat of 0.0 to 1.4 percent or less (Table 10). Additionally, NMFS has previously concluded that the proposed action is not likely to jeopardize the continued existence of listed salmon or destroy or adversely modify their critical habitat (Table 1).

8 ▪ Cumulative Effects

Cumulative effects are those effects of future tribal, state, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act. Non-Federal actions that require authorization under section 10 of the ESA, and that are not included within the scope of this conference, will also be evaluated in separate section 7 consultations.

Future tribal, state and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities in the action area are primarily those conducted under state, tribal or federal government management. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, or designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to geographic scope of the action area which encompasses several government entities exercising various authorities, and the changing economies of the region, make any analysis of cumulative effects speculative.

A Final Puget Sound Chinook Recovery Plan was adopted on January 19, 2007 (72 FR 2493), and a Final Recovery Plan for Southern Resident killer whales was published January 24, 2008 (NMFS 2008a). An Advanced Notice of Proposed Rulemaking regarding vessel effects on Southern Residents to gather information on the potential need for further regulations was published on March 22, 2007 (72 FR 13464). Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA listed salmon, and the listed Southern Residents, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them “reasonably certain to occur” in its analysis of cumulative effects.

Private activities are primarily associated with other commercial and sport fisheries, construction, vessel traffic and sound, and marine pollution. These potential factors are ongoing, expected to continue in the future, and the level of their impact is uncertain. Therefore, it is difficult to assess the cumulative impacts and the relative importance of effects additional to those already identified.

9 ▪ Integration and Synthesis of Effects

This section discusses the effects of the action in the context of the status of the species, the environmental baseline, and cumulative effects, and offers our opinion as to whether the effects of the proposed action are likely to jeopardize the continued existence of the Southern Residents.

The Southern Resident killer whale DPS has fewer than 90 members and a variable productivity rate. In NMFS' opinion, the loss of a single individual, or the decrease in reproductive capacity of a single individual, is likely to reduce appreciably the likelihood of survival and recovery of the DPS. Thus the section 7 analysis must scrutinize even small effects on the fitness of individuals that increase the risk of mortality or decrease the chances of successful reproduction.

NMFS' conclusions are informed by both the effects of vessel operations and prey reduction on the Southern Resident population. As described in section 7.1, Effects of Vessel Operation, the proposed action will result in an increase in vessel activity across the range of Southern Residents. Any effects on killer whales are likely to be small, however, considering the limited potential for temporal and spatial overlap of vessels and Southern Residents, the small number of vessels involved in the fishery, and the large area over which the action occurs. Any direct interaction between the FMP fisheries and Southern Resident killer whales would likely result in short-term behavioral avoidance, with insignificant effects.

For the reasons described in section 7.2, Effects of Prey Reduction, our effects analysis focused primarily on the likely percent reduction in Chinook prey available to whales as a result of the proposed harvest. To put that reduction in context, the analysis also reported the ratio of Chinook prey available to prey needed by the whales. We discussed the need to make conservative assumptions that focus our conclusions on conservative scenarios to mitigate for variable data confidence and uncertainty.

It is currently uncertain whether a lack of adequate prey at particular times in particular locations is limiting the ability of the Southern Resident killer whale DPS to survive and recover. There is anecdotal evidence that some individual whales in some years may be undernourished, although it is unknown whether their condition is a result of insufficient prey or some other cause. Researchers have correlated reductions in Chinook abundance with decreased survival of resident whales and decreased fecundity of Southern Residents. Information developed for the analysis in this opinion also provides evidence that under some conditions, in some locations and seasons, the ratio of prey needed to prey available is low (i.e., as low as 1.0 times prey needs).

In the short term, harvest under the FMP will reduce the prey available to the whales in most locations and time periods. For some periods and locations, the proposed harvest makes a negligible difference in the availability of prey. For example, during October to April, although the ratio of prey available compared to prey needed is very small (about 1.0 in coastal waters and 2.2 in inland waters), there is no detectable difference between the ratio with and without the proposed harvest. For other periods and locations, the proposed harvest makes a measurable difference in the availability of prey (11.8 percent reduction), but the ratio of prey available compared to prey needed is relatively large (greater than 60 times prey needs).

To arrive at conclusions in a section 7 consultation, we focused on those periods and locations where the reduction in available prey would be measurable and the ratio of prey available compared to prey needed appears to be relatively small. Without knowing the foraging efficiency of the whales, the determination of whether a given ratio is adequate is qualitative and based on best professional judgment. Our conservative scenarios focus on an all salmon diet composed mainly of Chinook, assume the whales are highly size-selective, and underestimate the prey available to the whales. Thus the conservative scenarios may not be the most likely, especially in coastal waters, where we have less direct evidence of Chinook preference and size selectivity. In addition, the scenarios with the lowest ratios of prey available to prey needed occur in poor salmon years, which are not expected to be a constant condition.

As the ratios of prey available to the needs of the whales get smaller, the foraging efficiency required by the whales to meet their needs gets increasingly greater. We expect that the whales need greater ratios of prey available to needs in coastal waters than in inland waters, because prey is likely more dense and predictably congregated in inland waters. In coastal waters, features that may congregate prey are likely spread out geographically and are potentially less predictable, and generally we would expect the whales are less efficient foragers under such circumstances. The ratios during July to September are twice as large in coastal waters as ratios estimated in inland waters, but considering the probable difference in Southern Residents' ability to forage efficiently in coastal versus inland waters, both sets of ratios are low.

While the FMP fisheries have the potential to adversely affect Southern Resident killer whales and their critical habitat by reducing prey in their range and critical habitat, the following factors reduce our concerns about the severity of the impact:

- The lowest ratios observed (i.e., in October- April) are not a reduction from the baseline.
- The greatest percent reductions, which occur during the July to September time period, have a minimal effect on prey available to Southern Residents in October to April of the subsequent year, when the ratios of prey available to the needs of the whales are lowest.
- During July to September, the proposed action causes the greatest percent reduction in prey (up to 3.9 percent), which is a detectable change in prey available to the whales' needs (i.e., 6.6 to 6.3 or a 0.3 difference). The detectable change occurs in poor years, and we do not anticipate poor Chinook years will be a constant condition in the future.
- The FMP includes measures to insure that long-term conservation goals for listed salmon are achieved, including the potential for fishery closures in low abundance years.
- NMFS will continue to review the PFMC's management recommendations for annual harvest and assess whether re-initiation is warranted as outlined in Section 13 of the opinion.

- NMFS will continue to review the available information on Southern Resident killer whales to evaluate the prey preferences in inland and coastal waters (species and size selection). If new information indicates that the conservative scenarios are the most likely, we will re-initiate consultation as outlined in Section 13 of the opinion.

- There are several factors that reduce the likely severity of effects from the proposed action, which we considered:

    - The amount of spatial and temporal overlap between Southern Residents (or their critical habitat) and the FMP fisheries is relatively small and direct interactions between the whales and vessels, gear or noise associated with the fishery are likely to be minimal.

    - Our estimate of the Chinook food energy required to sustain the Southern Resident killer whale population may be an overestimate, because we focused on the conservative assumptions that the population relies on a mostly-Chinook diet and is highly size-selective.

    - Our estimate of the total Chinook food energy available is likely an underestimate, because our estimates are after natural mortality (which includes predation by killer whales).

    - The most conservative scenario may not be the most likely scenario, particularly in coastal waters.

These factors suggest that the proposed action is not likely to reduce the reproductive success or increase the risk of mortality of any members of the Southern Resident killer whale DPS or impair the conservation value of essential features of its critical habitat.

10 ▪ Conclusions

After reviewing the current status of the endangered population of Southern Resident killer whales and their critical habitat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Southern Resident killer whale DPS or adversely modify its critical habitat.

11 ▪ Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary or appropriate to minimize impacts and sets forth terms and conditions in order to implement the reasonable and prudent measures.

Incidental take authorization of marine mammals can require authorization under section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and/or its 1994 Amendments. However, in this opinion the no jeopardy conclusion for Southern Resident killer whales was based on an anticipated level of prey reduction that would not rise to the level of "serious injury or mortality" under MMPA 101(a)(5)(E) for any individual Southern Resident killer whale, as described in more detail below (section 11.1, Amount or Extent of Incidental Take). Therefore, an MMPA 101(a)(5)(e) negligible impact determination or MMPA authorization is not required, and NMFS, therefore, issues the following incidental take statement for Southern Resident killer whales.

11.1 Amount or Extent of Incidental Take

The harvest of Chinook salmon that would occur under the proposed action could result in some level of harm to Southern Resident killer whales by reducing prey availability, which may cause animals to forage for longer periods, travel to alternate locations, or abandon foraging efforts. All individuals of the Southern Resident killer whale DPS have the potential to be adversely affected across their range. However, the extent of take from this adverse impact is not anticipated to appreciably reduce the survival and recovery of Southern Resident killer whales, because it is not anticipated that take will increase the risk of mortality (i.e., and therefore will not rise to the level of serious injury or mortality), or hinder the reproductive success of any individual Southern Resident killer whale (per our jeopardy analysis framework, as described in Section 1.2, Jeopardy Analysis Framework).

11.2 Effect of the Take

In the accompanying biological opinion, NMFS determined that the level of anticipated take of Southern Resident killer whales is not likely to result in jeopardy to the species.

11.3 Reasonable and Prudent Measures

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize the impacts from the proposed action on the Southern Resident killer whales.

1. In-season management actions taken during the course of the fisheries shall consider the extent of incidental take described in the Incidental Take Statement. NMFS will consult with the states and tribes to account for the catch of each fishery as it occurs through the season and track the results of these monitoring activities and, in particular, any anticipated or actual increase in the harvest rates of Chinook salmon from those expected preseason.

2. Harvest impacts shall be monitored using best available measures. Although NMFS is the federal agency responsible for carrying out this reasonable and prudent measure, in practical terms, it is the states and tribes that monitor catch impacts.

11.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, NMFS must continue to comply with all of the terms and conditions listed in the current biological opinions for listed salmon. In addition, NMFS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1a. NMFS shall confer with the affected states and tribes, and the PFMC chair, as appropriate, to ensure that in-season management actions taken during the course of the PFMC fisheries consider the type and extent of take specified in the Incidental Take Statement.

1b. NMFS shall confer with the affected states and tribes, and the PFMC chair, to account for the catch of the FMP fisheries throughout the annual season. If it becomes apparent in-season that any of the established harvest limits may be exceeded, NMFS, in consultation with the states and tribes, shall assess whether additional management measures are needed to reduce the anticipated catch, and if so, will implement those measures

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

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

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

2d. NMFS, in cooperation with the affected states and PFMC chair, shall ensure that any commercial vessel owner or operator participating in the PFMC fishery complies with 50 CFR 229.6 and reports all incidental injuries or mortalities of marine mammals that occur during commercial fishing operations to NMFS. "Injury" is defined in 50 CFR 229.2 as a wound or other physical harm. In addition, any animal that ingests fishing gear, or any animal that is released with fishing gear entangling, trailing, or perforating any part of the body is considered injured and must be reported.

12 ▪ Conservation Recommendations

NMFS has broad authority that can be used to further the survival and recovery of Southern Resident Killer Whales and their prey. We recommend that NMFS implements the following measures to reduce the risks of the proposed action and provide information for future consultations involving the implementation of fisheries regulations that may affect Southern Resident killer whales, as well as reduce the adverse affects associated with fishing activities:

1. *Monitor and report Southern Resident killer whales in the action area.* Although the Southern Residents are the subject of considerable scientific study, very little is known about their offshore habitat. The available information suggests that there is some degree of overlap between the FMP fisheries and the Southern Resident killer whales during certain times of the year. NMFS should work with the PFMC to teach fishermen how to identify, photograph, and report killer whale sightings in PFMC waters without causing harassment. With this information, we would better understand the level of overlap between the fisheries and the whales and improve our knowledge of the whales' offshore habitat.

2. *Support ongoing salmon recovery efforts to ensure an adequate food base for Southern Resident recovery.* In light of the inadequacy of information regarding the specific salmon stocks used by Southern Residents as prey, it is important to support salmon restoration efforts on a region-wide basis, with preliminary emphasis placed on river

basins that are or have the potential to be significant producers of Chinook and other salmonids. Successful salmon recovery programs must be broadly based and address the complex issues of land-use practices, commerce and energy demands, salmon harvest management, and hatchery management. Restoration measures for salmonids will require substantial actions across all categories of limiting factors and threats, as described in the Status of the Species and Environmental Baseline sections.

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3. *Conduct research on the correlation between Southern Resident killer whale survival, birth rates, and various salmon species and stocks.* Assessing whether Southern Resident killer whales have adequate prey resources to support their survival and recovery is difficult because we lack a detailed knowledge of the food habits and seasonal ranges of killer whales, uncertainties in the historical and current abundance levels of many localized populations of prey, and the cyclic nature of large-scale changes in ocean conditions. Studies of resident killer whales indicate that fish, and particularly salmon, are the major dietary component of resident whales with a reported preference for Chinook salmon. To improve our understanding of the relationship between Southern Residents and their prey, we recommend further study dedicated to identifying the year-round food habits of Southern Residents in all parts of their range, including additional analysis of information regarding the correlation between Southern Resident survival and fecundity and various salmon species and stocks within the range and distribution of this killer whale population.

4. *NMFS and the PFMC should cooperate with research partners to collect information on prey preference and biomass.* Although studies of resident killer whales indicate that fish, and particularly salmon, are the major dietary component of resident whales with a reported preference for Chinook salmon, more information is needed to determine the prey preference of Southern Residents in offshore waters. We recommend additional studies in cooperation with our research partners to confirm the relative importance of Chinook and to identify the contributions of other prey, including different salmon species, groundfish, herring, and squid. Information on prey size, annual variation in diet, and prey selection by age and sex class of whales in relation to species availability is also of interest.

5. *Minimize the ecosystem effects of the FMP fisheries.* Fisheries that catch fish in particular areas during discrete times have greater potential to produce localized depletions of fish, which may interfere with predators that also take advantage of fish concentrations in overlapping places and times. Although NMFS has not identified this as an issue of concern for the FMP fisheries, more information is needed to understand the effects of the fishery on an ecosystem level. Accordingly, NMFS should work with the PFMC to collect data and assess the potential for local depletion effects. Where a significant potential is identified, NMFS should work with the PFMC, the tribes, and states to develop means for reducing the impacts of fisheries that are concentrated in time and space.

13 ▪ Reinitiation of Consultation

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

14 ▪ Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554: Information Quality Act) specifies three components contributing to the quality of a document: utility, integrity, and objectivity. This section of the Biological Opinion addresses these Information Quality Act (IQA) components, documents NMFS' compliance with the IQA, and certifies that this Opinion has undergone pre-dissemination review.

Utility: This document records the results of one intra-agency consultation, completed under the authority of the ESA. The information presented in this document is useful to federal agencies, including NMFS, state natural resource management agencies, local and tribal governments. This consultation helps to fulfill NMFS' legal obligations under multiple authorities. The information is also useful and of interest to the general public because it describes the manner by which public trust resources are being managed and conserved. The information presented in these documents and used in the underlying consultations represents the best available scientific and commercial information.

Integrity: This consultation was completed on a computer system managed by NMFS in accordance with the relevant technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

Objectivity:

Information Product Category: Natural Resource Plan

Standards: This consultation and the supporting documents are clear, concise, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards, including the NMFS ESA Consultation Handbook, and ESA Regulations (50 CFR 402.01 et seq.).

Best Available Information: This consultation and the supporting documents use the best available information, as referenced in the Literature Cited section. The analyses provided in this Opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data, and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with the Northwest Region's ESA quality control and assurance processes.

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Appendix 1. Chinook Food Energy Available

Chinook food energy available with and without the action by cohort, region, time period, and depending on a range in size selectivity of the whales (LaVoy 2009).

Year	Time Period	Kilocalories available (with FMP Fisheries)				Kilocalories available (without FMP Fisheries)			
		Coastal		Inland		Coastal		Inland	
		Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity	Low Selectivity	High Selectivity
2008	Oct-April	9,271,746,405	2,299,064,039	5,102,911,827	711,624,251	9,287,630,851	2,300,029,783	5,102,950,907	711,626,221
	May-June	13,283,314,755	3,561,558,859	7,736,466,148	1,297,017,990	13,473,940,600	3,582,846,687	7,777,747,998	1,300,821,635
	July-Sept	14,145,565,710	3,181,368,212	10,045,996,809	2,266,807,051	14,588,263,743	3,310,149,433	10,156,342,837	2,299,426,664
2002	Oct-April	23,798,521,768	4,877,069,780	7,042,527,870	1,222,317,511	23,964,924,991	4,885,957,427	7,042,653,044	1,222,330,507
	May-June	32,214,661,257	8,622,057,108	9,911,388,423	2,150,168,782	33,807,402,448	8,739,822,211	9,969,344,967	2,155,204,861
	July-Sept	31,874,224,489	7,724,459,993	12,451,816,659	3,602,309,738	36,138,806,779	8,230,902,929	12,614,568,564	3,653,086,558

Appendix 2. Range in the Ratio of Prey Available

Range in the ratio of prey available to the whales' needs with and without the actions, depending on the year, time period, region, range in energy requirements of the whales (min and max, based on Noren in review), range in percent Chinook in the whales' diet, and range in size selectivity of the whales (LaVoy 2009).

Selectivity	Diet %	Time Period	Years	Prey available : prey needs							
				With FMP Fisheries				Without FMP Fisheries			
				Inland		Coastal		Inland		Coastal	
				Min	Max	Min	Max	Min	Max	Min	Max
Low Selectivity	86% Chinook	Oct- April	2008	18.7	15.6	4.8	4.0	18.7	15.6	4.8	4.0
			2002	25.8	21.5	12.4	10.4	25.8	21.5	12.5	10.4
		May-June	2008	26.9	22.5	39.3	32.5	27.0	22.6	39.3	32.8
			2002	34.5	28.8	93.9	78.3	34.7	28.9	98.5	82.2
		July-Sept	2008	18.9	15.8	34.2	28.0	19.2	16.0	34.6	28.9
			2002	23.5	19.6	75.7	63.2	23.8	19.9	85.8	71.6
	70% Chinook	Oct – April	2008	23.0	19.2	5.9	5.0	23.0	19.2	5.9	5.0
			2002	31.7	26.4	15.2	12.7	31.7	26.4	15.3	12.8
		May-June	2008	33.0	27.6	48.3	39.7	33.2	27.7	48.2	40.3
			2002	42.3	35.3	115.3	96.3	42.6	35.5	121.0	101.0
		July-Sept	2008	23.3	19.4	42.0	34.5	23.5	19.6	42.6	35.5
			2002	28.8	24.1	93.0	77.6	29.2	24.4	105.4	88.0
	60% Chinook	Oct – April	2008	26.8	22.4	6.9	5.8	26.8	22.4	6.9	5.8
			2002	37.0	30.9	37.0	14.8	37.0	30.9	17.9	14.9
		May-June	2008	38.6	32.2	56.4	46.3	38.6	32.4	55.5	47.0
			2002	49.4	41.2	49.4	112.3	49.7	41.5	141.2	117.9
		July-Sept	2008	27.2	22.7	49.0	40.2	27.2	22.9	48.2	41.5
			2002	33.7	28.1	33.7	90.6	34.1	102.7	123.0	102.7

Selectivity	Diet %	Time Period	Years	Prey available : prey needs							
				With FMP Fisheries				Without FMP Fisheries			
				Inland		Coastal		Inland		Coastal	
				Min	Max	Min	Max	Min	Max	Min	Max
High Selectivity	86% Chinook	Oct – April	2008	2.6	2.2	1.2	1.0	2.6	2.2	1.2	1.0
			2002	4.5	3.7	2.5	2.1	4.5	3.7	2.5	2.1
		May-June	2008	4.5	3.8	10.4	8.7	4.5	3.8	10.4	8.7
			2002	7.5	6.2	25.1	21.0	7.5	6.3	25.5	21.3
		July-Sept	2008	4.3	3.6	7.6	6.3	4.3	3.6	7.9	6.6
			2002	6.8	5.7	18.3	15.3	6.9	5.7	19.5	16.3
	70% Chinook	Oct - April	2008	3.2	2.7	1.5	1.2	3.2	2.7	1.5	1.2
			2002	5.5	4.6	3.1	2.6	5.5	4.6	3.1	2.6
		May-June	2008	5.5	4.6	12.7	10.6	5.6	4.6	12.8	10.7
			2002	9.2	7.7	30.9	25.8	9.2	7.7	31.1	26.1
		July-Sept	2008	5.3	4.4	9.3	7.7	5.3	4.4	9.7	8.1
			2002	8.3	7.0	22.5	18.8	8.5	7.1	24.0	20.0
	60% Chinook	Oct - April	2008	3.7	3.1	1.7	1.4	3.7	3.1	1.7	1.4
			2002	6.4	5.4	3.6	3.0	6.4	5.4	3.6	3.0
		May-June	2008	6.5	5.4	14.9	12.4	6.5	5.4	15.0	12.5
			2002	10.7	8.9	36.0	30.1	10.7	9.0	36.5	30.5
		July-Sept	2008	6.1	5.1	10.8	9.0	6.2	5.2	11.3	9.4
			2002	9.7	8.1	26.3	21.9	9.9	8.2	28.0	23.4