3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This section describes the biological, physical, and socioeconomic resources that are affected by research on Steller sea lions (SSLs) (*Eumetopias jubatus*) and Northern fur seals (NFSs) (*Callorhinus ursinus*) or that may be involved in their respective population declines. The objective of this section is to describe the past and present effects on relevant resources, thereby defining their baseline conditions, as a basis for the analysis of direct and indirect effects of the alternatives and the cumulative effects analysis presented in Chapter 4 of this document. This section also includes summaries of research programs that have been funded and permitted through the National Marine Fisheries Service (NMFS) in the past and how that research has been and is likely to be used to develop management actions for species conservation.

An important goal of this Environmental Impact Statement (EIS) is to provide an overview of the combined effects of research activities on SSLs and NFSs in the context of potential factors that have led to their reduced populations. The cumulative effects analysis in Chapter 4 provides the means to accomplish this goal. The concept behind cumulative effects analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually. Cumulative effects are defined by federal regulation as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (Center for Environmental Quality[CEQ] 1997, 40 Code of Federal Regulations [CFR] 1508.7). This chapter will focus on issues that are relevant to research and conservation of SSLs and NFSs, but will also address other past and present actions that are important for understanding the cumulative effects on the species that will be discussed in Chapter 4.

The overall spatial scope of the analysis is the geographic range of SSL and NFS, including the Bering Sea and the North Pacific Ocean south to California. When the overall spatial scope is not applicable to a given resource, a relevant geographic sub-area within the overall area is defined in the analysis. The overall time frame for the past/present effects analysis is defined as the period over which the populations of SSL and NFS began to decline to the present. Although there are earlier data from specific locations (i.e., NFS numbers on the Pribilof Islands rookeries), overall population trend surveys for these species were not conducted until the 1960s. For other resources, relevant data may be available from an earlier time period or may not be available until more recently. In these cases, a relevant time period is defined in the resource description.

The following descriptions of the affected environment have been compiled from several other sources, primarily other NMFS documents. In many cases the original documents are referenced and the pertinent information has been summarized. In other cases, pertinent sections of other NMFS documents have been reproduced from the original. All source documents are cited in the text with full references in Chapter 8 of this document.

3.2 Biological Environment

3.2.1 Steller Sea Lion

SSLs (*Eumetopias jubatus*), also found in the literature as Steller's sea lion and northern sea lion, are members of the order *Pinnipedia*, family *Otariidae* (composed of fur seals and sea lions), subfamily *Otariinae* (the sea lions).

The following sections on SSLs summarize information pertinent to this EIS and draw heavily from several NMFS documents. The interested reader is directed to these documents (and others cited in the text) for more detail about the scientific results of specific research projects and their application to management issues: 1) Draft Revised 2006 Draft Recovery Plan for the SSLs (*Eumetopias jubatus*) (NMFS 2006a); 2) SSL Research and Coordination: A Brief History and Summary of Recent Progress (Ferrero 2002); 3) NFS Subsistence Harvest EIS

2005 (NMFS 2005a); 4) Groundfish Programmatic Supplemental Environmental Impact Statement (PSEIS) 2004 (NMFS 2004a); and 5) SSL Protection Measures EIS (NMFS 2001a).

3.2.1.1 Distribution

The SSL ranges along the North Pacific Ocean rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands (AI) and Bering Sea, Alaska's southern coast, and south to California (Figure 3.2-1), (Loughlin 1984). Prior to the decline in the west, the largest rookeries were in the Gulf of Alaska (GOA) and AI. However, because the rookeries in the GOA and AI have declined, the largest rookeries are now in southeast Alaska and British Columbia.

SSL habitat includes a variety of both marine waters and terrestrial rookeries (breeding sites) and haulouts (resting sites). Terrestrial sites used by SSLs are generally on exposed rock shorelines associated with fairly shallow and well mixed waters with average tidal speeds and gradual bottom slopes (Call 2005, Ban 2005). Some rookeries and haulouts are also located on gravel/cobbles beaches. Peak pupping and breeding occur during June and July on rookeries located on relatively remote islands, rocks, and reefs. Although most often found within the continental shelf region, SSLs may also be found in pelagic waters (Bonnell 1983, Fiscus 1976, Kajimura 1988, Merrick 1997).

In general, SSLs seem to have a high degree of site fidelity; they return to breed at or near their natal rookeries (Calkins 1982, Alaska Sea Grant 1993, Loughlin 1984, Raum-Suryan 2002). Tagged and branded individuals have been seen at distances up to 1,784 kilometers (km) from their natal rookeries, but once they approach adulthood they generally remain within 500 km of their natal rookery (Raum-Suryan 2002).

3.2.1.2 Population Status and Trends

In 1990, the SSL was listed as threatened under the Endangered Species Act (ESA) as a result of a major decline in its population (55 Federal Register [FR] 12645, 55 FR 13488, 55 FR 49204, 55 FR 50005). A recovery plan was completed in 1992. In 1997, based largely on differences in genetics, morphology, and population trends, NMFS recognized two distinct population segments (DPSs) of SSLs under the ESA (62 FR 24345). The regulatory division between DPSs is Cape Suckling (144º west [W] longitude) in the northeast GOA. The eastern DPS includes SSLs born on rookeries from California north through southeast Alaska; the western DPS includes those animals born on rookeries from Prince William Sound westward (Bickham *et al.* 1996; Loughlin 1997). However, frequent movement is seen across this boundary by animals from both populations, particularly juvenile animals (Raum-Suryan *et al.* 2002). At the time the stocks were split, the western DPS was reclassified as endangered under the ESA while the eastern DPS remained listed as threatened.

<u>Critical Habitat</u>

NMFS designated critical habitat areas for SSLs in 1993 (50 CFR 226.202). Critical habitat includes marine waters, terrestrial rookeries (breeding sites), and haulouts (resting sites). The critical habitat for SSLs includes three separate zones: terrestrial, air, and aquatic. For both the western and eastern DPSs, the terrestrial zone extends 3,000 feet (ft) (0.9 km) landward from the baseline or base point of each major rookery and haulout in Alaska and the air zone extends 3,000 ft (0.9 km) above the terrestrial zone, measured vertically from sea level. In areas used by the western DPS, the aquatic zone extends 20 nm (37 km) seaward in state and federally managed waters from the baseline and basepoint of each major rookery and haulout that is west of 144º W longitude. In areas used by the eastern DPS, the aquatic zone extends 3,000 ft (0.9 km) seaward from the baseline or basepoint of each major rookery and haulout in Alaska that is east of 144º W longitude. In California and Oregon, critical habitat is the same as what is designated for the eastern DPS in Alaska, except that there is no terrestrial zone that extends landward.

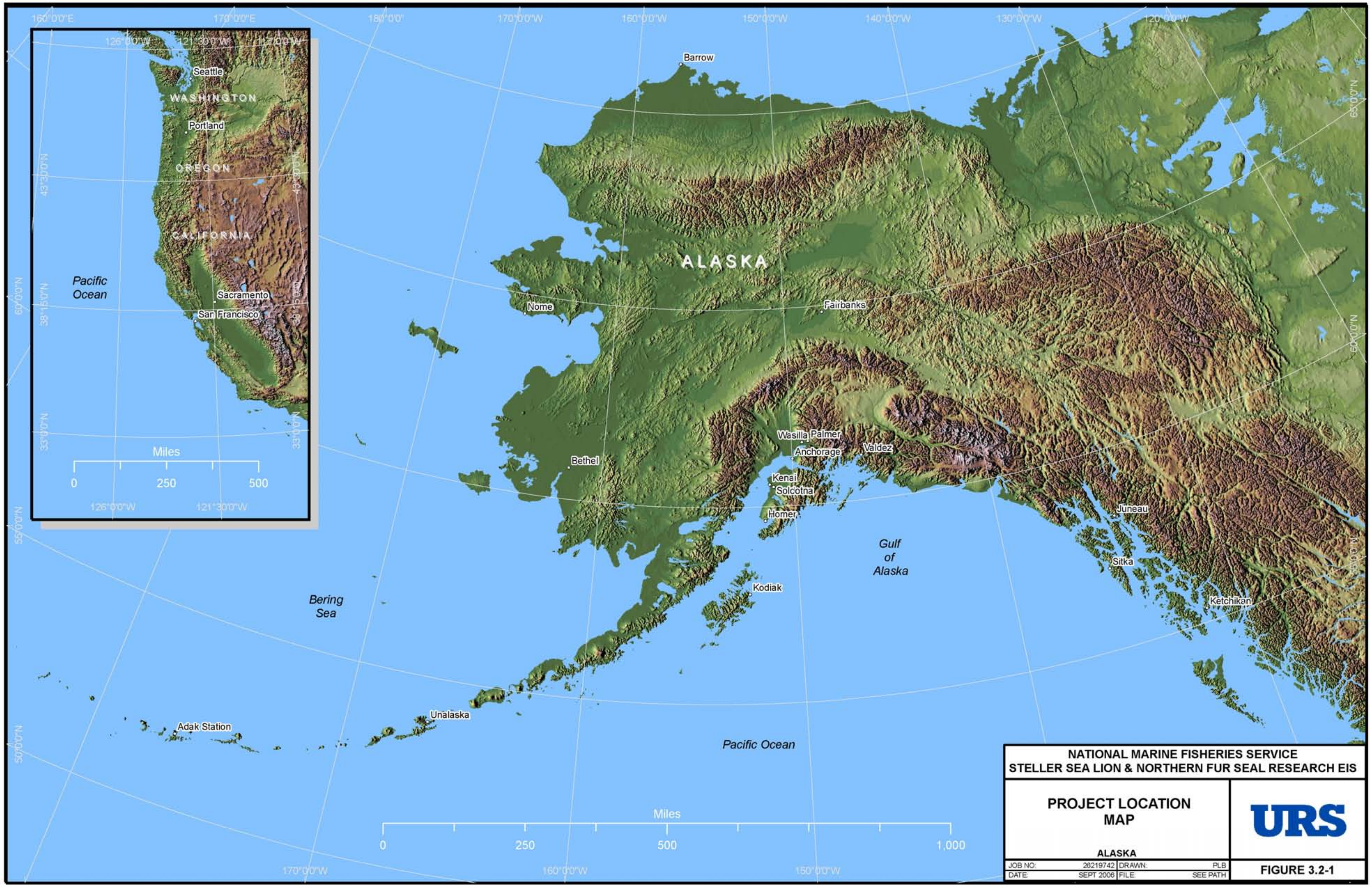

Figure 3.2-1 Project Location Map

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Designated critical habitat for the western DPS also includes three aquatic foraging areas that are based on at-sea observations of presumed foraging behavior. These foraging areas are in the vicinity of Seguam Pass in the AI, Bogoslof in the southeastern Bering Sea, and Shelikof Strait in the GOA. Designated critical habitats are shown in Figures 3.2-2 and 3.2-2A.

Western Distinct Population Segment

Population assessment for SSLs has been achieved primarily by conducting aerial surveys and on-land pup counts. Historically, this included surveys of limited geographical scope in various portions of the species' range, in many cases conducted using different techniques, and occasionally during different times of year. Consequently, reconstructing population trends for SSLs from the 1970s and earlier involves a mix of regional surveys conducted over many years.

For the western DPS of SSL in Alaska, count data have generally been combined and analyzed in six sub-areas (Table 3.2-1 and Figures 3.2-3 and 3.2-4), which are geographically convenient but do not necessarily reflect biologically important units. Because earlier efforts to count sea lions were concentrated in the center of their Alaskan range, evaluations of long-term trends have often been calculated for the "Kenai to Kiska" index area, which includes the central and western GOA and the eastern and central AI.

The first reported counts of SSLs in Alaska were made in 1956-1960 (Kenyon and Rice 1961; Mathisen and Lopp 1963), totaling approximately 140,000 animals in the GOA and AI regions (Merrick *et al.* 1987). Loughlin (1997) estimated that the Alaska portion of the western DPS (non-pups) totaled approximately 177,000 animals in the 1960s. Population declines were first observed with the advent of more systematic aerial surveys with high resolution photography (35 millimeter [mm] slides). The decline in numbers was first detected in the eastern AI in the mid-1970s (Braham *et al.* 1980) and spread eastward to the central GOA during the late 1970s and early 1980s and westward to the central and western AI during the early and mid 1980s (Merrick *et al.* 1987; Byrd 1989). Approximately 110,000 adult and juvenile SSLs were counted in the Kenai-Kiska region in 1976-1979, but by 1985 counts in this area had dropped to about 68,000 (Merrick *et al.* 1987). By 1989 counts in this area had dropped to 25,000 (Loughlin *et al.* 1990).

Population trend analyses during recent years have focused on 82 "trend sites," which are selected rookeries and haulout sites that have been surveyed consistently from the mid 1980s to the present (NMFS 1998b and 1995) (Table 3.2-1 and Figures 3.2-3 and 3.2-4). Trend sites include roughly 75 percent of animals observed in recent surveys (Sease 1997, 2001, and 1999). Following a rapid rate of decline in the 1980s, the intensity of which varied in different sub-regions, the population continued to decline throughout the 1990s but at a slower rate (Sease 2001 and 1999; Strick, 1997). The most recent surveys indicated a reversal of this trend, with an increase of about 5 percent per year from 2000-2004, although increases were not distributed evenly across the range in Alaska (Fritz 2005).

Pup surveys had been used to provide information on reproductive rates, but counting pups from aerial photography was unreliable because of poor resolution and obstruction of pups by adults. Pup surveys were therefore conducted by landing a team of biologists on the rookery during June or July and driving the non-pups into the sea. This allowed researchers to count the pups on land, but various numbers of pups also fled into the water with the adults. This resulted in some uncertainty about numbers and exposed those pups to risks of serious injury or death through aspiration of seawater, drowning, exposure to predators, and separation from their mothers (see Appendix F from the 2005 Environmental Assessment [EA] for a description of the risks involved in various research techniques). In the years prior to the 1992 SSL Recovery Plan, pups within the western DPS were counted only at selected rookeries on an alternating schedule. Extensive pup surveys were conducted at virtually all western DPS rookeries in Alaska in 1998, and at all, except the Near Islands in the western AI, in 1994 (Sease 1999; Strick 1997). The results of these surveys were generally similar to the patterns of decline and increase noted from aerial surveys of non-pups (Table 3.2-2).

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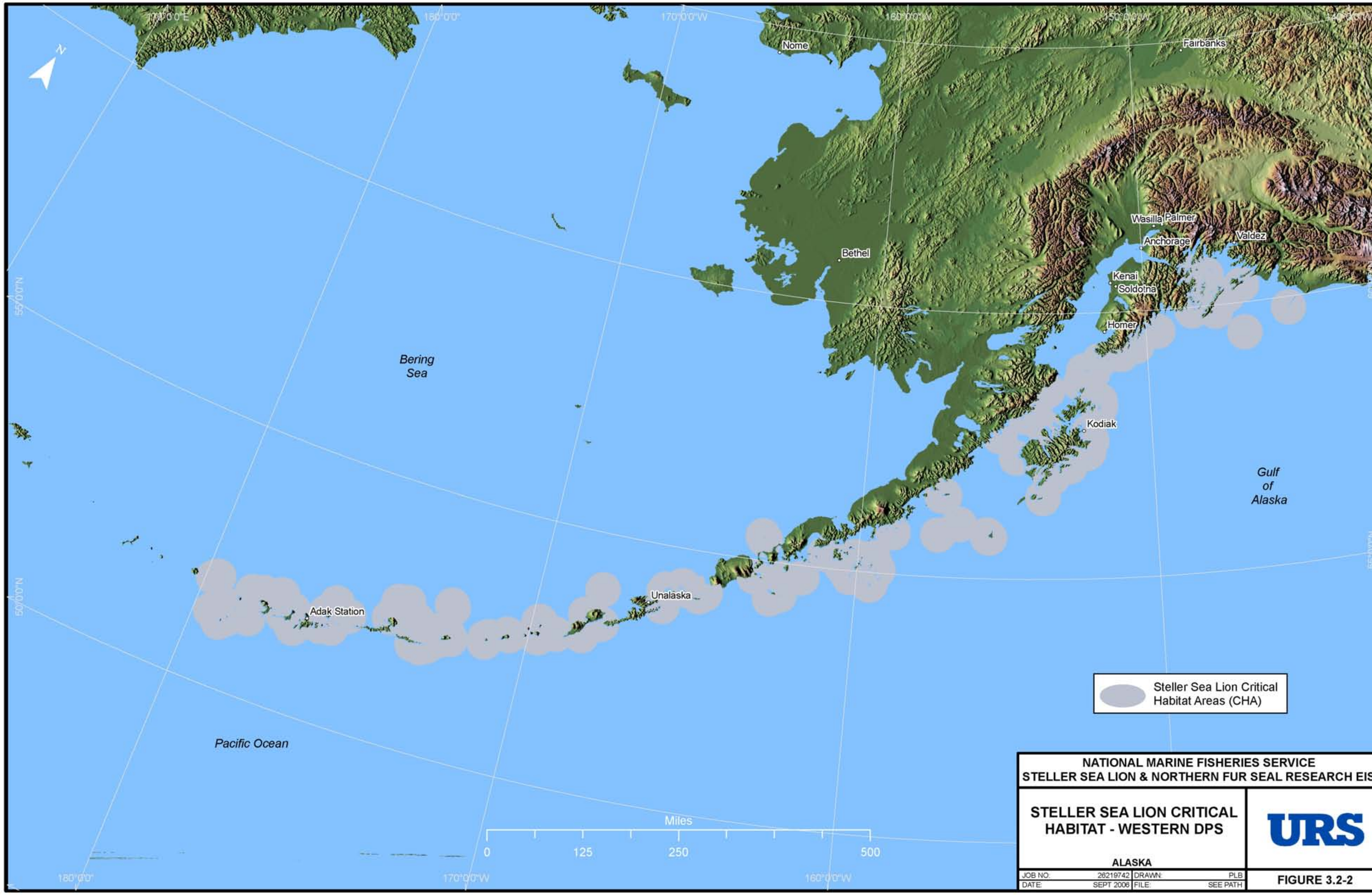

Figure 3.2-2 Steller Sea Lion Critical Habitat – Western DPS

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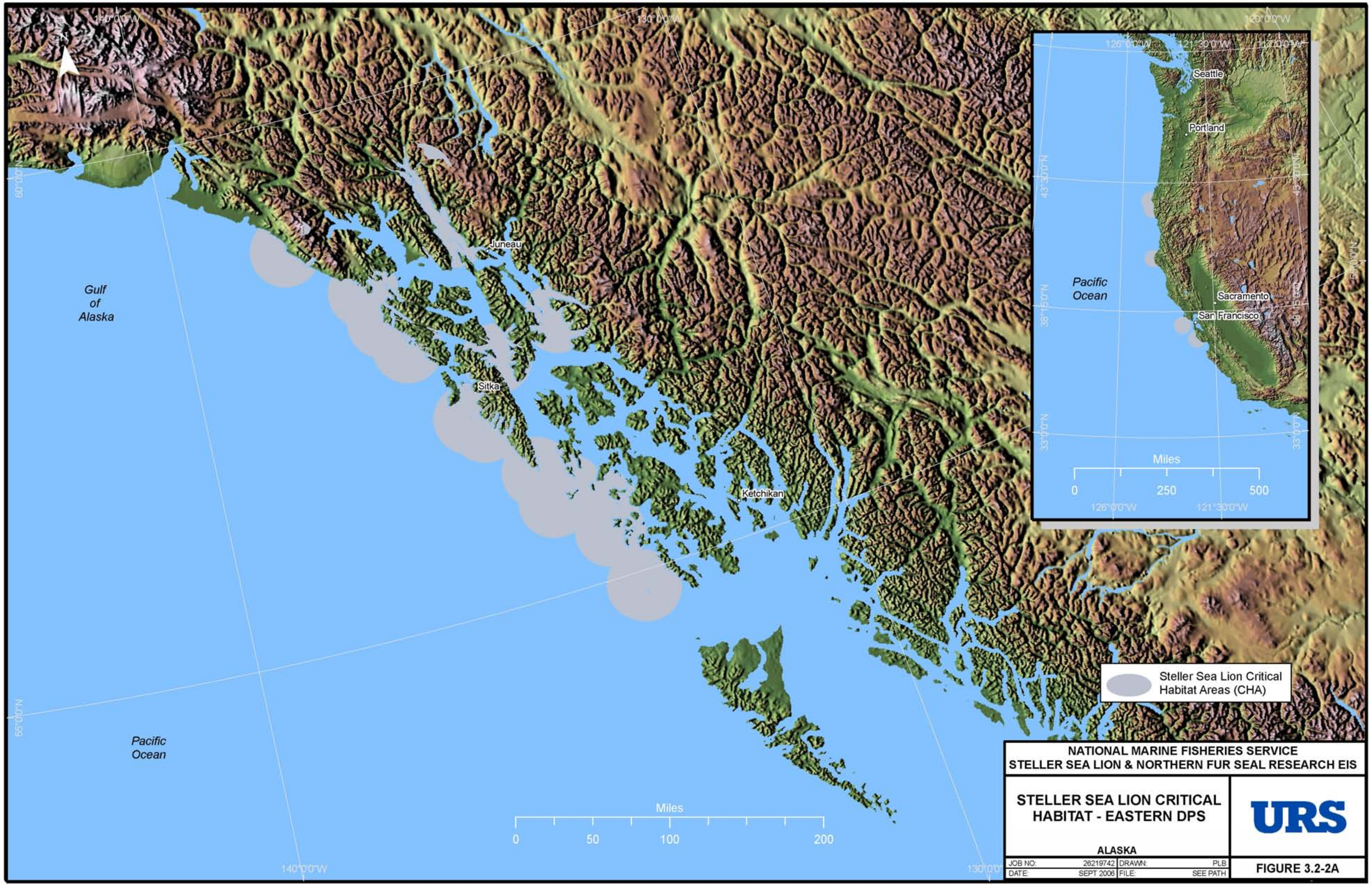

Figure 3.2-2a Steller Sea Lion Critical Habitat – Eastern DPS

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Table 3.2-1
Counts of adult and juvenile (non-pup) Steller sea lions at western DPS rookery and haul-out trend sites in Alaska during June-July surveys from 1956 to 2004

Year(s)	Gulf of Alaska			Aleutian Islands			Kenai-Kiska (69)	Western DPS in Alaska (82)
	Eastern (9)	Central (15)	Western (9)	Eastern (11)	Central (34)	Western (4)		
1956-60[1]		34,792	15,772	44,020	17,120		111,704	
1962					23,175			
1976-79[2]	7,053	24,678	8,311	19,743	36,632	14,011	89,364	110,428
1985		19,002	6,275	7,505	23,042		55,824	
1989	7,241	8,552	3,908	3,032	7,572		23,064	
1990	5,444	7,050	3,915	3,801	7,988	2,327[3]	22,754	30,525
1991	4,596	6,270	3,732	4,228	7,496	3,083	21,726	29,405
1992	3,738	5,739	3,716	4,839	6,398	2,869	20,692	27,299
1994	3,365	4,516	3,981	4,419	5,820	2,035	18,736	24,136
1996	2,132	3,913	3,739	4,715	5,524	2,187	17,891	22,210
1998	2,110[4]	3,467	3,360	3,841	5,749	1,911	16,417	20,438
2000	1,975	3,180	2,840	3,840	5,419	1,071	15,279	18,325
2002	2,500	3,366	3,221	3,956	5,480	817	16,023	19,340
2004[5]	2,536	2,944	3,512	4,707	5,936	898	17,099	20,533
1950s to 2000		**-91%**	**-82%**	**-91%**	**-68%**		**-86%**	
1970s to 2000	**-72%**	**-87%**	**-66%**	**-81%**	**-85%**	**-92%**	**-83%**	**-83%**
1970s to 1990	**-23%**	**-71%**	**-53%**	**-81%**	**-78%**	**-83%**	**-75%**	**-72%**
1990 to 2000	**-64%**	**-55%**	**-27%**	**+1%**	**-32%**	**-54%**	**-33%**	**-40%**
2000 to 2004	**+28%**	**-7%**	**+24%**	**+23%**	**+10%**	**-16%**	**+12%**	**+12%**

Notes:
1 1956 counts for the western GOA, 1957 counts for the central eastern Aleutians.
2 1976 counts for the eastern, central, and western GOA and the eastern Aleutians, and 1979 counts for the central and western Aleutians.
3 Gillon Point rookery, Agattu Island not surveyed in 1990.
4 1999 counts substituted for sites in the eastern Gulf of Alaska not surveyed in 1998.
5 2004 counts were from medium format photographs, while all others were from 35 mm photographs, aerial counts or beach counts. 2004 data reflect a -3.64% adjustment to account for film format resolution and count differences

Source: Adapted from Fritz and Stinchcomb 2005, National Marine Mammal Laboratory (NMML) unpublished data

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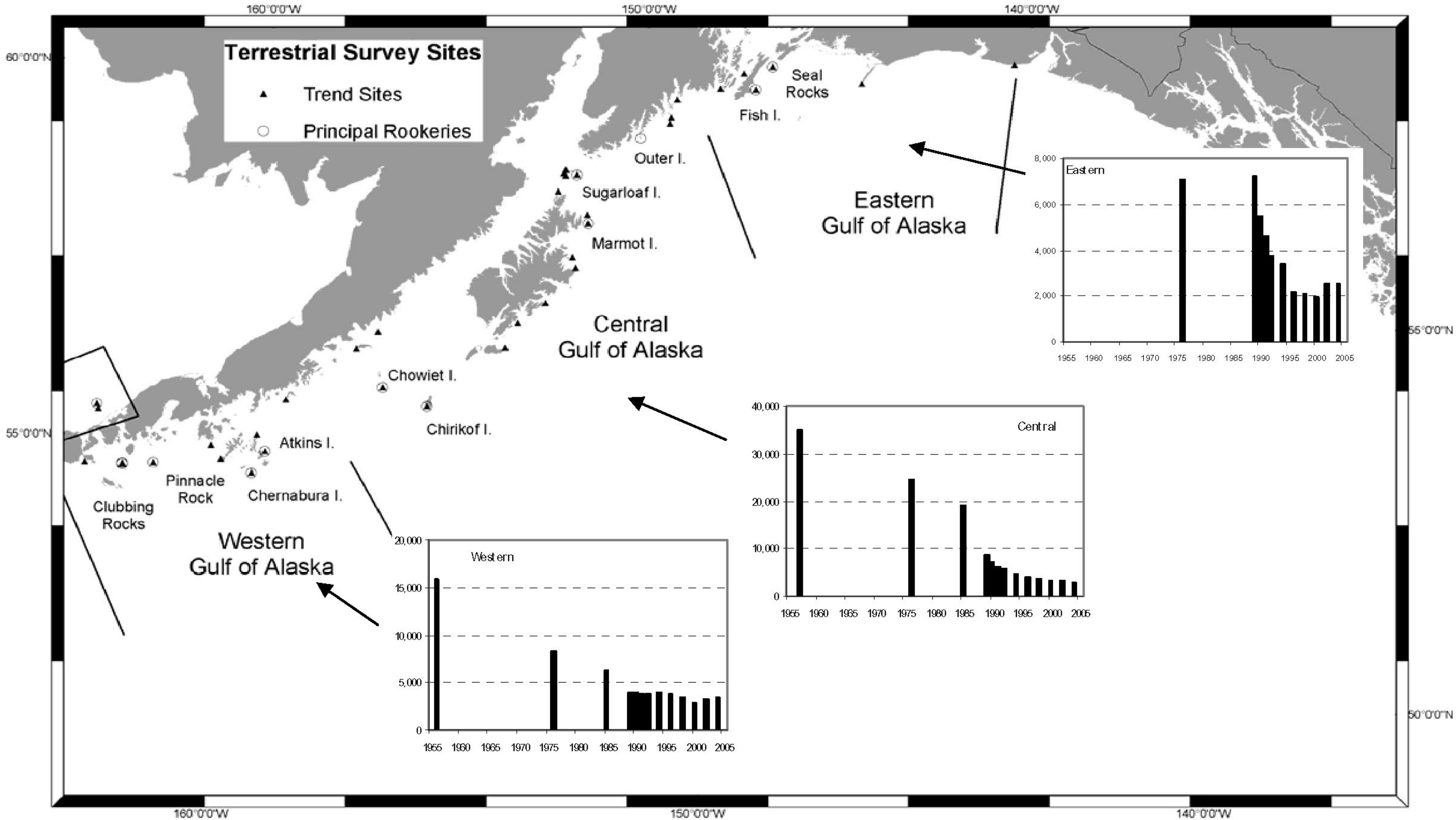

Figure 3.2-3 Counts of adult and juvenile Steller sea lions on western DPS trend sites in three sub-areas of the Gulf of Alaska, 1950s through 2004. Principal rookeries (named) and major terrestrial haul-out trend sites are shown (NMFS 1992; Fritz and Stinchcomb 2005).

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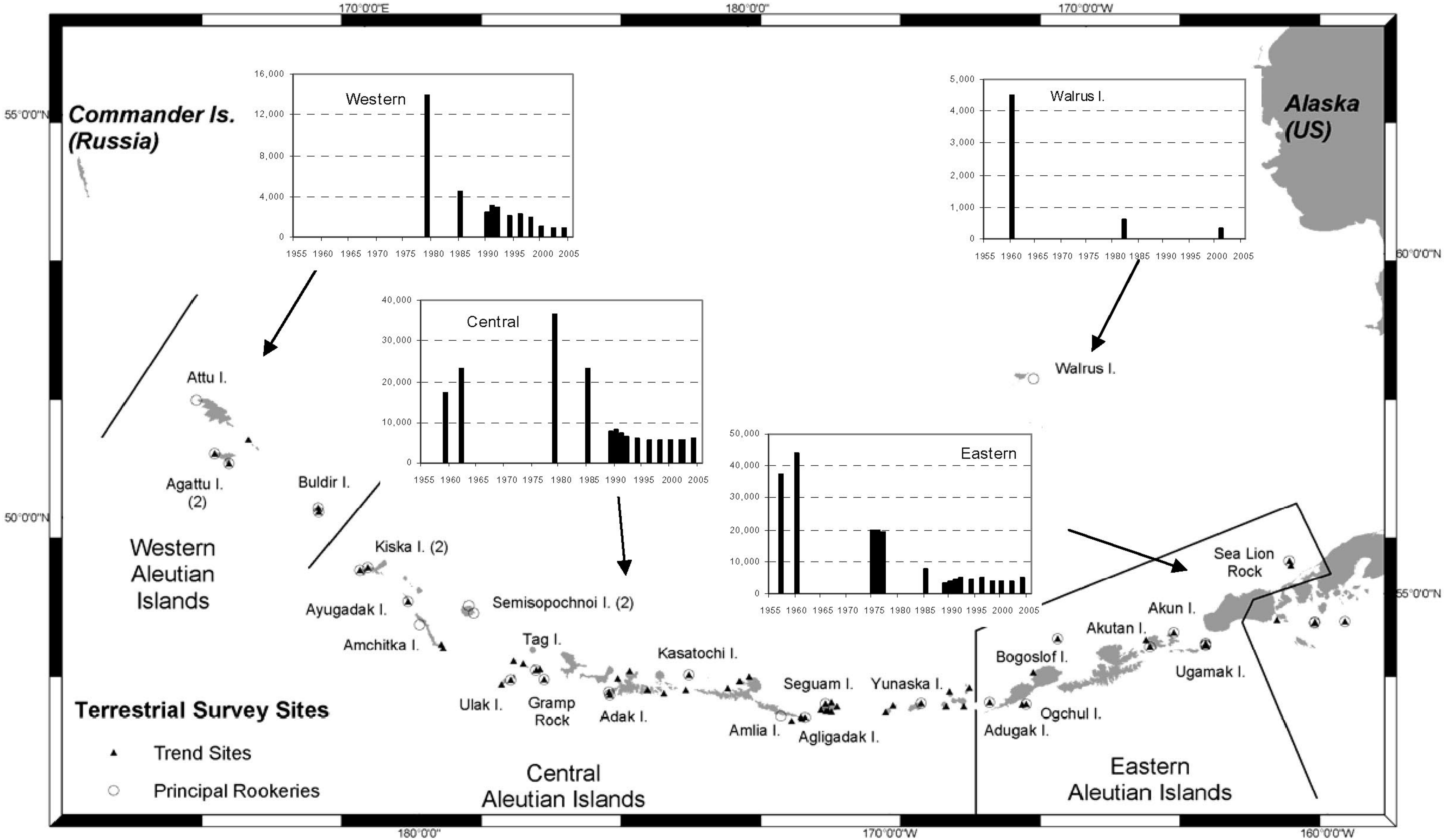

Figure 3.2-4 Counts of adult and juvenile Steller sea lions on western DPS trend sites in three sub-areas of the Aleutian Islands, 1950s through 2004. Counts on Walrus Island in the eastern Bering Sea are also shown, as are the location of principal rookeries (named) and major terrestrial haulout trend sites (NMFS 1992; Fritz and Stinchcomb 2005).

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Table 3.2-2
Counts of Steller sea lion pups at western DPS rookeries in Alaska during 1979 to 2005

Year(s)	Gulf of Alaska			Aleutian Islands			Eastern Bering Sea	Kenai-Kiska [7]	Western DPS in Alaska
	Eastern [1]	Central [2]	Western [3]	Eastern [4]	Central [5]	Western [6]	Walrus Island		
1979			8,616						
1982							334		
1984			6,435						
1985-89		10,254		4,778	9,428		250	30.8957	
1990-92		4,904	1,923	2,115	3,568		63	12,510	
1994	903	2,831	1,662	1,756	3,109		61	9,358	
1996	584								
1997	611					979	35		
1998	689	1,876	1,493	1,474	2,834	803		7,677	9,169
2001-02	586	1,721	1,671	1,561	2,612	488	39	7,565	8,678
2003-04	716	1,609	1,577	1,731					
2005	715	1,651	1,707	1,921	2,551	343	29	7,830	8,917
Earliest count to 1994		**-72%**	**-81%**	**-63%**	**-67%**			**-70%**	
Earliest count to 2001-02	**-35%**	**-83%**	**-81%**	**-67%**	**-72%**	**-50%**	**-88%**	**-76%**	**-5%**
1994 to 2001-02	**-35%**	**-39%**	**+1%**	**-11%**	**-16%**		**-36%**	**-19%**	
2001-02 to 2005	**+22%**	**-4%**	**+2%**	**+23%**	**-2%**	**-30%**	**-25%**	**+4%**	**+3%**
1979			8,616						
1982							334		
1984			6,435						

Notes:
1 Seal Rocks and Fish (Wooded) Island
2 Outer, Sugarloaf, Marmot, Chowiet and Chirikof islands
3 Atkins and Chernabura Islands, and Pinnacle Rock and Clubbing Rocks
4 Ugamak, Akun, Akutan, Bogoslof and Adugak islands.
5 Yunaska, Seguam, Kasatochi, Adak, Tag, Ulak, Ayugadak and Kiska (2) islands, and Gramp and Column Rocks.
6 Buldir, Agattu (2), and Attu islands.
7 Rookeries in the central and western Gulf of Alaska, and eastern and central AI.

Source: Adapted from Fritz and Stinchcomb 2005, NMML unpublished data

In 2002, researchers began using a new aerial survey photographic technique, medium-format color photogrammetry, which allowed counts of pups as well as improved counts of non-pups (Fritz and Stinchcomb 2005). This technique provided accurate results compared to traditional drive-counts and resulted in almost no disturbance on the rookery (Snyder *et al.* 2001).

Eastern Distinct Population Segment

The eastern DPS consists of SSLs born in southeast Alaska, British Columbia, Washington, Oregon, and California. Similar to the western DPS, population surveys prior to the 1970s were of limited geographical scope, used various techniques, and occurred during different times of year. Survey techniques since the 1980s have been the same as those used in the western DPS, including the use of trend sites.

In contrast to the population declines recorded in the western DPS, the SSL population in southeast Alaska increased by almost 4 percent per year between 1985-1989 (Loughlin 1992). From 1990 to 2000, counts of non-pup SSLs at trend sites showed an overall increase of 29 percent, or an average increase of almost 2 percent per year (Sease 2001) (Table 3.2-3). Trends in British Columbia, Washington, and Oregon have shown similar increases (Tables 3.2-4 and 3.2-5). While numbers in central and southern California have been decreasing, the eastern stock as a whole is stable or increasing slowly (Figure 3.2-5) (Angliss and Outlaw 2006).

SSLs in southeast Alaska are not an isolated population, as demonstrated by the movement of branded and tagged animals from southeast Alaska to British Columbia and Washington (Raum-Suryan 2002). In addition, recent mitochondrial deoxyribonucleic acid (DNA) studies with large samples of pups from newly established rookeries in the eastern DPS have shown that some females born in the western DPS are pupping in the eastern DPS (NMFS unpublished data).

Overall, the eastern DPS has increased at over 3 percent per year since the 1970s, more than doubling in southeast Alaska, British Columbia, and Oregon. The eastern DPS contained only about 10 percent of the total number of SSLs in the U.S. in the 1970s. However, large declines in the western DPS coupled with notable increases in the east resulted in a shift such that over half of the SSLs in the U.S. now belong to the eastern DPS (NMFS 2006a).

3.2.1.3 Reproduction and Growth

SSLs are highly sexually dimorphic, with males being much larger than females. They have a polygynous mating system where males fight each other for territories that attract many females. Mating and pupping occur in rookeries on relatively remote islands, rocks, and reefs. The largest males (>9 years old) establish territories in early May in anticipation of the females' arrival in late May and early June (Pitcher 1981). Pregnant females give birth to a single pup soon after arriving at the rookeries and mating occurs about one to two weeks after giving birth (Gentry 1970). Mating occurs primarily on land but may also occur in the water (Pitcher 1998; Gentry 1970; Gisiner 1985). The gestation period is probably about 50 to 51 weeks, but implantation of the blastocyst is delayed until about three and a half months after breeding (i.e., late September or early October) (Pitcher 1981). Females first breed between the ages of 3 and 8 years old and may produce young into their early 20s (Mathisen *et al.* 1962; Pitcher and Calkins 1981). Pupping is highly synchronous throughout the SSL range, with a median pupping date of 12-13 of June (Merrick 1987; Bigg 1985).

Much of the research on whether or not nutritional stress was a major factor in the decline of the western DPS compared animals from the declining western DPS with animals from the increasing eastern DPS. Many studies focused on mother and pup body conditions and maternal attendance patterns (Merrick *et al.* 1995; Davis *et al.* 1996 and 2004; Adams 2000; Brandon 2000; Rea *et al.* 2003). Contrary to what would be expected for animals experiencing acute nutritional stress, these studies found western DPS pups were either heavier or the same size as eastern DPS pups; there was no indication of poor body condition in pups or mothers; and higher pup growth rates were in declining western DPS areas. These observations indicate that at least this phase of reproduction may not be affected by nutritional stress: that is, if females are able to complete their pregnancy and give birth, then the size of those pups does not appear to be compromised.

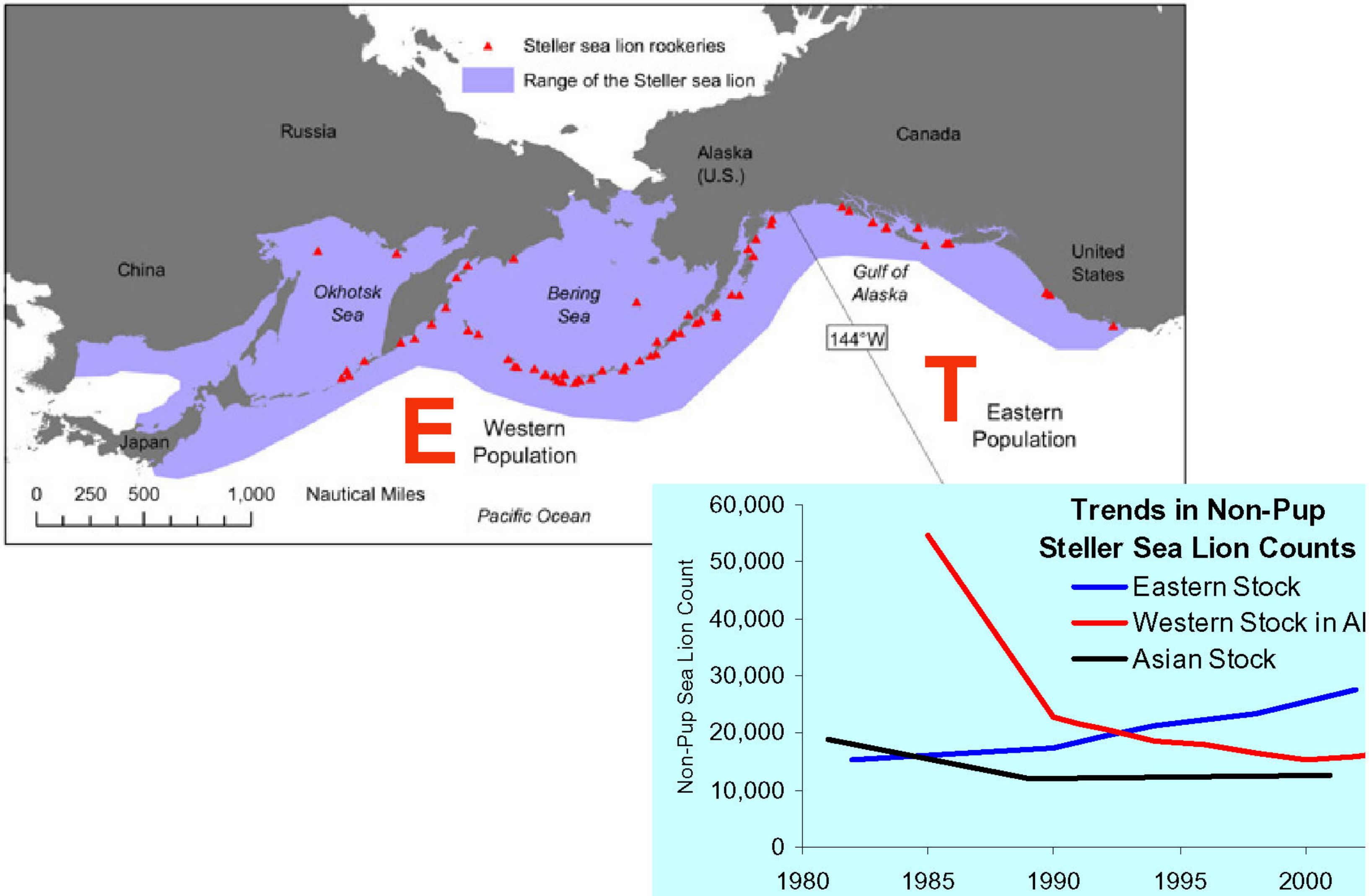


Figure 3.2-5 Breeding ranges of the western and eastern DPSs of Steller sea lions (triangles = terrestrial locations of major rookeries) in Northern Pacific. Trends in index counts of adult and juvenile (non-pup) sea lions on rookery and haulout sites within the breeding ranges of the eastern and western (Alaska only) DPSs are also shown.

Table 3.2-3
Counts of adult and juvenile (non-pup) Steller sea lions observed at individual rookeries as well as rookery and haul-out trend sites combined in southeast Alaska during June-July aerial surveys from 1979 to 2005

Year	Forrester Island	Hazy Island	White Sisters	Graves Rocks	Biali Rocks
1979	3,121	893	761	-	810
1982	3,777	1,268	934	-	722
1989	4,648	1,462	734	475	794
1990	3,324	1,187	980	937	596
1991	3,970	1,496	975	470	494
1992	3,508	1,576	860	366	398
1994	4,010	1,615	868	733	410
1996	3,551	1,759	894	475	342
1998	3,788	1,962	858	445	476
2000	3,674	1,824	1,398	558	690
2002	3,699	2,050	1,156	1,001	624
2005	5,557	2,293	1,078	–	598
Source: Adapted from Fritz and Stinchcomb 2005; NMML unpublished data					

Table 3.2-4
Counts of Steller sea lions on rookeries and haulouts in British Columbia, 1971-2002

Year	Non-pups	Pups	Total
1971	4,617	941	5,475
1977	5,219	963	6,274
1982	4,713	1,245	5,956
1987	6,109	1,084	7,193
1992	7,376	1,468	8,844
1994	8,091	1,186	9,277
1998	9,818	2,073	11,891
2002	12,121	3,281	15,402
Source: Carretta 2005			

Table 3.2-5
Counts of non-pup Steller sea lions on rookeries and haulouts in Oregon and of pups counted during ground counts or from medium-format photographs on the Rogue Reef and Oxford Reef rookeries 1976-2002

Year	Oregon Total Non-Pups	Rogue Reef Pups	Oxford Reef Pups	Washington Total Non-Pups
1977	1,461	--	--	--
1979	1,542	--	--	--
1980	1,632	--	--	--
1981	2,105	--	--	--
1982	2,604	--	--	--
1983	2,106	--	--	--
1984	1,867	--	--	--
1985	2,210	--	--	--
1986	2,289	--	--	--
1987	2,709	--	--	--
1988	2,825	--	--	--
1989	2,183	--	--	89
1990	2,414	492	298	--
1991	--	--	--	274
1992	3,581	--	--	278
1993	2,838	--	--	--
1994	3,293	--	--	384
1995	3,837	--	--	409
1996	3,205	685	335	594
1997	3,897	--	--	352
1998	3,971	--	--	470
1999	3,275	--	--	806
2000	2,927	--	--	778
2001	3,648	600	--	516
2002	4,169	746	382	--

Source: (Carretta 2005)

Mothers nurse pups and stay with them for about the first week, then go to sea on foraging trips which vary in average duration in different locations (Hood 1997; Higgins 1988; Brandon 1999). Pups generally are weaned before the next breeding season, but it is not unusual for a female to nurse her offspring for a year or more (Pitcher 1981). The length of the nursing period may be an important indicator of the female's condition and ability to support her pup, and the pup's condition at weaning (and hence, the likelihood that the pup will survive the post weaning period). Relatively little is known about the life history of SSLs during their juvenile years between weaning and maturity, although recent telemetry data indicate that yearlings that have reached nutritional independence greatly increase their foraging area and begin deeper diving (Loughlin 2003).

For mature females, the reproductive cycle includes mating, gestation, parturition (birth), and nursing or post-natal care. The reproductive success of an adult female is determined by a number of factors within a cycle and over time through multiple cycles. Although much of the effort to explain the decline of the western DPS has focused on juvenile survival rates, some evidence suggests that decreased reproductive success may also have contributed to the original decline (Pitcher *et al.* 1998; Calkins 1998). In the 1970s and 1980s, birth rates were estimated from the examination of reproductive tracts from collected animals. Intentional lethal take has not been requested or authorized for research purposes since the species was listed under the ESA. Current estimates of birth rates are derived from alternative techniques such as mark-resight estimation, analysis of reproductive hormone levels in feces or tissue samples, or population modeling.

Female growth is asymptotic, which means the growth rate is very high in early years, and tapers off thereafter. Females reach 87 percent of the asymptote during their third year (Winship 2001). Male growth is also asymptotic, but constant until about year six and thus males grow at a greater rate for a longer period than do females (Winship 2001). While males reach sexual and physiological maturity before seven years of age, they do not have the physical size or skill to obtain and defend a breeding territory until they are nine years of age or older (Pitcher 1981). Males may return to the same territory for up to seven years, but most return for no more than three years (Gisiner 1985). During the breeding season, males may not eat for one to two months. The rigors of fighting to obtain and hold a territory and the physiological stress of the mating season reduce their life expectancy to the point that males rarely live beyond their mid-teens, whereas females may live as long as 30 years.

3.2.1.4 Survival

Causes of pup mortality vary widely and include drowning, starvation caused by separation from mother, disease, parasitism, predation, crushing by larger animals, biting by other SSLs, and complications during parturition (Orr 1967; Edie 1977; Maniscalo 2002; Maniscalo 2006; Merrick 1987). Older animals may die as a result of injuries, starvation, disease, predation, subsistence harvests, intentional shooting by humans, fishery interactions, and entanglement in marine debris (Holmes 2003).

Modeling by York (1994) suggested that the observed decline in SSL abundance in the GOA may have been due to an increase in juvenile mortality. The estimated annual mortality from the table York created was as follows: 0.22 for ages 0-2, dropping to 0.07 at age three, increasing progressively to 0.15 by age 10, and finally 0.20 by age 20. Population modeling was indicative of the notion that the major decline of SSLs that occurred in the central GOA during the 1975-1985 period was primarily a function of juvenile survival (York 1994; Chumbley 1997). This idea is reinforced by evidence from low resighting rates of 800 pups tagged and branded at Marmot Island in 1987 and 1988 (Merrick 1988) and observations of relatively few juveniles at Ugamak Island (Merrick 1988). The low resighting rates do not confirm a corresponding drop in juvenile survival because some animals may have migrated to other sites where they were not observed. However, given the observations of relatively high site fidelity of animals returning to breed at their natal site, the "loss" of these animals is viewed as a significant increase in juvenile mortality consistent with the overall population decline in the central GOA (York 1994; Chumbley 1997; Holmes 2003; Fitch 1968; Jobling 1986; Perrin 1973). In addition, changes in adult survival may also have contributed to the decline. At present, survival rates for adults cannot be determined with sufficient resolution to determine if those rates have changed over time or are somehow compromised to the extent that population growth and recovery are threatened.

3.2.1.5 Prey and Foraging Behavior

<u>Prey</u>

Historically, studies of marine mammals' diets were based on analysis of the remains of prey in the stomach, which usually involved killing the animal. Currently, the most common method of identifying prey species consumed by pinnipeds is through analysis of bony remains in fecal (scat) collections. The interpretation of predator diet through the use of scat was first developed for terrestrial studies and has been adapted for use in marine mammal trophic studies over the past two decades. Scat analysis is a useful tool for monitoring seasonal and temporal trends in diets without the need to euthanize the animal. Other methods for evaluating pinniped diets include collection of stomach contents from live animals by lavage, collection of regurgitated stomach contents and intestinal contents by enema, and analysis of fatty acid and stable isotope composition of tissues samples collected from live animals.

Typically, the importance of any given prey species in marine mammal diet studies is based on some combination of the following two factors: the number of individuals of a particular species represented across all samples (prey number) and the number of samples containing that species across all samples containing prey remains (frequency of occurrence). All of the different methods of diet evaluation in marine mammals have their own set of biases that variably affect estimates of prey volume, weight, number, rank and frequency of occurrence (Sinclair In preparation). For example, stomach contents from an individual animal may represent an accumulation of a number of meals over an extended period of time. Certain prey parts such as squid beaks or large fish bones get trapped in stomach folds where they digest very slowly, or accumulate until regurgitated. Therefore, an accumulation of prey parts predictably overestimates the importance of some prey types over others. Regurgitations (spewings) represent a very small portion of the overall diet and primarily that of the largest prey items consumed. By comparison, scat typically represents meals eaten 12-72 hours prior and tend to underestimate the size of prey consumed because small items pass through the digestive tract more readily (and with less erosion) than large items (Sinclair 2002). Accordingly, diet studies should be interpreted with consideration of the method used to collect prey samples. Fatty acid and stable isotope analysis in tissues had been used to determine weaning status of pups and juveniles. This research gave an indication as to whether or not the animals had converted completely to a diet of fish and helped identifity the types of fish comsumed by individual sea lions (Rea *et al.* 1998).

Prey Species and Size

SSLs are generalist predators that eat various fish and cephalopods (Pitcher 1982) and occasionally other birds and marine mammals (Daniel 1992; Sinclair 2002). A recent analysis of the SSL diet compares trends in prey species consumption between summer and winter, when juveniles are first learning to forage on their own (Jones 1981; Brown 2002). SSL scats were collected (1990-1998) from 31 rookeries (May-September) and 31 haul out sites (December-April) across the U.S. range of the western population resulting in a sample of 3,762 scats with identifiable prey remains. Frequency of occurrence (FO) data values combined across years, seasons, and sites indicated walleye pollock (*Theragra chalcogramma*) and Atka mackerel (*Pleurogrammus monopterygius*) as the two dominant prey species, followed by Pacific salmon and Pacific cod. Other primary prey species consistently occurring at frequencies of 5 percent or greater included arrowtooth flounder (*Atheresthes stomias*), Pacific herring, Pacific sand lance, Irish lord (*Hemilepidotus hemilepidotus*), and cephalopods (squid and octopus).

Prior to the early 1990s, the diet of SSLs in the eastern part of their range was not well studied. Rockfish, hake, flatfish, salmon, herring, skates, cusk eel, lamprey, squid, and octopus are known to have been eaten by SSLs in California and Oregon (Olesiuk 1990). In British Columbia, principal prey has included hake, Pacific herring, octopus, Pacific cod, rockfish, and salmon (Trites 2006a). In southeast Alaska, the most commonly identified prey items were pollock, Pacific cod, flatfishes, rockfishes, Pacific herring, salmon, sand lance, skates, squid, and octopus (Calkins 1988; NMFS 2000).

All the available data on prey occurrence in stomach contents samples for the eastern and western SSL populations for the 1950s-1970s and the 1980s have been compiled (Zeppelin 2004; Tollit 2004). For both eastern and western populations, the occurrence of pollock, Pacific cod, and Pacific herring were higher in the 1980s than in the 1950s-1970s, suggesting that the dominance of pollock in the SSL diet might have changed over time across much of its range, although the data from the 1950s-1970s had both small sample sizes and limited geographic scope.

Size of prey consumed varies, ranging from several centimeters (cm) in length (i.e., sand lance and capelin) to over 60 cm in length (salmon, skates, pollock, and cod). Remains of pollock exceeding 70 cm in length have been recovered in SSL scats (Schauflerer 2004; Kitts 2004; Ingles 2005; Stansby 1976; Anthony 2000; Payne 1999; Van Pelt 1997).

Prey Quality

An important consideration in evaluating effects of changing diets or prey abundance on SSLs is the quality of the prey. Lipid content, and therefore energy density, varies greatly among SSL prey species, and within prey species depending upon life history stage, location, and time of year (Schauflerer 2004; Anthony 2000). Atka mackerel and gadids are generally low energy density prey (ranging from about 3 kilojoules/gram [kJ/g] to 6 kJ/g, though few data exist for Atka mackerel), while forage fish such as eulachon, herring, or capelin have generally higher energy contents (up to about 11 kJ/g). Because energy densities are seasonally variable, this is not an absolute relationship. For example, capelin and sand lance declined in lipid content, and therefore energy density, throughout the summer (Hu 2005; Mazzaro 2003). In addition to considerations of prey energy content, vitamins and other metabolites are essential for adequate nutrition (Didier 1999).

To estimate the amount of food required by SSLs in the wild, detailed measurements of metabolic rates and food intake requirements have been made in captivity. An SSL Recovery Team review of the earliest captive feeding studies suggested that they may not be generally representative of field situations (Fadely 1994; Rosen 2000b), a point that has also been highlighted by researchers conducting the studies (Castellini 2005). They cited the short duration, often less than two weeks, which may have been inadequate to trigger cues used by SSLs to adjust intake in response to dietary changes. Likewise, these studies fed SSLs single-species diets that were unrealistic for wild animals and did not directly measure changes in activity or body condition, which also affect food intake rates.

A set of captive feeding studies was conducted to address many of these concerns by performing feeding trials throughout the year, and by using mixed diets based on known diet compositions of free-ranging SSLs in different parts of their range (Castellini 2001; Tollit in press). Preliminary results indicate that SSLs have a tremendous ability to compensate for dietary shifts through physiological adaptations and behavior. Calkins *et al.* (2005) analyzed juvenile SSLs (one and two years old) that were captured in the wild and held for several months. Some animals were fed an exclusive pollock diet for an average of 54 days and others were fed a mixed diet of several fish species and cephalopods. All animals increased in mass on both diets, indicating that consumption of an exclusive pollock diet was not necessarily a deterrent to growth.

Studies of prey remnants from captive SSL scats indicate that there are significant differences in digestibility between and within prey species (NMML 1997). Castellini *et al.* (2005) examined the energetic requirements of captive SSLs in relation to metabolism, nutritional differences among fish prey species, and hydrodynamics. The results indicate that adding herring to the diet and decreasing the amount of pollock increased the metabolic turnover of protein by 30-50 percent. They also found seasonal differences between the nutritional value of prey samples, with the greatest variability found in herring, and a difference between age classes of pollock.

Although captive feeding studies can describe the metabolism of prey once ingested, they do not include components of foraging efficiency, or the cost to the SSL of acquiring a certain prey type. The net energy gain to an animal from ingesting a particular prey item depends not only upon the energy content of the prey but also on the energetic costs of finding, capturing, handling, and digesting the prey. The energy balance of foraging on any particular prey thus depends on the prey item's individual size, total biomass, availability, behavior, degree of aggregation, temporal and spatial distribution, and other factors.

Foraging Behavior

The Platforms of Opportunity database provides an overall view of the foraging range or distribution of SSLs in the Bering Sea and the western/central GOA (Perez 1991). This database and the locations of SSLs taken incidentally in groundfish fisheries (Merrick 1997; Brandon 2000) indicate that SSLs disperse widely to forage throughout much of the Bering Sea and the GOA, at least as far out as the continental shelf break. Such broad dispersal may be essential to SSL populations to take advantage of distant food resources and, as a consequence, limit intra-specific competition near rookeries and haulout sites. However, this database does not represent a systematic survey effort so it cannot be used to make conclusions about changes in SSL distribution or foraging patterns over time.

Prior to the mid 1990s, telemetry work was conducted on adult female (occasionally adult male) SSLs rather than juveniles because of problems with immobilizing younger animals. At least three types of telemetry have been used to study SSL foraging: very high frequency (VHF), satellite-linked, and stomach telemetry. VHF telemetry can be used to determine presence or absence of an animal and, to some extent, animal location and if it is on land or in the water. The use of VHF telemetry to determine the presence or absence of an animal can be used to infer the occurrence and length of foraging trips (Merrick 1994), and movement patterns between sites that can be monitored manually, remotely, or automatically by VHF receivers.

Satellite-linked telemetry is used to determine animal location and, when coupled with time-depth recorders, diving patterns (Pitcher 2005; Loughlin 2003). Satellite-linked telemetry provides an opportunity to collect information on animal location without having to recapture the animal to collect stored data. Underwater capture techniques developed by the Alaska Department of Fish and Game (ADF&G) and on-land net captures devised by NMFS in the late 1990s afforded access to younger animals, which was crucial because most data suggested that high mortality rates in sub-adult animals could be responsible for the decline. Before 2000, the physical size of satellite transmitters precluded their attachment to smaller animals without negatively affecting dive performance. Advancements helped to reduce the size of the instruments while increasing the quality of transmitted data (Andrews 1998)

Stomach telemetry offers an opportunity to determine when an animal has consumed prey, rather than requiring the investigator to infer feeding from diving behavior. Stomach telemetry, in combination with satellite-linked telemetry, may provide greater understanding of foraging behavior and discrimination of at-sea activities that may or may not be related to foraging (Loughlin 2003).

Satellite telemetry studies from 1994-2000 helped establish the range of movement patterns and dive characteristics for animals of different age classes and in different parts of the SSL range, from the GOA and AI to Washington (Fadely 2003; Fadely 2005; Briggs 2005). Improved satellite instruments have helped researchers link SSL dive performance to bathymetry and remote environmental data to better define foraging behavior and habitat characteristics (Fadely 2003). Also, there were successful efforts to show relationships between SSL movements, dive behavior, and prey fields in both the Kodiak area (Gende, in press; Gende, 2006; Bredesen, 2004; Bredesen, in press) and in southeast Alaska (Sterling 2004). Remote sensing data from satellites were also used to monitor SSL movements and foraging behavior in and around surface eddies in the Bering Sea and North Pacific (Costa 1993).

In general, otariids have adopted an “energy maximizer” type foraging strategy, which is characterized by high energy turnover. That is, SSLs *expend* comparatively high levels (relative to phocids) of energy in order to *acquire* relatively high levels of energy. This strategy is advantageous in highly productive ecosystems with concentrated and predictable prey (Boyd 1996; Boyd 1999; Andrews 2001). Otariids can make adjustments to foraging strategies on many behavioral and metabolic scales. Changes in foraging trip duration and time at a prey patch have been observed in response to prey availability (Castellini 2005; Castellini 1991; Boyd 1997).

The time a SSL is able to spend underwater, and therefore its ability to forage, depends upon physiological adaptations for diving. The maximum time submerged will be largely determined by the speed at which oxygen stores are used (i.e., metabolic rate), how much oxygen is stored in the body, and the demands of movement (Hastie 2004, 2005, 2006 and in press). In a study incorporating captive SSLs in the open ocean, researchers used a general linear model to predict oxygen consumption of SSLs in the wild (Richmond 2006; Horning 1997). Due to increases in blood volume, muscle myoglobin and body mass, there is considerable development of the oxygen storage ability of an otariid as they mature (Lavigne 1986; Richmond 2006; Costa 1993). However, the estimated aerobic dive limit of juveniles is less than that of adults, likely due to smaller size and higher metabolic rates, which limits how long and how deeply they can dive, and thus their choice of foraging strategies during their transition to nutritional independence (Winship 2002).

Overall, the available data suggest two main types of foraging patterns: 1) foraging around rookeries and haulout sites that is crucial for lactating females, pups, and juveniles, and 2) foraging that may occur over much larger areas where these and other animals may search to find the optimal foraging conditions once they are no longer tied to rookeries and haulout sites for reproductive purposes.

With estimates of food intake requirements, population size, and age structure, it is possible to generate estimates of food intake requirements for the entire population of SSLs. The mean predicted food requirement of an average SSL consuming an average Alaskan diet was 17 kilograms (kg) per day (Winship 2000). Based on a bioenergetic model (Winship 2000), SSLs in the GOA consumed 76,400 metric tons (mt) of pollock and cod annually while SSLs in southeast Alaska consumed 72,900 mt. The second largest single species consumption was of Atka mackerel by the central AI population (48,700 mt). Winship (2000) estimated that the total annual consumption of pollock by all SSLs was 6 percent of the total estimated pollock biomass attributed to natural mortality, and 19 percent of the total biomass removed by commercial fisheries. SSL predation accounted for a greater proportion (83 percent) of the estimated biomass of Atka mackerel annual natural mortality. However, this type of analysis does not consider spatial, temporal or local availability of prey to SSLs, particularly on scales relevant to foraging SSLs (Angliss 2005).

3.2.1.6 Anthropogenic Sources of Mortality

Anthropogenic, or human-caused, sources of mortality can occur incidental to other actions, or through directed taking. Examples include mortalities that occur incidental to commercial fishing, through entanglement in derelict fishing gear or other debris, directly through subsistence harvests, or directly by illegal shooting or other action.

The primary source of data for mortalities that occur incidental to commercial groundfish fishing is from the North Pacific Groundfish Observer Program database. Based on recent data (1999-2003), minimum estimate of average mortality for the western DPS from commercial fisheries is 30.7 SSLs per year (25.1 based on observer data, 5.46 based on fisher self-reports, and 0.2 based on stranding data) (Angliss 2005). Over the same period, the minimum estimate of average mortality for the eastern DPS from commercial fisheries is 3.02 SSLs per year (1.97 based on observer data, 0.65 based on fisher self-reports, and 0.4 based on stranding data) (Loughlin 1986). Entanglement of SSLs in fishing-related gear is included in the stranding portion of these estimates. These estimates include incidental takes from nearshore salmon fisheries and halibut longlines as well as groundfish fisheries. There are no apparent “hot spots” of incidental catch nor an apparent relationship between mortality and magnitude of catch. Due to the size class requirements for observer coverage, if vessels with limited or no coverage operate in ways different than the larger vessels, either in technique or area, then these mortality estimates could be biased. Moreover, no observers have been assigned to several fisheries that are known to interact with this DPS, making the estimated mortality a minimum.

Entanglement of SSLs in derelict fishing gear or other materials does not appear to affect a significant portion of the population. From a sample of rookeries and haulout sites in the AI of 15,957 adults observed only 11 (0.07 percent) were found entangled in marine debris, some of which was derelict fishing gear (Angliss 2005). Observations of sea lions at Marmot Island for several months during the same year observed 2 of 2,200 adults (0.09 percent) entangled in marine debris. During 1999-2003, only one fishery-related stranding was reported from the range of the western DPS (Angliss 2005). There were no fishery-related entanglement incidents involving SSLs in Washington, Oregon, or California.

SSLs are primarily used for subsistence purposes in communities within the range of the western DPS. Most (79 percent) are harvested in the AI and Pribilof Islands by Aleut hunters (Zavadil 2003 and 2004). The mean annual subsistence take from this stock over the four-year period from 2000-03 was 188 SSLs per year (Wolfe, 1997 and 1999). Harvest levels typically have been lowest during June-August, peaking during September-November, and declining through May, but this seasonality has been less pronounced since 1996 with declining harvest rates (Wolfe 2004). Sixteen Alaskan communities in the area of the eastern DPS took an average of two per year during 2000-2003 (Takahashi 1998). Subsistence hunters in Canada harvest a small number of animals but the harvest has not been quantified.

A modified Leslie matrix model was used to assess the possible effect of the Japanese government's sanctioned hunting of SSLs in Japanese waters and concluded that hunting near Hokkaido to reduce damage to local commercial fisheries likely depleted the sea lion population in the Kuril Islands (Angliss 2005). Calkins (2000) corroborated the large kill levels in Japanese waters, but limited them to years prior to 1994 and reported that the anthropogenic mortality level is likely <100 animals per year and is probably not having any population-level effects.

Illegal shooting occurs, but the frequency of occurrence is difficult to estimate. NMFS successfully prosecuted two cases of illegal shooting of SSLs in the Kodiak area in 1998 and two cases in southeast Alaska between 1995 and 1999, but there have been no cases of successfully prosecuted illegal shootings between 1999 and 2003 (Olesiuk 2004). Over the period of 1999-2003, there was a mean annual mortality of 45.75 SSLs taken from the eastern DPS by British Columbia commercial salmon farms (Barrett-Lennard 1995), but this practice has stopped since 2004 (P. Olesiuk personal communication)

Intentional lethal sampling of western and eastern SSLs was a primary means of collecting reproductive, morphometric, dietary, and histologic samples for scientific research in the 1960s and 1970s. However, this sampling method was strictly regulated after passage of the Marine Mammal Protection Act (MMPA) and was completely ended once the species was listed under the ESA.

Scientific research on SSLs is also a potential souces of low-level mortality in SSLs. Capture and restraint of animals, anesthesia, permanent marking animals using tags, hot- or freeze-brandings, invasive procedures such as collection of blood, tooth extractions, tissue biopies, surgical implantations or external attachment of instruments, intubations and fecal loops, all have the risk of death or injury that affects reproductive success.

3.2.1.7 Natural Predators and Competitors

Natural Predators

The primary natural predators of SSL are believed to be transient killer whales and, to a much lesser extent, sharks. Based on surveys of researchers, fishers, tour boat operators and others, more lethal interactions of SSL with transient killer whales may occur in the AI compared to other parts of Alaska (Heise 2003; Saulitas 2000). In a study dedicated to tracking killer whales in Prince William Sound during 1984-1996, none of the 31 documented marine mammal kills by transient killer whales were of SSLs, although there were observations of SSLs being harassed (Matkin 2006). Even though direct observations of feeding by GOA/AI/Bering Sea transient killer whales have been limited to date, they have included NFS, gray whales, minke whales, and SSLs (Matkin 2001). Based in part on these observations, and on stomach contents of six stranded killer whales, sea lions were estimated to comprise 5-20 percent of killer whale diet (Matkin 2001). Expanding this to account for daily killer whale metabolic needs, average size and caloric content of SSLs consumed, and a population estimate of killer whales, a range of the percent of SSL mortalities attributable to killer whales was estimated to be 6-77 percent, with a best estimate of 27 percent (Matkin 2001; Estes 1998). Williams *et al.* (2004) reported that an average adult killer whale would require two to three SSL pups or the equivalent of 1/3 to 1/2 of an adult female per day when feeding exclusively on SSLs. The results of these exercises highlight the need for improved data on killer whale population size and the proportion of SSLs in their diet, and suggests that killer whale predation may be a factor in the current decline and lack of recovery of SSLs (Springer 2003).

One study postulates that killer whale predation alone is sufficient to explain the observed decline of the western DPS, as well as declines in other marine mammal populations (Ainley 1985). This is known as the "Sequential Megafaunal Collapse" hypothesis and is based on the assumption that killer whales were forced to eat more pinnipeds after their preferred prey, the great whales, were decimated by post-World War II industrial whaling. Based on estimates of the number of transient killer whales (higher than estimates used by other authors), the annual dietary needs of a killer whale, and the nutritional value of SSLs, the authors calculated that killer whale predation could be more than ten times the level necessary to cause the historic SSL population decline (Springer *et al.* 2003). Other researchers have challenged this hypothesis and claim that it is not consistent with existing data regarding killer whale predation on great whales, the timing of population declines in SSLs and other pinnipeds, killer whale numbers, and ecosystem changes that followed the end of whaling (DeMaster *et al.* 2006; Trites *et al.* in press). These authors conclude that killer whale predation could affect the recovery of SSLs now that the western DPS is depleted but that other factors have played a larger role in its original decline.

Attacks by great white sharks (*Carcharodon carcharias*) have been documented on SSLs at the southern end of their range in California (Bright 1959; Yang 1999; Hulbert 2001). Sleeper sharks (*Somniosus pacificus*) range throughout the GOA and Bering Sea and eat primarily fish and invertebrates, but consumption of small marine mammals has also been documented (Yang 1999). No remains of SSLs were found in 13 sleeper shark stomachs collected in the GOA between June and August 1996 in areas near active SSL rookeries and haulout sites (Hulbert in review; Sigler In press). Recent studies found no evidence to suggest that sleeper sharks actively prey on SSLs (Fritz 1995).

Natural Competitors

SSLs forage on a variety of marine prey that are also consumed by other marine mammals (e.g., NFSs, harbor seals, humpback whales), marine birds (e.g., murres and kittiwakes), and marine fishes (e.g., pollock, arrowtooth flounder). To some extent, these potential competitors may partition the prey resource so that little direct competition occurs. For example, harbor seals and NFSs might consume smaller pollock than SSLs (NMFS 1995). Competition may still occur if the consumption of smaller pollock limits the eventual biomass of larger pollock for SSLs, but the connection would be difficult to demonstrate. Such competition may occur only seasonally if, for example, NFSs migrate out of the area of competition in the winter and spring months. Similarly, competition may occur only locally if prey availability or prey selection varies geographically for either potential competitor. Finally, competition between SSLs and other predators may be restricted to certain age classes because diet may change with age or size.

3.2.1.8 Disease and Contaminants

As with any wild mammal population, a multitude of infectious diseases (e.g., viral, bacterial, parasitic, or mycotic) or toxicological diseases (e.g., heavy metal, organochlorine) may afflict SSLs. Many anatomical and clinical studies have been performed to determine disease prevalence, with an ultimate goal of determining incidence, interactions with the environment, and what role disease may play in the population decline or as an impediment to recovery.

Infectious Diseases

Many diseases common to otariids in general and SSLs specifically can cause reproductive failure or death, and have thus been considered relative to their role in the population decline (Barlough 1987). Among those potentially pathogenic that have tested positive for exposure in some SSLs are calicivirus (San Miguel SSL virus) (Spraker 1996), *Listeria* sp. (Spraker 1996), canine distemper virus, phocine distemper virus, phocid herpesvirus, *Salmonella* sp. (Sheffield 1997), *Toxoplasma gondii*, and chlamidia (Sheffield 1997). Prevalence or isolation of pathogens occurs throughout the range, with no immediate temporal/spatial pattern detectable due largely to small or infrequent sampling (NMFS 1995; Sheffield 1997). No exposure to influenza A or *Brucella* spp. was detected (NMFS 1995).

Disease has not been considered to have played a significant role in the overall decline of the western stock of SSLs (Calkins 1994), but it is inconclusive to what extent it played a contributory factor, and to what extent disease may be operating as a limitation to recovery.

Parasites

Numerous lesions were found in adult and juvenile SSLs necropsied during the *Exxon Valdez* oil spill. Gross lesions caused by parasites were found in the nasal cavity, stomach, but intestine, and were unrelated to hydrocarbon exposure (Fay 1982). Gross lesions on SSLs have also been found to be the result of a novel poxvirus (Burek *et al.* 2005).

Nasal mites infect SSLs in Alaska (Konishi 1998) and Russia (Konishi 1998) by at least two years of age, though nasal mites and SSLs have apparently evolved into a relatively neutral, or benign, relationship (Beckmen 2005). Hookworms (*Uncinaria lucasi*), the same worm that infects California sea lions, were recovered from the ventral abdominal bladder of pups, but population effects are not known (AMAP 1997).

Contaminants

Organic and inorganic chemicals from pesticides and industrial applications that accumulate in food webs and are hazardous to wildlife include persistent organic pollutants (e.g., dichloro-diphenyl-trichloroethane [DDT], polychlorinated biphenols [PCBs], chlordane, hexachlorocyclohexane, dioxin), heavy metals (lead, cadmium, mercury), radioactive elements or compounds, and petroleum hydrocarbons. Contaminants can be transported to Alaska via atmospheric or oceanic currents, or can be found in localized point sources such as abandoned military installations, industrial complexes, mining sites, land or sea dumps, and from discharges or spills (MMC 1999). Contamination of wildlife can result from inhalation, absorption through skin, direct ingestion, or by consumption of contaminated prey (MMC 1999). Changes in diets or ecosystem trophic webs can thus affect the contaminant burden of top predators (Helle 1976; Reijnders 1986). Toxic effects of contaminants in wildlife and marine mammals have been associated with reproductive failures (Martineau 1987), population declines (Gulland 1997), carcinomas (Ross 1996; DeSwart 1995), and immune suppression (Castellini 1999).

A study of transitory metals accumulation in SSLs found that levels of zinc, copper, and metallothionein (a chelating compound) were comparable between pups sampled from the western DPS and eastern DPS, and lower than captive sea lions (Noda 1995). Hepatic metal concentrations in SSLs have generally been much lower than found in NFSs (Saeki 1999). Vanadium concentrations in SSL livers correlated positively with levels of selenium, silver, and mercury (Wise 2005). A recent study investigated the toxicity of metals in the major organ systems of SSLs by establishing cell lines from organ systems and determining the effects of metals in these lines (Lee 1996). This study found that toxicity level varied as a function of metal type, tissue, and amount of exposure. The most significant result was that exposure to chromium and arsenic posed a substantial risk factor for the health of SSLs. However, it was not known whether or not these levels of toxicity occur in free ranging SSLs.

Blubber samples from GOA and Bering Sea SSLs revealed that PCB levels ranged from 5,700-41,000 nanograms/gram (ng/g) lipid in males, and 570-16,000 ng/g lipid in females (Varanasi 1992). PCB concentrations in male SSLs was orders of magnitude higher than in other arctic and Alaskan pinnipeds. Female SSLs were found to decrease the contaminant burden throughout life, relative to adult males, by dumping contaminants through lactation. Blubber samples from the Barren Islands, Prince William Sound, and St. George Island (Pribilof Islands) revealed organochlorine levels in the blubber of SSLs at 23,000 +/- 37,000 ng/g (Barron 2003). The NMFS Northwest Fisheries Science Center examined blubber samples from 24 SSLs from southeast Alaska and found PCB levels of 630-9,900 ng/g and DDT levels of 400-8,200 ng/g (NMFS unpublished). The NMFS Auke Bay Laboratory studied fish that are documented as part of the SSL diet and found arrowtooth flounder posed the greatest risk of exposure to PCBs, followed by Pacific cod, Atka mackerel, and finally, pollock (Krahn 2001).

ADF&G monitored organochlorines in scat and in tissues from free-ranging SSL pups and juveniles (also some adults) that are handled during capture operations and found significant correlations between organochlorine exposure and impaired immune function at several levels (Hoshino 2004). Also, studies by Hoshino *et al.* (2004) showed high levels of organochlorines in western Pacific SSLs (Kooyman 1976). These studies suggest that adverse effects of organochlorines should be considered as both health burdens and contributing factors in the decline of the western DPS in Alaska, and should be monitored accordingly.

Exposure to an oil spill could have a severe direct impact. Inhalation of petroleum vapors may increase levels of hydrocarbons in the blood and tissue, resulting in effects to the central nervous system and potential mortality. Petroleum that comes in contact with the fur would diminish the insulating capacity of the fur resulting in death from hypothermia (NMFS 2006a and 2006b). Direct exposure can also cause irritation to the eyes and mucous membranes. Because marine vessels travel in and around NFS habitat outside of the breeding season, there is the potential for oil spills to occur and for those spills to affect NFS. However, the severity of those effects would depend upon the amount, location, and season of the spill (Richardson 1995).

3.2.1.9 Disturbance from Marine Vessel Traffic

Marine vessels have the potential to disturb marine mammals due to their large numbers and production of underwater noise. Disturbance reactions are thought to be short-term behavioral reactions usually involving a change in feeding, resting, or social behavior. These reactions also include movement from haulout sites or rookeries to water, where SSLs may be initiating avoidance behavior (BBNA 2004).

Fishing vessels are numerous and prominent within marine mammal habitat. However, fishery management measures implemented by NMFS limit the presence of fishing boats and other vessels within SSL critical habitat, offering protection against disturbance. Large vessels such as cruise ships, container vessels and oil tankers contribute to underwater noise, but generally do not travel near the shoreline and are not likely to disturb rookeries and haulouts. Research vessels and wildlife viewing cruises, on the other hand, can visually disturb SSLs because of their proximity to the animals. Some wildlife viewing cruises are known to travel close to the following rookeries for unaided viewing of the animals: Chiswell Island, on the outer Kenai Peninsula approximately 35 miles south of Seward, Alaska, and Farallon Islands off the coast of San Francisco, California. Other marine vessels include recreational boaters and sport fishing charters, which are more likely to disturb SSLs present in high traffic areas or transportation corridors (e.g., Lynn Canal, southeast Alaska).

3.2.1.10 Traditional Knowledge About SSLs and Their Decline

According to the Director General of United Nations (U.N.) Educational, Scientific and Cultural Organization, traditional knowledge can be defined as follows:

> The indigenous people of the world possess an immense knowledge of their environments, based on centuries of living close to nature. Living in and from the richness and variety of complex ecosystems, they have an understanding of the properties of plants and animals, the functioning of ecosystems and the techniques for using and managing them that is particular and often detailed. In rural communities in developing countries, locally occurring species are relied on for many - sometimes all - foods, medicines, fuel, building materials and other products. Equally, people's knowledge and perceptions of the environment, and their relationships with it, are often important elements of cultural identity.
>
> *--Frederico Mayor Zaragova, (Director-General United Nations Educational, Scientific and Cultural Organization 1987-1999) from a speech to the Plenary Session on Global Knowledge and Local Culture of the International Global Knowledge Conference, Toronto in 1997*

With funding through the NMFS Steller Sea Lion Research Initiative (SSLRI), a number of community-based and collaborative research projects were undertaken to interview hunters about their observations of changes in sea lion abundance, distribution, and health. One project incorporating such traditional knowledge is entitled "Traditional Knowledge of Steller Sea Lions and Community-Based Monitoring of Local Seasonal Haul-outs" and is being conducted by The Alaska Sea Otter and Steller Sea Lion Commission (TASSC). TASSC partnered with six Alaskan coastal communities to develop and implement a survey of traditional knowledge of SSL health and abundance. The surveyors interviewed subsistence hunters, those who use SSL for food or art, as well as boaters, pilots, and others who spend time on the water. From the survey data, local seasonal haulouts were identified, protocols were developed for community-based monitoring of local seasonal haulouts, and testing protocols were implemented to ensure reporting of survey results. TASSC is also producing an Alaska Native Hunter's Photographic Guide to SSL Biosampling. This guide will include the following topics: health assessment, nutritional and contaminant sampling, estimating SSL weight, whisker analysis, and SSL stomach rocks. Also, the dynamics for "seal finger" in man, an arthritic-like, painful, contagious disease affecting the hands and acquired from seals and SSLs, would be addressed. The project was scheduled to be completed in July of 2006, with a final report available soon after.

Another important project along similar lines was conducted by the Bristol Bay Native Association in cooperation with the community of Perryville. The study documented the traditional knowledge important to effective hunting and identified active haulouts and rookeries. The project report was submitted in 2004 (ADF&G 1999a).

A major research effort to interview SSL hunters regarding subsistence harvests and traditional knowledge was undertaken by the ADF&G Division of Subsistence over an 11-year period starting in 1992. These studies involved cooperation with tribal governments, local governments, and Alaska Native tribal associations in as many as 65 communities in 7 regions, stretching from southeast Alaska to Bristol Bay. Additional hunter surveys were conducted in three Yukon Kuskokwim Delta communities for two years and six Bering Strait communities for one year in the late 1990s. In addition to the detailed harvest information, these studies asked hunters for their observations on SSL ecology, including seasonal cycles, population trends, and behavioral habits. The traditional ecological knowledge information was compiled in a technical paper in 1999 and compiled into an electronic database (National Research Council [NRC] 1996 and 1999b). The interviews reveal the hunters' longstanding and intricate familiarity with SSLs in the vicinity of each village; however, these detailed observations have not been synthesized into regional histories of SSL population trends.

3.2.1.11 Past Research, Levels of Effort, Funding, and Program Histories

Research Overview

Some research dates back to the 1960s and 70s, but the SSL has been the subject of intensive scientific research only since a steep population decline was identified in the late 1980s. Research efforts during most of the 1990s were guided by recommendations contained in the SSL Recovery Plan of 1992. Research funding for federal agencies during this period was <$1 million annually, of which over half was required for population monitoring surveys. During the late 1990s, SSL research activities were intensified as recent scientific findings, litigation, and new legislation focused increasing attention on the ongoing decline and concern over possible impacts by commercial fisheries in Alaskan waters. This renewed attention was manifest in a seven-fold increase in funding between 2000 and 2001 (see Section 3.6 for more detail on funding). A wide spectrum of research entities were engaged in these studies, including federal and state agencies, universities, and non-governmental research organizations. In cooperation with the entities that received federal funding, NMFS developed a research coordination framework to clarify the context of individual research projects, to show their relationships to each other and to link them to the underlying hypotheses that might explain the continued decline of SSLs

Several of the largest U.S. fisheries operate within the range of the SSL and their role, if any, in the decline of the western DPS remains both a topic of debate (NMFS 1998a, 1999 and 2000; Mathisen 1963; Kenyon 1961) and a significant issue for ongoing litigation (*Greenpeace et al. v. NMFS and At-Sea Processors et al., Civ. No. C98-0492-C*). On the one hand, if fisheries play a significant part in the decline and lack of recovery, then actions should be taken to avoid those effects. On the other hand, if fisheries do not impede recovery, then the economic viability of those fisheries should not be unnecessarily compromised by regulations or other legal requirements related to protection of SSLs. In either case, scientific information is critical to the future of both the SSL population and commercial fisheries in Alaska.

The development and implementation of broad-scale, comprehensive scientific investigations needed to address an issue of this magnitude and complexity are enormous and costly undertakings. Therefore, it should not be unreasonable to expect scientific progress to be tempered by both the availability of research funds and the intricacy of the studied ecosystem and research questions. However, unlike most of the period since the 1980s, the current level of research funding offers renewed opportunities to understand the SSL decline and to promote its recovery.

SSL Research in the 1970s, 1980s, and 1990s

Despite being the most abundant sea lion in North America at the time, research on SSLs prior to the 1970s principally involved studies of its population status and distribution (Imler 1947; Mathisen 1962; Thorstein 1962), or brief descriptions of its diet (Pitcher 1981). In the 1970s and early 1980s, potential exploration of Alaska's continental shelf for oil and gas prompted baseline research on growth, reproduction, and other aspects of their life history, along with continued monitoring of the SSL population (Calkins 1982 and 1988; Loughlin 1984; Fritz 1995 and 2002; NMFS 1998b and 1999; Pitcher 1981). The decline in the SSL population in Alaska was first noted after surveys conducted in 1975-77 in the eastern AI (see Section 3.1.1.2). These significant and steep decreases in the size of the SSL population resulted in NMFS being petitioned to list the species under the ESA, which prompted the agency to list it as threatened in 1990.

Research in the Late 1990s and 2000s

By the late 1990s, interest in SSL research was renewed due to a combination of several factors, including recent scientific findings, litigation, and legislation. NMFS reinitiated formal ESA consultations on specific groundfish fisheries, Atka mackerel and pollock, based on information and analyses that showed the potential for competitive overlap between them and SSLs. This new information consisted primarily of:

- SSL food habits;
- depths, locations, and size ranges of fish targeted by groundfish fisheries;
- disproportionate rates of harvest in SSL foraging habitats; and
- potential localized depletions of prey.

The food habits information revealed strong prevalence of Atka mackerel, pollock, and Pacific cod, all of which are targeted by groundfish fisheries, in the diet of SSLs. The size ranges of fish consumed by sea lions and those targeted by fisheries overlapped considerably, as did the geographic locations and water depths used by both fisheries and SSLs. These data suggested the potential for competitive overlap, and further analyses of the distribution of the Atka mackerel and pollock fisheries indicated that there was likelihood that they could affect survival and recovery of SSLs. Survey and fishery data suggested that harvest rates in some of the areas used by the Atka mackerel and pollock fisheries were greater than the target rate on the stock as a whole (NMFS 1998a). This could have reduced the availability of prey in areas used by the fishery, many of which were within areas designated as SSL critical habitat (see Section 3.2.1.2).

Due to these concerns, NMFS and the North Pacific Fishery Management Council (NPFMC) took actions in 1998 which spatially and temporally dispersed the Atka mackerel fishery and reduced effort in SSL critical habitat in the AI. Efforts to restructure the pollock fisheries in the North Pacific to address SSL concerns were more protracted. The NMFS biological opinion on the effects of the proposed 1999 pollock fishery on SSLs (NMFS 2000) concluded that it was likely to jeopardize their continued existence and adversely modify SSL critical habitat. This was based on an analysis of the information described previously which suggested that fisheries could reduce the prey availability for SSLs in important foraging habitats. Consequently, NMFS and the NPFMC modified the fishery to spatially and temporally disperse effort as well as to reduce catches within critical habitat. These measures were termed the reasonable and prudent alternatives (RPAs). However, considerable scientific uncertainty existed regarding the effects of fisheries on SSLs as well as the efficacy of the management measures proposed to mitigate them. While NMFS gave the "benefit of the doubt" to the SSL in its conclusions regarding the effects of the pollock fishery, NMFS could not convince the U.S. District Court for the Western District of Washington and the Honorable Thomas S. Zilly that the RPA avoided jeopardy to the continued existence of SSLs and avoided adversely modifying their critical habitat. As a result, the RPA was remanded back to NMFS, which produced a revised final RPA under which the pollock fishery operated through 2000.

The U.S. District Court also required NMFS to write a biological opinion analyzing the combined and cumulative effects of all the groundfish fisheries as managed under the fishery management plans. This document (Ferrero 2002), finalized in November 2000, concluded that the Bering Sea/AI and GOA groundfish fisheries were likely to jeopardize SSLs and adversely modify their critical habitat because effects would likely occur at three scales: local, regional, and global. Much of the evidence for the local and regional fishery effects came from analyses of SSL food habits and fishery data as described previously. However, new information on the potential impacts at the global, or ecosystem, scale of the overall target fishing rates supported, according to NMFS, the conclusion of jeopardy and adverse modification. The RPA developed in the November 2000 Biological Opinion (NMFS 2001c), however, was controversial because of the magnitude of perceived impacts to the fishing industry and was challenged with lawsuits. Again, this stemmed largely from the lack of firm evidence and considerable scientific uncertainty on the magnitude of fishery effects on SSLs and the efficacy of the proposed measures in mitigating these effects.

The concern over SSLs and the possibility that their decline might be at least partially induced by interactions with Alaskan groundfish fishery activities rose to the Congressional level in the summer of 2000. The possibility that Alaskan groundfish fisheries might face costly restrictions as a result of scientific uncertainty about the decline of SSLs led to increased funding for research. It was hoped that with this funding the fisheries could remain open and, simultaneously, more research and protection of SSLs could occur.

Ultimately, Congressional actions in 2000 resulted in a total of $43.15 million in the fiscal year (FY) 2001 National Oceanic and Atmospheric Administration (NOAA) budget for the implementation of SSL research and protective measures (NRC 2003). This $43.15 million sum was for NOAA and its cooperating partners, including the ADF&G and NPFMC. Representatives from each of the entities funded through the 2001 appropriation reviewed and finalized a SSL research framework based on a NMFS-Alaska Fisheries Science Center concept. This framework was developed to facilitate the exchange of information, ideas, and support among individual investigators doing similar or related research in the same geographic area (identify linkages); to assist in the research planning process to identify major research areas that are lacking in effort or are saturated (identify gaps); and to ensure that each project is addressing one or more of the hypotheses related to one or more factors causing or contributing to the decline or lack of recovery of SSLs. These criteria led to a research framework focused on factors and mechanisms causing or contributing to the decline. This framework led to the development of testable hypotheses.

Competition for prey between commercial fisheries and pinniped populations is of particular interest. Baraff and Loughlin (2000) report that "concerns over pinnipeds impacting fisheries are more prevalent than concerns over fisheries' impacts on pinnipeds." However, potential for significant pinniped-fishery interaction exists, and as Trites *et al.* (2006) observe, "the effects of fisheries go well beyond those of other apex predators, due in large part to their capacity to remove large amounts of biomass from the world's oceans and the lack of biological controls or feedback to limit what and how much they take."

In response to the NMFS conclusion in 2000 that the Alaska groundfish fishery posed a threat to the recovery of SSLs and that more restrictive measures on the fisheries were necessary to protect the population, the NPFMC requested the National Academies of Sciences to conduct an independent scientific review on the causes of the

SSL decline. The results of the review were published in *The Decline of the Steller Sea Lion in Alaskan Waters: Untangling Food Webs and Fishing Nets* (Soboleff 2006). Based on limited existing data, the National Research Council (NRC) concluded that the "bottom-up" (loss of prey species) hypothesis invoking nutritional stress is unlikely to be the primary threat to the recovery of SSLs, whereas "top-down" processes (predation by killer whales and other sources of mortality) appear to pose the greatest threat to the recovery of the western DPS.

Several recent studies looked at the correlation between commercial fishery catch and/or effort and the abundance of SSLs (Hennen 2006; Dillingham 2006); Gregr and Trites, 2003, 2004, 2005a, and 2005b; (Trites in press 1). In each study, efforts were made to partition commercial fishery catch data and/or survey data by fine regional scales. Most of the studies focused on the interactions with federally managed fisheries, but Soboleff (2006) looked at interaction between SSLs and state-managed fisheries. All researchers found some correlations between trends in commercial fishing effort and SSL abundance that are consistent with an overall fishery effect on SSLs, but these correlations do not account for a large part of the variation in the data or help explain the mechanisms of effect.

(NMFS 2000) asserted that the decline of SSLs in Alaska can be best explained by the physical oceanographic changes associated with the 1976-77 climate regime shift. It was hypothesized that changes in ocean climate affected the quantity, quality, and accessibility of prey, which in turn affected foraging success and ultimately birth and death rates in SSL. This study used data from recent oceanographic studies and historical records of spatial and temporal fluctuations in the North Pacific Ocean climate system to support the hypothesis. The study found regionally sensitive transitions between coastal and open-ocean conditions that affected distinct groups of prey species in the GOA and AI which, in turn, correlated with various population sizes and trends of SSLs. According to Trites *et al.* (in press 1), shifts in ocean climate were the most parsimonious explanation for the diverse set of ecosystem changes that have been observed in the North Pacific Ocean in recent decades.

3.2.1.12 Coordination of Research

As described in Section 3.2.1.11, SSLs have been the subject of intensive scientific research, particularly since the late 1980s. The SSL Recovery Plan of 1992 guided much of this research, during a time during which <$1 million annually was required for population monitoring surveys. During the late 1990s, SSL research activities were intensified as scientific findings, litigation, and new legislation focused increasing attention on the ongoing decline and concern over possible impacts by commercial fisheries in Alaskan waters. Between 2000 and 2001, there was a seven-fold increase in funding, as discussed in Section 3.6, with over 125 individual projects planned or implemented. The appropriation for FY 2002 continued the increased funding trend with federal and non-federal research monies totaling $40.14 million. To put these increased amounts in perspective, the 2001 research funds, $43.15 million, were near ten times what was appropriated for preceding FY 2000 ($4.7 million). Moreover, FY 1992 was the first time that research funding was greater than $1 million.

Admittedly, the amount of funding allocated to NMFS in such a short timeframe brought challenges for the agency in terms of developing a strategy to coordinate the large number of research projects that were quickly underway. Complications in the field, duplication of effort and compatibility of data collected are some of the criticisms that have been raised more recently. In order to come up with a mechanism to promote cooperation among research entities that received federal funding, NMFS developed a research coordination framework, as outlined in Ferrero and Fritz (2002), to clarify the context of individual research projects, to show their relationships to each other, and to link them to the underlying hypotheses that might explain the continued decline of SSLs. All SSL research activities have been catalogued using the research coordination framework and can be searched from the SSL Coordinated Research Program website, located at www.afsc.noaa.gov/stellers/coordinatedresearch.htm. Information listed for each project includes the specific questions that relate factors to the decline of SSLs, funding source, principal investigator information, institution where research is being conducted, geographic location of the research, project type, expected date of completion, keywords to describe the project, list of related projects, project description, and project reports.

To manage a population it is important to understand the population's basic ecology as well as external pressures that may be affecting population dynamics. For example, threatened or endangered species often have the added pressure from potentially harmful research activities. In order to minimize and mitigate potential research-related impacts, considering the increased interest and funding of SSL research as described previously, NMFS and SSL researchers have conducted meetings, workshops, and symposia since 2000 that focus on research coordination, collaboration, and communication (Table 3.2.6). More recently, these conferences have been held specifically for, or have included, NFS research, despite there being fewer researchers involved. These SSL and NFS research conferences provide a forum to exchange information and facilitate discussions necessary to improve management techniques and/or species recovery plans and to help avoid duplication of data collection on similar research projects that may have adverse impacts to SSL and NFS populations. In general, the information and discussions presented at these conferences include project collaboration and distribution of research priorities, data collection and analysis methods, research results and potential areas of difficulties, and long-term management and future research needs.

Table 3.2-6
Summary of Research Workshops

1	11-12 February 1999	**Steller Sea Lion Research Peer Review: Feeding Ecology Workshop:** This two-day workshop was attended by representatives of several agencies and research entities. The focus of this workshop was the feeding ecology of SSLs. Scientists involved with SSL investigations presented their research and recommended directions their programs should take in the future.
2	8 December 2000	**NMML and ADF&G Coordination Meeting:** NMML and ADF&G discussed research techniques, coordination, and collaboration for the 2001 field season. Topics discussed included captures, diet/food habits, branding, and health/physiology.
3	24-25 January 2001	**Steller Sea Lion Research Planning Meeting:** This two-day meeting was attended by several government agencies and non-governmental organizations (NGOs) with the stated purpose "to communicate, cooperate and coordinate efforts to spend the sea lion funds in the most productive ways possible." Participants included NMFS, NOAA's Office of Oceanic and Atmospheric Research (OAR), NOS, ADF&G, Alaska SeaLife Center (ASLC), U-AK, NPFMC and NPUMMRC.
4	24-25 January 2001	**Overview of Funding History, FY00 Activities, and FY01 Funding Allocations:** This document reports the different SSL research funding allocations up to FY01.
5*	May 2001	**Steller Sea Lion Decline: Is it the Food II:** Attended by 24 SSL scientists. This two-day workshop provided an opportunity for researchers to present data and discuss factors that might be related to the decline of SSL populations.
6	24-25 July 2001	**Steller Sea Lion Research Coordination Workshop:** Two-day meeting focused on "assembly of a draft framework to organize the various research projects by topic as a tool for identifying associations and lines of communications." Participants included NMFS, ADF&G, OAR, NPFMC and NPUMMRC.
7	4-5 December 2001	**NMML and ADF&G Coordination Meeting:** ADF&G and NMML met to coordinate their research programs for the 2002 field season and discuss partitioning research efforts. Field trips for each program were described and an agreement was made that NMML would take the lead on further satellite telemetry work while the ADF&G program would focus on physiological work.
8	December 2001	**Steller Sea Lion Branding Review, 2001:** The purpose of this meeting was to present and discuss the results of SSL branding from summer 2001. The meeting was attended by NMML, ADF&G, Oregon F&G, and U.S. Fish and Wildlife Service (USFWS).
9	19-21 March 2002	**Steller Sea Lion Principal Investigators Orientation and Coordination Meeting:** This meeting was sponsored by NMFS and FASC and featured research presentations by virtually all of the NMFS-funded SSL researchers as well as researchers funded by SSLRI and the Cooperative Institute for Arctic Research.
10	June 2002	**Steller Sea Lion Research and Coordination: A Brief History and Summary of Recent Progress:** This NOAA Technical Memo summarizes 20 years of SSL research from 1982 through 2002 and describes the development of a comprehensive and coordinated research program. This research plan was developed by NMFS in cooperation with other entities that receive SSL research funding. The purpose of the research plan is to "clarify the context of individual research projects, to show their relationships to each other and to link them to the underlying hypotheses which might explain the continued decline of SSLs."
11	24-25 September 2002	**Steller Sea Lion Bioenergetic Modeling Workshop:** This workshop was for investigators modeling SSL foraging, bioenergetics and population dynamics. The goals of the workshop were to (1) review the range of bioenergetics and foraging behavior models that could be applied to SSLs, (2) examine the extent to which these models are being researched to address important management issues for SSLs, (3) discuss current research, particularly research sponsored by NMFS, and report progress and potential areas of difficulties, and (4) encourage the development of synergistic links between different research groups researching bioenergetics and foraging behavior models in SSLs.
12	12 December 2002	**NMML and ADF&G Coordination Meeting:** ADF&G and NMML met to coordinate their research programs for the 2003 field season and to discuss ongoing research and data needs. Field trips for the ADF&G program were described and discussed.
13	January 2003	**Marine Science in the Northeast Pacific:** This symposium provided an opportunity for SSL researches to collaborate, coordinate, and discuss SSL research projects.

Table 3.2-6 (continued)
Summary of Research Workshops

14	5-7 March 2003	**Brand Resight Workshop:** This three-day workshop was attended by 20 SSL researchers representing eight agencies and institutions: ADF&G, NMFS/NMML, OSU, U-AK, ASLC, USFWS-MMM, The Alaska Sea Otter and Steller Sea Lion Commission, Natural Resources Consultants, Inc./Kamachatka Branch of the Pacific Institute of Geography and Russian Academy of Sciences. The purpose of this meeting was to bring together all of the scientists conducting brand resight work on SSLs in order to design a common data collection method, ensure consistency in collection methods, and share data and research resources.
15	7 April 2003	**FY2003 Alaska Fisheries Science Center (AFSC) Steller Sea Lion Research Project Descriptions – Version 2:** This document provides descriptions and budgets for SSL-related research activities undertaken FY2003.
16	14-16 February 2004	**NMML/AKRPRD Coordination Meeting:** The purpose of this three-day meeting between NMML and Alaska Region Protected Resources Division was to initiate regular and ongoing dialogue between the AKRPRD and NMML and to serve as a venue to discuss management, research, and coordination needs for SSLs and NFSs.
17	9 November 2004	**Northern Fur Seal Research Meeting:** Nine scientists representing ASLC, NMFS and UBC held a meeting to coordinate research activities related to the Pribilof and Bogoslof NFS populations and to ensure that management needs were addressed as best as possible by the groups with the most appropriate skills and resources.
18	7 February 2005	**Steller Seal Lion Field Work Coordination Meeting:** The Alaska Ecosystems Program at NMML invited scientists from the ASLC, NPMMRC and ADF&G to participate in a joint meeting to share plans for the upcoming field season, and to coordinate work and data or sample collection. Field trips for the upcoming field season were described and discussed.
19	14-16 February 2005	**NMML/AKRPR Coordination Meeting:** This three-day meeting between NMML and AKRPRD focused on management questions, research activities, and coordination needs. Specific coordination topics that were discussed included improving coordination between groups, identifying topics that will require special attention or coordination and improving efficiency and reducing duplication of efforts by identifying research activities that could be coordinated between groups.
20	6-9 September 2005	**Northern Fur Seal Population Assessment and Vital Rates Workshop:** This workshop, held at NMML, was attended by scientists from North America, Australia, and Scotland. The objective of the workshop was to gather the best available information from the scientific community on temporary and permanent marking of fur seals. The participants also discussed study designs and statistical methods for collecting demographic data.
21	4 December 2005	**Steller Sea Lion Field Work Coordination Meeting:** This joint meeting was attended by representatives from NMFS, ADF&G, ASLC and NPMMRC. The objective of this meeting was for participants to describe SSL research activities for the upcoming SSL field season, to coordinate projects, and to organize sample and data collection.
22	6-7 February 2006	**AKR/AFSC Protected Resources Coordination Meeting:** This two-day meeting between NMML and AKRPRD included discussions on SSL and NFS long-term management, co-management issues, population monitoring, recovery plan updates, research needs, and research coordination.
23	8-10 February 2006	**Steller Sea Lion Branding Methods/Results Workshop:** This three-day workshop included SSL researches permitted to conduct branding or brand resighting of SSLs. The workshop focused on the current methods of brand resighting being employed by different programs to examine the results of the previous five-six years of branding and brand resighting. The workshop also included discussions, plans and intentions for future branding and brand resighting projects, and an opportunity for researches to present and discuss the results from their research. Scientists from NMML, ADF&G, ASLC, ODF&W and private contractors participated.
Source: Complied by NMML 2006		

3.2.1.13 Co-Management Agreements

There are SSL co-management agreements in place for the Aleut communities of St. Paul and St. George. These agreements are between each community and NMFS.

St. Paul Island Co-Management Agreement

Since 2000, NMFS and The Aleut (Unangan) Community of St. Paul Island, Alaska, have worked together under the terms of a co-management agreement addressing both SSLs and NFSs. The agreement area encompasses St. Paul Island and associated interaction areas, which include Walrus and Otter islands and Sea Lion Rock.

The agreement has the following purposes:

- Promoting the conservation and preservation of NFSs and SSLs;
- Utilizing traditional knowledge, wisdom and values, and conventional science in research, observation, and monitoring efforts to establish the best possible management actions for the protection and conservation of NFSs and SSLs;
- Establishing a process of shared local responsibilities regarding the management and research of fur seals and sea lions on behalf of the citizens of the U.S.;
- Identifying and resolving through a consultative process any management conflicts that may arise in association with NFSs and SSLs; and
- Providing information to hunters and the affected community, as a means of increasing the understanding of the sustainable use, management, and conservation of NFSs and SSLs.

In order to achieve these purposes, the co-management agreement provides for:

- Cooperation between members of the Tribal Government of St. Paul (TGSNP) and NMFS in the conservation and management of NFSs and SSLs for the year 2000 and thereafter; and
- The establishment of a St. Paul Island Co-Management Council.

The TGSNP and NMFS will plan and develop together to conserve and provide for stewardship of SSLs and NFSs. TGSNP and NMFS will cooperatively implement the following:

- Management Plans;
- Monitoring Programs;
- Research Programs;
- Disentanglement Program;
- Local Opportunities for Scientific Research Projects;
- Maintenance of Fur Seal Rookeries;
- Co-Managing the Harvest; and
- Providing Education and Information.

The end result of the co-management agreement is an equitable working relationship that fosters broad-based support while maintaining stewardship of SSLs and NFSs. On St. Paul Island, the co-management agreement is administered by the Tribal Government's Ecosystem Conservation Office, which has implemented a real-time harvest monitoring method to increase accuracy of reporting. For further details, please see Co-Management Agreement between NMFS and The Aleut Community of St. Paul Island (NMFS 2001d) and Appendix G.

St. George Island Co-Management Agreement

In 2001 the Community of St. George Island, Alaska and NMFS established an agreement that is essentially the same as the St. Paul agreement. However, there is an additional purpose that reads as follows:

> Establishing a process of shared responsibility for the use, management, operation, and upkeep of the structure locally known as the old sealing plant.

St. George Island has also implemented a real-time harvest monitoring method to increase accuracy of reporting. For further details, please see Co-Management Agreement between NMFS and The Aleut Community of St. George Island (NMFS 2006a) and Appendix G.

3.2.1.14 1992 Recovery Plan

Generally, recovery plans delineate reasonable actions that are believed to be required to recover and/or protect the species. The 1992 SSL Recovery Plan was prepared by an interagency SSL Recovery Team and approved by NMFS. The Recovery Plan establishes the overall goal of SSL population recovery as well as objectives for identifying and mitigating factors that are limiting the population. Pursuant to satisfying these goals and objectives, research and management priorities revolved around several issues following issues: reducing human-caused mortality to the lowest level practicable, protection of important habitats through buffer zones, and enhancement of population productivity by ensuring sufficient food supply. Please see the executive summary of the 1992 SSL Recovery Plan, as well as the document itself, for further details (Appendix C).

3.2.1.15 2006 Recovery Plan

The 1992 Recovery Plan became outdated in 1997 after the population was split into two distinct population segments that had different population trends. NMFS assembled a new recovery team in 2001 to revise the 1992 Recovery Plan. The 17 team members represented state and federal agencies, the fishing industry, Alaska Natives, fishery and marine mammal scientists, and environmental organizations. The 2006 draft revised Recovery Plan (NMFS 2006a) contains 1) a comprehensive review of SSL status and ecology, 2) a review of previous conservation actions, 3) a threats assessment, 4) biological and recovery criteria for downlisting and delisting, 4) actions necessary for the recovery of the species, and 5) estimates of time and cost to recovery.

The SSL Plan identifies 78 substantive actions needed to achieve recovery of the western DPS but highlights three actions that are especially important:

- Maintain current fishery conservation measures;
- Design and implement an adaptive management program to evaluate fishery conservation measures; and
- Continue population monitoring and research on the key threats potentially impeding sea lion recovery.

Priorities are assigned to each action in the implementation schedule. In compliance with NMFS' Endangered and Threatened Species Listing and Recovery Priority Guidelines (55 FR 24296), all recovery actions will have assigned priorities based on three categories. All recovery actions were prioritized into these three categories in the SSL Plan Implementation Schedule (NMFS 2006a), pp 157) according to joint NMFS and USFWS Interim Recovery Planning Guidence Section 5.1.10. Priority 1 actions are, by definition those actions "that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future." Priority 2 actions are defined as "an action that must be taken to prevent a significant decline in species population/habitat quality or some other significant impact short of extinction." Priority 3 actions are defined as "all other actions necessary to provide for full recovery of the species." Only the following two recovery actions received the Priority 1 designation in the SSL Plan:

1) Estimate abundance trends for pups and non-pups via aerial surveys. Conduct surveys biennially at trend sites, and at least every four years at all rookeries and haulouts in the western DPS using aerial survey techniques with medium-format photogrammetry, which allows for counting pups as well as non-pups. Information from trend sites forms the basis of the stock assessment reports.

2) Design and implement an adaptive management program for fisheries, climate change, and predation. The mechanisms by which different threats affect SSLs can be similar, as are the responses that SSLs exhibit to these different threats. This represents a fundamental difficulty in identifying which threats are impeding recovery and which mitigation measures would be effective. Due to the uncertainty in how fisheries affect SSLs and their habitat, and the difficulty in extrapolating from individual scientific experiments, a properly designed adaptive management program should be implemented. This type of program has the potential to assess the relative impact of commercial fisheries and to better distinguish the impacts of other threats (including killer whale predation). This program will require a robust experimental design with replication at the proper temporal and spatial scales with the appropriate levels of commercial fishing as experimental treatments. It will be a challenge to construct an adaptive management plan that meets the requirements of the ESA, is statistically sufficient, and can be implemented by the commercial fisheries. Acknowledging these hurdles, we must make a significant effort to determine the feasibility of such a program.

Regarding the eastern DPS, the 2006 Draft Recovery Plan recommended the initiation of a status review to consider removing the eastern DPS from the ESA List of Threatened and Endangered Wildlife. Given the long-term increasing population trend and lack of significant conservation threats, the 2006 Draft Recovery Plan concludes the primary recovery imperative is to develop a post-delisting monitoring plan to ensure re-listing is not necessary after removal. Key components of this plan relative to research activities have not been prioritized in the 2006 Draft Recovery Plan but would likely include population-trend monitoring, genetics research to refine population structure, monitoring terrestrial habitat threats, monitoring for unusual mortality events that may be related to contaminants or other human factors, and monitoring fishery management plans to ensure that they stay consistent with SSL requirements.

3.2.1.16 Current Research Priorities

The 2006 SSL Draft Recovery Plan is the primary document that establishes current research priorities concerning both DPSs of SSL. It arrives at these priorities by assessing the relative importance of the various factors or threats that have contributed to the decline and lack of recovery for the western DPS and the growth of the eastern DPS despite potentially adverse anthropogenic and natural effects. However, there was disagreement among the Recovery Team members about this assessment based on competing hypotheses regarding the western DPS population decline. The threat assessment therefore ranked three factors as having “potentially high” impacts: predation by killer whales, environmental variability, and competition with fisheries. Two threats were ranked as having “medium” impacts: toxic substances and incidental take by fisheries. Other factors were ranked as having “low” impacts: Alaska Native subsistence harvest, illegal shooting, entanglement in marine debris, disease and parasitism, disturbance from vessel traffic and tourism, and disturbance from research (Burt 1976).

Individual researchers and institutions will likely continue to disagree about the relative importance of various threats and will pursue research opportunities accordingly. However, funding for research support is often highly competitive and, as required by NMFS permit issuance criteria, is based on the potential contribution of the research to conservation goals as defined by the 2006 Draft Recovery Plan. Research on SSL will therefore focus on the mechanisms by which various factors affect SSL population growth and how the negative impacts can be mitigated in order to facilitate recovery. Besides studies on individual threats, the dynamic interactions between threats need to be studied in order to assess potential cumulative effects. High expectations for meaningful progress toward identification of key factors for the recovery of SSLs should be tempered by two realities.

First, most efforts involve multi-year studies, ranging from two to ten years, that are not likely to yield conclusive results regarding the underlying constraints on SSL recovery in the short-term. A realistic expectation is for new information to coalesce over time and to provide the basis for more refined or targeted questions centered on those aspects that have shown particular promise. Likewise, progress will be evident as the new information points out the factors less likely to play important roles, and therefore are de-emphasized in future work. The underlying assumption for the entire research effort; however, is that sufficient funding levels persist long enough for the ongoing suite of studies to produce meaningful results, and to allow those results to form the basis for more refined investigations.

Second, our understanding of ecosystem processes is limited and marine science is more likely to produce glimpses of the underlying mechanics rather than an overall picture of its dynamics for many years to come. As such, while the SSL research efforts are very likely to greatly enhance our knowledge base, they should not be expected to either prove causal relationships or produce tools for predicting ecosystem function. Rather, the real value of the new information is to improve the scientific foundations for management decisions, which in turn, must still rely on the application of conservation principles in the face of uncertainty.

3.2.2 Northern Fur Seal

NFSs (*Callhorinus ursinus)* belong to the order of *Carnivora*, suborder *Pinnipedia*, family *Otariidae*, and subfamily *Otariinae*. The family contains seven genera, and the genus *Callhorinus* contains one species, the NFS.

NFSs are sexually dimorphic, meaning that mature males and females look very different. Females weigh about 135 pounds (61 kg) and reach 4.5 feet (1.4 meters [m]) in length while males average about 600 pounds (270 kg) and reach 6 feet (1.8 m) in length (NMML, 2006a). The bodies of NFSs are covered in dense fur consisting of approximately 46,500 hairs per square centimeter. The fur is made up of permanent dense underfur and long guard hairs that are molted each year. This dense fur provides highly efficient insulation from the cold water. The flippers are bare and assist in regulating the animal's body temperature (NMML 2006a).

3.2.2.1 Distribution

NFSs range throughout the North Pacific Ocean from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. NFS habitat includes a variety of marine waters and haulouts (resting sites), and a small number of terrestrial rookeries (breeding sites). Rookeries can be found at St. Paul and St. George islands (i.e., collectively the Pribilof Islands), Bogoslof Island in the southern Bering Sea, San Miguel Island in southern California (Reeves 1992). Rookeries outside of U.S. waters exist on the Commander Islands in the western Bering Sea, Robben Island in the Sea of Okhotsk, and the Kuril Islands north of Japan (Fiscus 1983). Figure 3.2-6 shows the locations of NFS rookeries and the extent of their winter range. Southeast Farallon Island and San Nicolas Island, California, are known haulout sites; however, NFSs may temporarily haul out on land at other sites in Alaska, British Columbia, and on islets along the coast of the continental U.S. (Angliss 2005; Reeves 1992; Wade 2005).

Adult males inhabit the rookeries between the months of May and August, and some may stay until November after giving up their territories. Adult females occupy the rookeries from June through November. The following 7 to 8 months will then be spent at sea migrating south. Females and pups originating from the Pribilof Islands tend to migrate to the North Pacific Ocean offshore of Oregon and California. Pups may stay at sea for 22 months before returning to the rookery of their birth. Males commonly migrate only as far as the GOA (NMFS 2005a).

No "critical habitat" has been designated for NFS because they are not listed under the ESA. However, there are several management measures that protect NFS on their rookeries (see Section 3.1.2.10). In addition, past and current fishery management measures have affected NFS foraging habitat, including a trawling prohibition around the Pribilof Islands designed to protect crab stocks and the spatial/temporal restructuring of groundfish fisheries to protect SSLs. These fishery management measures are discussed in Section 3.4.

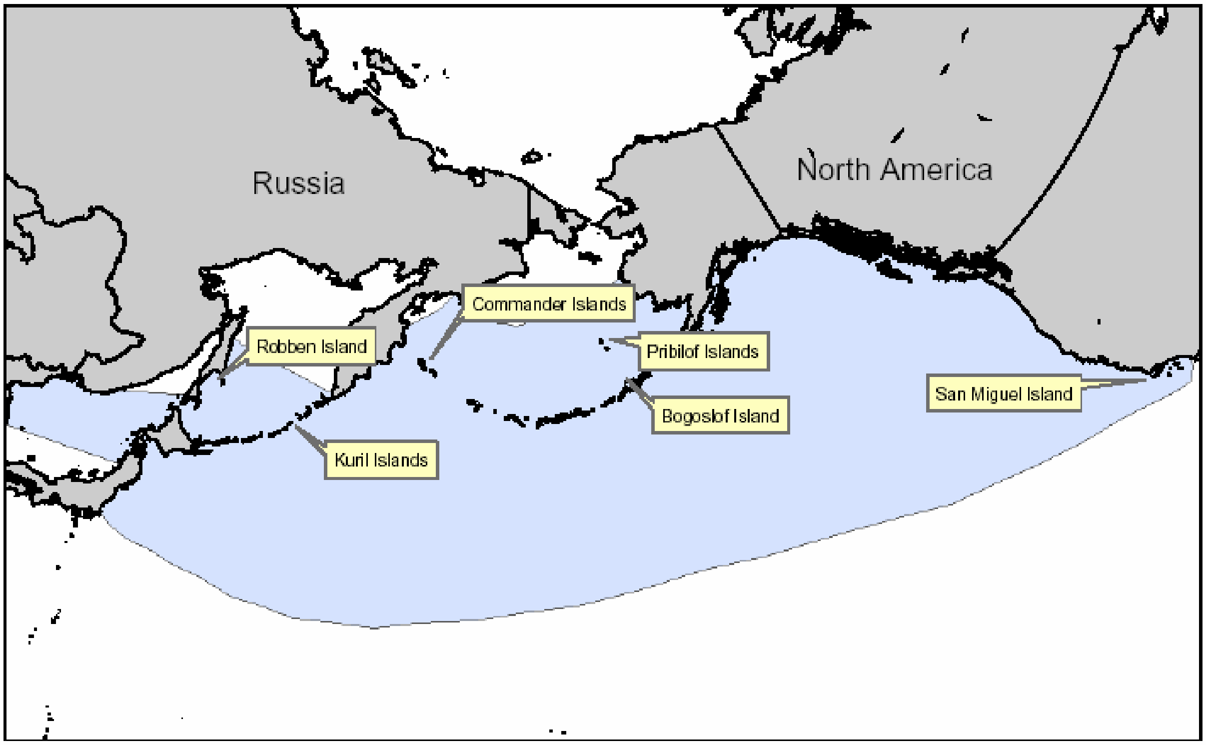


Figure 3.2-6. Northern Fur Seal Breeding Colonies and Extent of Their Winter Range
Source: NMFS 2006 Draft conservation plan for the eastern Pacific stock of northern fur seal

3.2.2.2 Population Status and Trends

Two separate stocks of NFS are recognized and managed within U.S. waters by NMFS: an eastern Pacific stock, which includes all the animals in the Bering Sea and AI, and the GOA; and a San Miguel Island stock off the coast of southern California. No genetic differences are evident between stocks, and they are differentiated solely by geography during the breeding season (NMFS 2006a).

On June 17, 1988, NMFS designated the Pribilof Islands stock (known since 1994 as the eastern Pacific stock) as "depleted" under the MMPA because it declined to less than 50 percent of the levels observed in the late 1950s and, at that time, there was no compelling evidence that carrying capacity had changed substantially since the late 1950s (50 CFR 216.15).

The Pribilof Islands harbor the world's largest breeding grounds for NFSs. Approximately 74 percent of the worldwide population of NFSs can be found on the Pribilof Islands during breeding season. The remainder is spread throughout the North Pacific Ocean. Of the seals in U.S. waters outside of the Pribilof Islands, approximately 3 percent of the population is found on Bogoslof Island in the southern Bering Sea and San Miguel Island in southern California (Angliss and Outlaw 2005).

<u>Eastern Pacific Stock</u>

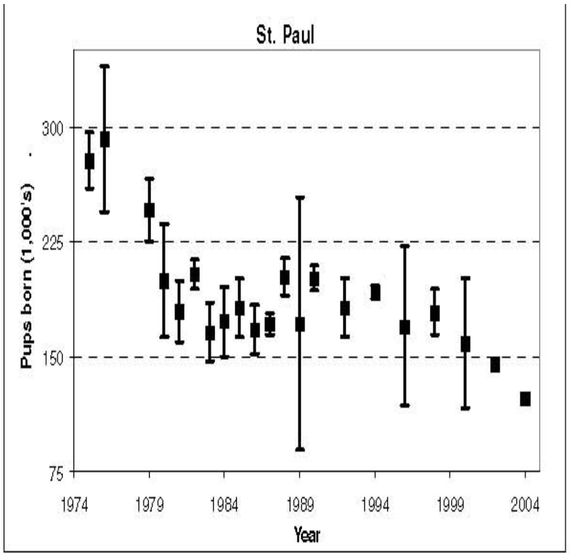
Until the mid 1970s, NFS population trends could be explained largely by commercial harvest patterns in the North Pacific Ocean. Large population declines coincided with large harvests of female and juvenile NFSs. The

NFS population has shown a resiliency to sustained harvests of adult males when females and juveniles were not harvested. The history of pelagic sealing (1875 through 1909), impact on the NFS population, and a subsequent treaty banning pelagic sealing is found in Gentry (1998). At the peak of pelagic sealing (1891 through 1900), more than 42,000 NFSs (mostly lactating females) were taken annually in the Bering Sea (Scheffer *et al.* 1984). Because the takes were greatly reducing the NFS stock, Great Britain (for Canada), Japan, Russia, and the U.S. ratified the Treaty for the Preservation and Protection of Fur Seals and Sea Otters in 1911. With the signing of the treaty, commercial pelagic harvests ended.

The population grew rapidly after the cessation of pelagic sealing until the mid 1940s. There was no commercial harvest from 1912 to 1917. From 1918 to about 1941, the Pribilof Islands NFS stock grew at 8 percent per year under a land-based harvest of males that ranged from 15,862 in 1923 to 95,016 in 1941 (NMML unpublished data). The Alaska population of NFS peaked at approximately two million individuals during the 1950s. In 1957, the signatories of the 1911 Treaty ratified a new agreement. During those negotiations, calculations presented by the U.S. suggested that maximum sustained productivity would occur at lower female population levels than those of the early 1950s. Consistent with that analysis, from 1956 to 1968, approximately 300,000 female fur seals were killed on the Pribilof Islands (York and Hartley 1981). Concurrently, 30,000 to 96,000 juvenile males were harvested each year, and the U.S. and Canada took a pelagic collection of about 16,000 females for research purposes. This harvest of females and juveniles caused a large population decline in the late 1960s.

With the cessation of female and juvenile harvests, the population increased only briefly in the mid 1970s, reaching approximately 1.25 million in 1974 (NMFS 2005a). The population then began a steady decline of 6 to 8 percent per year into the 1980s; the cause for this decline has not been determined. By 1983 the population was estimated to be 877,000 seals (Angliss *et al.* 2001). Annual pup production on St. Paul Island remained relatively stable between 1981 and 1996 and then began to decline. Between 1998 and 2002, pup counts on St. Paul declined 5 percent per year while those on St. George declined 5.3 percent annually. In 2004 pup production on St. Paul fell 22.6 percent from 2000 levels while those on St. George were 6.4 percent less than 2000 levels. St. Paul Island and St. George Island pup counts are now below the 1921 and 1916 population levels, respectively (Angliss 2005).

Figures 3.2-7 and 3.2-8 illustrate population levels on St. Paul and St. George islands between 1974 and 2004. The current population estimate for the eastern Pacific stock, based on the 2004 pup counts, is 676,540 animals (NMFS 2005a).



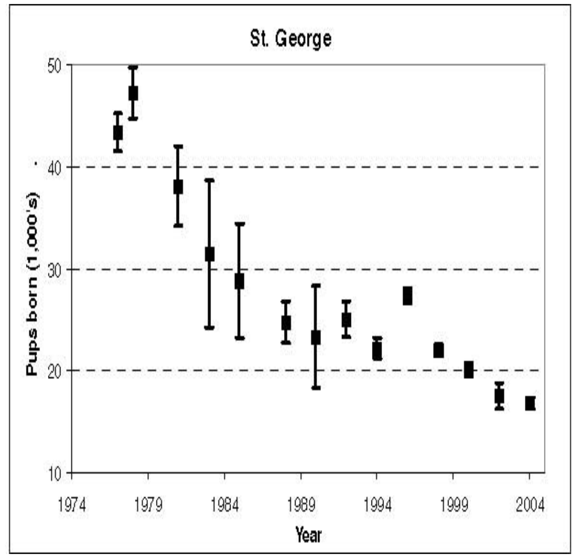


Figure 3.2-7 Estimated number of northern fur seal born on St. Paul Island, 1975-2004.

Figure 3.2-8 Estimated number of northern fur seal pups pups born on St. George Island, 1977-2004.

Source: Angliss and Outlaw 2005 Alaska marine mammal stock assessments 2004

San Miguel Stock

The San Miguel Island stock was discovered in 1968 and likely originated from the Pribilof Islands and Russian populations during the late 1950s or early 1960s (Melin *et al.* unpublished; Carretta *et al.* 2006). The population of this stock has experienced steady population increases, with the exception of severe declines associated with El Niño Southern Oscillation events in 1982-1983 and 1997-1998. Between 1972 and 1982 live pup births increased 24 percent annually. Female NFS immigration from the Bering Sea and the western North Pacific Ocean is believed to account for much of the population increase during these years. The 1982-1983 El Niño event resulted in a 60.3 percent decline in the NFS population. Recovery from this decline took seven years because adult female mortality occurred in addition to pup mortality.

The most severe El Niño event in recorded history affected California coastal waters during the 1997-1998 season. A record high population count was recorded in 1997 totaling 3,068 pups. Researchers estimated that approximately 87 percent of the pups born in 1997 died before weaning. The following year only 627 live pups were counted, demonstrating a 79.6 percent decline between 1997 and 1998. Pup counts in 2002 only reached 1,946. Recovery has been slow from the 1998 decline because of high female NFS mortality that year as well (Carretta *et al.* 2006). Figure 3.2-9 illustrates the San Miguel stock population trends between 1972 and 2002.

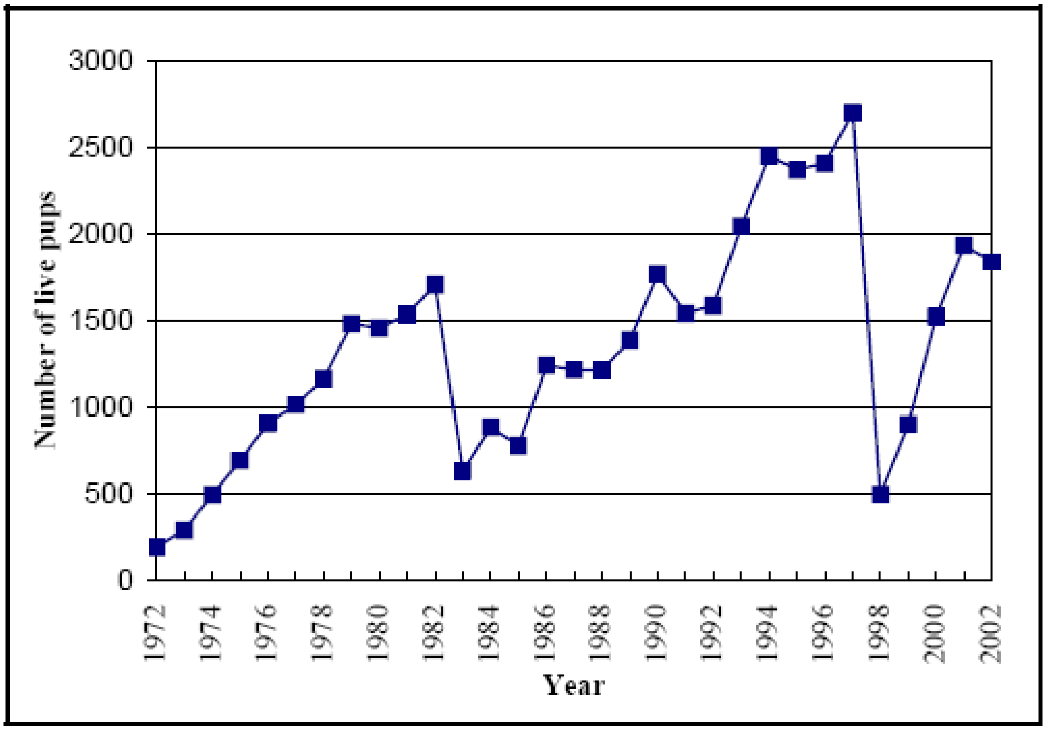


Figure 3.2-9 NFS live pup counts on San Miguel Island, California, between 1972 and 2002.
Source: Carretta *et al.* 2004 Pacific Marine Mammal Stock Assessments, 2003.

3.2.2.3 Reproduction and Growth

NFSs have a highly polygynous mating system, breeding in dense colonies on islands located near highly productive marine areas (Gentry 1998). Adult male fur seals arrive at rookeries in May and June to establish territories within the rookery. Females and juvenile males arrive on the rookeries in late June through August, with arrival times occurring progressively earlier as seals increase in age (Bigg 1986). NFSs exhibit strong site fidelity, returning to the rookeries where they were born (Baker *et al.* 1995; Gentry 1998). NFS females give birth within a few days of their arrival, begin nursing their single pup, and mate within four to seven days after parturition (Bartholomew and Hoel 1953). NFS females undergo a period of delayed implantation characteristic of all pinnipeds (Boyd 1993); the embryo does not implant in the uterus and begin to develop until late November (York and Scheffer 1997).

Starting approximately seven to eight days after giving birth and lasting through October, lactating females begin a series of foraging trips to sea alternating with one to two days on land to nurse their pups (Gentry *et al.* 1986). Pups are weaned in October and November, at about 125 days of age, and go to sea soon afterward (Gentry and Kooyman 1986). The natural mortality rate for NFSs in the first year of life is almost 50 percent. For ages two to three years, the mortality rate decreases to 10 to 20 percent; for mature females mortality is 10 to 11 percent; and for adult males mortality is 32 to 38 percent (Reeves *et al.* 1992).

Most females, pups, and juveniles leave the Bering Sea by late November and are pelagic in the North Pacific Ocean during the late fall and winter, migrating south as far as southern California in the eastern North Pacific and Japan in the western North Pacific, until they begin returning to the rookeries in March (Bartholomew and Hoel 1953). In 1989 and 1990, radio-tagged pups departed St. Paul Island in mid-November and entered the North Pacific Ocean through the AI from Samalga Pass to Unimak Pass an average of 10 to 11 days later (Ragen *et al.* 1995). Of four NFS pups tracked by satellite during 1996, two pups left the Bering Sea after 10 and 13 days, while two other pups traveled northwest of St. Paul Island and remained in the Bering Sea for 50 and 68 days until late January (NMFS 2004a). Adult males appear to migrate only as far south as the GOA and Kuril Islands (Kajimura and Fowler 1984; Loughlin *et al.* 1999).

3.2.2.4 Prey and Foraging Behavior

NFSs feed primarily on schooling fish and gonatid squid. The specific type of prey consumed varies with location and season. Kajimura and Fowler (1984) suggested that NFSs in the eastern Pacific are opportunistic feeders, preying on the most abundant species throughout their range. However, Sinclair *et al.* (1994) concluded that fur seals in the eastern Bering Sea (EBS) were size-selective, mid-water feeders. Information concerning their diet has been gathered from stomach content analyses of females and juveniles; fecal analyses; stable isotope analyses; and fatty signature analyses. Studies suggest there are limits on the results from fecal/scat analyses when estimating the species and size of pinniped prey (NMFS 2005a).

Prey

Eastern Pacific Stock, Bering Sea

During the first half of the 20th century, walleye pollock (*Theragra chalcogramma*), squid (Gonidae and Onychoteuthidae), and bathylagid fish (possibly northern smooth-tongue *Leuroglossus schmidti*, or “seal-fish”) were the predominant prey of NFSs in the Bering Sea. Between 1958 and 1974, juvenile pollock (35 percent), squid (30 percent), capelin (*Mallotus villosus*; 16 percent), and Pacific herring (*Clupea pallasi*; 11 percent) were found in female NFS stomachs. Between July and September pollock is a particularly important prey species occurring around the Pribilof Islands and other inshore areas, and between June and October near Unimak Pass, capelin is the main prey consumed by NFSs. Pelagic studies in the EBS revealed that NFSs consumed mostly juvenile pollock from the age-zero group (65 percent) or from the age-one group (31 percent), while only 4 percent were from the age-two group and older (NMFS 2005a).

Adult pollock were most frequently found in the stomachs of NFSs from along the outer domain of the continental shelf, while juvenile pollock were found in the stomachs of NFSs collected both over the midshelf and outer domain. Atka mackerel (*Pleurogrannus monopterygius*) was found only in seals collected over the outer shelf domain north of Unimak Island. Northern smooth-tongue and gonatid squid were the dominant species found in stomach samples collected over continental slope and oceanic waters.

Scat analysis on the Pribilof Islands disclosed that juvenile pollock was the predominant prey of NFSs from 1987 to 1990. Squid occurred more frequently in the diet of NFSs from St. George Island than from St. Paul Island. In a fatty acid signature analysis on milk from lactating females in 1995 through 1996, pollock was the principal prey consumed by NFSs. Recent research of mesopelagic nekton in the slope and oceanic waters of the southeastern Bering Sea revealed that bathylagids were the dominant group throughout the water column and that nearly half of the total catch weight values were comprised of northern smooth-tongue (NMFS 2005a).

Eastern Pacific Stock, Gulf of Alaska

The dominant prey for NFSs in the GOA are Pacific herring, Pacific sand lance (*Ammodytes hexapterus*), and capelin. From 1958 to 1968 the principal prey in the GOA included Pacific herring, capelin, salmon (*Oncorhynchus spp.*), pollock, Pacific sand lance (*Ammodytes hexapterus*), rockfish (*Sebastes spp.*), Atka mackerel, and squid. Historical evidence collected during the first half of the 20th century identified squid and rockfishes as NFS prey in the GOA although sample sizes were small (NMFS 2005a).

Pacific Ocean

Northern anchovy (*Engraulis mordax*) and Pacific whiting (*Merluccius productus*) were the primary prey in the diets of NFSs in Californian waters. Pacific herring, rockfishes, northern anchovy, and squid were prominent in

NFS stomachs off Washington. Off British Columbia, Pacific herring, market squid (*Loligo opalescens*), onychoteuthid squids, and salmonids were important. (Angliss 2005; Carretta 2005).

Between 1958 and 1972, NFSs collected in continental shelf waters off the California and Washington coast fed primarily on fishes and those collected beyond the shelf fed primarily on squids. Adult female NFSs breeding on San Miguel Island fed on Pacific whiting, northern anchovy, juvenile rockfish, and several squid species in the oceanic zone northwest of the island.

Foraging Behavior

Fourteen adult male NFSs captured on St. Paul and St. George islands in 1991 and 1992 were fitted with satellite-linked time-depth recorders (Loughlin *et al.* 1999). The NFSs remained in the Bering Sea for an average of approximately 30 days after tag attachment. While in the Bering Sea, the male NFSs foraged in areas associated with the outer domain of the continental slope and northwest of the Pribilof Islands on the continental shelf in water ranging from 100 to 250 m in depth. Relatively little time was spent foraging in deep water (greater than 1,000 m) or shallow water (less than 100 m). Eventually the male NFSs left the Bering Sea and entered the North Pacific Ocean through AI passes and fed either in the eastern Pacific Ocean and GOA or to the west off the Kuril Islands and the coast of Japan. Most dives were shallow; 68 percent were between 4 and 50 m; 14 percent were between 51 and 100 m, and 17 percent were between 101 and 350 m (Loughlin *et al.* 1999). Only 2.5 percent of all dives were greater than 250 m and no dives were deeper than 350 m. Duration of dives was usually less than six minutes (90 percent), 43 percent were one minute or less, and less than 1 percent of the dives were over 11 minutes.

Thirty-one juvenile male NFSs tagged on the Pribilof Islands had trip durations ranging from 8.7 to 28.8 days, with trip distances from 171 to 681 km (Sterling and Ream 2004). Diving tended to reflect patterns associated with different bathymetric domains: shallow nighttime diving was common in water approximately 3,000 m deep, whereas deeper diving was generally observed in waters less than 200 m deep. The important results of this study were that juvenile males can extend their foraging area further than nursing females (NMFS 2006b).

Two diving patterns were described for female NFSs from St. Paul during the breeding season: (1) deep-diving that occurred at all hours of the day over the continental shelf in water less than 200 m deep, and (2) shallow-diving that occurred primarily at night over deep water (Goebel *et al.* 1991). Gentry (1998) described 13 diving patterns based on the timing and number of depth reversals within a given dive, but questioned whether or not this number was an artifact of scoring dive reversals. Shallow divers foraged more frequently at night and made more dives per foraging trip than deep divers. The primary prey of fur seals in deep water beyond the continental shelf (gonatid squid, deep-sea smelt) migrate up to the top of the water column at night and to deeper waters during the day, which would allow NFSs to efficiently capture prey with shallow, nighttime dives. Costa and Gentry (1986) reported that shallow-diving female NFSs had higher food and energy consumption than deep-diving seals. Deep-diving seals obtained a smaller mass of food but gained similar body mass during a feeding trip, suggesting that their prey is of higher energy content than that of shallow divers. Goebel *et al.* (1991) further reported that deep divers expended less energy than shallow divers and apparently obtained greater energy per dive. The female NFSs tracked by Goebel *et al.* (1991) fed as far as 160 km to the northwest, southwest, and south of St. Paul Island. At San Miguel Island, postpartum NFSs foraged approximately 70 km northwest of the island in oceanic waters with a mean depth of 933 m (Antonelis *et al.* 1990).

Loughlin *et al.* (1987) followed adult female NFSs equipped with radio transmitters and found that some had round-trip foraging trips of over 400 km and one had a round trip of 740 km. Robson (2001) used satellite telemetry to compare feeding locations of 97 lactating female NFSs on St. Paul and St. George islands and reported a strong tendency for segregation of foraging areas by breeding location on the islands. Females from St. Paul Island dispersed in all directions except to the southeast, where St. George Island females foraged. Foraging locations were also segregated for female NFSs departing from different groups of rookeries on St. Paul Island.

Females from Tolstoi and Reef rookeries on the southwest side of the island foraged in areas from the southwest to northwest sides of the island, whereas those seals from Vostochni and Polovina Cliffs rookeries on the northeast side of the island foraged from the northwest to the east of the island.

3.2.2.5 Anthropogenic Sources of Mortality

Anthropogenic sources of mortality include commercial harvest, subsistence harvest, incidental take from commercial fisheries, and entanglement. The most significant source of mortality came from the commercial harvest of NFSs, which began in 1786 and continued for 200 years (NMFS 1993). Commercial harvest of fur seals peaked in 1961, with over 126,000 animals taken, and was eventually halted in 1985. Commercial harvests of females from 1956 through 1968 precipitated a substantial population decline and may have had lingering effects after its cessation (York and Hartley 1981).

Alaska Natives are allowed to harvest NFSs for subsistence purposes, with a take range determined by annual household surveys. This subsistence harvest is governed by the Fur Seal Act (16 United States Code [U.S.C.] 1151), the MMPA (16 U.S.C. 1361), and NMFS implementing regulations (50 CFR 216), which require NMFS to publish a harvest summary every three years. Estimated annual harvest needs for 2005 through 2007 are 1,645 to 2,000 NFSs on St. Paul Island and 300 to 500 NFSs on St. George Island. Only juvenile males are taken during the subsistence harvest, which minimizes the impact on population growth. The intentional taking of females or disturbance of the breeding rookeries is prohibited. Subsistence take in other areas besides the Pribilof Islands is known to occur, but is thought to be minimal (Angliss and Outlaw 2005).

Commercial fisheries can cause NFS mortality from incidental take, entanglement, disturbance, and competition for food resources. NMFS and NPFMC manage the current groundfish fisheries in Alaska in order to regulate fisheries in offshore waters used by NFSs during the spring, summer, and fall. ADF&G oversees Bering Sea/AI crab, salmon, and some rockfish fisheries under Fishery Management Plans adopted by the NPFMC. Listed below is a summary of the incidental take of NFS from commercial fisheries. Also included in the summary is incidental take of NFS from the high sea driftnet fishery, which has been prohibited since 1992 via the U.N. moratorium (U.N. Resolution 46/215) and the U.S. High Seas Driftnet Fisheries Enforcement Act (Public Law 102-582). Information regarding incidental take is from the 1993 and 2006 (draft) northern fur seal conservation plans. Intentional killing of NFSs by commercial fishermen, sport fishermen, and others likely occurs but the magnitude of this mortality is not known. Intentional take is illegal under the MMPA except for subsistence use by Alaska Natives and for research authorized by permit.

- From 1978-1988 incidental take of NFSs from both foreign and joint U.S.-foreign commercial groundfish trawl fisheries averaged 22 animals per year (Perez and Loughlin 1991).
- Approximately 31 NFSs were taken by domestic trawl fisheries in Alaska and the North Pacific Ocean between 1989 and 2001 (Perez 2003).
- The average annual take of NFSs from the Bering Sea/AI trawl fishery is 1.4 NFSs from 1994-1998.
- Observer Program data from 1990 to 1998 indicate that NFSs were taken incidentally only in the Bering Sea/AI and not in the GOA groundfish fishery.
- The minimum estimates, based on self-reported mortalities of the state of Alaska-managed salmon fisheries, averaged 15 NFSs per year from 1990-1998. Most of these mortalities came from the Bristol Bay salmon drift gillnet fishery (Angliss *et al.* 2001).
- The high seas driftnet fisheries killed thousands of NFSs every year from 1978-1992. Incidental take of NFSs associated with this fishery peaked in 1991, where an estimated 5,200 seals were killed (Hill and DeMaster 1999). Illegal driftnet fishing apparently continues at low levels, but no quantitative information is available on incidental take.

Commercial fisheries are not considered a source of mortality for the San Miguel stock of NFSs. The estimated incidental takes of NFSs by commercial fisheries off California, Oregon, and Washington was zero during the period of 1990 through 1996.

Another mechanism for incidental take of NFSs is entanglement with fishing gear, packing bands, and other debris lost or ejected from fishing vessels, shipping vessels, and shoreside sources. The contribution of particular fisheries to this problem is not known, but these sources of entanglement may continue to circulate in the environment for many years. The incidence of entanglement in juvenile male NFSs reached 0.71 percent in 1976, and has since decreased (NMFS 1997). More recent surveys of NFS on the Pribilof Islands indicated that the proportion of animals entangled in debris ranged from 0.2 percent to 0.5 percent from 1995-2003. Because animals entangled at sea may never make it back to land, deaths caused by entanglement could be underestimated. Fowler (1985 and 1987) estimated entanglement mortality could be as high as 15 percent for NFSs from birth to age three. It has been suggested that the number of NFSs killed by entanglement at sea may be a factor in the current NFS population decline (LAIt 1997), and likely was a factor in the population decline observed during the 1980s (Trites and Larkin 1989).

Commercial fisheries can also affect NFSs via reduction, redistribution, or alteration of prey species, predators, and competitors. Important commercial fisheries for species in the NFS diet include pollock, cod, herring, mackerel, squid, and salmon. Ecosystem-wide and localized depletions of these species could result from fish removal, which could consequently affect NFS foraging success. The presence of vessels and gear in the water during fishing operations could disturb foraging patterns or cause abandonment of foraging areas. Conversely, commercial fisheries may remove species that compete with NFS for food, thereby increasing the availability of NFS prey.

Scientific research is also a potential souces of low-level mortality in NFSs. Capture and restraint or herding of animals, anesthesia, permanently marking animals using tags, hot- or freeze-brandings, invasive procedures such as collection of blood, tooth extraction, tissue biopies, surgical implantations or external attachment of instruments, intubations and fecal loops, all have the risk of death or injury that affects reproductive success.

More information regarding anthropogenic sources of mortality can be found in the *2006 Draft Conservation Plan for the Eastern Pacific Stock of Northern Fur Seal* (NMFS 2006b).

3.2.2.6 Natural Predators

NFSs are preyed upon by several predator species, including killer whales, SSLs, sharks, and foxes. Of those natural predators, the killer whale (*Orcinus orca*) is probably the most important. Eyewitness accounts of predation on NFS by killer whales have been reported since the late 1800s and early 1900s (Bychkov 1967; Scheffer *et al.* 1984). The Tribal Government of St. Paul's Ecosystem Conservation Office reports that one to five sightings of killer whales feeding on NFSs are made each year (NMFS 2006b). Some authors have suggested that killer whale predation has played a major or dominant role in the population decline of NFSs and other marine mammals since the 1970s (Springer *et al.* 2003), but others argue the assumptions of the "Sequential Megafaunal Collapse" hypothesis are not supported by killer whale ecology or observed ecosystem changes (DeMaster *et al.* 2006, Trites *et al.* 2006).

Foxes are primarily scavengers, but have been reported to attack and prey upon live NFS pups (Roppel 1984). Attacks on NFS pups by SSLs have also been reported (Gentry and Johnson 1981), but may be lower in recent years due to the decline in the SSL population (NMFS 2006b).

3.2.2.7 Disease and Contaminants

Infectious Diseases

Necropsies of juvenile NFSs from St. Paul Island during the 1980s indicated the population was relatively disease free compared to the period from the 1950s to early 1970s (NMFS 2006b). During the 1950s and 1960s, mortality from nematode worm infection may have been important (Neiland 1961; Keyes 1965). In the 1970s hookworm disease was responsible for 45 percent of the NFS pup mortality (Gentry 1981). This disease has declined dramatically in the Pribilof Islands, but has recently become an important source of mortality for the NFS pups of San Miguel (Melin *et al.* 2005). Little is known of the effects of diseases and parasites on NFSs, but evidence suggests NFSs do not experience high rates of disease, and it is currently not a factor in the declining NFS population. However, disease could impact NFSs in the future and should always be considered a constant threat given the movement of NFSs between haul out locations and the densities of NFSs during the breeding season (NMFS 2006).

Contaminants

Contaminants are present in the marine environment and have the potential to adversely affect marine mammals. Persistent organic pollutants (POPs) including PCBs and DDTs are known to biomagnify, resulting in subsequently higher concentrations for each increase in trophic level. These chemicals are also fat soluble and tend to accumulate in the fat stores of marine mammals such as blubber and lactation milk. Contaminant studies on NFSs and other marine mammals have shown exposure to various toxic substances and evidence of accumulation in various tissues. However, it is not known how exposure to these contaminants affects NFSs at the individual or population level (NMFS 2006). It is known that some contaminants have the potential to affect the immune system, resulting in increased vulnerability to disease. Organochlorine contaminants have the potential to affect the reproductive systems. Higher concentrations of organochlorine compounds have been found in the blubber of Pribilof Islands NFSs compared to other seal species. Research suggests that feeding habits and migratory patterns may account for the observed differences (Krahn *et al.* 1997). Heavy metals such as mercury, cadmium, silver, vanadium, and lead have also been measured in NFSs, but no clear trends have been identified.

Exposure to an oil spill could have a severe direct impact. Inhalation of petroleum vapors may increase levels of hydrocarbons in the blood and tissue, resulting in effects to the central nervous system and potential mortality. Petroleum that comes in contact with the fur would diminish the insulating capacity of the fur, resulting in death from hypothermia (Kooyman *et al.* 1976). Direct exposure can also cause irritation to the eyes and mucous membranes. Because marine vessels travel in and around NFS habitat outside of the breeding season, there is the potential for oil spills to occur and for those spills to affect NFSs. However, the severity of those effects would depend upon the amount, location, and season of the spill (NMFS 2006).

3.2.2.8 Disturbance from Marine Vessel Traffic

Similar to that described in Section 3.2.1.9, disturbance from marine vessels can cause short-term behavioral reactions. Marine traffic from commercial fishing vessels, particularly actively fishing vessels, is a potential source of disturbance to NFSs (NMFS 2006b). This type of disturbance is limited off the Pribilof Islands because the Pribilof Islands Area Habitat Conservation Zone prohibits trawling in waters surrounding the Pribilof, St. Matthew, and St. Lawrence islands. Fuel barges, floating fish processors vessels, and container vessels can contribute to underwater noise. The level of disturbance caused by underwater noise is largely unknown. Other marine vessels that could potentially disturb NFSs on the Pribilof Islands include those vessels traveling to and from the harbors and fish processing plants. Evidence suggests that NFSs are more tolerant to this type of general vessel traffic (NMFS 2006b).

3.2.2.9 Traditional Knowledge

Sections 3.2.1.10 provided additional background on traditional knowledge. Coastal Alaska Natives have a long history of living closely with the marine resources of the Bering Sea and GOA. Their knowledge has been passed from generation to generation within Alaska Native communities, but has traditionally not been integrated with western science. As an attempt to bridge this gap, the Bering Sea Coalition and the Whirling Rainbow Center held the first International Indigenous People's Summit Conference on the Bering Sea, March 16 through 20, 1999, entitled "Wisdom Keeper's of the North: Vision, Healing, and Stewardship for the Bering Sea" (Bering Sea Coalition 1999).

At this meeting, many observations regarding environmental changes were made by Alaska Natives and others on the state of the Bering Sea ecosystem. In summary, Alaska Natives have identified the presence of natural and anthropogenic stressors on the marine environment and the effects of those stressors. The stressors include increased sea temperature, pollution, and overfishing. The effects include changes in sea ice thickness, declining or changing fish and animal populations, increases in fish parasites, contaminated fish and animal meat, and decreased quality of subsistence resources. Each of these observations directly or indirectly relates to NFSs and integration of this knowledge with western science may provide a better understanding of the declining NFS population. Additional examples of traditional knowledge of NFSs and their environment can be found in Merrill (1999), Vining (1995), and Vining (1998).

3.2.2.10 Past Research

Past research has been driven by priorities identified in the 1993 Conservation Plan, which included the following topics:

- Monitoring status and trend of NFSs;
- Monitoring health, condition, and vital parameters;
- Assessing and evaluating causes of mortality;
- Assessing and minimizing the effect of disturbance on NFSs;
- Investigating feeding ecology and factors affecting energetic requirements;
- Investigating relationships between NFSs, fisheries, and fish resources;
- Identifying natural ecosystem changes; and
- Coordinating conservation efforts with other agencies and countries.

<u>Research Overview</u>

Each year the NMML publishes *Fur Seal Investigations*, which annually report the results of NMML's research on NFSs. Research on NFSs has been conducted since at least 1909 when adult male NFSs were counted on the Pribilof Islands. Population surveys have continued annually since that time. One of the most accurate methods to monitor population trends is to observe and count pup production. Researchers monitor pup production by marking and recapturing the pups. NMML estimates Pribilof Islands pup production biennially.

Tissues and teeth collected from dead NFSs, either from natural death or death by subsistence harvests, are used to determine age-specific mortality and other health indicators. The mass and length, as well as the sex of pups born on the Pribilof Islands has been recorded for many years, which also helps determine basic life history and health. In addition, NMML and other researchers have studied the feeding ecology of female NFSs. This research has been carried out by examining NFSs in captivity, as well as scat and regurgitations of animals in the wild.

Research has also been conducted on the frequency of occurrence and effects of human-caused disturbance, harassment, and displacement of NFSs. These studies examined the effects of roads and flight corridors near the NFS breeding and resting areas on the Pribilof Islands. NMML has collected and archived NFS tissue for analysis of chemical contamination and implications on the NFS population and subsistence use of contaminated seals. Migration preferences of NFSs have also been researched and indicate that patterns in migration and natal site fidelity are related to age, sexual maturity, and season. Coordination of NFS research is briefly discussed in Section 3.2.1.12 of this document.

3.2.2.11 Co-Management Agreements

NMFS entered into co-management agreements with the tribal governments of St. Paul Island in 2000 (Appendix G) and the tribal government of St. George Island in 2001 (Appendix G). These agreements provided for shared responsibilities over subsistence harvests of NFSs and SSLs on the Pribilof Islands, with a combined purpose of recovering and maintaining the NFS and SSL populations for a sustainable subsistence take in the region. The tribal governments have expressed interest in a more comprehensive cooperative management regime for the NFS, which would include shared responsibility for setting harvest limits, research, and addressing conservation issues such as habitat protection and the effects of commercial fishing on this stock. Under each of the agreements a co-management committee reviews, among other things, the manner in which the subsistence harvest is executed and managed, and regulations governing the subsistence harvest of NFSs.

In conjunction with the implementation of the co-management plans, NMFS has worked with and obtained valuable input from both Tribal Governments on the Pribilof Islands in preparation of the 2006 Draft Conservation Plan for the eastern Pacific stock of NFS (NMFS 2006b).

3.2.2.12 1993 Conservation Plan

As required by the MMPA for depleted stocks, NMFS developed and published a conservation plan for NFS in 1993 (NMFS 1993). This conservation plan included information on the status of NFSs on the Pribilof Islands, causes of declines, threats to the species, critical information gaps, and recommended research and management actions for meeting the objectives of the plan.

The overall goal of the 1993 Conservation Plan was to promote recovery of the NFS population on the Pribilof Islands to a level appropriate to justify removal from the MMPA depleted listing, and towards this end take actions to promote the recovery of the NFS. Immediate objectives of the conservation plan were to 1) identify factors that might be limiting the population, and 2) to propose a set of actions that will minimize any human-induced activities that may be detrimental to the population.

3.2.2.13 2006 Draft Conservation Plan

The 2006 Draft Conservation Plan (NMFS 2006b) for the eastern Pacific stock of NFS was published as a revision to the 1993 Conservation Plan. This revision takes into account the reclassification of the eastern Pacific stock of NFS to include the Pribilof Islands and Bogoslof Island, but not San Miguel Island. This revision incorporates changes in management structure, including the co-management agreements with the Pribilof Islands Native communities for marine mammal species used for subsistence. It also includes interpretation of new information, identification of important research priorities, and recommendations for continued management of human activities that are thought to affect the eastern Pacific stock of NFSs.

The 2006 Draft Conservation Plan reviews and assesses the known and possible factors influencing NFSs in Alaska and contains pertinent information on NFSs breeding in California and Russia. Natural factors influencing the population include predation, parasitism, disease, and environmental change. Human-related factors influencing the population include subsistence harvests, direct and indirect effects of commercial fishing, marine debris, poaching, pollution, vessel and aircraft traffic, tourism, coastal development, noise, research activities, and oil and gas activities.

Consistent with the 1993 Conservation Plan, the goal of the 2006 Draft Conservation Plan is to recover the eastern Pacific stock to a level such that it is no longer designated as depleted. The 2006 Draft Conservation Plan builds on the two main objectives of the 1993 plan and proposes two additional objectives aimed at restoring and maintaining the eastern Pacific stock to its Optimum Sustainable Population (OSP) level (180,000 animals). The four objectives include 1) identify and eliminate or mitigate the cause or causes of human-related mortality of NFSs; 2) assess and avoid or mitigate adverse effects of human-related activities on or near the Pribilof Islands and other habitat essential to the survival and recovery of NFS; 3) continue and, as necessary, expand research or management programs to monitor trends and detect natural or human-related causes of change in the NFS population and habitats essential to its survival and recovery; and 4) coordinate and assess the implementation of the 2006 Draft Conservation Plan, based on implementation of conservation actions and completion of high priority studies.

Enhancing participation by Alaska Natives and other interested stakeholders is a cost-effective means to facilitate the long-term continuity of some research programs. Pribilof Islands residents have a long history of interactions with NFSs. Pribilovians have and will continue their involvement in many aspects of NFS conservation, subsistence harvest, management, and research.

NMFS intends to implement the following conservation actions based on the current understanding of NFS ecology. As new data are collected, analyzed, integrated, and interpreted, conservation measures and subsequent actions will change.

- Improve understanding of sources, fates, and effects of marine debris;
- Improve assessments of incidental take of fur seals in commercial fishing operations;
- Evaluate harvests and harvest practices;
- Work with the Tribal Governments under co-management agreements;
- Advise and consult with the relevant action agencies and industries;
- Review and make recommendations on proposed activities and actions that have the potential for adversely affecting NFSs;
- Conduct studies to quantify effects of human activities at or near breeding and resting areas;
- Undertake conservation or management measures as necessary to eliminate or minimize deleterious impacts to NFS;
- Assess and monitor pollutants;
- Quantify relationships between NFS, fisheries, and fish resources;
- Monitor and study changes in NFS population;
- Improve assessment of the effects of disease;
- Describe and monitor essential NFS habitats;
- Identify and evaluate natural ecosystem changes;
- Establish a conservation plan coordinator position;
- Develop and implement education and outreach programs;
- Develop and promote international conservation efforts; and
- Enforce existing regulations.

3.2.2.14 Current Research Priorities

The 2006 Draft Conservation Plan identified actions needed to achieve recovery of the depleted eastern Pacific stock, including the following field research components:

- Monitor and manage subsistence harvest;
- Identify and evaluate illegal harvests;
- Conduct basic studies on fur seal feeding ecology;
- Determine impact of fisheries;
- Monitor male and pup abundance at Pribilof Islands;
- Estimate pup survival;
- Evaluate marking and resighting program;
- Study vital rates;
- Conduct behavioral/physiological studies;
- Conduct comparative studies between Pribilof animals and other islands;
- Conduct oceanographic and fishery surveys in relation to essential fur seal habitat; and
- Reevaluate carrying capacity.

The Pribilof Islands Collaborative (PIC), together with scientists from the Alaska Fisheries Science Center (AFSC), NMML, and various universities, identified key data gaps in NFS research and agreed on the eight research priorities to help understand the decline of NFSs. PIC believes the following research priorities, if addressed in a coordinated fashion, would help identify the causes of the declining NFS population, thereby providing the basis for more effective planning, management, and remediation:

- Determine age-specific reproduction and survival rates across all age classes.
- Study foraging behavior, diet preferences, and nutritional requirements for all age classes and throughout the entire year.
- Evaluate late-season pup condition on the Pribilof Islands, just prior to their departure for sea.
- Determine the location and magnitude of predation, particularly by killer whales.
- Determine whether or not current system comparisons can act as natural experiments to distinguish among alternative hypotheses and help lay the groundwork for the possible future use of directed adaptive management experiments.
- Continue monitoring of mortality rates due to entanglement in marine debris.
- Evaluate the relationships between shifts in ocean climate and the NFS decline.
- Conduct investigations into which adaptive or experimental management approaches and designs would be most appropriate.

3.2.3 Killer Whales

Killer whales (*Orcinus orca*) are the ocean’s top predator and can live up to 80 years, reaching a length of about 27 feet, and weighing up to 10 tons (Zimmerman 1994). These whales begin breeding around the age of 15, and calve every three to 10 years until the age of 40. Calving can occur during all months of the year, with increasing frequency during the winter months. Physical characteristics of the killer whale include contrasting black and white pigmentation, and a prominent dorsal fin. Killer whales are found in all oceans and seas of the world, but prefer the colder waters of both hemispheres. Along the west coast of North America, killer whales occur seasonally as well as year-round along the entire Alaskan coast (Braham and Dahlheim 1982), in British

Columbia and Washington inland waterways (Bigg *et al.* 1990), and along the outer coasts of Washington, Oregon, and California (Green *et al.* 1992; Barlow 1995 and 1997; Forney *et al.* 1995; Angliss 2005).

Killer whales are known to form stable social groups called pods, which usually consist of less than 40 individuals. Researchers often label pods as "resident," "transient," and "offshore" to describe the whales' patterns of occurrence (Bigg *et al.* 1990; Ford *et al.* 2000; Angliss 2005). These three very distinct types of whales can also be distinguished from one another based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird *et al.* 1992; Hoelzel *et al.* 1998 and 2002; Barrett-Lennard 2000; Heise 2003). Eight killer whale stocks are recognized within the Pacific U.S. Exclusive Economic Zone (EEZ) is provided below. Range and abundance information has been gathered from the 2003 and 2004 U.S. Pacific Marine Mammal Stock Assessments (Carretta *et al.* 2004 and 2005) and the 2005 Alaska Marine Mammal Stock Assessments (Angliss and Outlaw 2005).

- **Alaska Resident stock** occurs from southeastern Alaska to the AI and Bering Sea. The estimated population of Alaska resident whales is 1,123 animals.
- **Northern Resident stock** occurs between British Columbia and part of southeastern Alaska. The population of this resident stock is estimated at 216 whales.
- **Southern Resident stock** occurs mainly in the inland waters of Washington state and southern British Columbia, but is also found in coastal waters between British Columbia and California. The population of this resident stock is estimated at 84 whales. This resident stock is designated as "endangered" under the ESA.
- **GOA, AI, and Bering Sea Transient stock** (GOA transient stock) occurs mainly from Prince William Sound through the AI and Bering Sea. The minimum population is estimate 314 whales.
- **AT1 Transient stock** occurs in Alaska between Prince William Sound and Kenai Fjords. The estimated population of the AT1 stock is eight whales. This stock was designated as "depleted" under the MMPA but is not listed as "threatened" or "endangered" under the ESA.
- **West Coast Transient stock** occurs between California and southeastern Alaska and includes whales observed in Canadian waters. The minimum population estimate for west coast transient whales is 314 animals.
- **Offshore stock** occurs off the coasts from California through Washington, and rarely in southeast Alaska. The minimum population estimate for offshore whales is 361 animals.
- **Hawaiian stock** occurs off the Hawaiian Islands. The estimated population of the Hawaiian stock is from 250 to 430 whales.

Transient killer whales on the other hand, have been known to prey on various species of marine mammals, including SSLs, grey whale, minke whale, NFSs, harbor seals, and sea otters. This predation has been documented throughout Alaska and British Columbia via surface observations (NMFS 2004b; NMFS 2004b), the collection of prey fragments at kill sites, and the examination of stomach contents of killer whale carcasses (Barrett-Lennard *et al.* 1995; Saulitis *et al.* 2000; Heise *et al.* 2003; NMFS 2005c). Resident and offshore killer whales on the other hand, feed on fish and tend to avoid contact with other marine mammals.

Researchers have suggested that predation of SSLs by transient killer whales could have played a significant role in the decline of the SSL population (Barrett-Lennard *et al.* 1995; Springer *et al.* 2003; Williams *et al.* 2004). Over the past 50 years the diet of the transient killer whale may have shifted from great whales, which became scarce after intensive whaling in the early 1900s, to other marine mammals. The need to change foraging behavior combined with the caloric intake of killer whales have led scientists to hypothesize that transient killer whales could decimate an SSL population (Springer *et al.* 2003; Williams *et al.* 2004). Conversely, documented observations of kills indicate that the diet of the transient killer whale primarily consists of harbor seals (Jefferson *et al.* 1991; Baird 1994), with only about 9 percent (observed) to 12 percent (modeled) of the kills being sea lions

(California and Steller) (Ford *et al.* 1998; Matkin *et al.* 2001). Of the SSLs consumed by transient killer whales, pups and young adults are more likely to be preyed upon due to the greater size and aggressiveness of adult SSLs. Heise *et al.* (2003) documented 32 lethal killer whale/SSL interactions in British Columbia and Alaska, and the majority involved young adult SSLs off the AI. Because research on transient killer whale predation of pinnipeds other than SSLs show that pups are more often consumed than adults, Heise *et al.* (2003) suggests that a higher percentage of SSL pups are killed than is documented.

3.2.4 Other ESA-listed Species

A discussion of federally designated threatened and endangered terrestrial and marine mammals that could occur in the project area is provided below. Other federally designated species may occur in the project area, but whether or not these species are relevant to SSL and NFS research activities will be determined by further Section 7 consultation for the Final EIS. If necessary, this section will be updated to include other relevant ESA listed species following this consultation.

San Miguel Island Fox

The San Miguel Island fox (*Urocyon littoralis littoralis)* is present on San Miguel Island, California, an important breeding ground for NFSs. The San Miguel Island fox is the largest native carnivore on San Miguel Island, which feeds primarily on deer mice and insects. Between 1994 and 1999, annual population monitoring documented a decrease in San Miguel Island foxes from 450 to 15 adults (Coonan et al. 1998). This marked decline in the population was a result of predation by golden eagles and disease from domestic dogs. The USFWS listed the San Miguel Island fox as an endangered species in 2004 (69 FR 10335). A captive propagation program initiated in 1999, has successfully bred and released foxes in order to aid species recovery (Coonan et al. 2005). Relocation of golden eagles from the island to the mainland is also expected to aid recovery of the fox.

Sea Otter

The USFWS, under MMPA guidelines, recognizes five stocks of sea otters in U.S. waters, including the southeast Alaska, southcentral Alaska, southwest Alaska, and Washington stocks (*Enhydra lutris* kenyoni), and the California (or southern) stock (*Enhydra lutris nereis*). Of these sea otter stocks, the southwest Alaska and California stocks are listed as threatened under the ESA. The other three sea otter stocks are not formally designated under the ESA, however, the Washington stock is legally designated as endangered by the State of Washington (Lance et al. 2004). In general, sea otters occur in nearshore coastal waters of the U.S. along the North Pacific Rim from the AI to California. The southwest Alaska stock includes Alaska Peninsula and Bristol Bay coasts, the Aleutian, Barren, Kodiak, and Pribilof Islands; and the California stock ranges along the mainland coast in California, from Santa Cruz County to Santa Barbara County. Sea otters are keystone species in nearshore kelp beds, where they feed on and maintain populations of sea urchins, crabs, sea cucumbers, clams, mussels, abalone, and other shellfish. The primary causes of sea otter decline are the historical commercial harvest of the 1700s and 1800s, oil and gas development, commercial fisheries, subsistence harvest, contaminants, habitat destruction, and disease.

Guadalupe Fur Seal

The Guadalupe fur seal (*Arctocephalus townsendi*) is generally found off the coast of Baja California, Mexico, but individuals can be seen in California's Channel Islands and as far north as the Point Reyes National Seashore, California. Commercial sealing during the 1700s and early 1800s severely depleted the population and resulted in their extinction from California waters. Guadalupe fur seal are now fully protected by Mexican national legislation, the U.S. ESA, and the U.S. MMPA. The Guadalupe fur seal is recovering from exploitation, and in 1993 the population was estimated at about 7,408 animals (Forney et al. 2000). Recent impacts on the Guadalupe fur seal include entanglement in drift and set gillnets and El Nino events.

Great Whales

Seven great whales known to occur in the project area are currently listed as "endangered" under the ESA as a result of heavy exploitation by commercial whalers during the 1900s. Other human influences such as ship strikes and net entanglements continue to deplete the current whale stocks, and environmental changes such as shifting predators and prey threaten the future of the whale species. In order to promote the recovery of these whale species, NMFS has published or is currently developing the required recovery plans that identify protection measures and actions to monitor the species. The ESA-listed species of great whales in the project area are listed in Table 3.2-7.

Table 3.2-7
ESA-Listed Great Whale Species in the Project Area

Common Name	Scientific Name	Area of Distribution
Humpback whale	*Megaptera novaeangliae*	Western Central, North Pacific
Blue whale	*Balaenoptera musculus*	North Pacific
Bowhead	*Balaena mysticetus*	Western Arctic
Fin whale	*Balaenoptera physalus*	Northeast Pacific
Right whale	*Eubalaena japonica*	North Pacific
Sei whale	*Balaenoptera borealis*	North Pacific
Sperm whale	*Physeter macrocephalus*	North Pacific

Source: Adapted from the International Whaling Commission web site and NMFS Office of Protected Resources web site accessed November 2006.

The primary prey of ESA-listed great whales consists of krill, copepods, and schooling fish. Because these whales and SSLs and NFSs are known to prey on similar species of fish, some competition for food resources may exist. Further depletion or extinction of these whales could indirectly affect SSLs and NFSs via cascading effects throughout the marine food webs. Brief descriptions of the current distribution and abundance of these whales within the project area are provided in Sections 3.2.4.1 through 3.2.4.7. Additional information on whale biology and life history can be found at the International Whaling Commission (IWC) website: http://www.iwcoffice.org/conservation/lives.htm, the NMFS Office of Protected Resources website: http://www.nmfs.noaa.gov/pf/species/esa.htm, and in the 2005 Pacific Coast Groundfish Essential Fish Habitat EIS (Carretta 2005).

3.2.4.1 Humpback Whale

At least three relatively separate populations of humpback whales are recognized in the U.S. EEZ and occur within the project area: the eastern North Pacific stock, the central North Pacific stock and the western North Pacific stock. The eastern North Pacific stock is found in coastal Central America and Mexico during the winter and spring and along the coast between California and southern British Columbia during the summer and fall months (Angliss 2005). The central North Pacific stock spends the winter and spring in the Hawaiian Islands, then migrates to northern British Columbia/southeast Alaska and the GOA to feed during the summer and fall (Angliss 2005). The western North Pacific stock is found in Japan during the winter and spring, and then probably migrates to waters of the Bering Sea and AI where they spend the summer/fall (Angliss 2005).

The abundance for the central North Pacific humpback whale stock was estimated at 4,005 animals (Calambokidis *et al.* 1997) and for the western North Pacific humpback whale stock was estimated at 394 animals (Calambokidis *et al.* 1997; Carretta 2005). Recent population estimates for the eastern North Pacific stock include 1,034 humpbacks in the feeding areas off the coasts of California, Oregon, and Washington (Calambokidis *et al.* 2003; NMFS 2004).

3.2.4.2 Blue Whale

The blue whale is the largest animal ever known to have lived on Earth. The IWC recognizes only one stock of blue whales in the North Pacific (eastern North Pacific stock), but some evidence suggests that there may be as many as five separate stocks (NMFS 2006a). Blue whales feed in California waters during the summer/fall and migrate south to productive areas off Mexico during the winter/spring. Blue whales are occasionally seen or heard off Oregon, but sightings are rare (Carretta 2005). Recent stock estimates include 1,744 blue whales in waters off California (NMFS 2004).

3.2.4.3 Bowhead Whale

The IWC recognizes five stocks of bowhead whales. The western Arctic stock is the only stock found in U.S. waters and is widely distributed in the central and western Bering Sea in winter (October/November-April). Bowhead whales are generally associated with the marginal ice front. From April through June, the whales follow leads in the ice and migrate north to the Beaufort Sea, where they remain until September when they begin their return to the Bering Sea (NMFS 2004).

From 1978 to 1993, counts of bowheads have indicated that the western Arctic stock increased from approximately 5,000 to 8,000 whales, a rate of 3.1 percent (Raftery *et al.* 1995). In 1993, the bowhead whale population was estimated to be 8,200 animals (IWC 1997). The 2001 spring census yielded data indicating a population of about 9,860 animals (IWC 2003; Angliss 2001).

3.2.4.4 Fin Whale

Fin whales are divided into three stocks for management purposes: the Northeast Pacific (Alaska) stock, the California/Oregon/Washington stock, and the Hawaii stock. The Northeast Pacific stock of fin whales ranges throughout the Bering Sea, AI, and GOA (NMFS 2004; Angliss 2005). The California/Oregon/Washington stock is found inside and outside of coastal waters along these three states.

Current abundance of fin whales in the Northeast Pacific is not available, but visual surveys in 1999 and 2000 yielded a regional estimate of abundance of 4,051 fin whales for the central-eastern and the southeastern Bering Sea areas (Moore *et al.* 2001; Angliss 2005). A rough estimate of the size of the population west of the Kenai Peninsula (western GOA) yielded a minimum estimate of 5,703 individuals (Carretta 2005). From 1996 and 2001 surveys, fin whales off the coasts of California/Oregon/Washington were estimated at 3,279 individuals (Barrow and Taylor 2001; Barlow 2003; NMFS 2004).

3.2.4.5 Right Whale

As determined from recent genetic analysis, two genetically different stocks of northern right whale are present in the waters off North America, including one stock in the North Atlantic and another in the North Pacific (Rosenbaum *et al.* 2000; Angliss 2005). Although both stocks of right whales are officially considered northern right whales (*Eubalaena glacialis*) under the ESA, right whales in the North Pacific are often referred to as *Eubalaena japonica*. Along the Pacific coast, sightings of the North Pacific right whales have been reported from Baja California in the south, Hawaii in the west, and the Bering Sea and Sea of Okhotsk in the north. Currently, there is no reliable estimate for the North Pacific right whale stock (Carretta 2005).

North Pacific right whales prefer coastal and shelf waters where they feed on copepods and krill. While little is known of their migratory pattern, their general distribution follows the distribution of their prey. In July 2006, NMFS published a final rule designating critical habitat for the northern right whale in the GOA and the southeastern Bering Sea, which comprises approximately 95,200 square kilometers of marine habitat (71 FR 38277).

3.2.4.6 Sei Whale

The IWC recognizes only one stock of Sei whales in the North Pacific (the eastern North Pacific stock) for management purposes, although there is evidence that more than one stock exists (Carretta 2005). Sei whales are distributed in temperate waters in all oceans, and are not usually associated with coastal features (NMFS 2004). In the North Pacific Ocean, the summer range extends from southern California to the GOA and across the North Pacific south of the AI, extending into the Bering Sea in the deep southwestern Aleutian Basin (Gambell 1985; Rice 1998; Carretta 2005). Based on surveys from 1996 and 2001, the abundance estimate for Sei whales in California, Oregon, and Washington waters is 56 whales (Angliss 2005).

3.2.4.7 Sperm Whale

The sperm whale is one of the most widely distributed of any marine mammal species, found in pelagic waters as far north as the Bering Sea (Leatherwood *et al.* 1982). For management purposes, the IWC has divided sperm whales in the North Pacific into eastern and western stocks. The western North Pacific stock is found near Japan. The eastern stock of North Pacific sperm whales has been further divided into three separate stocks as dictated by the U.S. waters in which they are found: California/Oregon/Washington, Alaska (North Pacific stock), and Hawaii (Carretta 2005).

The most recent population abundance estimate for sperm whales from 1996 and 2001 summer/fall ship surveys off California, Oregon and Washington is approximately 1,233 whales (Angliss 2005). The number of sperm whales occurring within Alaskan waters is unknown (Carretta 2005).

3.2.5 Other Marine Mammals (Cetaceans and Pinnipeds)

All species of marine mammals, including those listed under the ESA, are protected under the MMPA of 1972 as amended (16 U.S.C 1361-1421h). The MMPA places responsibility for conservation of marine mammals on two agencies: the Department of Commerce for cetaceans and pinnipeds other than walrus and the Department of the Interior for all other marine mammals, including walrus and Alaska polar bear. Discussion of sea otters can be found in Section 3.2.4. The MMPA provides protection to marine mammals so that they may attain an OSP within the carrying capacity of the habitat. The marine mammals that may share habitat range and food resources within the project area are presented in Table 3.2-8. Information regarding species abundance can be found in the U.S. Pacific Marine Mammal Stock Assessments (Angliss 2005) and Alaska Marine Mammal Stock Assessments (NMFS 2005c). General life history information can be found in the Pacific Coast Groundfish Essential Fish Habitat Final EIS (Lowry 1992). A discussion of the California sea lion and its relationship to SSLs is provided below.

3.2.5.1 California Sea Lion

The California sea lion is of particular importance because it has been used as a surrogate species for SSLs in the past for testing new instrumentation devices and procedures. The California sea lion includes three subspecies: *Zalophus californianus wollebaeki* (on the Galapagos Islands), *Z. c. japonicus* (in Japan, but now thought to be extinct), and *Z. c. californianus* (found from southern Mexico to southwestern Canada; herein referred to as the California sea lion). The breeding areas of the California sea lion are on islands located in southern California, western Baja California, and the Gulf of California. These three geographic regions are used to separate this subspecies into three stocks: (1) the U.S. stock begins at the U.S./Mexico border and extends northward into Canada; (2) the western Baja California stock extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock which includes the Gulf of California from the southern tip of the Baja California peninsula and across to the mainland and extends to southern Mexico (NMFS 2005c). Population trends indicate that counts of pups increased at an annual rate of 5.4 percent between 1975 and 2001.

Table 3.2-8
Summary of Other (Non-ESA) Marine Mammal Species in the Project Area and the Area of distribution

Common Name	Scientific Name	Area of Distribution (reduced to that which coincides with the project area)
Cetaceans		
Gray whale	*Eschrichtius robustus*	North Pacific: Two isolated geographic distributions, eastern and western
Minke whale	*Balaenoptera acutorostrata*	North Pacific: From the Bering and Chukchi Seas south to near the Equator
Beluga whale	*Delphinapterus leucas*	North Pacific: Beaufort Sea, eastern Chukchi Sea, EBS, Bristol Bay, Cook Inlet
Dall's porpoise	*Phocoenoides dalli*	North Pacific: over continental shelf, adjacent to the slope, and over deep oceanic waters. As far as 65ºN and 28ºN
Harbor porpoise	*Phocoena phocoena*	North Pacific: from Point Barrow to Point Conception, California
Pacific white-side dolphin	*Lagenorhynchus obliquidens*	Eastern North Pacific: from the southern Gulf of California, north to GOA, west to Amchitka in the AI; rare in southern Bering Sea
Baird's beaked whale	*Berardius bairdii*	North Pacific and adjacent seas (Bering, Okhotsk, Japan, and Cortez)
Cuvier's beaked whale	*Zihius cavivostris*	North Pacific: from Alaska (excluding high polar waters) to Baja California
Bottlenose dolphin	*Tursiops truncatus*	Pacific Ocean: From coasts of Hawaii to California
Risso's dolphin	*Grampus griseus*	Pacific Ocean: From GOA to California
Striped dolphin	*Stenella coeruleoalba*	Pacific Ocean: California to Washington; around Hawaii
Long-beaked common dolphin	*Delphinus capensis*	Pacific Ocean: Baja Peninsula
Short-beaked common dolphin	*Delphinus delphis*	Pacific Ocean: north to Washington, south to Baja California, Mexico, and west to Hawaii
Short finned pilot whale	*Globicephala macrophynchus*	Pacific Ocean: north to Washington, south to Baja California, Mexico
Pygmy sperm whale	*Kogia breviceps*	Pacific Ocean: north to Washington, south to Baja California, Mexico
Dwarf sperm whale	*Kogia sima*	Pacific Ocean
Stejneger's beaked whale	*Mesoplodon stejnegeri*	North Pacific, Sea of Japan, and deep waters of southwest Bering Sea
Pinnipeds		
California sea lion	*Zalophus californianus*	North Pacific: from southwestern Canada to southern California
Pacific harbor seal	*Phoca vitulina*	North Pacific: From Baja California, Mexico to Pribilof Islands in Alaska
Pacific walrus	*Odobenus rosmarus*	North Pacific: Bering Sea and Adjacent Arctic Ocean
Spotted seal	*Phoca largha*	Beaufort, Chukchi, Bering, and Okhotsk seas
Bearded seal	*Erignathus barbatus*	Bering, Chukchi, and Beaufort seas
Ringed seal	*Phoca hispida*	Southern Bering Sea
Ribbon seal	*Phoca fasciata*	North Pacific: From Bristol Bay in Bering Sea to Chukchi and western Beaufort seas
Northern elephant seal	*Mirounga angusirostris*	North Pacific: From AI in Alaska to Baja California, Mexico
Sea otter	*Enhydra lutris*	North Pacific: From AI in Alaska to Baja California, Mexico

Source: NMFS Protected Resources Division website: http://fakr.noaa.gov/protectedresources/esakspecies.pdf

California sea lions are not listed as “endangered” or “threatened” under the ESA or as “depleted” under the MMPA. They are not considered a “strategic” stock under the MMPA.

3.2.6 Fish

3.2.6.1 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) was reauthorized and amended by the Sustainable Fisheries Act (1996), and requires the existing eight regional fishery management councils to describe and identify essential fish habitat (EFH) in their respective regions, and to specify actions to conserve, enhance, and minimize adverse effects of fishing on EFH. Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity". The Magnuson-Stevens Act requires NMFS to assist the regional fishery management councils in the implementation of EFH in their respective fishery management plans (FMPs).

For the purposes of this EIS, marine EFH encompasses all estuarine and marine areas used by marine species, including tidewater and tidally submerged habitats from Alaska to Washington, Oregon, and California, excluding Canadian waters. The project area includes all state waters and the 200 nm offshore U.S. EEZ. In Alaska, the NPFMC has prepared and implemented five FMPs for Alaskan fisheries that encompass regional fisheries for certain species. The five FMPs for Alaska are: 1) Bering Sea/AI groundfish FMP, 2) GOA groundfish FMP, 3) Bering Sea/AI King and Tanner Crab FMP, 4) Alaska Scallop FMP, and 5) Salmon Fisheries FMP. All five FMPs are applicable to this project based on project location and identification of applicable EFH.

The Final Environmental Impact Statement (FEIS) for EFH Identification and Conservation in Alaska (Marsh 2005) and several other environmental reports describe the EFH baseline for this EIS. The EFH FEIS provides a comprehensive evaluation of marine habitats for fish, invertebrates, and marine mammal species present in the project area. Other detailed descriptions of EFH within the project area are available from NMFS sponsored documents and Pacific FMPs.

Alaska’s immense size provides EFH from two major offshore marine ecosystems, the GOA and the EBS. Designated marine EFH species present in these waters are listed in Table 3.2-9.

All five species of Pacific salmon are also present in the project area: pink (*Oncorhynchus gorbuscha*), coho (*O. kisutch*), chum (*O. keta*), sockeye (*O. nerka*), and Chinook (*O. tshawytscha*). All life stages of the species listed in Table 3.2-9 occur in the project area.

The population decline of SSLs coincided with the rapid growth of the groundfish fisheries in Alaska, and the reduction of other Alaskan pinniped species, including harbor seals (Pitcher 1990) and NFSs (Trites 1991a). Major prey species for these marine mammals include a variety of schooling fishes such as Walleye pollock, Atka mackerel, Pacific cod. Other fish such as capelin, Pacific sand lance, rockfish, Pacific herring, salmon, and cephalopods (octopus) are also part of the SSL diet (NOAA 2005c). Many of these fish species are also harvested in the Alaska groundfish fisheries.

Walleye pollock is an EFH species, one of the largest single-species fisheries in the world (Calkins 1988), and make up over 50 percent of the prey consumed by SSLs (Marsh 2005). A member of the cod family, Walleye pollock occurs in dense schools throughout the year. In the Bering Sea, pollock is the most abundant groundfish, with current biomass levels above the biomass at which maximum sustainable yield (MSY) is produced. The Bering Sea stock is considered healthy, but concerns exist about the level and trend of the GOA stock. The GOA stock is slightly above the biomass at which MSY is produced and has steadily declined since the 1980s until only recently (Kajimura 1984).

Table 3.2-9
Alaska Groundfish and Shellfish Species Found in the GOA and the EBS EFH Marine Ecosystem

Common Name	Scientific Name	Common Name	Scientific Name
Walleye pollock	*Theragra chalcogramma*	Sablefish (black cod)	*Anoplopoma fimbria*
Pacific cod	*Gadus macrocephalus*	Pacific halibut	*Hippoglossus stenolepis*
Yellowfin sole	*Pleuronectes asper*	Greenland halibut	*Reinhardtius hippoglossoides*
Arrowtooth flounder	*Atheresthes stomias*	Atka mackerel	*Pleurogrammus monopterygius*
Rock sole	*Pleuronectes bilineatus*	Alaska plaice	*Pleuronectes quadrituberculatus*
Flathead sole	*Hippoglossoides elassodon*	Butter sole	*Pleuronectes isolepis*
Rex sole	*Errex zachirus*	Dover sole	*Microstomus pacificus*
Longhead dab	*Pleuronectes proboscideus*	Rockfishes Pacific ocean perch	*Sebastes alutus*
Starry flounder	*Platichthys stellatus*	Roughey rockfish	*Sebastes aleutianus*
Thornyhead rockfish	*Sebastolobus spp.*	Northern rockfish	*Sebastes polyspinis*
Dusky rockfish	*Sebastes ciliatus*	Shortraker rockfish	*Sebastolobus borealis*
Shortspine thornyhead	*Sebastolobus alascanus*	Sharpchin rockfish	*Sebastes zacentrus*
Darkblotched rockfish	*Sebastes crameri*	Blue rockfish	*Sebastes mystinus*
Yelloweye rockfish	*Sebastes ruberrimus*	Skates	*Raja spp.*
Others Rattail	*Coryphaenoides spp.*	Octopus	*Octopoda*
Squids	*Sepioidea and Teuthoidea*	Blue king crab	*Paralithodes platypus*
Red king crab	*Paralithodes camtschatica*	Tanner (snow) crab	*Chionoecetes bairdi, C. opilio*
Golden (brown) king crab	*Lithodes aequispina*	Abalone	*Haliotis spp.*
Sea Snails	*Neptunea pribiloffensis, N. heros, N. lyrata, N. ventricosa, Fusitriton oregonensis, Buccinum angulossum, B. plectrum, B. scalariforme, B. polare, Volutopsius middindorffii, V. fragilis, Plicifusus kroyeri, Pyrulofusus deformis*	California sea cucumber	*Parastichopus californicus*
Shrimp	*Penaeus spp.*	Pacific weathervane scallop	*Patinopecten caurinus*
Sea urchins	*Diadema spp.*		
Source: Compiled by NMML			

3.2.6.2 Commercially Harvested Species

Dozens of commercially harvested fish species may occur within the project area including Walleye pollock, Pacific cod, Atka mackerel, herring, Pacific halibut, flatfish, rockfish, sablefish, Pacific salmon, highly migratory species (e.g., tuna, shark, and billfish/swordfish), and skate. Of these species, walleye pollock, Atka mackerel, Pacific herring, Pacific cod, and Pacific salmon are important prey of SSLs and NFSs. Because there is an overlap in the species consumed by marine mammals with those targeted by commercial fisheries, direct competition for resources may occur (Calkins and Pitcher 1982; NMFS 2005b; Perez and Bigg 1986; Sinclair *et al.* 1994 and 1996; Sinclair and Zeppelin 2002; Zeppelin *et al.* 2004). Detailed information on life history, trophic interactions, fisheries, and stock assessments for each of the commercially harvested species is provided in the Alaska Groundfish Fisheries Draft PSEIS (NMFS 2001a). The distribution and trophic interactions of the commercially harvested species that are important prey to SSLs and NFSs are summarized below.

Walleye Pollock

Walleye pollock is the most abundant groundfish species in the EBS, where the largest concentrations occur in the southeast, north of Unimak Pass (Kendall *et al.* 1996). It is the second most abundant groundfish stock in the GOA, with the largest spawning concentrations occurring in Shelikof Strait and the Shumagin Islands (Kendall *et al.* 1996).

Pollock is a major prey item for SSLs in the GOA and the Bering Sea (Merrick and Calkins 1995; Pitcher 1980a, 1980b and 1981). In the GOA, pollock is a major prey of both juvenile and adult SSLs. It appears that the proportion of animals consuming pollock increased from the 1970s to the 1980s, and this increase was most pronounced for juvenile SSLs. Sizes of pollock consumed by GOA SSLs range from 5 to 56 cm, and the size composition of pollock consumed appears to be related to the size composition of the pollock population. Juvenile SSLs consume smaller pollock on average than adults. Age one pollock were dominant in the diet of juvenile SSLs in 1985, possibly a reflection of the abundant 1984 year class of pollock available to SSLs in that year.

In the Bering Sea, available data indicate that pollock and Atka mackerel are currently the two dominant prey species of SSLs. Pollock is the principal prey year-round from the Bering Sea to the central AI. In the AI, pollock is replaced by Atka mackerel as the major prey source. Although pollock is a major prey item of SSLs, adult pollock may also be a major competitor with SSLs for prey resources such as forage fish and juvenile pollock. Researchers with the AFSC are currently investigating pollock and SSL interactions as prey competitors to predict how pollock populations affect SSL populations.

Pollock is also a significant prey item for other species of marine mammals in the EBS. Studies suggest that pollock is a primary prey item of NFSs when feeding on the continental shelf during the summer (Sinclair *et al.* 1994 and 1997). The pollock consumed by fur seals are primarily age zero and age one fish. Older age groups of pollock may appear in the diet, particularly when young pollock are less abundant (Sinclair *et al.* 1997).

Atka Mackerel

Atka mackerel is in greatest abundance in the AI. Evidence suggests that the GOA may be at the edge of the species range. It is possible that Atka mackerel only populate the GOA during periods when juvenile recruitment from the AI is strong (Lowe and Fritz 2000).

Marine mammals, mainly NFS and SSL, prey on Atka mackerel (Byrd *et al.* 1992; Livingston *et al.* 1993; Fritz *et al.* 1995; Yang 1996). It is a major prey species for SSLs in the Bering Sea and AI, and is the dominant species from the central AI west. The importance of Atka mackerel in SSL diet declines in winter when the availability of cod and pollock increase.

Pacific Cod

Pacific cod occur on the continental shelf and upper slope from Santa Monica Bay, California, through the GOA, AI, and EBS to Norton Sound (Bakkala 1984). The Bering Sea represents the center of greatest abundance, although Pacific cod are also abundant in the GOA and AI.

Pacific cod is known to be important prey for SSLs year around, becoming more significant during winter months when salmon are less available. Studies of winter diet indicate that Pacific cod have been a top prey item for both the western stock and the eastern stock of SSLs since the 1970s. Other predators of cod include NFSs, harbor porpoises, various whale species, and tufted puffins (Westrheim 1996).

Pacific Herring

Pacific herring is a pelagic species that occurs from California through the GOA and Bering Sea to Japan. Following spawning in the Bering Sea, herring move clockwise along the Alaska Peninsula to feed. They typically reach the Unimak Pass area by mid-summer. In late summer, herring from the Bering Sea move to overwintering areas in the vicinity of the Pribilof Islands (NPFMC 1998). In the GOA, spawning concentrations occur mainly off southeastern Alaska, in Prince William Sound (PWS), around Kodiak Island, and in Cook Inlet. However, little is known about GOA herring overwintering locations.

Evidence suggests that SSLs need fat-rich prey, such as herring, in their diet and may prefer to feed on herring during the winter in the GOA. However, the decline in herring stock over the past 20 years has translated to a potential decline in herring consumption by SSLs and a shift in diet to less fat-rich prey such as pollock. This shift has also been observed with NFSs. Herring are also important food sources for other marine mammals, fishes, and birds.

Pacific Salmon

Five species of Pacific salmon are found in the project area: pink, chum, sockeye, coho, and chinook salmon. These species are anadromous and have life cycle ranges that include coastal streams and river systems from central California to Alaska, and marine waters along the U.S. and Canada. Some of the more critical portions of these ranges are the freshwater spawning grounds and migration routes. Salmon are affected by a wide variety of factors in the ocean and on land, including ocean and climatic conditions, dams, habitat loss, urbanization, agricultural and logging practices, water diversion, and predators. Several wild salmon populations have disappeared from areas along California, Oregon and Washington where they used to flourish, and several evolutionarily significant units (ESUs) have been listed or proposed for listing as at risk for extinction under the ESA (see Section 3.2.6.4).

Salmon are preyed upon by SSLs and NFSs and are also important food sources for other marine mammals, fish, birds, and terrestrial mammals.

3.2.6.3 Forage Fish

In 1999, the NPFMC amended FMPs to include a category for forage fish species. The amendments were developed to protect forage fish resources by controlling fishing harvest and identifying the importance of these species as indicators on the health of the ecosystem. The forage fish categories include a diverse group of fish species with high lipid content. Many of these species are R-selected species (e.g., capelin and sand lance), which generally have higher reproductive rates, shorter life spans, attain sexual maturity at younger ages, and have faster individual growth rates than K-selected species (e.g., rockfish and many flatfish), which are generally long-lived, reach sexual maturity at an older age, and grow slowly.

Forage species are known to exist throughout the project area, from intertidal areas to depths of over 1,000 m (Brodeur *et al.* 1999). These species play a critical role in the transfer of energy between primary producers (plankton) and top predators such as seabirds, larger fish, and marine mammals, including SSLs and NFSs. Forage fish are also harvested by recreational, commercial, and subsistence fisheries. The following forage fish species are recognized and managed by NMFS:

- Eulachon, capelin, and other smelts (Family: *Osmeridae*);
- Lanternfishes (*Myctophidae*);
- Deep-sea smelts (*Bathylagidae*);
- Pacific sand lance (*Ammodytidae*);
- Pacific sandfish (*Trichodontidae*);
- Gunnels (*Pholidae*);
- Pricklebacks, warbonnets, eelblennys, and cockscombs (*Stichaeidae*);
- Shannys (*Stichaeidae*); and
- Bristlemouths, lightfishes, and anglemouths (*Gonostomatidae*).

Forage fish have undergone large, unexplained fluctuations in abundance. Fluctuations in forage fish densities have been implicated as contributing factors in the decline of seabirds, NFSs, and SSLs in the North Pacific (Kultez *et al.* 1997). SSLs and NFSs primarily feed on capelin and other r-selected fish species and have evolved in an ecosystem in which fluctuations and changes in relative abundance of these species have occurred. These marine mammals are generalists that are not dependent on the availability of a single species to sustain them, but instead rely on a suite of species, any one (or more) of which is likely to be abundant each year. However, differences in energy content exist among forage species, with herring, sand lance, and capelin containing higher energy content per unit mass than other species such as juvenile pollock (Payne *et al.* 1999). It is possible that changes in availability of higher energy content forage fish may influence growth and survival of marine mammals reliant on forage species as their main prey.

3.2.6.4 ESA-Listed Pacific Salmon Species

An ESU is defined as a population that 1) is substantially reproductively isolated and 2) represents an important component in the evolutionary legacy of the species (Johnson *et al.* 1994). Currently, there are ESA-listed Pacific salmon ESUs that originate from freshwater habitat in Washington, Oregon, Idaho, and California (see Table 3.2-10). No stocks of Pacific salmon originating from freshwater habitat in Alaska are listed under the ESA. Although, six chinook ESUs, one sockeye ESU, and five steelhead (*O. mykiss*) ESUs can be found in Alaska waters during the marine phase of their life cycle (Trites 2006a). These salmon stocks are mixed with, and not distinguishable from, hundreds to thousands of other non-listed salmon stocks originating from the Columbia and Willamette rivers, British Columbia, Alaska, and Asia.

Populations of Pacific salmon are declining due to anthropogenic and natural factors resulting in degraded water quality, inaccessible or degraded spawning habitat, resource competition, and increased predator populations (NOAA 2005b). Recent studies indicate that predation may significantly influence depleted salmon stocks. The predators of concern for these salmon stocks are piscivorous fish and birds, and marine mammals. While SSLs and NFSs do prey on salmon species, the principal marine mammal species affecting the depleted salmon stocks on the west coast are the increasing populations of Pacific harbor seals and California sea lions.

Table 3.2-10
Summary of the Endangered Species Act Status of Pacific Salmon

Species		ESA Listing Status
Sockeye Salmon *(Oncorhynchus nerka)*	Snake River	Endangered
	Ozette Lake	Threatened
Chinook Salmon *(O. tshawytscha)*	Sacramento River Winter-run	Endangered
	Upper Columbia River Spring-run	Endangered
	Snake River Spring/Summer-run	Threatened
	Snake River Fall-run	Threatened
	Puget Sound	Threatened
	Lower Columbia River	Threatened
	Upper Willamette River	Threatened
	Central Valley Spring-run	Threatened
	California Coastal	Threatened
Coho Salmon *(O. kisutch)*	Central California Coast	Endangered
	Southern Oregon/Northern California	Threatened
	Lower Columbia River	Threatened
Chum Salmon *(O. keta)*	Hood Canal Summer-run	Threatened
	Columbia River	Threatened
Steelhead *(O. mykiss)*	Southern California	Endangered
	Upper Columbia River	Threatened
	Central California Coast	Threatened
	South Central California Coast	Threatened
	Snake River Basin	Threatened
	Lower Columbia River	Threatened
	California Central Valley	Threatened
	Upper Willamette River	Threatened
	Middle Columbia River	Threatened
	Northern California	Threatened
	Puget Sournd	Proposed Threatened
Source: NOAA 2006(d); http:www.nmfs.noaa.gov/pr/species/esa.htm		

3.2.7 Other Marine Species

3.2.7.1 Invertebrates

A variety of invertebrates may be present within the project area including assorted mussels, crustaceans, sponges, squid, octopi, and jellyfish. Squid, octopus, crab, and shrimp are occasional prey of marine mammals and can be found in the Pacific Ocean from southern California to Alaska. Squid (order Teuthoidea) are cephalopod mollusks that are related to octopi. Several squid species, including the magistrate armhook squid (*Berryteuthis magister*), boreal clubhook squid (*Onychoteuthis borealijaponicus*), neon flying squid (*Ommastrephes bartrami*), and market or opal squid (*Loligo opalescens*) are found in the project area. In addition to being prey items to marine mammals, squid are also fed heavily upon by seabirds and some salmon species at certain times of the year. Species of octopus in the project area include the North Pacific giant octopus (*Enteroctopus dofleini*) and the flapjack octopus (*Opisthoteuthis California*). Octopus are thought to be primarily benthic, where they establish dens in rocky areas or dig dens in sand-shell substrates.

A variety of crab species, including Dungeness (*Cancer magister*), King (*Paralithodes camtschaticus*), snow (*Chionoecetes opilio*), and Tanner (*C. bairdi*) crabs, are present in the project area and generally live in bays, inlets, around estuaries, and on the continental shelf. Pandalid shrimp species in the project area include Northern pink shrimp (*Pandalus borealis*), found from Unalaska in the AI to San Diego, California; humpy shrimp (*P. goniurus*), which ranges from the Puget Sound to the Arctic Coast of Alaska; sidestripe shrimp (*Pandalopsis dispar*) located from Oregon to the Bering Sea; coonstriped shrimp (*P. hypsinotus*), found from the Strait of Juan de Fuca to the Bering Sea; and the spot shrimp (*P. platyceros*), which ranges from San Diego to Unalaska Island. Pandalid shrimp live mostly in the subtidal zone as adults and feed on polychaetes and small crustaceans.

3.2.7.2 Sea Turtles

Sea turtles are highly migratory, and four of the six species found in U.S. waters have been sighted off the west coast, including the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), and loggerhead (*Caretta caretta*) sea turtles. All four sea turtles are listed under the ESA. NMFS and USFWS have finalized recovery plans between the years of 1991 and 1998 for each species. These recovery plans contain more detailed information on the species and are available on the NMFS, Office of Protected Resources, Marine Turtle Recovery Planning Website; http://www.nmfs.noaa.gov/pr/species/turtles/conservation/planning.htm.

Entanglement in fishing gear, or bycatch, is a largely unquantified, ongoing problem for sea turtles. NMFS requires modifications to fishing gear (e.g., turtle excluder devices) and time-area closures to help reduce sea turtle bycatch in some commercial fisheries. Habitat loss, egg poaching, marine debris, beach nourishment, and artificial lighting are also common threats to sea turtles.

3.2.7.3 Seabirds

There are hundreds of bird species that have been documented to reside, breed, or migrate through the project area (West 2002) (Figure 3.2-10). Many of these species would be unlikely to experience any effects from SSL and NFS research activities and will not be discussed. Birds that nest or feed on lands and nearshore waters used by SSLs and NFSs may be affected by some field research activities. These include several species of seabirds, waterfowl, raptors, shorebirds, and passerines. Seabirds that nest on islands used by SSLs and NFSs include fulmars, storm-petrels, gulls, terns, puffins, murres, auklets, and murrelets. Bald eagles, peregrine falcons, ravens, crows, jays, and several species of sparrows, thrushes, and warblers also nest on these islands. Other water birds that may be present in the vicinity of rookeries and haulouts include loons, grebes, sea ducks, phalaropes, oystercatchers, and sandpipers.

The USFWS is responsible for the conservation of birds in U.S. territory and conducts or participates in numerous programs to monitor habitat quality, population trends, and reproductive success of hunted and non-hunted species in coastal areas. The USFWS Division of Migratory Bird Management website, http://www.fws.gov/birds/Management.htm, provides links to a variety of survey programs, many of which can be queried for information about specific locations and species. The USFWS has an extensive program to monitor seabirds in Alaska (Figure 3.2-11), many of which nest on islands that are also used by SSLs and NFSs. The results from these surveys are published regularly (Dragoo *et al.* 2004).

There are a number of species in the project area that are listed as endangered or threatened under the ESA. In partial fulfillment of its obligations under the ESA, Section 7, NMFS has began consultations with the USFWS to determine the ESA listed birds that could occur within the project area (Appendix I). The following brief accounts of ESA-listed species provide their basic status and distribution relative to this project. See the cited references for additional natural history information. If necessary, this section will be updated to include other relevant species following further consultation with USFWS.

Bald eagles (*Haliaeetus leucocephalus*) are abundant in Alaska and have never been listed under the ESA in that state. However, the populations of bald eagles in Washington and Oregon have been listed as threatened under the ESA since 1978 (43 FR 6233). The USFWS originally proposed to delist the species in the Lower 48 states in 1999 (64 FR 36454) and has recently reopened public comments on that proposal (71 FR 8238). Regardless of the outcome of the delisting effort, bald eagles everywhere will remain protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668–668d).

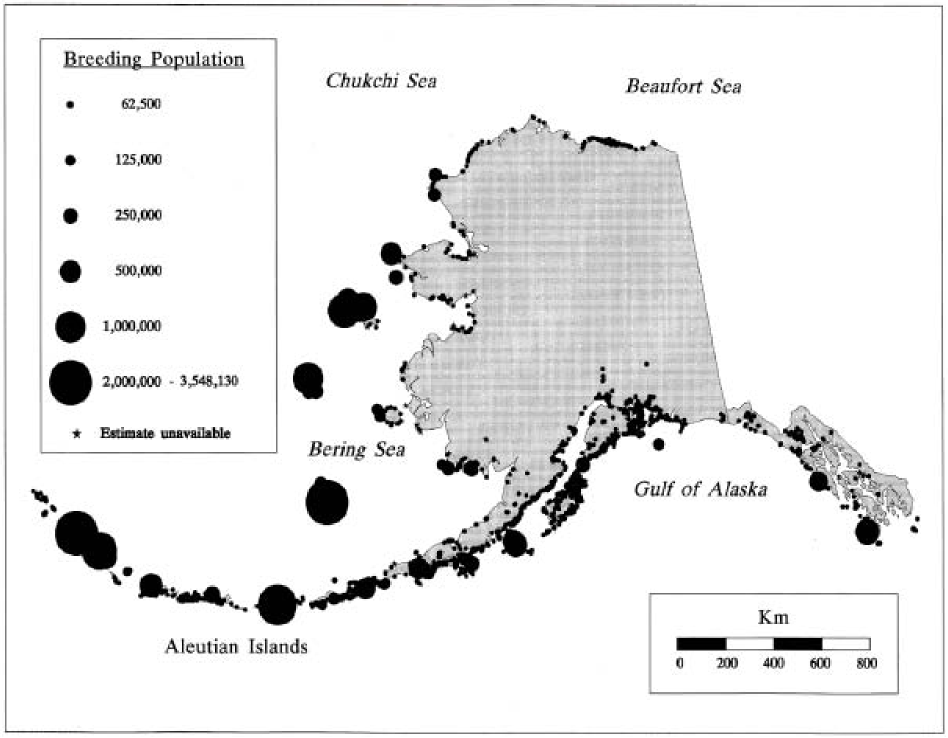


Figure 3.2-10 Seabird colonies of Alaska. Source: USFWS 2000.

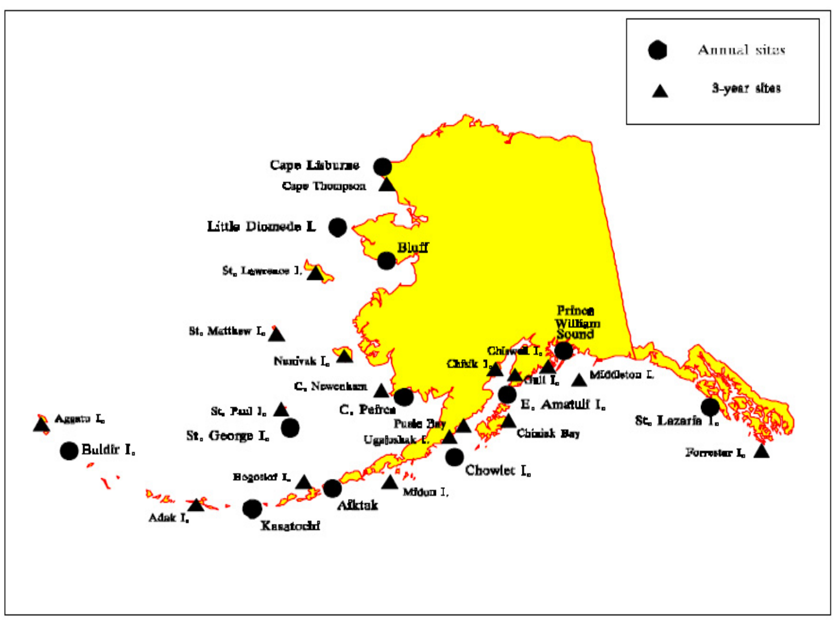


Figure 3.2-11. Location of seabird colony sites in Alaska monitored by the U.S. Fish and Wildlife Service and the USGS Biological Research Division. Some sites are monitored annually (circles), while others are monitored on three-year rotation (triangles).
Source: NMFS 2004.

The short-tailed albatross (*Pheobastria albatrus*) was originally designated as endangered under the Endangered Species Conservation Act of 1969 as a foreign-listed species (because they do not nest in U.S. territory) and has been treated as an endangered species in U.S. waters since 1973 when the ESA replaced the 1969 Act (USFWS 2000). Short-tailed albatross have been observed in AI waters, the Bering Sea, and the GOA in all months of the year but do not come to land anywhere in Alaska (USFWS 2000). The USFWS determined that designation of critical habitat within the U.S. would not be beneficial to the short-tailed albatross (USFWS 1998 and 2000). Conservation efforts in the U.S. have focused on measures to minimize the incidental take of short-tailed albatross in commercial fisheries (NMFS 2004a).

Marbled murrelets (*Brachyramphus marmoratus*) are found along the Pacific coast of North America from California to the Bering Sea, with the largest concentrations in southeast Alaska and Kodiak Island (Piatt and Naslund 1995). This species was listed as threatened under the ESA in 1992 in Washington, Oregon, and California (57 FR 45328) but is not listed in Alaska. Critical habitat was designated in 1996 (61 FR 26255), but these areas are mostly inland and would not be affected by SSL or NFS research. Marbled murrelets travel back and forth between old-growth forests and the sea except for two months in the fall when the birds are flightless and stay at sea. Habitat loss and fragmentation by timber harvests and road building, oil spills, and incidental catch in fishing nets are all conservation concerns (DeGange 1996).

Kittlitz's murrelets (*Brachyramphus brevirostrus*) are endemic to the North Pacific Ocean, ranging discontinuously along the coast of Alaska with concentration areas in Glacier Bay, Malaspina Forelands, and PWS (Day *et al.* 1999). They nest at scattered sites located high on recently de-glaciated rocky slopes and forage in sheltered, nearshore waters that are glacially affected. The USFWS received a petition to list Kittlitz's murrelets as endangered under the ESA in 2001 (Center for Biological Diversity *et al.* 2001) and published a notice of intent to consider the species a candidate for listing on May 4, 2004 (USFWS 2004). Conservation concerns include glacial retreat due to global warming and oceanic regime shifts.

Steller's eiders (*Polysticta stelleri*) are small sea ducks that spend most of the year in nearshore marine waters, coming to land only to nest. Most of the Pacific population nests in Siberia, while a small number nest in Alaska on the Yukon-Kuskokwim Delta and the arctic coastal plain (USFWS 1999). The Pacific population winters primarily along the Alaska Peninsula and large numbers concentrate in Bristol Bay before spring migration (USFWS 2001). Steller's eiders were listed as threatened under the ESA in 1997 (62 FR 31748) and critical habitat was designated in 2001 (USFWS 2001, Figure 3.2-12). Potential contributing factors to the population decline include predation, subsistence and sport hunting, consumption of lead shot on the breeding grounds, non-specific changes in the marine ecosystem, and toxic contamination from fish processing plants and other sources (USFWS 2002).

Spectacled eiders (*Somateria fisheri*) are large, diving sea ducks that spend most of the year in marine waters. They nest and molt in northern Alaska coastal areas and congregate during the winter in exceedingly large and dense flocks in polynyas in the pack ice in the central Bering Sea between Saint Lawrence and Saint Matthew islands. The Alaska breeding population was listed as threatened under the ESA in 1993 (58 FR 27474) and critical habitat was designated in 2001 (USFWS 2001), all of which is north of the Yukon-Kuskokwim Delta in areas that are not used frequently by SSL or NFS. Conservation concerns include subsistence hunting and consumption of lead shot on the breeding grounds (USFWS 2001).

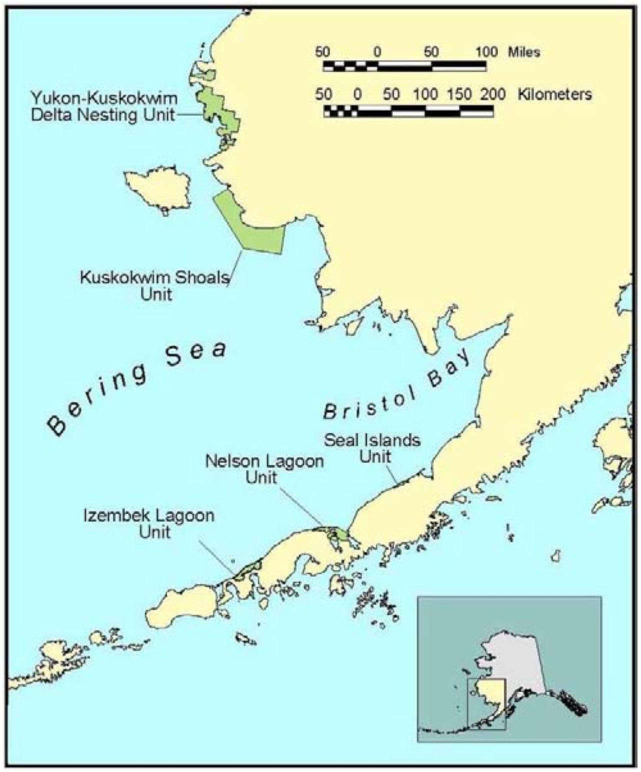


Figure 3.2-12. Steller's eider critical habitat areas. The three areas on the north side of the Alaska Peninsula are used for molting in the fall, wintering, and staging during spring migration.
Source: USFWS (66 FR 8849).

California brown pelicans (*Pelecanus occidentalis californicus*) breed in nesting colonies on the rocky islands off California bearing steep rocky slopes, little vegetation, minimal human disturbances, and high-quality marine habitat. Non-breeding pelicans range from southern California to Washington (USFWS 1983). The California brown pelican were listed as endangered along the Pacific coast and other areas of the U.S in 1970. Reasons for the marked decline of the species in the 1960s and 1970s include consumption of pesticide-laden fish, human disturbances, and lack of food (USFWS 1983). Because of the pelicans' recent recovery, the status of the species is currently under a five-year review initiated in May, 2006, to determine if delisting under the ESA is warranted (71 FR 29908).

California least terns' (*Sterna antillarum browni*) range extends along the Pacific coast of California, from San Francisco to Baja California. The birds nest in colonies on open beaches kept free of vegetation due to tidal scouring. The California least tern was listed as an endangered species in 1970, and is currently under a five-year review for delisting the species (70 FR 39327). Conservation concerns include habitat loss and El Nino events (USFWS 1985).

The western snowy plover (*Charadrius alexandrinus nivosus*) breeds on coastal beaches, sand spits, and dunes above the high tide line. The Pacific coast population of the western snowy plover was listed as endangered in 1993, and is currently under a five-year review for delisting the species (69 FR 13326). Conservation concerns include habitat loss and degradation caused by human disturbance, urban development, non-native beachgrass, and predators (USFWS 2001b).

Xantus's murrelets (*Synthliboramphus hypoleucus*) were listed as endangered under the California Endangered Species Act in 2002, and are designated as a candidate species for federal listing (Burkett et al. 2003). The breeding range of the Xantus's Murrelet is limited to the Channel Island of California and the west coast of Baja California, Mexico. Murrelets are more dispersed during the non-breeding season, extending from the Oregon coast to southern Baja California. The declining population among the Channel Islands is linked to predation by non-native (rats and feral cats) and native (island fox) species, oil pollution, and artificial light pollution (Burkett et al. 2003).

3.2.8 Ecosystem Interactions

A great deal of research on SSLs and NFSs is focused on testing various hypotheses concerning their population declines. These hypotheses propose different mechanisms to account for increased mortality and/or reduced reproductive success, including adverse interactions with commercial fisheries, regime shifts in the ocean environment, climate change, predation, hunting, contaminants, and disease. The extent of research efforts to test these hypotheses and the important results of that research are summarized in the respective species accounts and other sections of this chapter. Another hypothesis is that some of these factors are interacting in non-linear ways; that is, synergistically, to reduce the carrying capacity of the environment or to hold the populations below historical levels.

The PSEIS for the Alaska groundfish fisheries contained an extensive description of the North Pacific ecosystem and how it is influenced by climatic processes and fishing (Section 3.10 of NMFS 2004). In an ongoing effort to incorporate ecosystem-based management principles into fishery management, the annual Stock Assessment and Fisheries Evaluations (SAFE reports published annually by NMFS), contain an Ecosystems Considerations appendix that discusses recent advances in understanding multi-species interactions with the marine environment. The 2006 Draft Recovery Plan for SSL (NMFS 2006a) and the 2006 Draft Conservation Plan for NFS (NMFS 2006b) also contain summaries of the most recent ecosystem level research.

The physical and biological characteristics of the North Pacific Ocean ecosystem show variations on several time scales, including decadal scales (Schumacher and Alexander 1999, Trites *et al.* 2006b). Some fluctuations in fish, bird, and mammal populations seem to correlate with these decadal scale climate changes (Springer 1998 and 2004, Benson and Trites 2002, Piatt 1996). One abrupt and major decadal scale change that is often discussed in the context of SSL population declines is the 1976/1977 regime shift that dramatically changed environmental conditions in the Bering Sea/AI and GOA (Benson and Trites 2002). However, there is considerable disagreement on the mechanisms and extent to which these environmental factors affected both fish and marine mammal populations.

During the first three quarters of the twentieth century, the growth of commercial fishing, whaling, and northern fur seal harvesting affected North Pacific Ocean ecosystems by targeting important components of the food web, including top predators (Trites *et al.* 1999). Commercial seal harvests and whaling ended in the 1980s but large-scale commercial fishing continues to the present. These human activities have affected the dynamics of competition and predation across many spatial and temporal scales, thereby directly or indirectly affecting populations of many species throughout the ecosystem. At the same time, natural environmental fluctuations, particularly climatic processes, have been major agents of change in North Pacific Ocean ecosystems (Robards 1999; Anderson and Piatt 1999; Meuter 1999; NMFS 2004a).

The effects of ocean climate change extend over different temporal, spatial, and population scales and influence the important biological processes of reproduction, growth, consumption, predation, movement, and survival of marine organisms. Human activities and oceanic fluctuations can therefore have overlapping effects on the ecosystem level that can change the carrying capacity of the environment for marine mammals. The difficulty is in trying to understand the relative contribution and combined impact of fisheries and other human perturbations with the impact of broad, regional events such as climatic shifts (Francis *et al.* 1999). The primary way scientists have attempted to address these ecosystem-level interactions is through modeling. Models can be as simple as conceptual diagrams that show a picture of how scientists think a certain ecosystem process operates or they can be complicated computer-based programs with quantitative descriptions of the relationships between various factors and the growth, reproduction, movement, or survival of different species.

Livingston (1997) and Hollowed *et al.* (2000) reviewed the status of models that have been developed to understand the effects of climate and fishing on ecosystems. These modeling efforts have been supported by data collection instituted in conjunction with fishery management programs, especially for the Bering Sea/AI and GOA groundfish fisheries. Hunt *et al.* (2002) proposed that the pelagic ecosystem in the southeastern Bering Sea alternates between bottom-up control in cold regimes and top-down control in warm regimes. In their proposed Oscillating Control Hypothesis, Hunt *et al.* (2002) hypothesize that when cold or warm conditions span decades, the survival and recruitment of piscivorous versus planktivorous fishes are variably affected, along with the capacity of fish populations, (and arguably, apex predator populations) to withstand commercial fishing pressures.

Recent models have been used to examine the relative importance and combined effects of commercial fishing, predation by killer whales, ocean climate change, and competitive interactions between different species on SSLs and their ecosystems as a whole (Trites *et al.* 1999, DeMaster *et al.* 2006, Guenette *et al.* 2006). These models indicate that bottom-up and top-down processes occur simultaneously and suggest that SSLs have been both positively and negatively affected by changes in their food base (due to fishing and ocean climate change), as well as by competition with large flatfish, and by the effects of predation by killer whales (particularly when sea lion numbers are low). These modeling efforts indicate that all four factors (fishing, ocean productivity, competition, and predation) likely contributed to the decreasing trends observed in the western DPS sea lions and the increasing trend in the eastern DPS (Guenette *et al.* 2006). Modeling efforts for ecosystem-level changes important to NFSs are not as advanced as they are for SSLs. Modeling studies have been a valuable tool for understanding complex interactions between human-caused and natural environmental changes. However, computer-based models are sensitive to the numerous assumptions made about mechanisms and interrelationships between ecosystem components that are based on relatively little data. Continued improvement in modeling efforts therefore depends on improved data from many different field studies.

3.3 Physical Environment

The project area considered in this document encompasses the entire range of SSLs and NFSs in California, Washington, Oregon, and Alaska, including the eastern (threatened) and western (endangered) populations of SSL. This area includes both state waters and the EEZ off the coasts of California, Washington, Oregon, and Alaska. However, most of the research under the proposed action would focus on animals located on rookeries and haulouts, and in waters surrounding these areas. The project area would also includes the facilities at the ASLC in Alaska.

3.3.1 The North Pacific Ocean, Bering Sea, and Gulf of Alaska Ecosystems

Bounded on the north and east by the North America land mass and essentially open to the west and south, the northeast “quadrant” of the Pacific Ocean includes the GOA and the Bering Sea. Although separated from the main ocean body by the AI, the Bering Sea is considered to be a northern extension of the northeast Pacific Ocean by virtue of hydraulic communication through the numerous passes and channels between the islands. On the west and south, the bounds of the northeast Pacific Ocean are generally considered to be the International Dateline and the northern 30th parallel, respectively.

Although dotted by numerous seamounts rising to within 1,000 m of the surface, seabed depths over most of the northeast Pacific Ocean tend to be greater than 4,000 m. Maximum depths of more than 7,000 m occur in the Aleutian Trench, which parallels and marks the southern base of the AI chain (Figure 3.3-1). Along the land boundary, the continental shelf (depth less than or equal to 200 m) is relatively narrow (less than 50 km) along the British Columbia and southeast Alaska coasts, and then broadens to 100 km or more along southcentral Alaska coast. Along portions of the Kenai and Alaska peninsulas, the continental shelf attains a width of nearly 200 km.

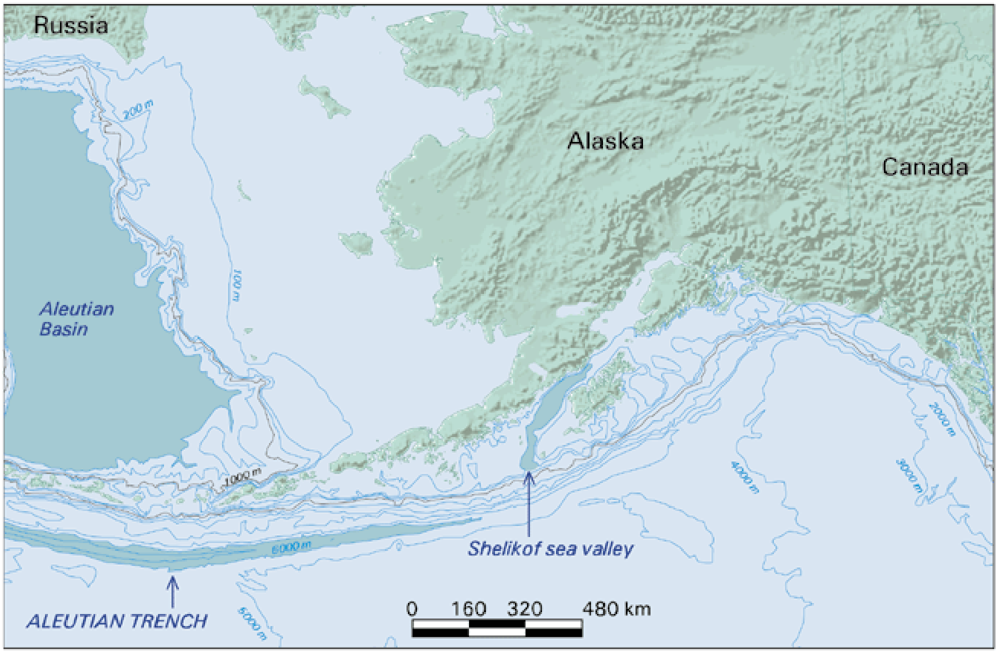


Figure 3.3-1. North Pacific Ocean
Source: http://access.afsc.noaa.gov/ichthyo/history.cfm

3.3.1.1 Bering Sea

The Bering Sea is a semi-enclosed, high-latitude sea. Of its total area of 2.3 million square km, 44 percent is continental shelf (depths less than 200 m), 13 percent is continental slope, and 43 percent is deep water basin (depths up to 3,800 m along the western margin of the sea). The EBS is characterized by an exceptionally broad (>500 km) shelf region with a narrow continental slope adjoining an extensive Aleutian Basin (see Figure 3.3-1). Its broad continental shelf on the east side of the Bering Sea is one of the most biologically productive areas in the world.

A special feature of the Bering Sea is the pack ice that covers most of its eastern and northern continental shelf during winter and spring. The dominant circulation of the water begins with the passage of North Pacific water (the Alaskan Stream) into the Bering Sea through the major passes in the AI (Figure 3.3-2) (Favorite *et al.* 1976). There is net water transport eastward along the north side of the AI, and a turn northward at the continental shelf break and at the eastern perimeter of Bristol Bay. Eventually Bering Sea water exits northward through the Bering Strait, or westward and south along the Russian coast, entering the western North Pacific via the Kamchatka Strait. Some resident water joins new North Pacific water entering Near Strait, which sustains a permanent gyre around the deep basin in the central Bering Sea.

The Pribilof Islands are situated within two large marine ecosystems: the EBS/AI and the GOA. Their continental shelf areas make up about 74 percent of the total area (2,900,785 square km) of U.S. continental shelves. They are located in the central Bering Sea, approximately 310 miles (500 km) west of the mainland and 185 miles (300 km) north of the Aleutian Chain. The Pribilof Islands support high concentrations of marine mammals, seabirds, fish, and invertebrates. This biodiversity and biological productivity results from the proximity of the islands to the continental shelf break, particularly Pribilof Canyon, along with the general ecological complexity of the isolated island habitat and its assemblage of nearshore habitats, sea cliffs, beaches, sand dunes, and coastal wetlands unique in the central Bering Sea (NMFS 2005b).

The Pribilof Islands are made up of two larger inhabited islands known as St. George and St. Paul islands, two small rocky islets called Otter Island and Walrus Island, and a small rocky outcropping known as Sea Lion Rock. St. George Island is 35 square miles in area, and is the southernmost island, located approximately 15 miles (25 km) from the shelf break. St. Paul is 44 square miles in area, and is the northernmost island, situated 47 miles (76 km) north northwest of St. George, and 62 miles (100 km) from the shelf break. Otter Island is located 9 miles (14 km) south of St. Paul, and Walrus Island is about 7 miles (11 km) east of St. Paul. Sea Lion Rock is about a quarter mile offshore of the southern tip of St. Paul (NMFS 2005b).

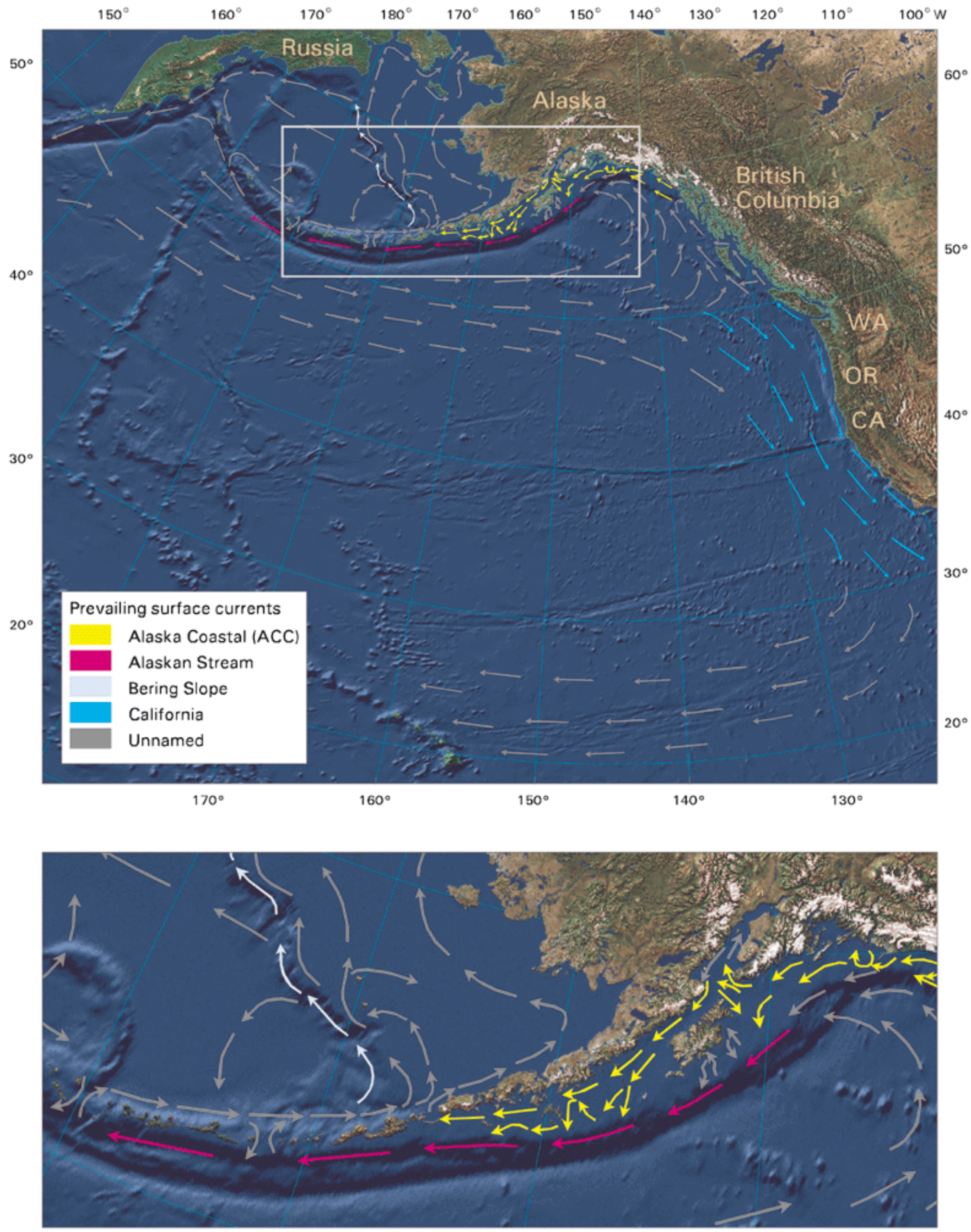


Figure 3.3-2 Circulation Patterns in the North Pacific Ocean
Source: http://access.afsc.noaa.gov/ichthyo/history.cfm

3.3.1.2 Gulf of Alaska

The GOA generally includes all waters within the EEZ along the southeastern, southcentral, and southwestern coasts of Alaska from Dixon Entrance to Unimak Pass, a distance along the Alaskan coastline of more than 2,500 km. Numerous troughs and shallow banks characterize the topography of the western GOA. The Aleutian shelf area, as defined by the 200 m isobath, is narrower than the EBS shelf (65-175 km) and drops abruptly to depths of 5000-6000 m in the Aleutian Trench, which parallels the shelf edge (see Figure 3.3-1). The Alaskan Stream, which flows southwesterly and roughly parallel to the shelf break at 50-100 centimeters per second (cm/sec), dominates offshore, near-surface circulation (see Figure 3.3-2). Nearshore, the Alaska Coastal Current (ACC) is the dominant feature (Reed and Schumacher 1986). The upper layer flows in a southwesterly direction. With surface speeds of 25-100 cm/sec, the ACC in the vicinity of Shelikof Strait is one of the most vigorous and dynamic coastal currents in the world (Stabeno *et al.* 1995). Temperatures follow a clear seasonal pattern, with the coldest values occurring in March and the warmest values in August (Reed and Schumacher 1986). Freshwater discharge into coastal waters peaks in the fall and strongly affects the circulation (Royer 1998). This region has been referred to as the Coastal Downwelling Domain and is characterized by mainly onshore flow at the surface (Ware and McFarlane 1989).

3.3.1.3 North Pacific Ocean Off of the United States West Coast

In contrast to the EBS and the western GOA, the continental shelf is narrow off the U.S. west coast (Figure 3.3-3). Off Washington and northern Oregon, the shelf width is less than 70 km, whereas off southern Oregon and northern California it narrows to less than 30 km, reaching a minimum of about 10 km off Cape Mendocino. A series of submarine canyons transect the shelf and slope off Washington and California. These canyons are absent off Oregon where rocky submarine banks are found along the shelf. The U.S. west coast is part of an extensive Coastal Upwelling Domain extending from Baja California to southern British Columbia (Ware and McFarlane 1989). The oceanography of this region is characterized by the California Current system, a typical eastern boundary current regime (Hickey 1989 and 1998) (see Figure 3.3-2). The main California Current proceeds southwards along the U.S. west coast and is slow, meandering, broad, and indistinct. Prevailing winds cause downwelling close to the coast in winter and upwelling of cold, nutrient-laden oceanic water close to the coast in summer. The intensity of Ekman transport and associated upwelling is variable along the coast and tends to increase from north to south with a local maximum at Cape Mendocino off northern California. Annual sea-surface temperature minimums and salinity maximums generally occur in summer after sustained upwelling-favorable winds.

Figure 3.3-3 North Pacific Ocean Off of the U.S. West Coast
Source: http://access.afsc.noaa.gov/ichthyo/history.cfm

3.3.2 Substrate

The EBS sediments are a mixture of the major grades representing the full range of potential grain sizes of mud (subgrades clay and silt), sand, and gravel (Smith and McConnaughey 1999). Sand and silt are the primary components over most of the seafloor, with sand as the predominate sediment in waters with a depth less than 60 m. In general, the fraction of finer-grade sediments increases (and average grain size decreases) with increasing depth and distance from shore. This grading is particularly noticeable on the southeastern Bering Sea continental shelf in Bristol Bay and immediately westward. However, there is considerable fine-scale deviation from the graded pattern, especially in shallower coastal waters and offshore of major rivers, due to local variations in the effects of waves, currents, and river input (Johnson 1983).

Considerable local variability in sediment type can be found in areas along the shores of Bristol Bay and the north coast of the Alaskan Peninsula, as well as west and north of Bristol Bay, especially near the Pribilof Islands.

There is a general pattern whereby nearshore sediments in the east and southeast on the inner shelf (0-50 m depth) often are sandy gravel and gravelly sand. These give way to plain sand farther offshore and west. On the middle shelf (50-100 m), sand gives way to muddy sand and sandy mud, which continues over much of the outer shelf (100-200 m) to the start of the continental slope. Sediments on the central and northeastern shelf (including Norton Sound) have not been extensively sampled, but Sharma (1979) reports that while sand is dominant in places, there are concentrations of silt both in shallow nearshore waters and in deep areas near the shelf slope. In addition, there are areas of exposed relict gravel possibly resulting from glacial deposits. These departures from a classic seaward fining of grain size are attributed to the large input of fluvial silt from the Yukon River and to flushing and scouring of sediment through the Bering Strait by the net northerly current. (NMFS 2005a)

Compared to the Bering Sea, the GOA has relatively weaker currents and tidal action near the seafloor and, therefore, a variety of seabed types such as gravely-sand, silty-mud, and muddy to sandy gravel, as well as areas of hardrock (Hampton *et al.* 1986). Investigations of the northeast GOA shelf (less than 200 m) have been conducted between Cape Cleare (148° W) and Cape Fairweather (138°W) (Feder and Jewett 1987). The shelf in this portion of the GOA is relatively wide (up to 100 km). The dominant shelf sediment is clay silt originating primarily from either the Copper River or the Bering and Malaspina glaciers. Sediments are generally transported in a westerly fashion once they enter the gulf. Sand dominates the soil composition nearshore, especially close to the Copper River and the Malaspina Glacier.

Water Column

Temperature, salinity, and density remain constant with depth in the near-surface mixed-layer of the EBS, which varies from about 10-30 m in summer to about 30-60 m in winter (Reed 1984). Therefore, waters over the inner shelf (less than 50 m) are well-mixed most of the time. On the middle shelf (50-100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher 1981). On the outer shelf (100-200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Overall, surface temperatures in winter vary from about -1°Centigrade (C) in the north to about 3°C in the south, then increase to a maximum in August of 8°C-12°C, with the higher temperatures nearshore. Surface salinities range from about 31.4 practical salinity units (psu) inshore to about 32.4 psu on the outer shelf to about 33.1 psu in the oceanic water. Lower salinities may be found close to shore near river mouths, and the patterns of the isohalines show low-salinity water from the GOA entering the Bering Sea at Unimak Pass and proceeding along the north side of the Alaska Peninsula to Bristol Bay (Royer 1981, Schumacher *et al.* 1982). The bottom salinities on the inner shelf also show this low-salinity feature north of the Alaska Peninsula. Bottom salinities over the entire shelf range typically from 31.4 psu to 32.8 psu, slightly higher than at the surface. The highest bottom salinities are present west of Unimak Pass in summer, possibly from enhanced inflow of oceanic water to the inner slope (NMFS 2004a).

Because of the plentiful coastal runoff in the eastern GOA and the general excess of precipitation over evaporation, the salinity changes dominate over temperature changes in controlling water density and thus water structure. Generally, water density increases with depth, but the greatest increase occurs in the permanent pycnocline at 30 m from the surface (25.0 ft thick) to 200 m from the surface (26.8 ft thick). Above this pycnocline lies a 30-m-deep constant density (25.0 ft) surface-mixed layer, and below this pycnocline are slowly increasing values, 26.8-27.7 ft from 200 to 1,500 m. The density structure closely follows the salinity structure with the permanent halocline marked by a rapid increase with depth, from 32.0 to 33.8 psu. This halocline is typically located between 30 and 200 m, underneath the surface-mixed layer. Below the halocline, salinity values slowly increase to 34.4 psu down to 1,500 m. These are the relatively permanent physical properties in the GOA and AI areas. Significant changes occur only rarely, with large-scale changes in circulation (Reed 1984).

3.3.3 Temperature and Nutrient Regimes

Surface waters have relatively low salinities in the North Pacific high latitudes because of excess precipitation and runoff over evaporation. Cooling these surface waters even to the freezing point does not make them sufficiently dense to cause them to descend any deeper than 200 m in the water column. Consequently, the deeper water in the North Pacific must originate elsewhere, and must flow in through the South Pacific because the connection with the Arctic Ocean, through the Bering Strait, is too narrow and shallow to be of consequence.

These deeper waters of the North Pacific originate in the southern (i.e., Antarctic) and North Atlantic Oceans, where the combination of surface temperatures and salinities produces very dense waters that subsequently sink to the sea floor. The Pacific Ocean has been described as a vast estuary, with low-salinity surface outflow from the North Pacific mixing with deeper, more saline water flowing in at depth through the South Pacific. Ultimately the increasingly dense North Pacific water returns to the areas of sinking in the North Atlantic to complete the circuit, which is estimated to take centuries to complete.

Nutrients are distributed throughout the world's oceans by this system of deep circulation. For example, inorganic phosphates are consumed by plant growth at the surface and are regenerated at greater depths as the plants die, sink, and decay. Consequently, nutrients are in greater concentrations at depths of 1 to 2 km than at the surface. Inflow of the deeper water into the Pacific Ocean brings in water that is high in phosphate compared to the average concentration in the Atlantic Ocean. As a result, the accumulated phosphate in the Pacific Ocean has a concentration about twice that of the Atlantic (NMFS 2004a).

3.3.4 Climatic Regime Shifts

A chronology of inter-decadal climatic changes affecting the North Pacific Ocean was compiled from available measured atmospheric pressure data by Minobe (1997) for the period 1899 through 1997. A climatic regime shift was defined as a transition from one climatic state to another within a period substantially shorter than the lengths of the individual epochs of each of the (two) climatic states. Data illustrated rapid strength changes in the Aleutian low in the winter and spring seasons. Bi-decadal pressure averages during 1899 through 1924 showed that the Aleutian low was about one millibar (mb) weaker than average, then strengthened to one mb below normal during 1925 through 1947. Similar behavior occurred in the later part of the twentieth century as the Aleutian low shifted back to one mb above normal from 1948 to 1976, and then strengthened back to one mb below normal during 1977 through 1997.

An update of evidence for regime shifts in the North Pacific Ocean in the 1920s, the 1940s, a major one in the winter of 1976/1977, and a minor one in 1988/1989 was presented recently at the North Pacific Marine Science Organization (PICES) symposium (Hare *et al.*, Hare and Mantua 2000, McFarlane *et al.*, Park and Oh, Kang *et al.*, Suga *et al.*, Yasuda *et al.*, Savelieva *et al.*, Rogachev, Overland *et al.*, Miller and Schneider, and Minobe 2000). Coincidently, the beginnings of another large change in 1998/1999 were mentioned at the symposium; these are discussed in more recent papers by Minobe (2002), Conners *et al.* (2002), Mantua and Hare (2002), and Schwing *et al.* (2002) (NMFS 2004a).

In the late 1970s a steep change in climate, referred to as a regime shift, occurred in the North Pacific Ocean. While evidence summarized by Minobe (1979) suggests there have been previous regime shifts, it was the 1970s regime shift that stimulated extensive research on the topic, with a particular focus on how oceanic ecosystems were responding to these phenomena. Although more than a decade was required to recognize the pattern, the regime shift of 1976/1977 is now widely acknowledged, as well as its associated far-reaching consequences for the large marine ecosystems of the North Pacific Ocean. The 1989 regime shift has been studied extensively by Hare and Mantua (2000) who assembled and examined 100 environmental time series of indices (31 climatic and 69 biological) to obtain evidence of regime shift signals. A few examples of these illustrate that such signals are evident in the Bering Sea/AI and GOA data.

Niebauer (1998) reports that prior to the late 1970s, below-normal sea ice cover in the Bering Sea was typically associated with El Niño/Southern Oscillation (ENSO) conditions. These conditions caused the Aleutian Low atmospheric pressure center to move east of its average or normal position, with the result that warm Pacific air was directed over the Bering Sea. Conversely, above-normal sea ice cover was associated with La Niña conditions, during which the Aleutian Low moves west of its normal position, allowing higher pressure and colder weather in the Bering Sea. However, since the 1970s regime shift, ENSO conditions are causing the Aleutian Low to move even farther east, causing winds to blow from the east and north off Alaska, and resulting in above-normal ice cover in the Bering Sea.

Before the regime shift, ENSO and La Niña conditions occurred with about the same frequency. Since the regime shift, ENSO conditions are about three times more prevalent. Both Mantua *et al.* (1997) and Minobe (1997) present evidence that this regime shift is the latest in a series of climate shifts that date back at least to the late 1800s and might be attributable to a 50- to 70-year oscillation in a North Pacific atmospheric-ocean coupled system.

Therefore, abundant evidence suggests that the coupled atmospheric-oceanic system of the North Pacific is subject to multiple forcing factors, each having characteristic behaviors and different frequencies of occurrence. The evidence also indicates that, rather than there being a single average or normal condition, the overall system appears to stabilize periodically around two or more normal states, changing from one to another abruptly in what has been termed a regime shift. These are the characteristics of systems whose dynamics are addressed by chaos theory, which is a body of mathematical theory that focuses on systems that have multiple states of equilibrium. Chaos theory attempts to define the mechanisms that cause the systems to change from one equilibrium state to another and to predict all such equilibrium conditions.

Using available sea level pressure and sea surface temperature data, along with coastal air temperature data from Sitka, Overland *et al.* (2000) formulated a conceptual chaotic model for the North Pacific. They were able to determine that the energy content of North Pacific time series of these parameters is broad-banded (i.e., over a broad frequency range) and temporally irregular (i.e., non-steady with respect to time). They reported that their conceptual model reflects the observed irregular behavior and suggests that the transitions from one equilibrium state to another are rapid rather than gradual.

A new review paper summarizes a pattern of multi-decadal (about 50 years) change in the Pacific Ocean (Chavez *et al.* 2003) characterized by about 25-year boom and 25-year bust cycles in the opposing anchovy-sardine populations. In the mid-1970s the change was from a cool anchovy regime to the warm sardine regime. Satellites have recently confirmed an increase in basin-wide sea-level slope after the 1997/1998 ENSO coincident with a dramatic increase in chlorophyll off California, indicating a shift back to a cool anchovy regime that occurred in the middle to late 1990s. The effects of ENSO in the tropics, which radiate north on a shorter cycle of three to seven years and have some unmeasured anthropogenic effects, may tend to mask some of the synchronicity of changes in the physical and biological systems (NMFS 2004a).

Long-term changes in fish populations around the North Pacific Ocean have apparently been influenced by climatic change of the same 50- to 70-year variability. Alaska salmon decreased in the 1940s and increased in the 1970s. Larger Japanese sardine catch amounts occurred in the regimes with the deepened Aleutian low. Baumgartner *et al.* (1992) found evidence of approximately 60-year variability in sardine and northern anchovy populations in the eastern North Pacific from sediments in the Santa Barbara basin dating back to A.D. 270 (NMFS 2004).

3.3.5 Distant Forcing Parameters

As described in Section 3.3.5, the phenomenon known as ENSO, as described by Philander (1990), has long been recognized as a significant factor in the interannual variability of atmospheric-oceanic response. ENSO events radiate from the equatorial regions at irregular intervals, but range most commonly from three to seven years between events. ENSO events account for approximately one-third of the ice and sea surface temperature variability in the Bering Sea (Niebauer and Day 1989). ENSO forcing in the oceans at high latitudes is primarily through poleward propagation of Kelvin waves (Jacobs *et al.* 1994). This conclusion is supported by data of Enfield and Allen (1980) who found poleward-propagating, coastal-trapped disturbances along the west coast of North America that were correlated with equatorial disturbances. Royer (1994) reported that ocean temperature fluctuations at depth at an oceanographic observation station near Seward (GAK 1) are well-correlated with ENSO events.

In addition to fluctuations associated with ENSO forcing, the water temperature variations at GAK 1 have been found to be associated with the lunar nodal tide component, which has a period of 18.6 years (Royer 1994). This tide component is the twelfth largest of all tidal components and is related to the 18.6-year periodicity of the lunar declination. Equilibrium tide theory predicts that this tidal component will vary with latitude, where amplitudes will increase with latitude (Parker *et al.* 1995). Because the inter-decadal sea surface variability seems to occur simultaneously in the GOA and Bering Sea, it is expected that this component forces Bering Sea parameters in a similar fashion as in the GOA. Temperature anomaly patterns are similar with no phase shift, which suggests that the forcing is simultaneous (NMFS 2004a).

3.3.6 Coastal Land Characteristics

3.3.6.1 Sanctuaries, Parks, and Historic Sites

Some existing and proposed research occurs within National Wildlife Refuges (NWRs). NWRs are maintained by USFWS, which may require holders of NMFS permits for research on SSLs to obtain special use permits for certain activities within the boundaries of an NWR. Refuges are established for three purposes: (1) the restoration, preservation, development, and management of wildlife and wetlands habitat; (2) the protection and preservation of endangered or threatened species and their habitat; and (3) the management of wildlife and wildlands to obtain the maximum benefits from these resources (NMFS 2005a).

The Alaska Maritime National Wildlife Refuge (AMNWR) includes over 3,000 islands, islets, rocks, pinnacles, and headlands from northwest Alaska into the Bering Sea and along 4,800 miles of Alaska's coastline and the Aleutian chain. Most of the AMNWR (2.64 million acres) is designated wilderness and has the most diverse wildlife species of all the NWRs in Alaska, including 15 to 30 million birds (80 percent of all Alaska seabirds, including species of puffins, kittiwakes, murres, petrels, auklets, murrelets, and gulls) representing about 55 species. In addition to SSLs, marine mammals such as harbor seals, walrus, sea otters, polar bears, and whales are also common within the AMNWR. Other animals within the AMNWR include bald eagles, peregrine falcons, bears, caribou, musk oxen, river otters, and foxes. The AMNWR also contains many Aleut archeological sites, as well as remnants of the only World War II battles fought on U.S. soil (NMFS 2005a).

3.3.6.2 Designated Critical Habitat Areas, Rookeries, and Haulouts

Critical habitat has been designated for SSLs in California, Oregon, and Alaska (50 CFR 226.202). See Section 3.2.1.2 in the SSL account for a description and maps. No critical habitat has been designated for any endangered whale species other than right whales. Right whale critical habitat has only been designated in the Atlantic Ocean (50 CFR 226.203), which is not within the project area. Critical habitat has been designated for several species of salmon and steelhead in California, Oregon, Idaho, and Washington (50 CFR 226.204, 226.205, 226.210, and 226. 212). Critical habitat for salmon and steelhead includes all river reaches accessible to the listed salmon within the range of the ESUs listed, and consists of water, substrate, and adjacent riparian zone of estuarine and riverine reaches in specified hydrologic units and counties (NMFS 2005a).

3.4 Social and Economic Environment

3.4.1 Subsistence Harvesting

This section describes the contemporary context of subsistence harvest of SSLs and NFSs in Alaska. In general, the subsistence use of natural resources by Alaska Native peoples represents a set of relationships with the local environment and a continuity of use that stretches back to prehistoric times, despite changes in technology and society. Subsistence activities are a central element of contemporary village life that often involve myriad social and cultural elements and whose importance ranges from being a basic component of physical sustenance to a part of relationships involved with a sense of group identity and individual feelings of well-being. Subsistence is also important to many of Alaska's non-Native residents, despite greater or lesser differences between groups in the specific cultural context of subsistence. In the case of SSLs and NFSs, however, non-Native residents may not participate in the taking of these animals. While subsistence take of sea lions and seals was common in prehistoric and historic times among residents of what are now the coastal areas of the states of Alaska, Washington, Oregon, and California, only Alaska Natives currently qualify for a subsistence take exemption for species that are otherwise protected under the terms of the MMPA of 1972 (as reauthorized in 1994 and amended through 1997; the specific exemption for Alaska Natives is found in Section 101 [16 U.S.C. 1371]) and the ESA. Specifically, the Alaska Native exemption within the MMPA allows for Alaska Natives who dwell on the coast of the North Pacific Ocean or Arctic Ocean to take marine mammals for the purposes of subsistence (or for the purposes of creating and selling authentic native handicrafts and articles of clothing).

3.4.1.1 SSL Subsistence Harvesting

<u>Harvest Levels and Regional Variation</u>

Two types of information are available on harvest levels of SSLs that are applicable across a broad geographic base. The first type of information derives from comprehensive, in-depth ADF&G subsistence surveys that are intended to provide an overall baseline for the contemporary subsistence harvest patterns in a given community. Most communities in Alaska now have such baseline documentation dating to the mid-1980s through the late 1990s. This baseline information has the benefit of closely documenting actual take, and permits analysis of the role of the harvests of SSLs and NFSs within the entire round of subsistence activity in a given community, notably the proportional contribution of harvest of these species overall subsistence production in a community. However, these comprehensive studies have not been repeated in most communities, and therefore suffer the limitation of not being particularly useful in examining time-series trends. The second type of information derives from an annual sampling effort managed by ADF&G specifically directed toward SSL (and harbor seal) takes. This effort results in consistently produced annual estimates by community, providing the ability to more easily look at trends over time for over 60 communities. Most recently this research has been conducted by the Subsistence Division of ADF&G, the Alaska Native Harbor Seal Commission, and the Aleut Marine Mammal Commission, under contract with NMFS. The 2005 study (ADF&G Technical Paper No. 303) included information through 2004 on subsistence takes of harbor seals and sea lions in 62 coastal communities. Information for 61 communities was collected through interviews with persons in 1,209 Alaska Native households. In addition, the 2003 research included information on subsistence takes by hunters in St. Paul through a separate project run by the Ecosystem Conservation Office of The Aleut Community of St. Paul. These surveys are some of the most intense and representative surveys of their type done in the state of Alaska. Taken together, these two types of data represent the best available information for SSL subsistence harvest across communities in Alaska.

The documented total community harvest information presented in this section is extracted from the ADF&G Community Profile Database. The Community Profile Database is a compilation of the data collected through the comprehensive baseline community surveys noted previously. While these are primarily focused on subsistence harvest documentation, they also typically include associated demographic and economic information. As noted, analysis of trends is not possible with these data. The comprehensive baseline community surveys are not repeated on a regular schedule. Where these studies have been repeated for a community at several points in time, it is typically due to a link to other ongoing studies or directed toward specific resource management questions. Specific management concerns can also result in detailed studies of subsistence harvests of a particular species, as is the case with the lengthy series of studies of SSL and harbor seal subsistence harvests. Thus, the time series information from some communities and for some resource categories is better than for others. For some communities, only a single year baseline survey is available, and for many communities this information is now as much as two decades old. Furthermore, even for communities with multiple years of information available, the interpretation of the differences from year to year can be complex and problematic.

Because community subsistence activities and harvests vary each year, and surveys are not conducted annually or even within an overall temporal sampling design, the results from different years cannot simply be averaged. Where information for more than one year is available, ADF&G has addressed this problem by designating one year's results as "most representative" of the overall pattern of subsistence activities and level of harvest for that given community. This designation is based on ethnographic and other non-survey community context information. This limitation is especially important for communities for which information is rather dated.

Table 3.4-1 presents information derived from ADF&G surveys of all subsistence resources harvested by a given community plus the specific SSL harvest for communities with reported sea lion harvests. Together, these two types of information allow for at least a rough assessment of the relative dependency of a community on SSLs within the overall subsistence harvest. A major caveat for the information contained in this table is that each community was surveyed only a limited number of times and for different years than most other communities, meaning comparability between communities is limited. It is also important to note that the documented SSL percentage of total subsistence harvest shown in the table is a measure of the use and reliance upon this resource at the time of the study (i.e., 1980-1997). Percentages for those communities studied in the 1980s almost certainly does not represent the current harvest, which generally is assumed to be much lower than that in the past. For Atka, Akutan, Old Harbor, St. George, and St. Paul (and perhaps Unalaska and several other communities), SSLs have represented, in the past, a substantial resource in terms of relative contribution to overall community subsistence resource consumption. It should also be clearly noted that the information in Table 3.4-1 taken from the comprehensive baseline studies is not totally consistent with the information presented in Tables 3.4-2 through 3.4-9, which is taken from the intensive SSL subsistence harvest surveys conducted from 1992 to 2004. Different sampling and statistical expansion methods were involved in the two types of studies. ADF&G considers the time series data to be the more accurate assessment of SSL harvest (personal communication, Fall 2006). What is evident, however, is that the area of heaviest subsistence use of SSLs is in southwestern Alaska and is concentrated in relatively few communities.

Tables 3.4-2 through 3.4-9 present estimates extrapolated from sample surveys documenting SSL subsistence harvest in all Alaskan communities for the period 1992 (the first year of focused surveys on SSL [and harbor seal] harvests) through 2004, except for 1999, when no survey was conducted due to lack of funding. Nine communities surveyed in previous years could not be included in the 2000 survey, however, as local surveyors could not be secured. For these communities (Anchorage, Atka, Homer, Hydaburg, Kenai, Nikolski, St. George, Tyonek, and Valdez), ADF&G estimated that the SSL harvest in 2000 was the same as in 1998 (the most recent year for which harvest information was available). In addition, the 2000 harvest survey for a tenth community, St. Paul, was conducted independently by a local hunter association with funding from NMFS.

As shown in Table 3.4-2, total overall SSL takes declined sharply from 1992 to 1995, with takes leveling off in subsequent years. Especially dramatic decreases in take are seen in the Pribilof Islands over the 1992-2004 time span.

Table 3.4-1
Documented total community subsistence harvest and relative dependence on SSL harvest,[1] Alaskan coastal communities.

Community	Region	Year	Total community subsistence harvest (edible pounds)	SSL		
				Number harvested	Edible pounds	% Community harvest
Alakanuk	W	1980	431,904	9	1,200	0.3
Quinhagek	W	1982	536,584	16	2,286	0.4
Sitka	SE	1996	1,749,772	2	400	0.0
Chenega Bay	SC	1993	27,809	12	997	3.6
Nanwalek	SC	1997	42,593	5	1,048	2.5
Tatitluk	SC	1997	322,915	19	3,712	1.1
Akhiok	SW	1992	25,735	3	600	2.3
Akutan	SW	1990	47,397	38	7,688	16.2
Aleknagik	SW	1989	54,079	2	221	0.4
Atka	SW	1994	37,307	44	8,700	23.3
False Pass	SW	1988	28,586	1	220	0.8
Iliamna	SW	1991	82,915	1	130	0.2
Ivanof Bay	SW	1989	15,677	1	150	1.0
Manokotak	SW	1985	118,337	16	1,639	1.4
Nikolski	SW	1990	36,945	26	5,143	13.9
Old Harbor	SW	1997	88,851	37	7,442	8.4
Ouzinkie	SW	1997	55,015	1	264	0.5
Perryville	SW	1989	45,729	11	2,067	4.5
Port Lions	SW	1993	78,371	2	356	0.5
St. George	SW	1994	11,330	3	556	4.9
St. Paul	SW	1994	131,814	141	28,214	21.4
Unalaska	SW	1994	355,081	72	14,423	4.1

Notes: [1]Numbers are for the "most representative" year for which information is available. ADF&G does only limited surveys and subsistence use can vary greatly from year to year. Communities with documented use but no harvest are not included.
Source: ADF&G Community Profile Database 2001.

Table 3.4-2
Estimated Subsistence Take of SSLs, by Area in Alaska, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Southeast Alaska	6	1	5	0	0	0	8	2	0	7	7	12
North Pacific Rim	32	35	26	31	14	6	29	17	15	6	25	54
Upper Kenai-Cook Inlet	10	11	1	0	3	0	0	0	1	0	0	0
Kodiak Island	58	58	61	137	60	38	18	19	35	16	36	17
South Alaska Peninsula	2	6	6	8	5	8	9	13	12	8	5	4
Aleutian Islands	135	124	122	96	58	52	37	76	98	105	107	96
Pribilof Islands	297	245	193	68	46	56	78	43	38	43	32	32
South Bristol Bay	0	0	0	0	0	0	0	0	0	0	0	0
North Bristol Bay	8	7	1	0	0	4	0	0	0	0	0	1
TOTAL	548	487	415	340	186	164	179	170	199	185	212	216

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-3
Estimated Subsistence take of SSLs, Southeast Alaska Communities, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Angoon	0	0	0	0	0	0	0	1	0	0	0	0
Craig	0	0	0	0	0	0	0	0	0	0	0	3
Hoonah	0	0	0	0	0	0	0	0	0	0	5	7
Juneau	0	0	1	0	0	0	0	0	0	0	0	0
Kake	0	0	1	0	0	0	0	0	0	0	0	0
Klawock	1	0	0	0	0	0	0	1	0	1	2	1
Sitka	5	1	2	0	0	0	8	0	0	6	0	0
TOTAL	6	1	4	0	0	0	8	2	0	7	7	11

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-4
Estimated subsistence take of SSLs, North Pacific Rim and Upper Kenai-Cook Inlet Alaska Communities, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Chenega Bay (NPR)	8	18	7	7	2	0	0	0	1	0	2	0
Codova (NPR)	0	2	0	1	0	0	0	0	4	4	3	3
Nanwalek (NPR)	6	10	4	9	5	0	2	7	4	2	5	2
Port Graham (NPR)	5	1	0	12	1	0	1	5	0	0	1	13
Seldovia (NPR)	0	0	0	0	0	2	0	0	0	0	0	0
Tatitlek (NPR)	13	5	16	3	5	4	22	2	6	0	14	37
Valdez (NPR)	0	0	0	0	0	0	3	3	0	0	0	0
Anchorage (UK-CI)	10	11	1	0	1	0	0	0	1	0	0	0
Kenai (UK-CI)	0	0	0	0	2	0	0	0	0	0	0	0
TOTAL	42	47	28	32	16	6	28	17	16	6	25	55

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-5
Estimated subsistence take of SSLs, Kodiak Island Alaska Communities, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Akhiok	4	0	3	2	7	8	3	3	1	0	4	1
Kodiak City	0	13	1	2	3	3	1	2	3	3	0	0
Larsen Bay	1	0	2	3	0	0	0	0	0	0	0	0
Old Harbor	46	33	48	113	50	26	13	13	29	9	32	12
Ouzinkie	3	8	7	16	0	0	0	0	3	5	0	3
Port Lions	3	5	0	0	0	1	1	0	0	0	0	1
TOTAL	57	59	61	136	60	38	18	18	36	17	36	17

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-6
Estimated subsistence take of SSLs, South Alaska Peninsula Alaska Communities, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Chignik Lagoon	0	1	0	0	0	0	0	0	0	0	0	0
Ivanof Bay	0	4	0	0	2	2	2	0	3	3	0	0
King Cove	1	1	4	5	0	4	4	4	3	2	0	2
Perryville	1	0	1	3	3	2	1	5	1	4	4	2
Sand Point	0	0	0	0	0	0	2	5	5	0	1	0
TOTAL	2	6	5	8	5	8	9	14	12	9	5	4

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-7
Estimated subsistence take of SSLs, Aleutian Islands and Pribilof Islands Alaska Communities, 1992-2004.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
Adak (AI)	-	-	-	-	-	-	-	-	-	-	1	3
Akutan (AI)	30	23	16	6	16	6	6	5	18	3	9	5
Atka (AI)	39	25	54	40	17	12	17	17	45	86	82	63
Nikolski (AI)	8	6	0	0	3	3	1	1	7	1	0	2
Unalaska (AI)	59	69	52	50	22	30	13	53	28	16	16	23
St. George (PI)	70	19	20	8	8	28	20	20	14	7	14	14
St. Paul (PI)	227	227	173	60	38	28	58	23	24	36	18	18
TOTAL	433	369	315	164	104	107	115	119	136	149	140	128

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-8
Estimated subsistence take of SSLs, South Bristol Bay and North Bristol Bay Alaska Communities, 1992-2003.

Area	Year											
	1992	1993	1994	1995	1996	1997	1998	2000	2001	2002	2003	2004
All South Bristol Bay Communities	0	0	0	0	0	0	0	0	0	0	0	0
Manokotak (North Bristol Bay)	4	0	0	0	0	0	0	0	0	0	0	0
Togiak (North Bristol Bay)	4	7	1	0	0	4	0	0	0	0	0	0
Twin Hills	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	8	7	1	0	0	4	0	0	0	0	0	1

Note: Take estimate is by individual sea lions and includes both harvested and struck and lost animals. Values are rounded to the nearest integer; sum of communities may not equal regional total in previous table due to rounding error.
Source: ADF&G 2005.

Table 3.4-3 provides information by community for the southeast Alaska region for 1992-2004. As shown, regional harvest levels are relatively modest and for some years no SSLs were taken for subsistence in the entire region. Total subsistence take for the region never exceeded 11 SSLs during this period. Table 3.4-4 provides similar subsistence take information by community for the southcentral Alaska region. As indicated in the table, there has been considerable variation from year to year and between communities, such that in any given year one of several different communities may have accounted for the highest level of take within the region.

Table 3.4-5 provides annual community SSL harvest level estimates for the Kodiak region for 1992-2004. While there is considerable variation by year, the concentration of take in Old Harbor within this region is apparent. Table 3.4-6 provides analogous take information from the south Alaska Peninsula communities. The modest levels of take for this region are relatively evenly distributed across the communities.

As shown in Table 3.4-7, the Aleutian/Pribilof Islands region is the center of SSL subsistence activity in terms of total numbers of SSLs taken. Several communities have high levels of use relative to others, but use generally became more evenly distributed across a number of communities following a sharp decline in takes in St. Paul after 1994. The community of Atka became predominate between 2002-2004, accounting for over half the annual total take in the two regions each year. Table 3.4-8 for Bristol Bay, shows that between 1992 and 2004, only three communities in the region had any estimated take and the years of no estimated take exceeded the number of years with at least some estimated take.

Looking across regions, in 2004 approximately 45 percent of the total subsistence take of SSLs occurred in the AI region, about 25 percent in the North Pacific Rim region, about 8 percent in the Kodiak Island region, and about 15 percent in the Pribilof Islands region. The southeast Alaska and south Alaska Peninsula regions accounted for about 6 and 2 percent, respectively, of the total subsistence take in 2004, while the north Bristol Bay region accounted for less than 1 percent of take. In 2004 a total of 21 of the 62 surveyed communities reported harvesting SSLs, with 9 communities reporting takes of five or more SSLs. The seven top ranking communities were Atka (63 SSLs), Tatitlek (37 SSLs), Unalaska (23 SSLs), St. Paul (18 SSLs), St. George (14 SSLs), Port Graham (13 SSLs), and Old Harbor (12 SSLs). These seven communities accounted for 180 SSLs, or 83 percent of the total Alaska subsistence take.

The number of individuals reporting hunting SSLs has also declined substantially since the early 1990s. The estimated numbers of households that reported at least one member hunting SSLs were 199 (1992), 222 (1993), 210 (1994), 158 (1995), 130 (1996), 97 (1997), 111 (1998), 86 (2000), 98 (2001), 102 (2002), 97 (2003), and 98 (2004). In general, declines in the numbers of SSL hunters occurred at a time when SSLs became increasingly hard to find in local hunting areas and consequently more difficult and expensive to hunt. Rate of success, however, has not tracked in parallel with numbers of hunters or reported increases in time and effort necessary to hunt successfully. The proportion of unsuccessful hunting households for SSLs has been 30 percent (1992), 35 percent (1993), 40 percent (1994), 24 percent (1995), 35 percent (1996), 23 percent (1997), 33 percent (1998), 19 percent (2000), 21 percent (2001), 31 percent (2002), 22 percent (2003), and 22 percent (2004) (ADF&G 2005).

Steller Sea Lion Subsistence Methods

SSLs are taken for subsistence by a number of methods throughout the year. There is seasonal variation in the take. According to the 2003 ADF&G survey, while SSLs were reported taken in every month except June, success was greatest in November and lowest in May, June, and July. Unlike a number of other subsistence activities that are more broadly participatory, hunting for SSLs is a relatively specialized activity, and a relatively small core of highly successful hunters from a limited number of households account for most of the harvest. For the years surveyed, individuals from only 20 to 29 percent of all households in the relevant communities actually hunted SSL (Wolfe 2001). Once harvested, SSL is distributed among a much wider range of households than those participating in the harvest (Wolfe and Hutchinson-Scarbrough 1999; Wolfe 2001).

There has been some change in harvesting techniques over recent years, and there is also variation by region. For Kodiak Island communities, the SSL harvest used to take place at their haulouts, and 20 or 30 were transported at a time aboard purse seiners. Thus, one or two hunters could supply an entire village. Currently, hunting SSLs typically involves two or three individuals using skiffs to hunt in open water. The hauling capacity of such skiffs is one or two animals and Kodiak hunters prefer to take young adults of medium size rather than large bulls or young pups. Some SSLs are taken from locations where they are known to swim close to the shoreline. The animal is then retrieved using a skiff. Peak months for harvest are October through December (Hayes and Mishler 1991).

Hunting methods vary somewhat in the AI and Pribilof Islands and are documented in Wolfe and Mishler (1995). Pribilof Islands residents hunt SSLs almost exclusively from the shore and target swimming juvenile (mid-size) males. On St. Paul Island, SSL hunting is most commonly done from shore at Northeast Point, accessible by truck. St. Paul hunters take advantage of known SSL "swimways." Once shot, the hunter waits for the wind and sea to bring the carcass to shore, as heavy seas generally preclude the use of a skiff. A "sea dog" (a retrieval device consisting of a piece of wood with hooks attached to a 30- to 40-foot rope) assists in this process. Not all animals are recovered, but hunters try to shoot only those animals for which there is a high probability of eventual recovery. Hunters will at times hunt from skiffs in calm weather. SSL hunting on St. Paul occurs mainly from September through May and is predominately shorebased, as is hunting on St. George, which occurs mainly from January through May. SSL harvest in the Aleutian Chain (Atka, Unalaska, Akutan, and Nikolski) occurs mostly from skiffs in open water, and hunters target both sexes. When skiff travel is risky or for a change of pace, SSL hunting is also done from concealed shore stations. Aleutian Chain hunters will typically concentrate effort near haulout locations and take more adult and female animals than do Pribilof Islands hunters.

Declining SSL Populations and Subsistence Efforts

ADF&G has tried to address the possible linkage between the decline in the overall SSL population and a decrease in the SSL subsistence harvest effort between 1992 and 1998 (Wolfe and Mishler 1997 and 1998; Wolfe and Hutchinson-Scarbrough 1999; Wolfe 2001). They note that while the total number of SSLs harvested for subsistence use has decreased, interpretation of this change is not straightforward. A number of factors could be at work. For example, take of SSLs has decreased at the same time that the number of people hunting SSLs has decreased. One possibility is that take is down simply because fewer people are hunting. While it is not clear that the annual average harvest per hunter has declined (although ADF&G has not investigated this in a rigorous manner), it is likely that declining SSL populations play a role in the decisions people make regarding whether to hunt or not. ADF&G states:

> "… there are probably a variety of local factors related to the year-to-year changes in the number of households hunting SSLs in particular communities, including seasonal hunting conditions, local food needs, and personal circumstances of hunters. It is likely that the declines in the numbers of SSL hunters in many communities are because SSLs are increasingly harder to find and consequently more difficult and expensive to hunt. As SSLs become scarcer in a community's hunting area, an increasing number of hunters in the community probably choose to stop hunting them. While the hunters that continue to hunt appear to maintain annual harvest rates similar to past years, hunters probably are investing more time and money in pursuit of the SSL harvest. In addition to these factors, it is quite likely that some SSL hunters have chosen to reduce their hunting activity because of perceived problems with SSL populations" (Wolfe and Hutchinson-Scarbrough 1999:69, and essentially repeated in Wolfe 2001:77).

In earlier documents, ADF&G had also suggested that another factor in the decrease of SSL subsistence take may be the increased availability of seasonal wage employment in local communities. Some hunters may be choosing to work rather than to hunt, as a conscious economic choice of time allocation (Wolfe and Mishler 1997 and 1998). This explanation is not stressed as much in their 1999 report, being included more generally as

"… personal circumstances of hunters" (Wolfe and Hutchinson-Scarbrough 1999:69). It should be noted that hunting SSLs requires a considerable amount of effort and in most cases the cooperation of several people, so that time management and allocation could be a significant factor. Another possible reason for the decrease in SSL subsistence harvest could be the result of a cultural change in taste, such that the consumptive demand for SSLs may have decreased over time (e.g., younger generations, less exposed to regular consumption of SSLs, may not want to eat SSL as much as elders do). While this has been mentioned anecdotally during field research conducted for other projects, no documentation exists on this possible factor.

While the available information suggests some support for a direct relationship between the overall SSL population and the level of subsistence harvest, such support is not definitive and other factors cannot be excluded. Given the relatively small numbers involved, the concentrated efforts of a single hunter or just a few hunters can make a relatively large difference in community harvest totals. It does appear that present SSL harvest methods are likely to be more successful, and certainly more efficient, when animal populations (and density) are higher. The most recent numbers from the ADF&G survey concerning SSL takes suggest that the number of hunters have stabilized in recent years. They suggest that this stabilization is in response to local perceptions of problems with the SSL population, when some hunters decided to voluntarily abandon subsistence hunting until SSL numbers recovered (ADF&G 2005). A number of factors (e.g., cost, geographic convenience) may be at work, however, such that a recovery in SSL abundance may not necessarily result in a marked increase in subsistence take. At this point, more research is necessary to fully understand the complexity of the interplay between these different factors and how this interplay determines the subsistence demand for SSLs.

3.4.1.2 NFS Subsistence Harvesting

Harvest Levels and Regional Variation

The context of subsistence harvest and the information available to document harvest levels of NFSs is somewhat different from SSLs. Similar to the situation with SSLs, NFS harvest data are included in the comprehensive baseline ADF&G surveys that have now been conducted for most communities in Alaska. A second type of information derives from annual subsistence harvest reporting conducted in the Pribilof Islands, where subsistence takes of NFSs are highly concentrated.

Table 3.4-9 provides documented total community harvest information extracted from the ADF&G Community Profile Database for all communities outside of the Pribilof Islands. As shown in the table, only three non-Pribilof communities, the Aleutian communities of Akutan, Nikolski, and Unalaska, show any level of harvest for NFSs for any ADF&G survey year. For Akutan, during the single year documented, NFS harvests accounted for about 2 percent of the total subsistence harvest in the community. For Nikolski and Unalaska, NFS harvests accounted for about 0.2 of 1 percent and less than 0.1 of 1 percent of total community subsistence harvest, respectively. As noted in the SSL subsistence discussion, community surveys are not repeated on a regular basis, and multiple comprehensive studies of a community at different times are typically performed in relation to other ongoing studies or directed towards specific resource management questions.

Table 3.4-10 provides documented NFS subsistence harvest information for the communities of St. Paul and St. George from 1985-2003. Subsistence harvests declined dramatically over this period in both communities. Precise reasons for this decline are unknown, but, like SSL subsistence harvesting, there is some suggestion from community members for a direct relationship between the overall NFS population and the level of yearly subsistence take. Members of the communities of St. Paul and St. George have also suggested that a declining number of elders within the community and an overall change in food preference by younger generations of residents have led to decreased demand and therefore a decreased take of NFS for subsistence. It is additionally possible that takes have declined over the years due to a perceived health risk from eating large quantities of NFS, which are suspected to contain high levels of mercury. Reports from local community members also suggest that the biology of the NFS has changed over time, resulting in a different, unnatural taste. Finally, the commercial fishing and subsistence harvest seasons coincide, reportedly resulting in a labor shortage for the subsistence harvest as more and more able-bodied men are employed by the fishing industry. At this point, however, more research is necessary to fully understand the complexity and interplay of these factors and how this interaction determines the subsistence demand for NFSs.

Northern Fur Seal Subsistence Methods

Commercial harvest of NFSs on the Pribilof Islands began shortly after the first known discovery of the islands in 1786. The commercial harvest was continued by the U.S. when the Pribilof Islands came under U.S. jurisdiction, with the purchase of Alaska from Russia in 1867. On October 14, 1984, the Interim Convention on the Conservation of NFSs, which authorized the commercial harvest, expired and Congress failed to ratify a new treaty extension. Because domestic law did not provide for a commercial harvest of marine mammals in the U.S., the commercial harvest of NFSs was then terminated.

The method of subsistence harvest of NFSs on the Pribilof Islands is a direct outgrowth of the commercial harvest that took place on the islands for many generations. The history of the island communities has been intertwined with the history of NFS harvest since its inception, when Russians relocated Aleuts from villages on the Aleutian Chain to the previously uninhabited Pribilof Islands to work the harvest.

The Fur Seal Act of 1966 authorized the taking of NFSs by Alaska Natives for subsistence purposes. Under 16 U.S.C. 1153(b), Indians, Aleuts, and Eskimos who live on the Pribilof Islands can take NFSs for subsistence purposes as defined in 16 U.S.C. 1379(f)(2) under such conditions as recommended by the North Pacific Fur Seal Commission and accepted by the Secretary of State pursuant to regulations promulgated by the Secretary.

Following the termination of the commercial harvest, NMFS issued an emergency interim rule on July 8, 1985, to govern the subsistence taking of NFSs for the 1985 season under the authority of Section 105(a) of the Fur Seal Act. A final rule was published on July 9, 1985. The subsistence harvest of NFSs on the Pribilof Islands, Alaska, is governed by regulations found in 50 CFR part 216 subpart F--Taking for Subsistence Purposes. These regulations were published under the authority of the Fur Seal Act, 16 U.S.C. 1151, *et seq.*, and the MMPA, 16 U.S.C. 1361, *et seq.* (see 51 FR 24828, July 9, 1986). The purpose of these regulations was to limit the take of

NFSs to a level providing for the subsistence needs of the Pribilof Aleuts using humane harvesting methods, and to restrict taking by sex, age, and season for herd management purposes.

Given this historical and legislative context, the subsistence harvest of NFSs is very different from what is seen with the harvest of SSLs elsewhere and is conducted in the Pribilof Islands as an organized, land-based, group activity. The following description of the harvest is abstracted from the NFS subsistence harvest EIS (Ferraro 2002) and gives a sense of the organization of the harvest and the number of individuals and roles involved, in contrast to what is seen in SSL harvesting. NFS harvesting may be characterized as more of a communal activity, whereas SSL harvesting tends to be pursued by individual hunters or very small groups of hunters. While SSL harvests may ultimately benefit substantial numbers of community residents through distribution and redistribution of the harvest, NFS harvests themselves more directly involve larger numbers of community residents in a more immediate manner.

The structure and conduct of the subsistence harvest established by the regulations is essentially the same as was developed and applied to the commercial harvest, whereby a harvest foreman makes the onsite decisions and supervises the entire harvest event. The specific locations from and frequency by which NFSs can be harvested are specified by the regulations, which permit only the taking of sub-adult male NFSs from haulout areas. Only experienced sealers can participate in the most important elements of the harvest, which are organized and managed by the harvest foreman. Additionally, a certified veterinarian with expertise regarding NFSs is contracted by NMFS to serve as the Humane

Observer for the harvest. The Humane Observer works interactively with the harvest operation and foreman regarding the physical parameters and condition of the seals.

If the decision is to proceed, the harvest crew is assembled and the harvest foreman selects those who will go to the haulout area to round up a group of sub-adult males from the herd, which is then slowly driven to the harvest area. The round-up crew, accompanied by the Humane Observer, selects that part of the herd composed mostly of two- to four-year-old males as the harvest group. Females and any male NFSs beyond four years old are excluded from the drive to the harvest area as soon as possible. Pups are very rarely involved in the round-up and drive as they are seldom found on the haulout areas during the harvest season.

Once the drive ends at the harvest area, the animals are left to rest and cool down in a loose group. The harvest foreman stations and directs the "watchboys," usually ranging in age from 9 to 18 years old, around the group to keep it together. When the harvest foreman and Humane Observer decide that the grouped NFSs are sufficiently rested and cooled, the foreman directs the "pod cutters" to begin separating a small pod of seals from the herd. Two pod cutters, each with a long club inserted into the opening of a square 5-gallon metal coffee container, cut into the herd at sides opposing one another. They run the containers along the ground, which both produces a noise and serves to separate, and effectively cut out a pod of NFSs from the herd. The number of "stunners" (individuals who will actually take the animals as described below) available determines the number in a pod. This disturbance effectively separates out the harvestable seals, and the remaining seals are allowed to return to the haulout areas from which they came.

Once this pod is isolated from the herd, the foreman directs the "stunners" to begin taking the animals down. This is the most important part of the harvest event and thus the stunners are those individuals who are the most experienced and/or proficient in using a hardwood club approximately 5 to 6 feet long to deliver a swift blow to the back of the animal's head. The skull of an NFS is relatively thin; therefore, such a blow effectively and immediately renders the animal unconscious.

As each NFS is taken down by the stunners, one or more of the most experienced sealers make a quick incision to the chest cavity to disable the diaphragm and the heart, thereby ensuring the animal will not regain consciousness or incur suffering. Once the harvestable NFSs have been taken, the harvest crew proceeds to butcher the carcasses as soon as possible to prevent spoilage. The process is repeated until the subsistence needs are met for that day. The rest of the herd is released into the haulout area from which they came. The meat is distributed to individual subsistence households or frozen for future use by the community. This process is repeated throughout the harvest season.

NFS Populations and Subsistence Efforts

As described in Section 3.2.1.13, NMFS entered into co-management agreements with the Tribal Governments of St. Paul and St. George under Section 119 of the MMPA in 2000 and 2001, respectively. These agreements are specific to the conservation and management of NFSs and SSLs in the Pribilof Islands, with particular attention to the subsistence take and use of these animals. NMFS has worked with both communities to integrate the agreements into one management plan for the purpose of recovering and maintaining SSL and NFS populations to levels that provide for a sustainable subsistence take of these species in the Pribilof Islands region.

To initiate the harvest, NMFS publishes a proposed annual subsistence harvest estimate. The purpose of the notice is to provide an estimate for the annual subsistence need for St. Paul and St. George. To minimize negative effects on the NFS population, the subsistence harvest has been limited to a 47-day harvest season (June 23-August 8), during which only sub-adult male NFSs may be taken. Further, the regulations governing the harvest require that it be conducted and managed in the most non-wasteful manner possible.

These established harvest methods have generally remained unchanged since the adoption of co-management. However, an important change has occurred regarding the annual documentation of each individual harvest event. Prior to the co-management era, a NMFS employee was present in the field at each individual harvest event, in addition to the harvest foreman and Humane Observer, to monitor the conduct of harvest per the regulations, document the number of NFSs taken, and record other information. These functions are now fulfilled by the respective local tribal governments.

Prior to the 1994 subsistence harvest, NMFS, in cooperation with the Tribal Governments of each island, conducted an annual household survey of the local subsistence communities to estimate the number of NFSs required to meet their subsistence needs for that year. NMFS would then publish the proposed estimates in the FR for comment prior to finalizing the number of NFS that could be taken on each island. These estimates were set for each island and consisted of a lower and upper range. In 1994, the manner in which the harvest take ranges were established was changed by setting the ranges for a three-year period rather than annually. In 1996, NMFS requested that the Tribal Government of each island determine the number of NFSs that would be needed by their communities each year for the three-year period 1997 through 1999. The approach was repeated for the period 2000-2002.

Table 3.4-9
Documented total community subsistence harvest and relative dependence on NFS harvest,[1] Aleutian Island communities.

Community	Region	Year	Total community subsistence harvest (edible pounds)	Northern fur seal		
				Number harvested	Edible pounds	% Community harvest
Akutan	SW	1990	47,397	67	1,005	2.1
Nikolski	SW	1990	36,945	6	90	0.2
Unalaska	SW	1994	355,081	7	105	< 0.1

Notes: [1]Little information is available on NFS subsistence harvests outside of the Pribilof Islands in the ADF&G CPDB and the years and communities shown represent all of the available harvest information in the database. Atka and Sitka do not appear in the database for fur seal harvests, but they do show up as having received at least a small amount of fur seal products from subsistence harvests elsewhere one year each (1994 and 1996, respectively). ADF&G does only limited surveys and subsistence use can vary greatly year to year.
Source: ADF&G CPDB, accessed March, 2004.

Table 3.4-10
Subsistence harvest levels for NFSs on the Pribilof Islands, 1985 - 2003

Year	Subsistence Take Ranges		Actual Harvest Levels	
	St. Paul	St. George	St. Paul	St. George
1985	–	–	3,384	329
1986	2,400-8,000	800-1,800	1,299	124
1987	1,600-2,400	533-1,800	1,710	92
1988	1,800-2,200	600- 740	1,145	113
1989	1,600-1,800	533- 600	1,340	181
1990	1,145-1,800	181- 500	1,077	164
1991	1,145-1,800	181- 500	1,645	281
1992	1,645-2,000	281- 500	1,482	194
1993	1,645-2,000	281- 500	1,518	319
1994	1,645-2,000	281- 500	1,616	161
1995	1,645-2,000	281- 500	1,525	260
1996	1,645-2,000	281- 500	1,591	232
1997	1,645-2,000	300- 500	1,153	227
1998	1,645-2,000	300- 500	1,297	256
1999	1,645-2,000	300- 500	1,000	193
2000	1,645-2,000	300- 500	754	121
2001	1,645-2,000	300- 500	597	184
2002	1,645-2,000	300- 500	648	203
2003	1,645-2,000	300- 500	522	132

Source: NOAA, 2005

3.4.2 Commercial Fishing

Much federally funded research on SSLs and NFSs has, in the past, been directly or indirectly associated with management of commercial fisheries. As discussed in Section 3.2.1.11, during the late 1990s, SSL research activities were intensified as recent scientific findings, litigation, and new legislation focused increasing attention on the ongoing SSL population decline and concern over possible impacts by commercial fisheries in Alaskan waters. In 2001, the measures proposed and analyzed in the *Steller Sea Lion Protection Measures Final Supplemental Environmental Impact Statement* prepared by NMFS Alaska Regional Office directly involved changes in the management of the Alaska groundfish fishery with an aim to minimize impacts of the fishery on SSLs based on information from research on SSLs. The protection measures disperse fishing over time and area to protect against potential competition for SSL prey species near rookeries and important haulouts. The benefits of the measures consist of improvements to SSL populations; excluding commercial fishing leaves more prey for sea lions. The primary cost of the measures is the potential reduction in profits that occurs as boats incur additional costs as they travel to more distant locations and/or experience lower levels of catch in alternative fishing areas.

Section 3.2.1.11 notes that the possibility that the Alaska groundfish fishery might face additional costly restrictions as a result of scientific uncertainty about the decline of SSLs led to increased funding for SSL research. It was hoped that with this funding the fishery could remain open while, simultaneously, more research and protection of SSLs could occur.

To date, the Alaska groundfish fishery has been the only fishery directly affected by SSL protection measures. However, as indicated in Section 3.2.6.2, dozens of commercial fisheries operating in waters off Alaska and the west coasts of Canada and the U.S. are within the geographic range of the SSL and NFS; these fisheries could potentially affect the populations of SSLs and NFSs through competition for prey, direct mortality, or disturbance. This section provides a broad economic overview of the various fisheries that may occur within the project area. Economic data on each fishery are summarized in tables.

3.4.3 Alaska Commercial Fisheries

This section divides the pertinent Alaska fisheries into two broad segments: 1) non-groundfish and 2) groundfish. The division is based primarily on the availability of data. In general, the State of Alaska, through ADF&G and the Commercial Fisheries Entry Commission (CFEC), maintains fishery statistics for all fisheries that are either primarily managed by the state or are processed onshore. These fisheries include most non-groundfish fisheries. The groundfish fishery is the only fishery in Alaska that both is managed primarily by the federal government and which processes a significant portion of the fish at sea. Because of this, detailed data on groundfish are more easily accessible through federal sources. In particular, this EIS draws on information provided in "Economic Status of the Groundfish Fisheries off Alaska, 2004" (Hiatt 2005), which was published by NMFS AFSC as part of the most recent "Stock Assessment and Fishery Evaluation Report for the Groundfish Fisheries of the Gulf of Alaska and Bering Sea/AI Area."

Table 3.4-11 provides an overview of the ex-vessel value of the five major species groups targeted in Alaska's fisheries. Groundfish accounted for more than half of the total ex-vessel revenue. Ex-vessel value is defined by ADF&G as "the post-season adjusted price per pound for the first purchase of commercial harvest."

Table 3.4-11
Overview of Fisheries by Major Species in Real Dollars, 2000-2004

Year	Shellfish	Salmon	Herring	Halibut	Groundfish	Total
	($Millions Adjusted to 2004 Dollars)					
2000	155.5	268.9	10.5	147.0	652.2	1,234.1
2001	131.5	200.7	11.1	127.0	623.1	1,093.4
2002	156.0	136.1	9.5	135.1	648.9	1,085.6
2003	180.1	172.6	9.1	170.3	626.5	1,158.6
2004	165.4	225.3	13.7	168.7	592.9	1,166.0
Source: Hiatt 2005.						

3.4.3.1 Non-Groundfish Fisheries

This section summarizes economic information on the non-groundfish fisheries in Alaska. These fisheries include the salmon, herring, halibut, crab, other shellfish, and sablefish fisheries. Table 3.4-12 includes data on total catch and ex-vessel value for the years 2001 to 2004.

Table 3.4-12
Overview of All Non-Groundfish Fisheries by Species, 2001-2004

Species	2001	2002	2003	2004
	Total Catch (Thousands of Pounds)			
Crab	47,342	57,930	57,170	52,841
Halibut	56,651	59,191	58,972	57,983
Herring	84,727	69,541	73,078	70,886
Other shellfish	7,152	8,240	8,754	7,898
Sablefish	32,313	33,192	38,198	39,108
Salmon	689,428	524,177	635,835	697,892
Ex-Vessel Value ($Millions)				
Crab	116.0	142.3	167.8	154.0
Halibut	110.6	127.5	163.4	169.4
Herring	13.0	11.7	11.9	14.0
Other shellfish	8.7	9.6	10.0	11.9
Sablefish	60.6	63.1	80.5	74.2
Salmon	205.1	145.0	193.1	255.0
Source: CFEC Fishery Statistics, http://www.cfec.state.ak.us/fishery_statistics/earnings.htm.				

3.4.3.2 Groundfish Fishery

Tables 3.4-13 through 3.4-15 are presented in this section to privide an economic summary of the Alaska groundfish fishery. Data presented include landings and ex-vessel value by major species groups, gear, and fishery area.

Table 3.4-13
Gulf of Alaska Groundfish Catch by Species, Gear and Target Fishery, 2003-2004

Year	Target Fishery	Species											
		Pollock	Sable-fish	Pacific Cod	Arrow-tooth	Flathd. sole	Rex Sole	Flat Deep	Flat Shallow	Rock-fish	Atka Mack.	Other	Total
		(Thousands of Metric Tons, Round Weight)											
2003	**Hook & Line**												
	Sablefish	0.0	13.2	0.1	0.3	0.0	0.0	0.0	0.0	0.9	0.0	0.2	14.7
	Pacific cod	0.0	0.0	12.4	0.0	0.0	-	0.0	0.0	0.0	0.0	0.8	13.3
	Rockfish	-	0.0	0.0	-	-	-	-	-	0.5	-	0.0	0.5
	Halibut	-	0.5	0.4	0.1	0.0	0.0	0.0	0.0	0.4	-	0.4	1.7
	Total	0.1	13.7	13.0	0.3	0.0	0.0	0.0	0.0	1.8	0.0	2.8	31.7
	Pot												
	Pacific cod	0.0	-	20.7	0.0	0.0	-	-	0.0	0.0	0.0	0.4	21.2
	Total	0.0	-	20.7	0.0	0.0	-	-	0.0	0.0	0.0	0.4	21.2
	Trawl												
	Pollock, bottom	3.2	0.0	0.1	0.4	0.1	0.0	0.0	0.0	0.0	-	0.0	3.8
	Pollock, pelagic	46.2	0.0	0.2	0.3	0.1	0.0	-	0.0	0.2	0.0	0.2	47.1
	Pacific cod	0.3	0.0	13.3	1.1	0.2	0.1	0.0	0.6	0.1	0.0	0.3	16.0
	Arrowtooth	0.3	0.3	0.8	15.1	0.4	1.0	0.2	0.1	1.0	0.0	0.3	19.6
	Flathead sole	0.1	0.0	0.3	2.2	0.9	0.1	0.0	0.1	0.1	0.0	0.3	4.2
	Rex sole	0.1	0.1	0.6	5.9	0.4	2.2	0.2	0.0	0.5	0.0	0.5	10.6
	Flatfish, deep	0.0	0.1	0.0	0.2	0.0	0.0	0.3	0.0	0.1	-	0.0	0.8
	Flatfish, shallow	0.1	0.0	1.6	2.2	0.4	0.0	0.0	3.4	0.0	0.0	0.7	8.5
	Rockfish	0.3	1.2	1.7	1.4	0.1	0.2	0.1	0.1	19.7	0.4	0.2	25.4
	Total	50.6	1.8	18.9	29.9	2.5	3.6	0.9	4.6	21.8	0.6	3.2	138.3
	Total												
	Total	50.7	15.5	52.6	30.2	2.5	3.6	0.9	4.6	23.6	0.6	6.4	191.1
2004	**Hook & Line**												
	Sablefish	0.0	14.8	0.1	0.2	0.0	-	0.0	0.0	0.9	0.0	0.4	16.4
	Pacific cod	0.0	0.0	13.1	0.1	0.0	-	0.0	0.0	0.1	0.0	0.9	14.2
	Rockfish	-	0.0	0.0	-	-	-	-	-	0.3	-	-	0.5
	Halibut	0.0	0.8	0.3	0.0	0.0	-	0.0	0.0	0.2	0.0	0.1	1.5
	Total	2.0	15.6	13.5	0.3	0.0	-	0.0	0.0	1.5	0.0	1.8	33.0
	Pot												
	Pacific cod	0.0	-	25.6	0.0	0.0	0.0	-	0.0	0.0	0.0	0.6	26.2
	Total	0.0	-	25.6	0.0	0.0	0.0	-	0.0	0.0	0.0	0.6	26.2
	Trawl												
	Pollock, bottom	9.6	0.0	0.3	0.7	0.2	0.0	0.0	0.0	0.1	0.0	0.1	11.1
	Pollock, pelagic	53.1	0.0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.2	53.9
	Sablefish	-	0.1	-	0.0	0.0	0.0	0.0	-	0.0	-	0.0	0.2
	Pacific cod	0.2	0.0	13.5	1.6	0.1	0.1	0.0	0.8	0.3	0.0	0.2	16.8
	Arrowtooth	0.2	0.1	0.5	6.0	0.8	0.2	0.1	0.3	0.1	0.0	0.4	8.5
	Flathead sole	0.0	0.0	0.2	1.5	0.9	0.2	0.0	0.0	0.0	0.0	0.1	3.1
	Rex sole	0.0	0.0	0.2	2.0	0.1	0.7	0.0	0.0	0.3	0.0	0.1	3.5
	Flatfish, deep	0.0	0.1	0.1	0.3	0.0	0.0	0.5	0.0	0.0	-	0.0	1.2
	Flatfish, shallow	0.1	0.0	0.8	0.7	0.2	0.0	0.0	1.8	0.0	0.0	0.5	4.1
	Rockfish	0.4	1.0	1.7	1.8	0.1	0.1	0.1	0.1	19.7	0.7	0.1	25.9
	Total	63.7	1.3	17.6	15.0	2.4	1.5	0.7	3.1	20.6	0.8	2.2	128.8
	Total												
	Total	63.9	16.9	56.7	15.3	2.4	1.5	0.7	3.1	22.1	0.8	4.6	188.0

Note: Totals may include additional categories. The target, determined by AFSC staff, is based on processor, week, processing mode, NMFS area, and gear. These estimates include only catch counted against federal total allowable catch.
Source: Hiatt 2005.

Table 3.4-14
Bering Sea and AI Groundfish Catch by Species, Gear and Target Fishery, 2003-2004

Year	Target Fishery	Species												
		Pollock	Sable-fish	Pacific Cod	Arrow-tooth	Flathd. sole	Rock Sole	Turbot	Yellow-fin	Flat Other	Rock-fish	Atka Mack.	Other	Total
	(Thousands of Metric Tons, Round Weight)													
2003	**Hook & Line**													
	Sablefish	0.0	0.7	0.0	0.1	0.0	-	0.6	-	0.0	0.1	0.0	0.1	1.6
	Pacific Cod	7.1	0.1	107.9	1.3	0.4	0.0	0.2	0.6	0.1	0.1	0.0	16.7	134.6
	Turbot	0.0	0.1	0.0	0.2	0.0	0.0	1.6	-	0.0	0.1	0.0	0.2	2.2
	Halibut	0.0	0.2	0.1	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.3	1.1
	Total	7.1	1.2	108.1	1.6	0.4	0.0	2.5	0.6	0.1	0.4	0.0	17.4	139.6
	Pot													
	Sablefish	0.0	0.7	0.0	0.1	0.0	0.0	0.1	-	0.0	0.0	0.0	0.0	0.9
	Pacific Cod	0.0	0.0	22.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.4	22.7
	Total	0.0	0.7	22.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.4	23.6
	Trawl													
	Pollock, bottom	14.1	0.0	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.3	0.4	0.3	15.6
	Pollock, pelagic	1,440.3	0.0	5.8	0.6	1.6	1.3	0.0	0.1	0.2	0.8	0.4	1.4	1,452.6
	Pacific Cod	9.8	0.1	61.3	4.9	1.5	6.1	0.1	1.1	1.3	0.5	4.9	3.1	94.7
	Arrowtooth	0.2	0.0	0.1	1.2	0.1	0.0	0.2	0.0	0.2	0.1	0.0	0.1	2.4
	Flathead sole	3.0	0.0	1.8	2.1	6.5	1.2	0.1	2.5	0.7	0.1	0.0	1.0	18.9
	Rock sole	5.0	0.0	3.4	0.4	0.8	19.5	0.0	6.6	1.2	0.0	0.0	1.0	38.0
	Turbot	0.1	0.0	0.0	0.2	0.1	0.0	0.2	0.0	0.0	0.0	-	0.0	0.7
	Yellowfin	11.8	-	4.7	1.1	2.9	8.5	0.0	69.8	9.0	0.0	0.0	3.2	111.0
	Other flatfish	0.1	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	1.0
	Rockfish	0.5	0.0	0.3	0.5	0.0	0.0	0.2	-	0.0	11.1	0.7	0.1	13.5
	Atka mackerel	0.5	0.0	1.9	0.3	0.0	0.2	0.1	0.0	0.0	7.4	51.6	0.5	62.6
	Total	1,485.5	0.2	79.7	11.8	13.8	37.0	0.9	80.3	12.9	20.4	58.2	11.0	1,811.8
	Total													
	Total	1,492.7	2.1	209.8	13.6	14.3	37.0	3.5	81.0	13.0	20.8	58.4	28.8	1,975.0

Table 3.4-14 (continued)
Bering Sea and AI Groundfish Catch by Species, Gear and Target Fishery, 2003-2004

Year	Target Fishery	Species												
		Pollock	Sable-fish	Pacific Cod	Arrow-tooth	Flathd. sole	Rock Sole	Turbot	Yellow-fin	Flat Other	Rock-fish	Atka Mack.	Other	Total
	(Thousands of Metric Tons, Round Weight)													
2004	**Hook & Line**													
	Sablefish	-	0.6	0.0	0.0	-	-	0.1	-	-	0.1	0.0	0.0	0.8
	Pacific Cod	5.3	0.0	112.8	1.4	0.6	0.0	0.2	0.6	0.2	0.2	0.0	18.6	140.0
	Turbot	0.0	0.1	0.0	0.2	0.0	0.0	1.2	-	0.0	0.1	0.0	0.1	1.7
	Halibut	0.0	0.2	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3	0.7
	Total	5.4	0.9	113.0	1.6	0.6	0.0	1.5	0.6	0.2	0.4	0.0	19.1	143.3
	Pot													
	Sablefish	0.0	0.8	0.0	0.1	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.9
	Pacific Cod	0.0	0.0	17.2	0.0	0.0	0.0	-	0.1	0.0	0.0	0.1	0.3	17.7
	Total	0.0	0.8	17.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.5	18.9
	Trawl													
	Pollock, bottom	17.4	0.0	0.2	0.1	0.1	0.3	0.0	0.2	0.2	0.1	0.6	0.3	19.5
	Pollock, pelagic	1,418.3	0.0	6.2	0.5	2.0	2.3	0.0	0.7	0.3	0.4	0.4	1.8	1,433.0
	Sablefish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.1
	Pacific Cod	13.7	0.1	62.1	8.0	2.8	9.2	0.1	1.8	2.4	0.5	4.7	3.4	108.9
	Arrowtooth	0.5	0.1	0.2	1.6	0.1	0.0	0.1	0.0	0.3	0.1	0.4	0.1	3.4
	Flathead sole	5.3	0.0	2.8	3.8	9.7	2.1	0.2	2.4	0.7	0.1	0.0	1.8	29.0
	Rock sole	8.9	0.0	5.6	0.3	0.9	24.3	0.0	3.9	1.9	0.0	0.0	0.8	46.8
	Turbot	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	-	0.0	0.3
	Yellowfin	10.4	0.0	3.6	0.3	1.1	10.1	0.0	65.6	6.3	0.0	0.0	1.6	99.0
	Other flatfish	0.6	0.0	0.2	0.9	0.1	0.1	0.0	0.0	0.3	0.0	0.1	0.1	2.6
	Rockfish	0.3	0.0	0.2	0.4	0.0	0.0	0.1	-	0.0	9.0	0.4	0.1	10.4
	Atka mackerel	0.5	0.0	2.4	0.4	0.0	0.2	0.1	0.0	0.1	7.1	53.6	0.7	65.2
	Total	1,476.1	0.3	83.5	16.5	16.8	48.6	0.7	74.7	12.7	17.3	60.3	10.9	1,818.4
	Total													
	Total	1,481.4	2.0	213.8	18.2	17.4	48.7	2.2	75.4	12.8	17.7	60.5	30.5	1,980.6

Note: Totals may include additional categories. The target, determined by AFSC staff, is based on processor, week, processing mode, NMFS area, and gear. These estimates include only catch counted against federal total allowable catch.
Source: Hiatt 2005.

Table 3.4-15
Ex-Vessel Value of Groundfish Fishery by Area, Vessel Category, Gear and Species, 2000-2004

Species	Year	Gulf of Alaska			Bering Sea/Aleutian Islands			All Alaska		
		Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total
		($Millions)								
All Gears										
Atka mackerel	2000	0.0	0.0	0.0	0.0	9.4	9.4	0.0	9.5	9.5
	2001		0.0	0.0	0.0	21.0	21.0	0.0	21.1	21.1
	2002	0.0	0.0	0.0	0.1	11.1	11.1	0.1	11.1	11.2
	2003	0.0	0.1	0.1	0.1	9.7	9.8	0.1	9.8	9.9
	2004	0.0	0.1	0.1	0.2	12.2	12.3	0.2	12.3	12.5
Flatfish	2000	2.8	1.6	4.4	1.3	36.2	37.5	4.1	37.8	41.9
	2001	2.3	1.4	3.6	0.6	27.1	27.7	2.9	28.4	31.3
	2002	2.0	1.5	3.5	0.5	33.5	34.0	2.5	35.0	37.5
	2003	1.4	2.2	3.6	0.6	32.1	32.7	1.9	34.4	36.3
	2004	1.4	0.6	2.0	0.7	39.2	39.9	2.1	39.8	41.9
Pacific cod	2000	37.5	6.6	44.1	33.0	83.9	116.9	70.5	90.4	161.0
	2001	24.9	5.6	30.4	17.8	78.7	96.4	42.6	84.2	126.9
	2002	39.4	5.8	45.2	20.4	70.2	90.6	59.8	76.0	135.8
	2003	27.5	5.1	32.6	34.3	89.2	123.5	61.8	94.2	156.1
	2004	27.5	3.8	31.3	24.0	84.1	108.0	51.5	87.8	139.3
Pollock	2000	20.2	0.1	20.2	155.1	122.8	277.9	175.3	122.8	298.1
	2001	19.1	0.0	19.1	177.0	138.8	315.8	196.1	138.8	334.9
	2002	11.9	0.0	12.0	197.5	149.4	347.0	209.5	149.5	358.9
	2003	10.3	0.1	10.4	181.3	120.7	302.0	191.5	120.8	312.4
	2004	12.1	0.0	12.2	185.5	149.6	335.1	197.7	149.6	347.3
Rockfish	2000	4.9	2.9	7.9	0.1	3.0	3.1	5.0	5.9	11.0
	2001	3.3	2.2	5.5	0.2	2.6	2.8	3.5	4.8	8.3
	2002	4.4	3.1	7.5	0.2	3.0	3.3	4.6	6.2	10.8
	2003	4.8	3.1	7.9	0.2	3.8	4.0	5.0	6.9	11.8
	2004	4.7	3.7	8.5	0.2	3.8	4.0	4.9	7.5	12.4
Sablefish	2000	60.3	9.0	69.2	3.0	3.6	6.6	63.2	12.6	75.8
	2001	47.9	7.4	55.2	4.5	2.2	6.7	52.3	9.6	61.9
	2002	48.6	8.9	57.5	4.5	2.4	6.9	53.0	11.3	64.4
	2003	62.4	9.8	72.2	6.4	2.6	9.0	68.8	12.4	81.2
	2004	60.2	9.1	69.2	1.9	1.9	3.8	62.1	11.0	73.1
All species	2000	125.9	20.1	146.0	192.5	259.1	451.5	318.4	279.2	597.6
	2001	97.5	16.5	114.1	200.1	270.5	470.6	297.6	287.0	584.6
	2002	106.5	19.5	126.0	223.2	269.8	493.0	329.6	289.3	619.0
	2003	107.1	20.7	127.7	222.9	258.7	481.6	330.0	279.3	609.3
	2004	106.2	17.5	123.7	213.1	293.5	506.6	319.2	311.0	630.2
Hook and line										
Flatfish	2000	0.5	0.0	0.5	0.1	3.1	3.2	0.5	3.1	3.7
	2001		0.0	0.0	0.1	1.2	1.3	0.1	1.2	1.3
	2002		0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0
	2003		0.0	0.0		0.9	0.9		0.9	0.9
	2004		0.0	0.0		0.7	0.7		0.7	0.7
Pacific cod	2000	5.9	4.3	10.2	0.6	65.3	65.9	6.5	69.6	76.2
	2001	5.1	2.9	8.0	0.9	63.0	63.8	5.9	65.8	71.8
	2002	22.2	5.0	27.1	3.0	54.4	57.4	25.2	59.3	84.5
	2003	4.7	4.1	8.8	0.4	67.3	67.8	5.1	71.5	76.5
	2004	5.4	2.9	8.3	0.5	63.5	64.0	5.8	66.4	72.2

Table 3.4-15 (continued)
Ex-Vessel Value of Groundfish Fishery by Area, Vessel Category, Gear and Species, 2000-2004

Species	Year	Gulf of Alaska			Bering Sea/Aleutian Islands			All Alaska		
		Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total
		($Millions)								
Hook and line										
Rockfish	2000	2.2	0.2	2.4	0.1	0.3	0.4	2.3	0.5	2.8
	2001	1.9	0.2	2.1	0.2	0.2	0.4	2.1	0.4	2.5
	2002	2.0	0.2	2.1	0.2	0.2	0.3	2.1	0.3	2.5
	2003	1.6	0.3	1.8	0.1	0.2	0.3	1.7	0.5	2.2
	2004	1.7	0.2	2.0	0.1	0.2	0.3	1.8	0.4	2.2
Sablefish	2000	59.1	7.1	66.2	3.0	3.1	6.0	62.1	10.1	72.2
	2001	46.9	6.0	52.9	4.4	1.5	6.0	51.3	7.5	58.8
	2002	47.6	6.6	54.2	4.4	1.8	6.3	52.0	8.4	60.5
	2003	60.5	8.0	68.5	3.4	2.3	5.7	63.9	10.3	74.2
	2004	57.6	7.5	65.1	1.9	1.5	3.4	59.5	9.0	68.5
All Species	2000	69.4	11.6	81.0	3.8	72.8	76.5	73.2	84.3	157.5
	2001	53.9	9.0	62.9	5.6	67.2	72.7	59.4	76.2	135.6
	2002	71.7	11.8	83.5	7.7	58.7	66.4	79.4	70.5	149.9
	2003	67.2	12.5	79.6	3.9	72.2	76.1	71.1	84.7	155.7
	2004	64.8	10.7	75.5	2.4	69.5	71.9	67.2	80.2	147.4
Pot										
Pacific cod	2000	14.9	0.8	15.7	10.4	1.7	12.2	25.3	2.5	27.8
	2001	8.4	1.0	9.4	7.0	1.7	8.7	15.5	2.7	18.2
	2002	9.6	0.3	9.9	5.9	1.0	6.9	15.5	1.3	16.8
	2003	8.2	0.1	8.3	12.1	1.0	13.0	20.3	1.0	21.3
	2004	13.9	0.2	14.0	8.0	1.8	9.8	21.9	2.0	23.8
Trawl										
Atka mackerel	2000	0.0	0.0	0.0	0.0	9.4	9.4	0.0	9.5	9.5
	2001		0.0	0.0	0.0	21.0	21.0	0.0	21.0	21.0
	2002	0.0	0.0	0.0	0.1	11.1	11.1	0.1	11.1	11.2
	2003	0.0	0.1	0.1	0.1	9.7	9.8	0.1	9.8	9.9
	2004	0.0	0.1	0.1	0.2	12.2	12.3	0.2	12.3	12.5
Flatfish	2000	2.4	1.6	4.0	1.2	33.1	34.3	3.6	34.7	38.3
	2001	2.3	1.4	3.6	0.5	25.9	26.4	2.8	27.2	30.0
	2002	2.0	1.5	3.5	0.4	32.6	33.0	2.5	34.1	36.5
	2003	1.4	2.2	3.6	0.6	31.3	31.9	1.9	33.5	35.5
	2004	1.4	0.6	2.0	0.7	38.5	39.2	2.1	39.1	41.2
Pacific cod	2000	16.8	1.4	18.2	21.9	16.8	38.7	38.7	18.3	57.0
	2001	11.3	1.7	13.0	9.9	14.0	23.9	21.2	15.7	36.9
	2002	7.6	0.5	8.1	11.5	14.8	26.3	19.0	15.4	34.4
	2003	14.6	0.9	15.5	21.8	20.9	42.7	36.5	21.7	58.2
	2004	8.3	0.7	9.0	15.5	18.7	34.2	23.8	19.4	43.2
Pollock	2000	18.5	0.1	18.5	155.1	121.8	277.0	173.6	121.9	295.5
	2001	19.1	0.0	19.1	177.0	137.7	314.7	196.1	137.7	333.8
	2002	11.9	0.0	12.0	197.5	148.1	345.7	209.5	148.2	357.6
	2003	10.3	0.1	10.3	181.3	119.6	300.9	191.5	119.7	311.2
	2004	12.1	0.0	12.2	185.5	148.5	334.0	197.7	148.6	346.2
Rockfish	2000	2.7	2.7	5.4	0.0	2.7	2.7	2.7	5.5	8.2
	2001	1.4	2.0	3.5	0.0	2.4	2.4	1.5	4.4	5.9
	2002	2.4	3.0	5.4	0.1	2.9	2.9	2.5	5.8	8.3
	2003	3.2	2.8	6.0	0.0	3.6	3.6	3.3	6.4	9.7
	2004	3.0	3.5	6.5	0.1	3.6	3.7	3.1	7.1	10.2

Table 3.4-15 (continued)
Ex-Vessel Value of Groundfish Fishery by Area, Vessel Category, Gear and Species, 2000-2004

Species	Year	Gulf of Alaska			Bering Sea/Aleutian Islands			All Alaska		
		Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total	Catcher vessels	Catcher processors	Total
		($Millions)								
Trawl										
Sablefish	2000	1.2	1.9	3.0	0.0	0.6	0.6	1.2	2.5	3.6
	2001	1.0	1.4	2.4	0.0	0.7	0.7	1.0	2.1	3.1
	2002	1.0	2.4	3.3	0.0	0.5	0.6	1.0	2.9	3.9
	2003	1.9	1.8	3.7	0.0	0.3	0.3	1.9	2.1	4.0
	2004	2.6	1.6	4.1	0.0	0.4	0.4	2.6	2.0	4.6
All species	2000	41.6	7.7	49.3	178.3	184.6	362.8	219.8	192.3	412.1
	2001	35.2	6.5	41.7	187.5	201.6	389.1	222.7	208.1	430.8
	2002	25.0	7.4	32.4	209.6	210.1	419.7	234.6	217.6	452.1
	2003	31.7	8.1	39.8	203.9	185.5	389.4	235.6	193.6	429.2
	2004	27.4	6.7	34.1	202.1	222.2	424.3	229.5	228.8	458.4

Note: These estimates include only catch counted against federal total allowable catch. Ex-vessel value is calculated using prices in Hiatt (2005). All fish species includes additional species categories. The value added by at-sea processing is not included in these estimates of ex-vessel value.
Source Hiatt 2005.

3.4.3.3 U.S. West Coast Fisheries

This section summarizes economic information on the U.S. West Coast fisheries. The tables include information on the total landed catch and ex-vessel value for the years 2000 to 2005. All data are from the Pacific Coast Fisheries Information Network (PacFIN).

Table 3.4-17
Overview of U.S. West Coast Fisheries by Management Group, 2000-2005

Year	Coastal Pelagic	Crab	Groundfish	Highly Migratory	Other	Salmon	Shrimp
	Ex-Vessel Value ($ Millions)						
2000	42.27	77.29	65.12	32.71	35.80	24.34	21.88
2001	32.75	67.75	53.70	31.42	31.13	22.76	17.93
2002	33.26	73.14	44.94	22.17	31.41	27.53	22.52
2003	35.72	131.02	50.61	33.90	27.63	32.64	12.61
2004	32.94	114.44	49.99	33.29	29.79	48.86	12.41
2005	43.63	96.99	56.45	24.06	29.26	37.63	15.74
(Millions of Pounds, Round Weight)							
2000	499	37	279	32	26	22	37
2001	432	34	235	33	24	38	42
2002	404	42	170	29	26	45	59
2003	277	82	189	44	22	43	33
2004	317	69	277	37	22	43	22
2005	348	62	304	23	21	27	26

Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-18
Catch and Ex-Vessel Value of Groundfish Processed at Sea, 2000-2005

Year	Millions of Pounds, Round Weight	Ex-Vessel Value ($ Millions)
2000	267	106.74
2001	222	95.27
2002	187	78.33
2003	190	81.70
2004	265	103.35
2005	333	126.50

Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-19
Pelagic Catch by Gear Group, 2000-2005

Year	Shrimp Trawls	Troll Gear	Net Gear except Trawl	Shrimp Trawls	Misc.	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)					
2000	626	646	496,512	1	191	426
2001	1,381	300	430,219	0	*	132
2002	22	1	404,101	1	*	46
2003	170	2	277,078	1	132	33
2004	315	2	316,078	0	*	122
2005	219	0	347,702	*	*	34

Note: * No data available.
Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-20
Crab Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Pot and Trap Gear	Net Gear except Trawl	Shrimp Trawls	Misc.	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)					
2000	1	36,573	9	3	19	8
2001	0	33,604	16	6	19	0
2002	6	42,394	32	2	34	1
2003	2	81,660	37	1	19	*
2004	0	68,039	26	2	29	0
2005	0	61,683	14	0	27	0

Note: * No data available.
Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-21
Groundfish Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Troll Gear	Pot and Trap Gear	Net Gear except Trawl	Shrimp Trawls	Misc.	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)						
2000	266,170	78	2,135	245	685	*	10,089
2001	223,632	82	1,736	227	535	1	9,151
2002	160,296	50	1,220	151	197	6	7,937
2003	177,310	53	1,914	186	69	0	8,667
2004	265,822	88	1,865	149	52	*	8,790
2005	292,154	97	2,255	128	35	*	9,200

Note: * No data available.
Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-22
Highly Migratory Species Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Troll Gear	Net Gear except Trawl	Misc.	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)				
2000	3	17,771	7,247	199	6,662
2001	0	22,159	3,920	116	6,411
2002	0	17,217	3,285	200	7,896
2003	1	34,272	3,295	236	6,461
2004	1	30,190	2,550	154	3,847
2005	3	19,398	3,242	170	630

Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-23
Other Species Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Troll Gear	Pot and Trap Gear	Net Gear except Trawl	Shrimp Trawls	Misc.	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)						
2000	582	47	1,219	4,318	86	16,781	3,108
2001	818	66	1,016	3,632	126	14,930	3,310
2002	882	61	1,595	3,880	114	15,666	3,568
2003	746	60	1,853	4,221	193	11,756	2,737
2004	651	78	1,505	3,255	168	12,914	3,040
2005	1,096	77	2,331	2,766	108	12,154	2,632

Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

Table 3.4-24
Salmon Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Troll Gear	Net Gear except Trawl	Hook and Line Gear Except Troll
	(Thousands of Pounds, Round Weight)			
2000	15	8,084	13,683	14
2001	12	7,295	30,185	13
2002	6	11,140	33,962	116
2003	4	13,167	29,632	1
2004	28	12,463	30,526	66
2005	31	9,416	18,006	18

Note: * No data available.
Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html

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Table 3.4-25.
Shrimp Catch by Gear Group, 2000-2005

Year	Trawls except Shrimp Trawls	Pot and Trap Gear	Net Gear except Trawl	Shrimp Trawls	Misc.
	(Thousands of Pounds, Round Weight)				
2000	1,024	502	0	34,094	191
2001	1,068	527	1,017	39,161	217
2002	836	547	0	56,569	206
2003	613	582	0	31,111	224
2004	748	662	*	19,850	241
2005	642	665	*	24,009	211

Note: * No data available.
Source: PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html.

3.4.3.4 Canadian West Coast Fisheries

This section summarizes economic information on Canadian West Coast fisheries. Table 3.4.26 includes information on the total landed catch and ex-vessel value for the years 2000 to 2005. All data are from Fisheries and Oceans Canada.

Table 3.4-26.
Overview of Canadian West Coast Fisheries by Management Group, 2000-2005

Year	Coastal Pelagic	Crab	Groundfish	Highly Migratory	Other	Salmon	Shrimp
	Ex-Vessel Value (CAN$ Thousands)						
2000	49,831	21,591	92,815	5,619	40,115	52,412	38,289
2001	36,429	36,507	84,869	14,473	38,656	37,143	35,991
2002	37,107	28,166	75,882	8,094	43,188	57,294	22,972
2003	35,487	38,235	85,291	5,906	53,653	48,664	33,362
2004	27,914	47,134	82,884	2,017	44,679	52,622	30,387
2005	32,144	27,433	101,316	3,905	45,072	33,823	43,212
(Thousands of Pounds, Round Weight)							
2000	30,424	2,999	71,917	2,390	6,938	19,496	4,346
2001	24,389	5,767	110,628	3,652	6,571	24,729	4,379
2002	26,338	4,187	104,816	3,656	7,433	33,269	3,712
2003	28,848	7,075	120,554	2,718	7,737	38,551	3,497
2004	23,848	9,462	115,050	570	9,907	25,613	2,690
2005	28,779	5,294	147,430	1,039	9,647	27,043	2,862

Source: Fisheries and Oceans Canada Commercial Landings, http://www.dfo-mpo.gc.ca/communic/statistics/commercial/landings/seafisheries/index_e.htm.

3.5 Coastal Communities

Coastal communities associated with or near SSL and NFS research activities are varied and far-flung. For example, within Alaska alone, terrestrial survey sites for SSLs range from islands in the far western Aleutians to the U.S./Canadian border at the southern end of the southeast Alaska panhandle, an east-west distance of about 2,150 miles, equivalent to the distance from the Pacific coast of San Diego, California, to the Atlantic coast of Charleston, South Carolina. Along a north-south axis, SSL survey sites range nearly 1,800 miles from the northern reaches of the GOA to the northern California coast. Terrestrial survey sites for NFSs are more limited in number but are found on the Pribilof Islands and Bogoslof Island in the Bering Sea and the Channel Islands off the California coast, a geographic span of approximately 2,800 miles. Along these vast reaches of ocean and coast, communities vary from small villages to large metropolitan areas, but the number of research sites is limited and relatively few of the sites are immediately adjacent to communities or within their immediate resource use ranges. Also, community impacts associated with SSL and NFS research activities are more likely in some types of communities than others, such as small, relatively isolated communities.

Communities may experience impacts from SSL and NFS research activities in a number of ways. These include (1) direct interactions with communities in the course of permitted research-related activities, (2) interactions with community-based commercial fishing activities, (3) interactions with community-based SSL and NFS subsistence activities, and (4) environmental justice impacts. (Communities may also experience interactive impacts based on several different types of impacts occurring simultaneously.)

3.5.1 Direct Interactions with Communities During Research-Related Activities

Direct interactions, in the context of SSL and NFS research by permitted scientists and their staff, encompass four main types of interactions: ecological impacts, economic activities, educational/training activities, and sociocultural interactions that may generate their own type of social impacts. Ecological impacts involve the perceived effects of research on animals by local community members, as well as the displacement of subsistence hunting activities by research. In the case of SSL and NFS, however, research and subsistence activities are sufficiently dispersed to such a degree that displacement impacts were mentioned by neither researchers nor community members during the interview process detailed below. The remaining pertinent interactions are summarized by type in this section.

3.5.1.1 Background/Approach

Information, especially quantitative or specific community/spatial information, on how researchers interact with communities, necessary for this analysis, was not readily available and was recognized as a data gap to be addressed. To understand how scientists interact with local community members, a series of telephone interviews were conducted with permitted researchers, research team members, and local community leaders. The starting point for these interviews began with contacting researchers associated with four major research institutions/governmental entities: the ADF&G, the AFSC, the ASLC, and the University of British Columbia. To gather a wide range of experiences, however, 43 researchers representing 25 different institutions were contacted by email or phone for an interview. A total of 17 interviews were conducted with SSL and/or NFS researchers about how their research-related activities affected local communities. The purpose of these interviews was not to provide analysts with a statistically valid sample for quantitative analysis. Instead, these interviews were conducted in an attempt to capture the general nature, direction, and magnitude of interactions in broad terms. This information aids in understanding the types of potential community and social impacts. To gain a more holistic perspective, interviews were also done with local community members likely to interact with SSL and NFS researchers during their fieldwork. As explained below, locals in the Pribilof Islands are more likely to experience direct contact with visiting researchers, and three local community members in this area were chosen for interviews based on their previous interest in the EIS process.

An interview protocol featuring open-ended questions was used to guide the telephone interview. These questions covered several topical areas as outlined below.

- Questions started with a request for a general description of overall interaction during fieldwork and following this “grand tour” question, respondents were asked a number of more specific questions.
- The first few specific questions concerned economic-related activities, including economic expenditures in the communities, such as employment (e.g., hiring field assistants from the community) and private sector income (e.g., chartering vessels from community-based entities), among others. It was expected that these types of impacts would be relatively more important in communities with a small economic base than in larger communities with greater economic inputs.

- Interactions not directly economic in nature, such as educational or training programs (e.g., contributions to school curricula or research internship programs for local residents) were also explored through a series of open-ended questions. As with economic activities, the relative importance of these impacts was expected to be magnified in small, rural communities compared to communities with greater diversity of educational and training opportunities.
- Interviewees were also queried about researcher interactions with subsistence hunters of SSL and NFS. These relationships were explored through a series of questions aimed at illuminating the reasoning behind cooperation strategies, as well as the possible benefits of interaction between subsistence hunters and research staff.
- Finally, a general question was asked of respondents to recall their most memorable interaction with a member of a local community. This question was posed in an attempt to explore themes and issues possibly missed in previous, more structured questions and to allow respondents to explore what types of interactions were more meaningful to them.

Analysis of the information gathered through the interviews suggests that, in general, there are distinctions between SSL and NFS research activities that entail quite different types of community interaction between research staff and local community members. This difference in interaction can be largely attributed to the wide geographic range of SSL and the specific research strategies employed by SSL researchers. SSL research usually involves the chartering of a vessel in the more (relatively) demographically and economically diversified communities of Seward, Kodiak, Dutch Harbor, and Anchorage. Research is then done at sea, miles away from any community. For the majority of these researchers, time for community interaction is limited, at most, to a day of staging at the dock. The nature of interaction is generally economic in nature, with researchers purchasing minor supplies, car rentals, or a few meals at local restaurants.

The nature of interaction between NFS researchers and local community members, on the other hand, is generally quite involved. Because NFSs that are the primary subjects of research reside near the small, isolated communities of St. Paul and St. George, the presence of outside research staff is immediately noticed. Additionally, because NFS research is done largely in rookeries near the communities of St. Paul and St. George, researchers are not isolated from community members during active research. For the majority of these researchers, community interaction can and does happen at all times of the day. The nature of the interaction generally ranges from regular minor economic activity (e.g., purchasing small items at the local store) to interaction not directly economic in nature (e.g., educational outreach, training programs).

3.5.1.2 Economics

Economic interactions between SSL researchers and local community members in the larger communities of Seward, Kodiak, Dutch Harbor, Anchorage, and Juneau generally take the form of vessel charters, with minor economic interaction surrounding the staging process. Contracts for charters are awarded to vessel owners, who in turn supply the research staff with transportation to sea and lodging. Whether or not the vessel is owned locally is generally of little practical consequence to the SSL researchers interviewed. In terms of provisioning, meals are either included in the contract and are provided by the vessel, or food is brought along on the voyage. For some research trips, particularly those spent mostly at sea or in remote locations, bringing or shipping food is seen as the only logical, cost-effective choice. If a store is nearby, however, and meals are not included in the charter, provisions are sometimes purchased in local stores by SSL researchers.

Vessel support services, such as any necessary repairs to the vessel, are covered by the chartered company. Repair and replacement of scientific equipment, when possible, are usually done in the nearest, largest community. Before boarding the charter, SSL researchers in these communities sometimes eat meals at the airport or nearby diners. Some respondents spoke of purchasing small snacks or minor supplies, like batteries or gloves, in the store before embarking on the chartered vessel. In larger cities like Anchorage, the majority of supplies are purchased from local businesses with only specialty scientific equipment shipped to the staging point. A short hotel stay by researchers is also not uncommon if the chartered vessel is not immediately available for boarding upon arrival. Once the SSL researchers board the vessel, however, they are generally self-sustaining, with a number of respondents detailing their efforts to bring back-up equipment and supplies in an effort to maximize research time on the open sea. A few respondents spoke about hiring a small number of locals on a temporary basis to assist with aerial surveying or handling animals for measurement.

Economic interactions between SSL and NFS researchers and local community members in smaller communities, particularly St. George and St. Paul, do not generally involve chartered vessels. Economic activity in these communities usually takes the form of regular, small purchases at the local store. These local purchases act as a way for a small number of NFS and SSL researchers to incorporate themselves into the local community at least to some degree and may facilitate that building of interpersonal relationships. One researcher called his conscious decision to buy as much as possible locally as, “giving something back.” Other researchers, however, find the hours of the local stores inconvenient and bring as many supplies as possible with them to these small communities.

In the Pribilof Islands, researchers generally lodge in government housing, although one mentioned renting space from the local government or church during the busy season. Repair and replacement of research equipment are largely done by local community members. NFS researchers, in particular, spoke about hiring local community members on a short-term basis to assist in the weighing and measuring of animals during the field season. The hiring of field technicians from the local community was recalled by both SSL and NFS researchers who spend a majority of their field season living in small communities like St. George and St. Paul.

3.5.1.3 Educational/Training

Non-economic interactions between SSL researchers and locals in the larger, more economically and demographically diverse communities are generally informal meetings “on the pier” before embarking on the charter for research at sea. Based on descriptions from interview respondents, conversations usually concern topics such as the weather or the research agenda. Both of these topics of conversation are not considered idle “small-talk” by local community members, and researchers generally describe these conversations as lively, memorable, and largely supportive of the research on SSLs. These conversations act as an informal exchange of information between researchers and locals, with information from both parties impacting the lives of the other. For the locals, whether or not they are interested in the local ecosystem for subsistence, sport, or economic livelihood, many people who take the time to inquire as to the nature of research gain a deeper, more scientific, understanding (or corroboration) of anecdotal events. For the researcher, information from local community members can inform theses, provide appropriate geographic areas for future research, or provide a window into rare animal behavior. Researchers who took the time for these informal talks before going to sea spoke of being particularly interested in historical information about animal density, movement patterns, human/animal interaction, and other aspects of local and traditional knowledge (such as discussed in Sections 3.2.1.10 and 3.2.2.9) in reference to the animals studied.

Interview respondents also talked about their willingness to be interviewed by different media outlets, including local newspapers and local radio stations, about their research and its larger implications. Respondents were also quick to add that their research is regularly presented at academic conferences and printed in academic publications. Some of these presentations and publications are available on departmental websites for public viewing. One respondent even detailed a password-protected website detailing his research, available only to people from the community in which he worked. Finally, research is sometimes presented by SSL researchers to large collections of local people in public meetings. The format and tone of these public meetings vary, from a formal presentation of data and results, to an informal dialog concerning SSL and their behavior. Respondents said that these meetings were generally well attended and that the information exchange was appreciated by people in the community. Other SSL researchers said that time and budgetary constraints precluded them from giving any formal presentations to large collections of community members. These researchers were careful to add, however, that the results of their research were nevertheless publicly available.

For the majority of SSL researchers using chartered vessels and doing much of their research at sea, educational outreach to students and training was mainly focused on building the skill-sets of non-local college students. A small minority of SSL researchers, however, reported taking on interns and volunteers from the local community to assist with less specialized aspects of research. Volunteer opportunities included, among other things, the possibility to identify individual seals and behaviors from observation stations.

Non-economic interaction between SSL and NFS researchers and locals in smaller, more isolated communities manifests itself as the same kind of interactions present in larger communities, but with higher frequency. Researchers working in small communities, specifically St. George and St. Paul, spoke of daily informal interactions with community members. Because many of the researchers interviewed have been working in the Pribilof Islands for years, many of them spoke of easy and friendly relationships with local community members. For many researchers, informal conversations with locals concerning their research are fruitful in many of the ways previously outlined: Researchers gain historical and temporal knowledge otherwise unavailable to them, and locals gain a deeper scientific understanding of animal behavior and ecology that reinforces or corroborates traditional knowledge. Many researchers interviewed expressed a sense of duty to explain their research as carefully as possible to local community members in smaller communities with high Alaska Native populations because, as people who rely on SSL and NFS for subsistence, researchers are directly affecting the food supply.

Formal presentations to large collections of local community members seemed to be more frequently cited in interviews with SSL and NFS researchers who did much of their work in smaller communities. These presentations regularly outline the nature of the research and its implications for the daily lives of people living around, and subsisting on, SSL and NFS. In St. George and St. Paul, these presentations are relatively uncommon, but community leaders believe that presentations could be easily arranged in conjunction with tribal co-management representatives. As was the case with SSL researchers who charter vessels, SSL and NFS researchers who work in smaller communities present their research at academic conferences, annual meetings, and in academic publications. Many also expressed their willingness to participate in interviews with television, radio, and print media in an attempt to share their research with as many people as possible. This openness has its benefits as well, suggested by one respondent who was identified by a local community member from his appearance on the Discovery Channel. This identification as a television personality, he believed, could have led to partial legitimization (eventually leading to a sense of trust) in the eyes of local community members.

Because SSL and NFS research in the Pribilof Islands takes place mainly on land with small crew sizes, a number of people from the local community are brought on to assist with research in these areas. Volunteers and interns are largely either subsistence hunters or local students. A number of researchers talked at length about the importance of including children in their work, and events during research that involved children were regularly recounted as being highly memorable. Researchers involved students for a variety of reasons, including a conscious attempt to incorporate children from the local community in biological research in an attempt to foster scientific curiosity. This experience, a few respondents believed, could eventually lead to Alaska Native SSL and NFS research specialists. Additionally, some respondents believed that reaching out to children in the community, and exposing them to the work of biologists and ecologists, would help reduce the historical tension between researchers and locals. Finally, the inclusion of local students in the research provides children the opportunity to enter rookeries and closely interact with NFS in a manner otherwise not possible (or otherwise not legal). Some respondents believe that this interaction provides children an opportunity to engage with NFS in a more holistic manner, providing this with direct experience of NFS biology and ecology to compliment the traditional accounts of how important these animals have been for the Pribilof Islands Aleuts.

3.5.1.4 Sociocultural

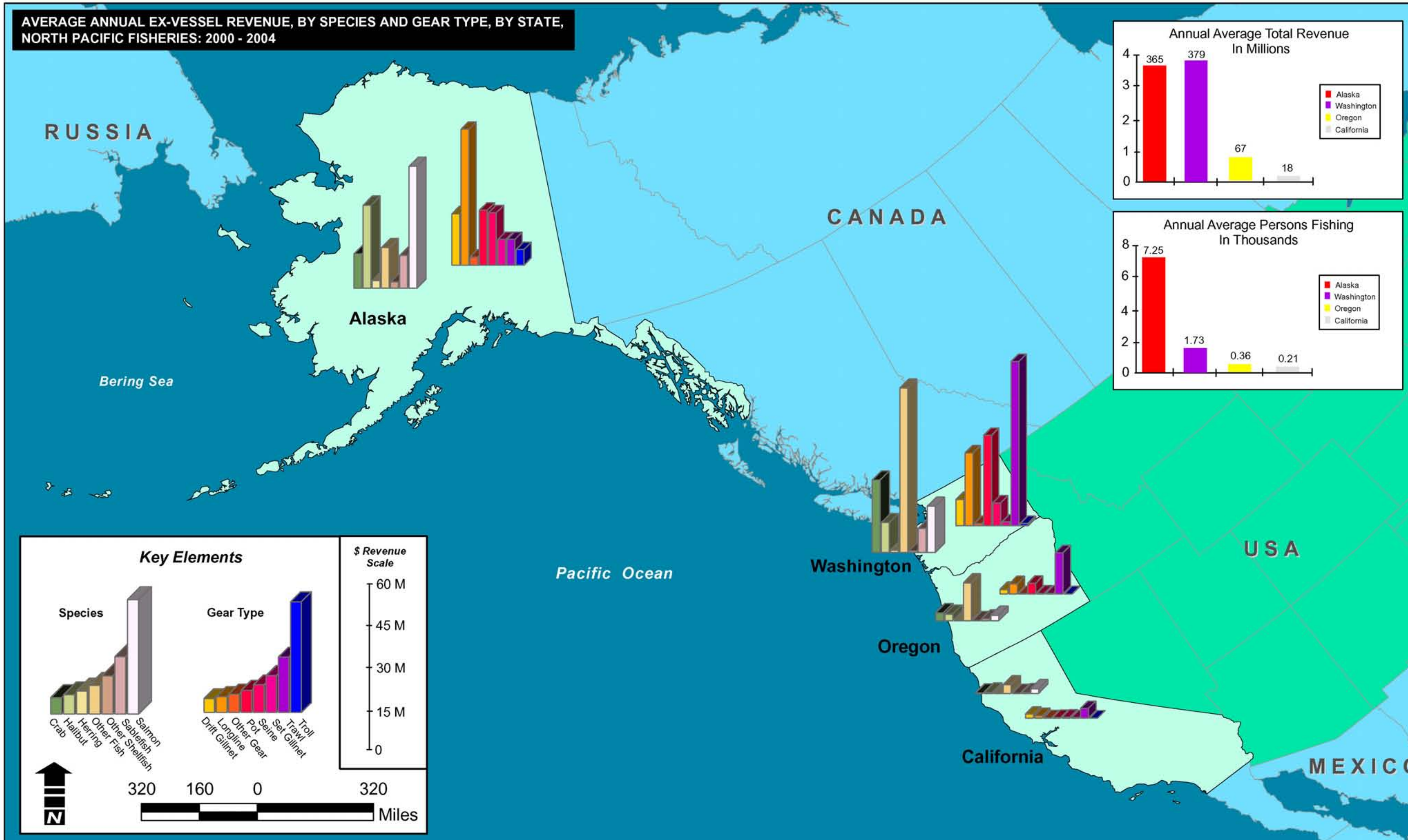
As noted during recent (August 2006) public scoping for this EIS, social impacts to communities may occur through researchers "just showing up" in more remote communities in a culturally inappropriate manner. Local residents perceive it as culturally inappropriate when researchers come to work/research in or near a community without giving what is seen as adequate notice and without providing full disclosure of research intent or otherwise giving an opportunity for a type of informed consent for research cooperation desired by local residents and governmental (including tribal) entities. This type of impact is perhaps more likely in rural Alaska Native communities where cultural privacy is typically more highly valued than in the larger, more diverse communities such as Seward or Kodiak, where much of the staging for large research efforts is based. The smaller communities may be more vulnerable to potential adverse outcomes of research-related activities through multiple ties to local resources. As a result of recent efforts to strengthen local participation some rural Alaska Native communities (such as St. George and St. Paul) have institutional entities in place that provide for varying degrees of resource co-management that can serve to channel interactions with outside researchers and represent local interests in those interactions more effectively than can be done in larger, non-Native communities. Interviews with local community members in the Pribilof Islands suggest that these arrangements have been relatively successful, and instances of culturally insensitive researchers arriving to do research are getting rarer. Public scoping comments would suggest that integration of local traditional knowledge would benefit both communities and the research program itself, as would a protocol for handling interactions with communities that encompasses ethical guidelines for such interactions.

3.5.2 Interactions with Community-Based Commercial Fishing Activities

As noted in other sections, SSL and NFS research may be directly or indirectly related to commercial fishing activities, but the nature of these interactions has not been established. Understanding the nature of the interactions between SSL and NFS research and commercial fishing activities would allow an analytic focus on particular species or fisheries by gear type in particular geographic areas. Depending on the nature of these interactions, a greater or lesser set of communities would be involved, as commercial fishing-related activity takes place over a great deal of Alaska, and involves vessels (and processing entities) from multiple states. While parallel information is not readily available for fisheries that take place off of the coasts of Washington, Oregon, and California, harvest information on potentially relevant North Pacific fisheries that take place off of Alaska for recent years (2000-2004) has been developed on the state level (linked to the state of vessel ownership), by gear and by species, and is portrayed in Figure 3.5-1. As shown in this figure, interactive impacts accruing to commercial fishing activities off of Alaska could result in potential impacts well beyond Alaska itself. Information by species and gear types for this same period has been developed on a community-level basis for Alaska communities. Figure 3.5-2 illustrates the distribution, among Alaska regions, of total annual average revenue derived from commercial fishery harvesting activities for individual communities. Similar information is available by species group and gear type for these communities as well. Figure 3.5-3 illustrates the distribution of fishing effort by community as measured by individual permit activity. Similar information broken out by species group and gear type by community has also been developed.

3.5.3 Interactions with SSL and NFS Community-Based Subsistence Activities

A range of interactions between SSL and NFS research activities and communities engaged in SSL and NFS subsistence activities are possible. The type or extent of potential impacts of SSL and NFS research on communities is based on the nature of the specific research activities. As shown in Figure 3.5-4, the communities that engage in SSL subsistence harvest are far-flung, with NFS subsistence harvest highly concentrated in the Pribilof Islands. It should be noted that SSL subsistence harvesting and research exists in close proximity to NFS subsistence harvesting and research in the Pribilof Islands, although the scale of SSL research in this geographic region is smaller than NFS research of the same type. A complete listing of the communities with reported SSL



Source: Alaska Geospatial Data Clearinghouse 2003; ESRI 2003; Hiatt 2005; PacFIN, http://www.psmfc.org/pacfin/data/index-r316.html

Path: P:\2005\05080426 Stellar Sea Lion Northern Fur Seal EIS\5GIS\Mxd\SOCIO\STATE_FISHERIES.mxd, 04/05/06, marraccinib

Figure 3.5-1 State Fisheries

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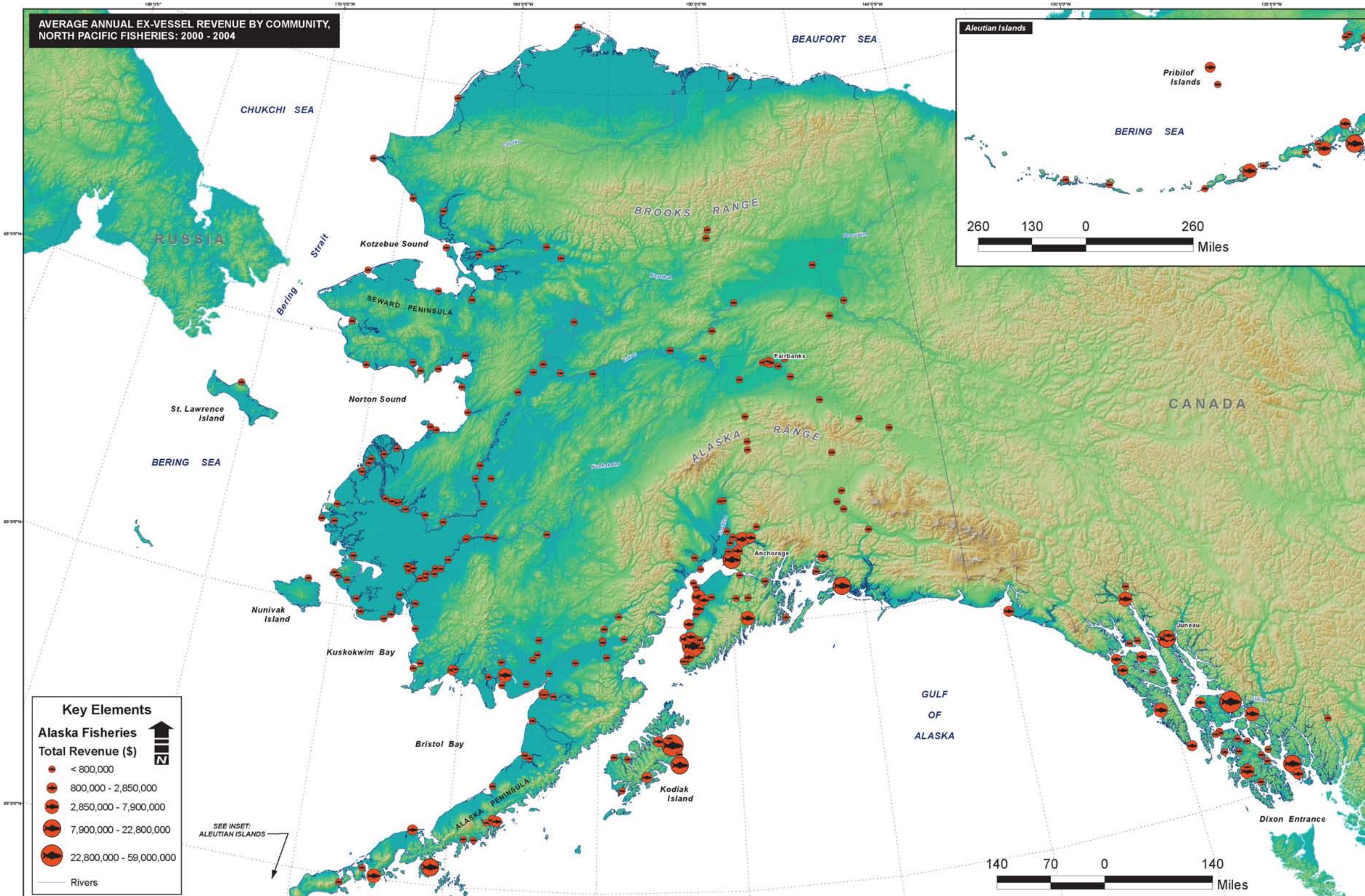

Figure 3.5-2 Alaska Fisheries Revenue

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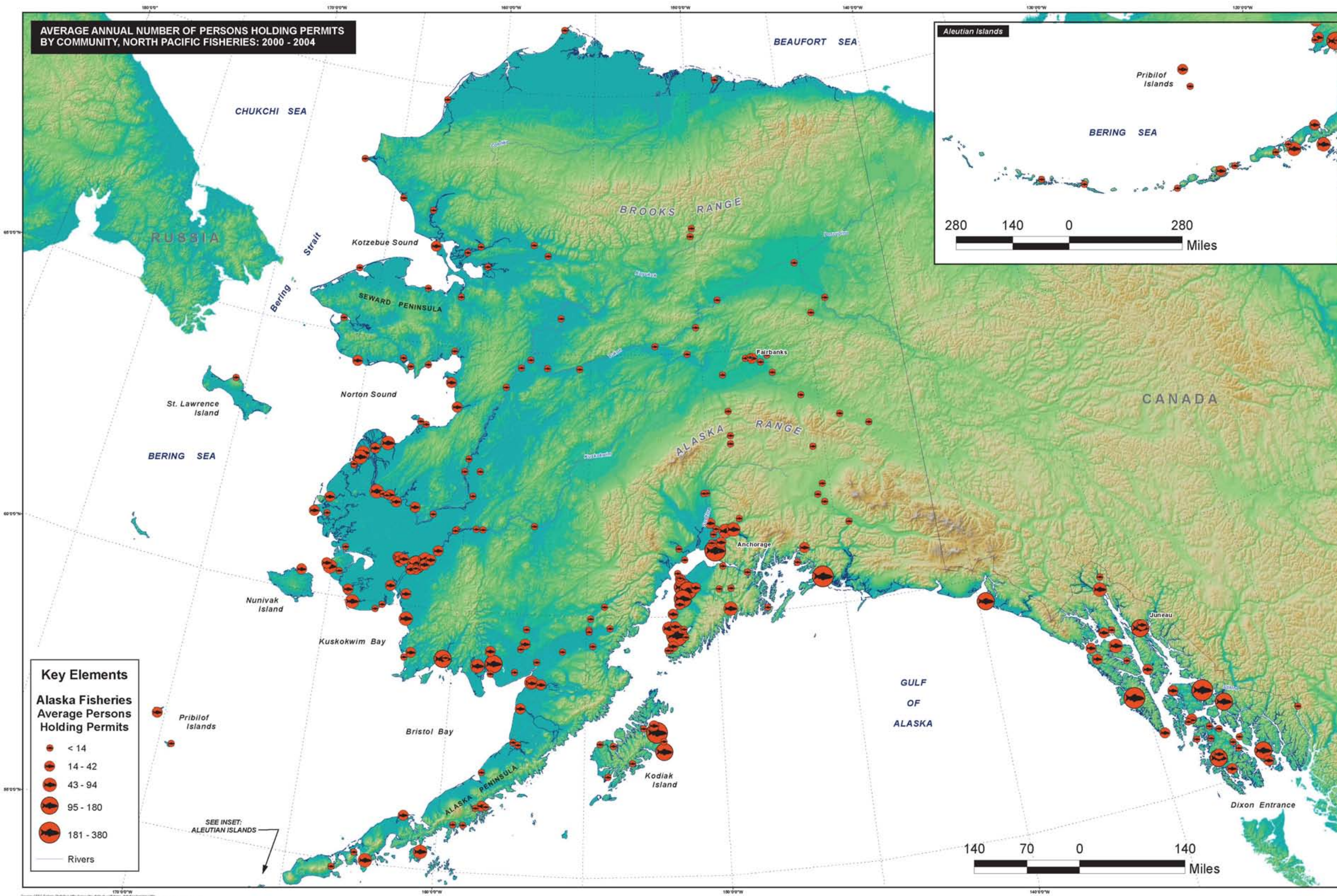

Figure 3.5-3 Alaska Fisheries

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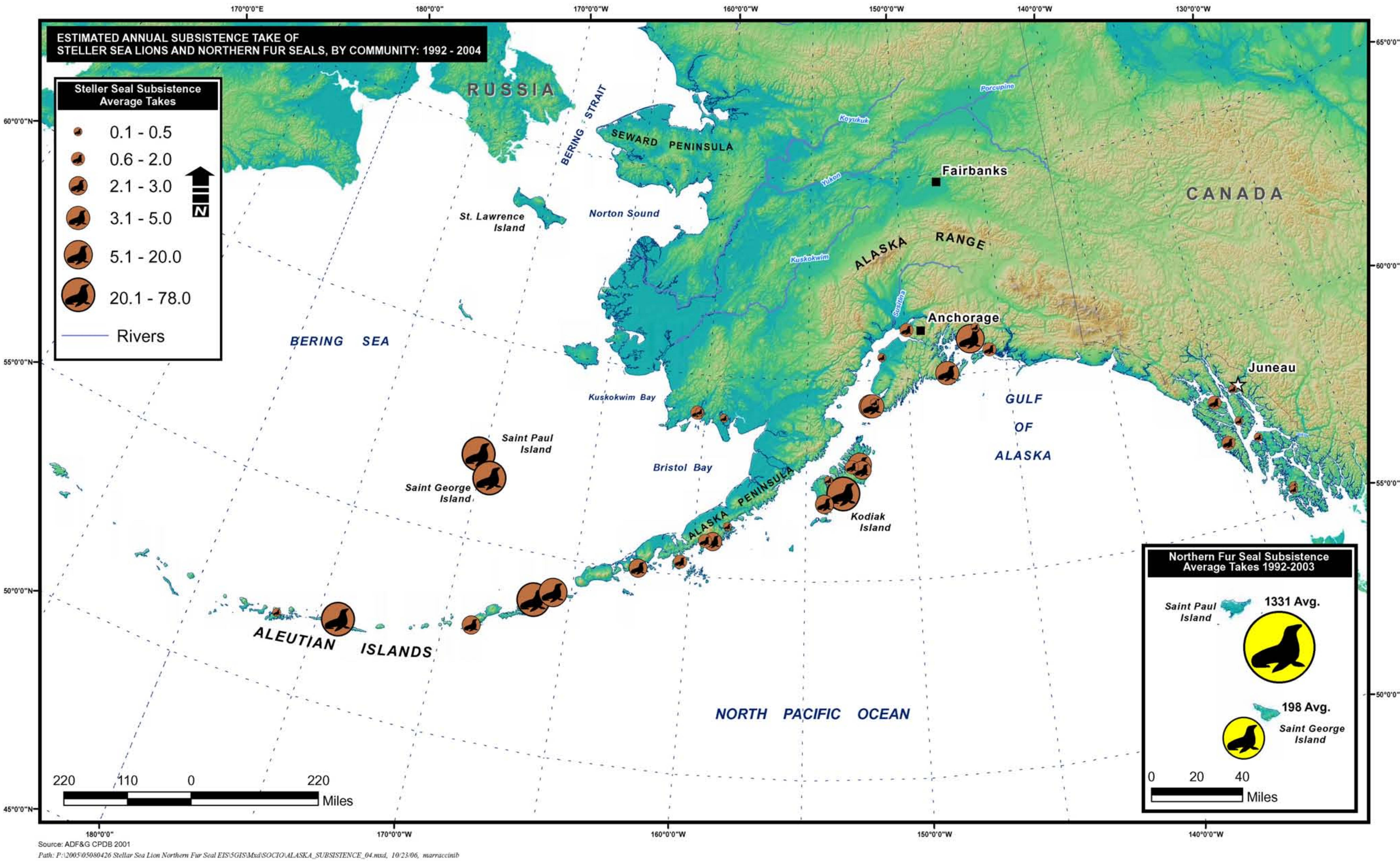

Figure 3.5-4 Alaska Subsistence

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and NFS subsistence take in recent years is provided in the subsistence harvesting section (Section 3.4.1) of this document. As noted in that discussion, interactions between SSL and NFS research activities and subsistence activities may be of a number of different types, ranging from mutually beneficial exchange of information on a regular basis to unplanned episodic interactions that have adverse outcomes for either research or subsistence activities or both. Interviews with researchers, however, portrayed many interactions with subsistence hunters as cooperative. This was especially true of NFS research in the Pribilof Islands where subsistence hunters regularly provide organs and other tissue samples from their traditional take to researchers for investigations concerning animal disease and toxicology. The general perception of this cooperative relationship by researchers is that subsistence hunters, through assisting with research, are taking an even more active role in the protection and stewardship of their surrounding ecosystem. Some researchers admitted, however, that their relationships with subsistence hunters are tenser than other local community members with whom they interact.

3.5.4 Environmental Justice

The following identification of affected populations is required under Executive Order 12898, Environmental Justice (59 CFR 7629). Under Executive Order 12898, demographic information is utilized to determine whether or not minority populations, low-income populations, or Native Americans are present in the area potentially affected by the proposed project. If so, a determination must be made whether or not implementation of the proposed project may cause disproportionately high and adverse human health or environmental impacts on those populations. The analysis of impacts is found in Section 4.9.4.

The CEQ defines the term “minority” as persons from any of the following U.S. Census categories for race: Black/African American; Asian; Native Hawaiian or Other Pacific Islander; and American Indian or Alaska Native. Additionally, for the purposes of this analysis, “minority” also includes all other nonwhite racial categories that were added to census definitions in the most recent census, such as “some other race” and “two or more races.” The CEQ also mandates that persons identified through the U.S. Census as ethnically Hispanic, regardless of race, should be included in minority counts. The term “Hispanic” is an ethnic marker, suggestive of a common linguistic and cultural history associated largely with Spanish colonialism in the New World. Ethnic categorization on the U.S. Census overlaps with (that is, is not mutually exclusive from) racial categorization, so persons of any or all races may identify themselves as Hispanic. For the purposes of environmental justice analysis, all persons except for “white, non-Hispanic” are considered “minority.” The Interagency Federal Working Group on Environmental Justice guidance states that a “minority population” may be present in an area if the minority percentage in the area of interest is “meaningfully greater” than the minority population of the general population (CEQ 1997).

For the purposes of this demographic analysis, minority populations and low-income populations in the Pribilof Islands are characterized and contrasted with the general (larger) population of Alaska. This analysis focuses on the communities of St. George and St. Paul based upon the above discussion, which suggests that these communities may experience the greatest impact due to their rural nature, limited local economies, and closest ties to localized research-related activities. Interviews with permitted researchers and staff suggest that communities outside the Pribilof Islands, specifically communities that participate in SSL subsistence harvesting, do not come into extended, direct contact with research staff due to the nature of SSL research methods. In fact, no researcher interviewed recollected interrupting SSL subsistence activities during their research. Additionally, because SSL research generally requires a larger seaport, researchers engaged in studying SSL do not regularly engage with smaller, rural, economically limited communities for any extended period of time. Due to the brief and relatively minor interactions between SSL researchers and communities near key SSL research areas, these communities were eliminated from further consideration under this Environmental Justice analysis.

Table 3.5-1 illustrates the racial and ethnic composition of the potentially affected communities of St. George and St. Paul, as well as Alaska as a whole. The proportions of minority populations in St. George and St. Paul are 92.1 percent and 87.0 percent, respectively. These proportions are substantially higher than the state of Alaska, which has a minority population of 32.4 percent. The communities of St. George and St. Paul have predominately Alaska Native populations, with otherwise little demographic diversity. In these two communities, whites are the next largest proportion, comprising 7.9 percent of the total population of St. George and 13.0 percent of the total population of St. Paul.

Table 3.5-2 illustrates the proportion of people with income considered below poverty in the potentially affected communities of St. George and St. Paul, as well as Alaska as a whole. The proportions of people with income below poverty in St. George and St. Paul are 7.9 and 11.9 percent, respectively. These proportions are similar to the proportion of people in Alaska with income below poverty, which is 9.4 percent.

Table 3.5-1
Study Area Race and Ethnicity, 2000

2000	St. George	St. Paul	State of Alaska
Total Population	152	532	626,932
White	**7.9%** (12)	**13.0%** (69)	**69.3%** (434,534)
Black or African American	**0.0%** (0)	**0.0%** (0)	**3.5%** (21,787)
American Indian and Alaska Native	**92.1%** 140	**85.9%** (457)	**15.6%** (98,043)
Asian	**0.0%** (0)	**0.0%** (0)	**4.0%** (25,116)
Native Hawaiian and Other Pacific Islander	**0.0%** (0)	**0.6%** (3)	**0.5%** (3,309)
Some Other Race / Two or More Races	**0.0%** (0)	**0.6%** (3)	**7.0%** (44,143)
Hispanic or Latino	**0.0%** (0)	**0.0%** (0)	**4.1%** (25,852)
Total Minority	**92.1%** (140)	**87.0%** (463)	**32.4%** (203,144)
Source: U.S. Bureau of Census 2000			

Table 3.5-2
Study Area Income Below Poverty Level, 1999

1999	St. George	St. Paul	State of Alaska
Total Population	139*	555*	612,961
Income Below Poverty Level	**7.9%** (11)	**11.9%** (66)	**9.4%** (57,602)
Note: * 1999 total population is an estimate based off of total and proportion of people with income below poverty level Source: U.S. Bureau of Census 2000			

3.6 Economic Impacts of Federally Funded Research

This section describes the economic impacts of federally funded SSL and NFS research. First, an overview of the levels and recipients of SSL and NFS research funding is provided. Next, a methodology is developed, based on a review of literature, for estimating the regional economic impacts of SSL and NFS research expenditures. Measuring the economic impact of direct expenditures captures the direct, indirect, and induced effects of SSL and NFS research funding flowing into states from federal sources. Lastly, this section describes possible economic benefits derived from the output of SSL and NFS research.

3.6.1 Overview of Levels and Recipients of SSL and NFS Research Funds

The federal government supplies the majority of the funding for SSL and NFS research, and the economic effects of SSL and NFS research depend largely on how much money is appropriated by the U.S. Congress for the research either through earmarks or through the NOAA budget. Table 3.6-1 provides an overview of federal funding levels for SSL research and management by FY. As discussed in Section 3.2.1.11, a dramatic increase in funding between 2000 and 2001 led to an intensification of SSL research activities. This increase in SSL research funding was the result of a direct U.S. Congress appropriation. The possibility that Alaska groundfish fisheries might face costly restrictions as a result of scientific uncertainty about the decline of SSL led to increased funding for research. It was hoped that with this funding the fisheries could remain open while, simultaneously, more research and protection of SSLs could occur.

Table 3.6-1
Funding for SSL Research and Management

	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	Total
	(Millions of Dollars)							
National Marine Fisheries Service National Marine Mammal Laboratory	1.95	7.85	17.65	5.85	4.61	9.35	2.20	49.46
Alaska Department of Fish and Game	1.10	2.50	2.49	2.00	2.00	3.20	1.54	14.83
North Pacific University Marine Mammal Research Consortium	0.80	0.80	3.50	2.50	2.50	2.50	1.95	14.55
Alaska SeaLife Center	1.00	6.00	5.00	5.00	6.00	7.00	4.94	34.94
University of Alaska Fairbanks	0	1.00	1.00	1.00	1.00	1.50	0.97	6.47
North Pacific Fishery Management Council	0	2.00	2.00	2.00	2.00	2.00	1.00	11.00
National Oceanic and Atmospheric Administration Office of Oceanic and Atmospheric Research	0	6.00	6.00	0	0	0	0	12.00
National Oceanic and Atmospheric Administration National Ocean Service	0	2.00	2.00	0	0	0	0	4.00
Steller Sea Lion Research Initiative	0	15.00	0	0	0	0	0	15.00
Alaska Fisheries Development Foundation	NA	0	0.50	1.00	1.00	0	0	2.50
Prince William Sound Science Center	NA	0	0	0	1.00	1.00	0	2.00
Total	4.85	43.15	40.15	19.35	20.11	26.55	12.60	166.75

Note: NA – Data unavailable
Source: NMFS Alaska Regional Office 2006

As shown in Table 3.6-1, the Congressional funds were directed to several organizations, both federal and non-federal, that are involved in SSL research. In addition, a new competitive federal grants program, the SSL RI, was administered through the NMFS Alaska Regional Office in Juneau. While federal entities could not compete directly for these grant funds, they could be identified as collaborative partners. In 2001, grant awards for one to three-year projects were made to universities inside and outside of Alaska, the State of Alaska, and non-profit organizations.

The North Pacific Universities Marine Mammal Research Consortium was formed with four participating institutions: the University of Alaska, the University of British Columbia, the University of Washington, and Oregon State University. Funding for the Consortium's SSL and NFS research program has been obtained from the North Pacific Marine Science Foundation. These funds are distributed among other entities, as well as among the four participating institutions.

As shown in Table 3.6-1, funding for SSL research peaked in 2001 and 2002. Funding levels since that time have fluctuated, but there has been an overall downward trend. SSL research funding is not expected to reach the 2001/2002 levels again in the foreseeable future. The budget for SSL research since 2001 has been the largest for a U.S. endangered species (Holmes *et al.* 2006). It has been argued that this investment in SSL research and management is prudent given the economic importance of the commercial fisheries potentially at stake (e.g., Hogarth, 2005); however, some researchers have expressed concern about the high level of federal funding for research on a single species at a time when research funds for many other endangered species are non-existent (Dalton 2005).

The sharp decline in funding for SSL research in FY 2006 was due to the reduced budget for NOAA (Bengtson 2006; DeMaster 2006). The decline in funding led some recipient institutions to scale back research activities. For example, at the ASLC there was a prioritization of research activities that led to employment cuts—five out of the approximately 35 positions supported by SSL federal funds were lost (Atkinson 2006). The ADF&G was able to continue a mark-resight program initiated in 2001 to provide estimates of age-specific survival and reproductive rates; however, research on the foraging ecology of SSL had to be scaled back (Rea 2006). At NMML the funding cuts led to a reduction in field activities, and a planned increase in contract and temporary positions at the facility was cancelled (Bengtson 2006; DeMaster 2006).

Currently, funding dedicated for NFS research is only a small fraction of the funding for SSL research. NFSs were the subject of much early research owing to the species' historic economic importance; as Scott *et al.* (2006:2) note, "The intensive research conducted on northern fur seals involve budgets that could only have been sustained for a species of high commercial value." Commercial harvests of the species ended in the United States in 1984, with the expiration of the Interim Convention on Conservation of North Pacific Fur Seals. The lapse of the Convention significantly reduced research funding into the causes of the fur seal decline and limited the subsequent scope of the broad NFS research program approved by the North Pacific Fur Seal Commission (Gentry 1998 cited in NMFS 2006a). As noted in Chapter 2, however, funding levels for NFS research have recently increased. The improvement is due, at least in part, to uncertainty about the role of climate change, food limitation, interactions with commercial fisheries, and predation in recent declines in NFS populations in the Pribilof Islands. Since 2004, for example, the North Pacific Research Board has awarded $1.04 million for studies investigating the causes of the population decline. Recipients of these funds include the University of Alaska Fairbanks, NMFS AFSC, ASLC, University of Washington, and North Pacific Universities Marine Mammal Research Consortium.

3.6.2 Economic Impact of SSL and NFS Research Expenditures and Output

Federally funded research on SSLs and NFSs results in a variety of economic impacts. Research expenditures are the most tangible sources of impacts of research activity on the local economy. Research-related spending not only generates jobs and income in the entities that are recipients of the research funds, it can have a "ripple" economic effect throughout a region.

In addition, it may be appropriate to focus on the economic value of the research output as well as on the regional impact of research expenditures. Scientific and technological advances from basic and applied research can produce economic benefits for society that may or may not be readily translated into dollar values. This section examines the potential economic impact of both the expenditures and output of SSL and NFS research activities.

3.6.2.1 Regional Economic Impact of Research Expenditures

Expenditures toward SSL and NFS research directly support the functions of the institutions carrying out the research. In the case of universities, research funds support faculty investigators, student assistants and others directly involved in the research activity. The administration of research projects and various research-supporting activities generate additional permanent and temporary positions within the universities. In the case of other institutions, such as the NMFS NMML, research money is a primary source for funding the employment of in-house researchers, supporting staff, and other workers. SSL and NFS research funds have also directly created employment opportunities outside the institutional setting. For example, the Alaska Sea Otter and Steller Sea Lion Commission, in partnership with six Alaska coastal communities developed and implemented a traditional knowledge of SSL health and abundance survey. The Commission provided funding to the local governments, which then hired community surveyors.

In addition to the direct employment created by research activities, SSL and NFS research funding can benefit a large variety of businesses in the private economy by providing funding recipients with procurement budgets that allow them to purchase research-related equipment, supplies and services (e.g., computer components and other high-tech equipment, professional and maintenance services, travel services, aircraft and vessel charters, food for animals, field camp supplies, and printing and photographic services). The periodic convening of researchers at research symposia and workshops can also benefit businesses in the service sector, such as hotels and restaurants. As indicated in Section 3.2.1.12, there have been 23 meetings, workshops, and symposia held over the last six years that focused on SSL and NFS research coordination and collaboration. Also, revenue, employment and income are generated in the economy by businesses that use "products" from SSL and NFS research as inputs for the production of goods and services. For example, the SSLs on public display at the ASLC, a marine research aquarium, are a tourist attraction that helps support the tourism industry in Seward, Alaska. Lastly, the majority of the wages and salaries of researchers and other research-related workers circulate back into the local economy through purchases of local goods and services, thereby providing a foundation for other jobs in the retail and service sectors.

These direct, indirect, and induced economic impacts of research spending can be measured in terms of total number of jobs created, payroll produced, and business sales generated within a region using a regional economic impact model based on input-output relationships. Of course, if the scope of the economic impact analysis is the entire U.S. rather than an individual region, federally supported research is then merely a transfer of money—not an injection. Most studies of the economic impacts of research expenditures estimate the impacts of money flowing from outside a region into the region's economy. In other words, federally funded research can be viewed as an economic "base" enterprise that sells its output to customers outside the region and brings new dollars into the region in the process (Goldsmith and Cravez 2004). In this analysis, the focus is the impact of SSL and NFS research on state economies, particularly the states in which the entities receiving federal SSL and NFS research funds are located and where the researchers live and work.

To estimate the economic impacts of external SSL and NFS research funding in different states, one could measure how many research positions, purchases, or the like were supported by the investment and what indirect and induced effects are attributable to the funding. This analysis would be exceedingly costly and time-consuming because it would require custom studies for each research project to determine its impact. Alternatively, there is sufficient evidence on the economic impact of federally funded research in general to estimate the economic impact of research on SSLs and NFSs at the state level. Table 3.6-2 summarizes studies conducted in Alaska and Washington that document the benefits of university research using input-output type models. The study of the "multiplier" effects related to research at the University of Alaska Anchorage reported an overall output multiplier for spending on wages and goods and services of 1.5, meaning that every dollar of direct research expenditures by the university generated an additional $0.50 in indirect and induced spending in the state. The output multiplier calculated for the University of Washington is 2.2. In general, output multipliers for Washington and other states with large, integrated economies are larger than those for states with less developed economies, such as Alaska, because businesses and households make a larger share of their purchases within the state. Multipliers from the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Input-Output Modeling System reveal that multipliers for impacts in private sector research and development and, separately, professional services, are similar to those reported in Table 3.6-2. This finding strengthens the assumption that the impacts of university-based research are similar to those of federally funded research conducted at private or federal facilities.

Table 3.6-2
Summary of Literature Review of Regional Economic Impacts of University Research

Source	University/Affected State or Region	Output Multiplier to Calculate the Overall Economic Impact
Goldsmith and Cravez (2004)	University of Alaska Anchorage/Alaska	1.5
University of Washington (2002)[1]	University of Washington/Washington	2.2
Note: [1]Examined the economic impact of all university spending, not just research-related expenditures.		

To estimate the total economic output (wages and sales of goods and services) generated by SSL and NFS research activities across broader statewide economies, research expenditures inside and outside Alaska were estimated for FY 2006 (Table 3.6-3). The distribution of research expenditures accounted for research dollars that "leaked" out of a state when purchases were made out-of-state. For example, researchers from institutions outside of Alaska may have procured airplane transportation or vessel support services from Alaska-based entities in the course of conducting field work. Not allowing for out-of-state expenditures would lead to an underestimation of economic impacts in Alaska. In FY 2006, the North Pacific Marine Science Foundation budgeted $1.04 million (53%) of its $1.95 million SSL research funds to be spent in Alaska (Carey 2006a). That same FY, total SSL research funding for the NMML in Seattle was $2.20 million, of which $1.47 million (67%) was spent in Alaska (Carey 2006b). In both cases, the SSL research funds not spent in Alaska is primarily in salaries. This distribution of research expenses is generally what would be expected for institutions whose SSL research largely consists of field studies conducted out-of-state. Studies of research expenditure patterns by Charney and Pavlakovich-Kochi (2003) and Goldsmith and Cravez (2004) reported that about half of university research budgets is paid out in wages and benefits. In all of the input-output studies reviewed for this analysis, wages and salaries are assumed to be spent locally.

Table 3.6-3
Distribution of SSL and NFS Research Expenditures Inside and Outside of Alaska, FY 2006

State	Research Expenditures (Millions of Dollars)[1]
Alaska	10.09
Outside of Alaska	2.51
Note: [1]In constructing this table, an adjustment was made for out-of-state expenditures.	

The University of Alaska Anchorage output multiplier in Table 3.6-2 was used to estimate the economic effect of SSL and NFS research spending on the Alaska economy in terms of the combined direct, indirect, and induced impacts; the University of Washington output multiplier was used to estimate the total economic effect of SSL and NFS research spending on the regional economy outside of Alaska. The results are summarized in Table 3.6-4. The estimated total spending generated by SSL research expenditures in FY 2006 was $15.1 million in Alaska and $5.5 million outside of Alaska.

Table 3.6-4
Total Economic Impact of SSL and NFS Research Expenditures Inside and Outside of Alaska, FY 2006

State	Total Spending Generated by Research Expenditures (Millions of Dollars)
Alaska	15.1
Outside of Alaska	5.5

Economic Impact of Research Output

While employment and output multipliers related to research expenditures are a good starting point for understanding the impact of SSL and NFS research, they do not necessarily tell the complete story. Federally funded research can result in new products, productivity gains, and other benefits to society. To understand this broader set of impacts, analysts need to consider the additional economic growth that is generated by the outcome of the research, and not just the ripple effects of the initial expenditures. For example, some research investments, such as those made in engineering, communication systems and biomedical technology, lead to innovative products and processes, licensing agreements, patents, and other tangible benefits. The economic returns from the commercialization of new scientific or technological advances assume two forms: 1) profits to the individual innovator (or shareholders of a corporation), along with higher wages and compensation for workers, and 2) benefits to the economy channeled through the adoption of new products and processes by other firms (National Research Council Committee on Science, Engineering, and Public Policy 1992). The latter also includes benefits to consumers through a wider range of product choices that better satisfy human needs. The value of this research output can be compared to the initial research investment to determine the return on investment, and the rate of return can be compared to the rate of return provided through alternative investments.

However, not all research spending is equally productive, and the benefits of some research can not be readily expressed in monetary terms because the outputs are not traded in observable markets. In the case of research on SSLs and NFSs, the purpose of the research, as stated in the 2006 SSL Draft Recovery Plan and the 2006 NFS Draft Conservation Plan, is to promote the recovery of the species' populations to levels appropriate to justify removal from ESA listings and to delineate reasonable actions to protect the depleted species under the MMPA (see *NMFS Steller Sea Lion and Northern Fur Seal Research EIS Public Scoping Report*). Public preferences for providing this protection for SSLs and NFSs are primarily the result of the non-consumptive value people attribute to such protection (Lew 2005). Because the protection of wildlife, such as NFSs and SSLs, is not a "commodity" traded in observable markets, standard market-based approaches to estimate its economic value cannot be applied. As a result, studies that attempt to estimate these values must rely on survey-based non-market valuation methods, which involve asking individuals to reveal their preferences or values for non-market "goods," such as the protection of species, through their responses to questions in hypothetical market situations. A positive preference for protection of a species is expressed as a "willingness to pay" for it. This willingness to pay exists because the protection of SSLs, NFSs, and other wildlife contributes to human welfare, where "welfare" is broadly defined to reflect the overall happiness or satisfaction of an individual or group of individuals (National Research Council 2004).

A survey-based non-market valuation method called the contingent valuation method (CVM) has been used to provide an empirical point estimate of the total economic value attributable to the protection (and enhancement) of the western SSL stock, including economic value that has no market or commercial basis (Giraud and Valcic 2004; Giraud *et al.* 2002). This study constructed and administered a questionnaire survey that included a closed-ended CVM question formatted similarly to a typical public goods referendum. Specifically, the survey described a hypothetical expanded federal SSL recovery program that would double research funding and increase the restrictions of commercial fishing around the critical habitat of the western stock of SSL in the GOA, Bering Sea and North Pacific Ocean. The survey noted potential impacts to Alaskan coastal communities that depend on the fishing industry as well as potential benefits from the expanded program. However, the survey explicitly stated that biologists are unsure why the sea lion populations have been declining and gave no guarantee that the expanded program would ensure species recovery.

This information was followed by the question, "If the Expanded Federal Steller Sea Lion Recovery Program was the only issue on the next ballot and it would cost your household $X in additional federal taxes every year for the next Y year(s), would you vote in favor of it?" The dollar amount and payment duration were filled in by the analysts prior to administering the questionnaire. By varying the printed dollar amount across the sample of respondents, the voter referendum format allowed the analysts to statistically trace out a demand-like relationship between the probability of a "yes" response and the dollar amount. The researchers have not yet investigated temporal elasticity of 'willingness to pay' estimates, and only a one-year payment duration was analyzed.

The survey was administered to a sample of households in three study areas: 1) the Alaskan boroughs that contain SSL critical habitat, 2) the entire state of Alaska, and 3) the entire U.S. Because the benefits of preserving federally listed threatened and endangered species are national in scope, both the value per household and number of households to aggregate over should include all U.S. households (Loomis and White 1996).

The SSL CVM study found that the value of an expanded recovery program for the species in the U.S. sample was positive and substantial. The estimated mean one-time payment was $100.22 per household. If the average value per household is adjusted to account for non-responses with the assumption that they represented a zero willingness-to-pay, the mean benefit is $61.13. With 101,562,700 households throughout the nation, and a $61.13 value per household, willingness-to-pay totals about $6.2 billion for the expanded federal protection program for the western stock of the SSL. The 95 percent confidence interval is from $5.8 billion to $16.17 billion. This economic value estimate of an expanded recovery program may be conservative, because the valuation responses were treated as household responses rather than as individual responses. Treating the responses as individual responses would increase benefits substantially.

The results of CVM are often highly sensitive to what people believe they are being asked to value, as well as the context that is described in the survey. Given the vague outcome of the SSL protection program described in the above CVM study, what respondents were evaluating is somewhat uncertain. A more definitive value of the SSL might have been obtained if a link had been established between an expanded protection program and a well-defined discrete outcome, such as a specific probability that the western SSL population would recover. NMFS is currently conducting a study to collect information that can provide additional insights into public values for protecting SSLs (Lew 2005). This study will employ a survey-based non-market valuation method that adopts a choice experiment, or stated choice, approach for eliciting economic values for SSLs. The final survey implementation will follow Office of Management and Budget approval. NMFS will use stated choice data collected through the survey to estimate a preference function for explaining choices between protection programs that differ in the levels of population sizes, ESA-listing status, geographic distribution, and costs. This estimated function will provide NMFS and the NPFMC with information on public preferences and values for alternative SSL protection programs, and how several factors affect these values (Lew 2005).

Economists acknowledge that, in general, questions of validity, bias, and reliability persist in the use of CVM and other survey-based non-market valuation methods used to evaluate environmental assets. In 1992, NOAA commissioned a blue ribbon panel to advise the agency on the use of CVM for measuring non-use values (Arrow *et al.* 1993). The panel concluded that CVM studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages, including loss of non-use values, as long as certain sampling and survey design guidelines are followed. Critique of the methodology employed by Giraud and Valcic (2004) and Giraud *et al.* (2002) to evaluate the benefits of an expanded program to preserve the SSL is beyond the scope of this analysis, but the use by these analysts of a willingness-to-pay and a dichotomous choice format is consistent with guidelines set forth by Arrow *et al.* (1993). Nevertheless, CVM and other survey-based non-market valuation methods depend on asking people questions, as opposed to observing their actual behavior, which is a source of considerable controversy among economists, policy makers, and others. The conceptual, empirical, and practical problems associated with developing dollar estimates of economic value on the basis of how people respond to hypothetical questions about hypothetical market situations are a continuing source of debate.

Apart from debates about the technical acceptability of survey-based non-market valuation methods with respect to their validity and reliability, there are criticisms of the basic principles underlying the economic valuation of at-risk species. A number of these criticisms contend that non-market valuation methods are inherently inadequate because they are based only on the preferences of the current generation and neglect the ethical issue of the inter-generational allocation of natural endowments. For example, Berrens *et al.* (1998) note that irreversible species or ecosystem losses involve inter-generational equity issues because they constrict the choice sets of future generations. Preserving species where positive net benefits are to be earned is obviously a good idea, but preserving species only when doing so meets economic efficiency criteria may place future generations in a disadvantaged position (Bishop 1993).

Other critics focus on the fact that economic valuations are rooted in anthropocentric or human-centered benefits, that is, these valuations rest on the basic assumption that value derives from what people find useful. However, some would argue that human uses and the values to which they give rise are not deserving of any special consideration when it comes to a decision on whether or not to preserve a species (Albers *et al.* 1996). This non-anthropocentric or biocentric viewpoint assumes that all living things have value even if no human being thinks so (National Research Council 2004). According to one interpretation of this notion of non-anthropocentric intrinsic value, non-human species have moral interests or rights unto themselves (Callicott 1986; Nash 1989; Regan 1986; Stone 1974). This reference to morals, rights, and duties implies an ethic that rejects the assumption that humans even have a choice regarding whether or not to protect a particular species or ecosystem; rather, it is seen as an obligation (National Research Council 2004; Mazzotta and Kline 1995). These arguments are inconsistent with the economic principle of trade-offs between money and wildlife species because they present individuals with the moral imperative that we ought to preserve plants and animals (Stevens *et al.* 1991). As Costanza *et al.* (1997) and Pearce and Moran (1994) note, concerns about the preferences of future generations or ideas of intrinsic value translate the valuation of environmental assets into a set of dimensions outside the realm of economics.

How prevalent such ethically motivated values are among members of the U.S. general public is difficult to gauge. According to Herzog and Dorr (2000), much of the research on attitudes toward non-human species has been conducted with non-representative samples. They note, however, that some relevant surveys have been conducted by commercial polling organizations using large probability samples of Americans. An example provided by Herzog and Dorr is the 1994 survey the *Times Mirror* commissioned Princeton Survey Research Associates to conduct to assess the views of Americans toward a variety of social causes. Of those sampled in the survey, 23 percent had a “very favorable” attitude toward the animal rights movement, 42 percent had a “mostly favorable” attitude, 21 percent had a “mostly unfavorable” view and 9 percent had a “very unfavorable” view of the movement.

More recently, a Gallup poll found that 96 percent of Americans say that animals deserve at least some protection from harm and exploitation, while just 3 percent say animals do not need protection “since they are just animals” (Moore 2003). 25 percent of Americans say that animals deserve “the exact same rights as people to be free from harm and exploitation.” However, among those who support the same rights for animals as people, 44 percent oppose banning medical research on laboratory animals and 55 percent oppose banning all types of hunting. The substantial numbers of people who oppose proposals to limit the harm and exploitation of animals—despite saying they want the same rights for animals that people have to be free from harm and exploitation—suggest that the issue of animal rights may be more complex than some initially expected (Moore 2003). Clearly, additional in-depth public surveys are needed before we can better understand people's motivations for supporting efforts to protect species such as the SSL and the NFS.

Finally, it is important to note that it may not be necessary that a given management or research policy have positive or negative implications for the survival of an entire SSL or NFS population in order for a segment of the American public to be affected. Some individuals may hold a positive value for avoiding losses of part of a species’ population even if recovery is fairly rapid (Bishop and Welsh 1992)—witness the opposition by some members of the public to the 1999 gray whale (*Eschrichtius robustus*) hunt by the Makah people of the Pacific Northwest, despite the fact that NMFS deemed the eastern North Pacific gray whale stock to be in good condition and capable of withstanding a restricted harvest. It is likely that for some opponents to the whale hunt the harvest of even a single whale is one too many because of the value of the special qualities they ascribe to a living whale or because the killing of a whale conflicts with their ethical principles. Similarly, if a given management or research policy has adverse consequences for individual SSLs or NFSs, but not for populations of these species as a whole, it is likely that some individuals would experience a loss of welfare, which, as noted previously, is a measure of an individual's relative happiness or satisfaction, or would feel moral unease.

In summary, the desired output of SSL and NFS research is to improve the survival or recovery of the species in the wild. The one existing survey effort to understand the economic value of SSL indicates that this enhanced protection has positive and substantial societal value. Additionally, there may be value associated with the protection of the SSL and the NFS that lies outside the categories of value subject to economic investigation.

3.7 Grant and Permitting Process

3.7.1 Granting Process

NMFS administers a broad range of financial assistance and program partnership activities directed at supporting the core mission of NMFS. Grant awards are made to universities, state agencies, and public or private sector non-profit organizations to fund activities pertaining to the research and management of fisheries, marine mammals, and habitat conservation. Some grant awards are discretionary, based upon compliance with existing defined NMFS program goals and objectives. Other grant awards are directed by Congress, with grant funds "earmarked" in the federal budget for specific activities.

Funding for research activities on SSLs and NFSs has been derived from a variety of sources over the years, including federal, state, and private institutions. Prior to their listing under the ESA in 1990 and for most of the 1990s, federal funding for SSL research through NMFS was less than one million dollars per year, with a majority of funds supporting census work (Ferrero 2002). As the population continued to decline into the late 1990s, a series of legal and scientific challenges led NMFS to place restrictions on the commercial fishing industry to help alleviate the population decline, even though there was no scientific consensus on how effective such restrictions would be as conservation measures. In response, the U.S. Congress dramatically increased funding for SSL research in 2001 and directed NMFS to disburse funds for a diversity of research projects through several research agencies plus a new federal grants program, the SSLRI, administered through the NMFS Alaska Region Office in Juneau.

The SSLRI required prospective grant recipients to submit proposals based on a specified set of research and eligibility criteria (NMFS 2001a). Funding could be in the form of outright grants or cooperative agreements, depending on whether or not agencies were directly involved in the research, and matching funds from other sources were not required. The SSLRI application package contained standard NOAA budgetary control forms and guidelines. The solicitation notice described the priorities for the types of research that would be funded and the evaluation criteria for awards. The evaluations included consultation with NMFS scientists and other experts on the scientific merits of the proposed research as well as on the capability of the researchers to effectively carry out their proposal. Proposed budgets were also evaluated for reasonableness of cost estimates and adequacy for fulfilling the research objectives. Proposals were also evaluated by a Constituency Panel that included representatives from the fishing industry, Alaska coastal communities, and other qualified personnel selected by the NMFS Alaska Region Administrator. NMFS Program Office compiled the technical, budgetary, and constituency evaluation rankings and made recommendations for funding. The Alaska Region Administrator, in consultation with the NOAA Assistant Administrator for Fisheries, determined which projects should be funded based on these recommendations and on the need to avoid duplication with existing agency research efforts. Final funding amounts were based on negotiations between NMFS and the recipient and were subject to an additional review by the NOAA Grants Management Division.

The Alaska Region Grants Program Office has also distributed some SSL research funds through the Saltonstall-Kennedy competitive grants program, a program designed to provide financial assistance for research and development projects to strengthen the U.S. fishing industry. However, that program has not distributed grants since FY 2003 due to lack of funding in the federal budget.

Information on how to apply for grants from NMFS is available on the NOAA Grants Program website: http://www.ago.noaa.gov/grants/pdf/. This site includes links to numerous forms that may be applicable to different research projects. Additional information on the types of research grants that are currently available can also be found on the Alaska Region Grants Office website: http://www.fakr.noaa.gov/omi/grants/.

3.7.2 Permitting Process

Information on what types of activities require permits, who may apply for permits, and permit application instructions are currently available from the NMFS Permits Division, Office of Protected Resources (F/PRI) website: http://www.nmfs.gov/pr/. As the one requesting an exemption to a take moratorium, the applicant must demonstrate that permit issuance would not be detrimental to protected species (i.e., will not disadvantage, jeopardize, or otherwise adversely affect a protected species). Accordingly, the MMPA, ESA, and NMFS implementing regulations establish information requirements for permit applicants. When NMFS F/PR1 receives an application, its permit scientists first review it to make sure all required information has been supplied. If an application is incomplete, F/PR1 contacts the applicant and requests the missing information. The permit process cannot proceed further until F/PR1 has a complete application. If an applicant currently holds a permit to take marine mammals, or has held a permit in the past, the new application will not be processed until all reports required to date under such permits have been submitted.

When the application is considered complete, the Office Director makes an initial determination regarding the appropriate level of review required under the National Environmental Policy Act (NEPA). The Office Director may consult with the Marine Mammal Commission (MMC) during this initial NEPA determination as appropriate. If the proposed action qualifies for Categorical Exclusion under rules implementing NEPA, the application process continues with the next step. If the Office Director determines that an EA or an EIS is required, the appropriate document must be completed before the application process continues.

The next two steps occur simultaneously: F/PR1 sends the application out for scientific review and publishes a Notice of Receipt in the FR to begin a mandatory 30-day public review and comment period. The Office Director may extend this comment period and hold public hearings on the application at his/her discretion. Reviewers include appropriate NMFS scientists, the Marine Mammal Commission and its Committee of Scientific Advisors on Marine Mammals, other appropriate federal agencies, NMFS Enforcement, and, for ESA-listed species, NMFS Endangered Species Division. The application may also be sent to appropriate independent experts at the discretion of the Office Director. The reviewers have a period of at least 45 days or longer (as established by the Office Director) to submit their comments on the application. If no comments are received in that time, it is assumed that there are no objections to issuance of the permit. After considering the comments and recommendations of all reviewers, the Office Director will reassess the level of NEPA review required by the proposed project. If that determination requires a more extensive environmental assessment than was indicated in the initial NEPA review (e.g., from a Categorical Exclusion to an EA or from an EA with FONSI to an EIS), the new NEPA review must be completed before the permit process can continue. If no new NEPA analysis is required, the process continues as below.

Within 30 days of the close of the public hearing or, if no public hearing is held, within 30 days of the close of the public comment period, the Office Director will issue or deny a special exception permit. The decision to issue or deny a permit will be based upon:

- All relevant issuance criteria set forth at Sec. 216.34;
- All purpose-specific issuance criteria as appropriate set forth at Sec. 216.41, Sec. 216.42, and Sec. 216.43;
- All comments received or views solicited on the permit application; and
- Any other information or data that the Office Director deems relevant.

If the permit is issued, the holder must date and sign the permit and return a copy of the original to the Office Director. The permit shall be effective upon the permit holder's signing of the permit. In signing the permit, the holder agrees to abide by all terms and conditions set forth in the permit and acknowledges that the authority to conduct certain activities specified in the permit is conditional and subject to authorization by the Office Director. If the permit is denied, the Office Director shall provide the applicant with an explanation for the denial. The applicant or any party opposed to a permit may seek judicial review of the terms and conditions of such permit or of a decision to deny such permit. Review may be obtained by filing a petition for review with the appropriate U.S. District Court as provided for by law.

3.7.3 Permit Amendments

Scientific research permits may be amended by the Office Director. Requests for amendments to permits should be submitted in writing to the Chief of NMFS F/PR1, and should address all applicable sections of these instructions, including a detailed description of the proposed changes. Amendment requests involving an increase in number, changes of location or species, or more intrusive activities are subject to a 30-day public review and are granted or denied at the discretion of the Office Director. Amendment requests must be endorsed and signed by the principal investigator named in the permit. Less intrusive activity or minor changes not involving numbers, species, or locations may be authorized at the discretion of the Office Director without public review.

3.7.4 Other Permits Needed for Research

In addition to obtaining research permits from F/PR1, researchers may also need to obtain special use permits for working on and near state, federal, and Native lands. NMFS requires research applicants to obtain and abide by all applicable permits as a condition of doing research and receiving grants. The following is a partial list of permits that may be required, depending on the nature and location of research activities:

- Animal and Plant Health Inspection Service (APHIS) run by the U.S. Department of Agriculture (USDA) has responsibility under the Animal Welfare Act (AWA) for captive warm-blooded animals, including marine mammals, and has established regulations and standards for animal care, including "Specifications for the Humane Handling, Care, Treatment, and Transportation of Marine Mammals (9 CFR Ch 1, Subpart E)." Most U.S. facilities maintaining marine mammals are required to be licensed or registered by APHIS.
- The Native village governments of St. Paul and St. George control access to the rookeries and haulouts on the Pribilof Islands. Many other Alaska coastline areas are owned by Native corporations or have been claimed for conveyance under the Alaska National Interest Lands Conservation Act (ANILCA). Research that takes place on Native lands typically requires a special use permit from one or more Native organizations.
- Military clearance (U.S. Navy) is required for access to Adak, Shemya, Amchitka, and Attu islands in the Aleutian Chain.
- U.S. Coast Guard permits are required for operating marine vessels in U.S. waters, with certification for types of use and numbers of passengers on a vessel-specific basis. They also issue permits for working around lighthouses that they maintain.

- A special use permit is required from the USFWS for work on national wildlife refuges, including the AMNWR.
- The Alaska Department of Natural Resources (ADNR), Division of Mining, Land, and Water requires a land use permit for working/camping on state lands longer than 14 days or if more substantial structures are erected.
- A permit might be required by the ADF&G if the use will take place in a state game refuge or special use area (SUA), which include tidelands and submerged lands adjacent to national parks, refuges, and reserves, such as the Alaska Maritime National Wildlife Refuge, the Kenai Fjords National Park coastline, Resurrection Bay, Lake Clark National Park coastline, Marmot Island (eastern half), and Togiak coastline.
- The National Park Service (NPS) has a national research permit and reporting system that is park specific and project specific.
- The respective departments of state lands and parks for Washington, Oregon, and California also have special land use permits that may apply on their lands. These state agency land use permits are oriented toward reviewing consumptive uses rather than temporary camps in remote places. All are project and area specific.

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