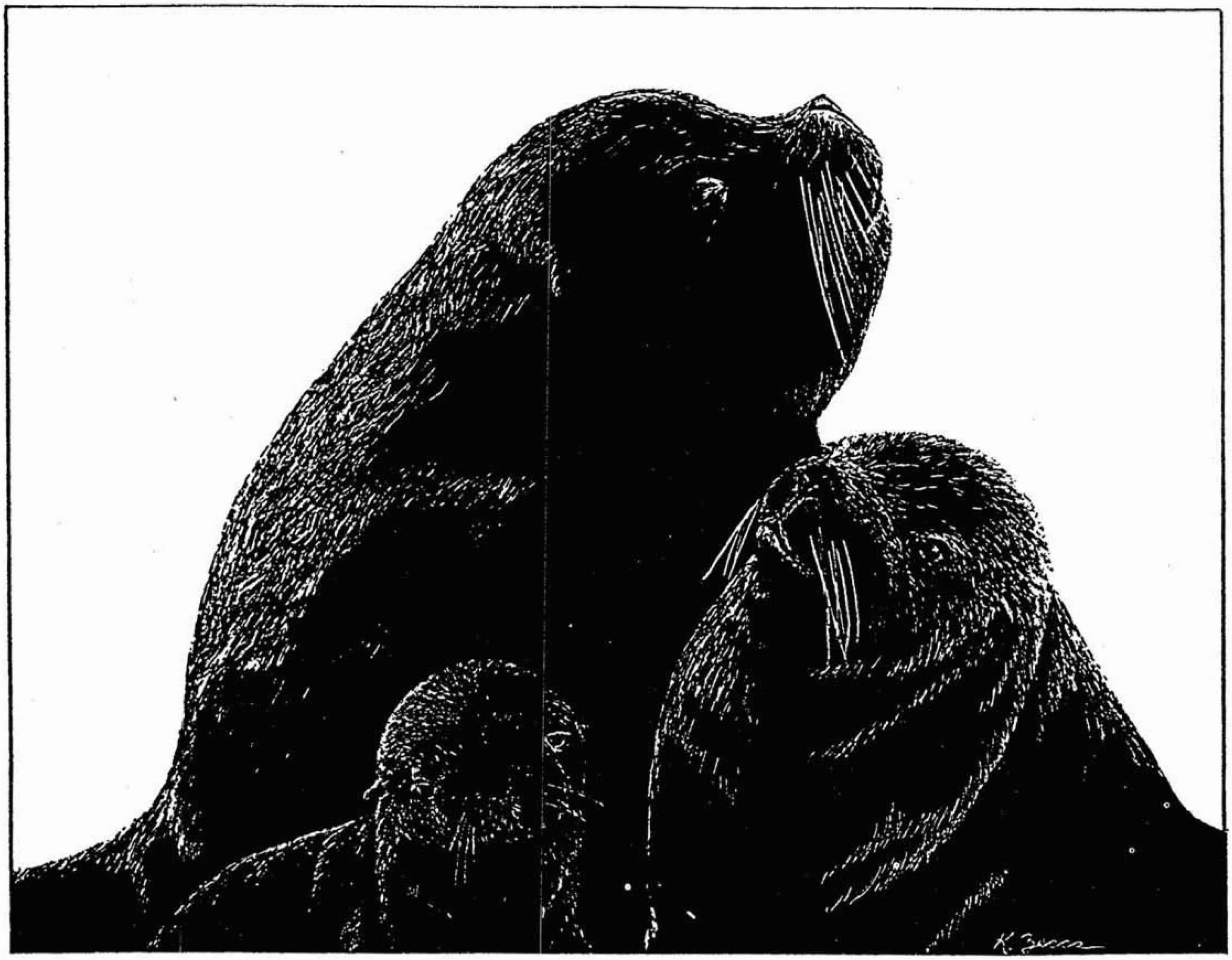
Final Recovery Plan for

Steller Sea Lions
Eumetopias jubatus



U.S. Department of Commerce
National Oceanic and Atmospheric Administration

National Marine Fisheries Service
Office of Protected Resources

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RECOVERY PLAN

for the

STELLER SEA LION
(Eumetopias jubatus)

Prepared by the

STELLER SEA LION RECOVERY TEAM

for the

OFFICE OF PROTECTED RESOURCES
NATIONAL MARINE FISHERIES SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SILVER SPRING, MARYLAND

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Approved: [signature]

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Assistant Administrator for Fisheries

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, sometimes with the assistance of recovery teams, contractors, state agencies, and others. The Steller Sea Lion Recovery Plan was prepared by a recovery team and approved by the National Marine Fisheries Service. It does not necessarily represent official positions nor approvals of all the team members or cooperating agencies, other than the National Marine Fisheries Service, involved in the plan formulation. The plan represents the official position of the National Marine Fisheries Service only after it has been signed by the Assistant Administrator for Fisheries as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status and completion of tasks described in the plan. Goals and objectives will be attained and funds expended contingent upon agency appropriations and priorities.

This final plan incorporates the new format that has become standard in recovery plans in recent years. It is intended to serve as a guide that delineates and schedules those actions believed necessary to restore the Steller sea lion as a viable self-sustaining element of its ecosystem. It is recognized that some of the tasks described in the plan are already underway. The inclusion of these ongoing tasks represents an awareness of their importance, and offers support for their continuation.

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PREFACE

On April 5, 1990, the National Marine Fisheries Service (NMFS) published an emergency rule listing the Steller sea lion as a threatened species under provisions of the Endangered Species Act (ESA). This action resulted in part from a petition submitted by the Environmental Defense Fund, which requested that Steller sea lions be designated as an endangered species. A protective listing was deemed appropriate because of a major, rapid decline in sea lion numbers that had occurred throughout most of Alaska. The final listing, published on November 26, 1990, became effective on December 4, 1990.

Section 4(f) of the ESA requires that recovery plans be developed for endangered and threatened species unless the appropriate Secretary finds that such a plan will not promote conservation of the species. Each plan must incorporate: (1) a description of site-specific management actions that may be necessary to achieve goals for conservation and survival of the species; (2) objective measurable criteria that can be used to determine whether a species can be removed from a list; and (3) estimates of the time and costs for carrying out actions needed to achieve the plan's goal.

NMFS has determined that a recovery plan would promote the conservation of the Steller sea lion. This plan was written by the Steller Sea Lion Recovery Team at the request of the Assistant Administrator for Fisheries, NMFS. A preliminary draft Steller Sea Lion Recovery Plan was prepared by members of the Recovery Team and circulated to a select group of technical experts for review (see Acknowledgements). A revised Technical Draft was submitted to NMFS on February 20, 1991, and NMFS made this draft available for public review and comment. A final draft of the Steller Sea Lion Recovery Plan, which incorporated, to the maximum extent possible, all relevant comments received, was submitted by the Recovery Team to NMFS on October 3, 1991.

A Recovery Plan identifies the specific management actions that must be taken to ensure that the species of concern recovers to the point that it can be removed from ESA listing. Unlike the situation with many other species where the problems and necessary remedial actions can be clearly identified, the factors that have caused the decline in Steller sea lion abundance are poorly known. It has therefore been difficult to design and evaluate the probable effectiveness of potential management actions. The plan recommends continuation of ongoing research and development of new programs designed to improve our understanding of sea lion management needs. Although the amount of research being conducted on Steller sea lions is increasing, it may still be a long time before we will understand the role of all of the factors that may be influencing the population. Because of these uncertainties, the Recovery Team recognized as an immediate objective the need to identify actions that are most likely to stop the decline of the Steller sea lion population. Actions that are likely to have such an effect are given the highest priority in the Recovery Plan.

When it was possible to identify a specific management action that the Team thought likely to help stop the population decline or to enhance recovery of the Steller sea lion population, that action has been specifically recommended in the Recovery Plan. The Team also described a monitoring program that should be conducted in order to allow a continuing evaluation of the population trend and status of Steller sea lions. Results from research and monitoring programs will be considered in subsequent revisions and modifications to this Recovery Plan.

The goal of this Recovery Plan will be met when the Steller sea lion population has recovered to the extent that it can be removed from ESA listings. It is possible that at that point the species would still qualify for listing as depleted under terms of the MMPA, and it would therefore be necessary for a conservation plan to be in place. In that case, the Recovery Plan should be reviewed and revised as necessary to reflect MMPA requirements and the biological and ecological situations at that time.

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LIST OF ABBREVIATIONS

ABF	Alaska Board of Fisheries
ADFG	Alaska Department of Fish and Game
CDFG	California Department of Fish and Game
DOS	U.S. Department of State
DFO	Department of Fisheries and Oceans, Canada
ESA	Endangered Species Act of 1973, as amended
FWS/NWR	U.S. Fish and Wildlife Service, National Wildlife Refuge System
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NMML	NMFS, National Marine Mammal Laboratory
NPFMC	North Pacific Fisheries Management Council
ODFW	Oregon Department of Fish and Wildlife
PRBO	Point Reyes Bird Observatory
PSMFC	Pacific States Marine Fisheries Commission
USCG	United States Coast Guard
VNIRO	All-Union Research Institute for Fisheries and Oceanography, Moscow, Russia

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EXECUTIVE SUMMARY

A major decline in the abundance of Steller sea lions has occurred throughout their range over the past 30 years. Counts of adults and juveniles in the region from the Kenai Peninsula to Kiska Island (i.e., the central and western Gulf of Alaska, and the eastern and central Aleutian Islands) declined 63% between 1985 and 1989. The greatest decline occurred in the eastern Aleutian Islands, where 10,802 sea lions were counted in 1985 but only 3,145 in 1989. The number of sea lions at Seguam Island, a rookery in the central Aleutian Islands, declined 80% from 1985 to 1989; pup counts at Seguam also declined 80% from 1985 to 1989. A comparison of trend sites (rookeries and haulouts that have been counted during every major survey) between the late 1950s and 1990 showed an overall decline of 78%. Population modeling suggests that decreased juvenile survival was the most likely cause of the decline in sea lions in the central Gulf of Alaska during 1975-1985. Analysis of 1991 counts indicates an additional decline of approximately 5% in the overall number of animals on the trend sites since 1989-1990.

The number of adult and juvenile animals in the Gulf of Alaska and Aleutian Islands formerly represented about 75% of the world population (Gulf of Alaska = 38%; Aleutian Islands = 37%); however, the proportion is changing as the Alaskan portion of the population declines. Both natural and human-caused factors have been hypothesized as contributing to these declines.

Changes in the quantity or quality of available prey may influence the health and fitness of individual sea lions. Evidence that major shifts have occurred in the abundance of fish in the Bering Sea over the past several decades is well documented. In the 1950s and early 1960s, the most abundant pelagic species was Pacific herring, whose biomass exceeded 3-5 million metric tons. However, rapid increases in the estimated size of walleye pollock stocks in both the Bering Sea and Gulf of Alaska occurred between the 1960s and 1980s. In the late 1970s, walleye pollock biomass increased significantly, from an estimated 0.8 million to more than 3.5 million metric tons. Recent estimates indicate that the pollock biomass has accounted for nearly 85% of the pelagic fish population in that region. Walleye pollock have been shown to be an important prey of Steller sea lions in the Gulf of Alaska, Bering Sea, and North Pacific Ocean. Commercial fisheries which target on several of the most important prey species of Steller sea lions, including pollock, remove millions of metric tons of fish, much of which is potential sea lion food. The development and expansion of commmercial fisheries throughout the species' range may have caused detrimental changes in the sea lions food supply. However, the complexity of ecosystem interactions, and limitations of data and models make it difficult to determine how fishery removals may have influenced the population.

Natural changes in the environment may also be partly responsible for the decline in numbers of Steller sea lions in some areas. The factors responsible for producing these changes, however, are not well known. Thus, although there is evidence suggestive of changes in the abundance of major fish species and the environment, the causes of these changes and their influence on Steller sea lion population trend are largely unknown.

The overall goal of this Recovery Plan is to promote recovery of the Steller sea lion population to a level appropriate to justify removal from ESA listings. Immediate objectives are to identify factors that are limiting the population, to propose a set of actions that will minimize any human-induced activities that may be detrimental to the survival or recovery of the population, and actions necessary to cause the population to increase. Although it is not clear what factors have contributed to the Steller sea lion population decline, and it is apparent that a great deal of information vital to the effective management of the species is lacking, there is an urgent need to take immediate actions to safeguard against further population declines, and to provide for recovery of the species. Immediate actions that should be taken include efforts to reduce human-caused mortality to the lowest level practicable, protection of important habitats through buffer zones and other means, and enhancement of population productivity by ensuring that there is an ample food supply available. Conservation and management measures implemented when Steller sea lions were listed under the ESA, and since, have addressed some of these needs. Additional management actions are described in the Recovery Plan. Progress toward achieving these goals and objectives will be measured by criteria for delisting of the species which are described in the Plan.

The Recovery Team believes that management designed to provide for recovery of the sea lion population should be based on biological principles and ecological understanding. The research program recommended by the Recovery Team will require a considerable amount of funds, time, and effort to produce the information needed to design a complete and effective set of conservation measures. Management agencies therefore should not preclude consideration of more immediate conservation measures or management experiments that could further reduce human impacts, or that would respond to proposals by the scientific community designed to evaluate certain hypotheses.

I. NATURAL HISTORY

A. Species Description

Sea lions belong to the Order Carnivora, Suborder Pinnipedia, Family Otariidae, and Subfamily Otariinae. The family contains the extant genera Arctocephalus, Callorhinus, Eumetopias, Neophoca, Otaria, Phocarctos, and Zalophus. The genus Eumetopias contains one species, the Steller (northern) sea lion, E. jubatus. Unless noted otherwise, all references to sea lions in this document are to Steller sea lions.

Steller sea lions are the largest otariid and show marked sexual dimorphism, males being larger than females. The average adult standard length is 282 cm for males and 228 cm for females (maximum of about 325 cm and 290 cm); weight of males averages 566 kg and females 263 kg (maximum of about 1,120 kg and 350 kg) (Fiscus, 1961; Calkins and Pitcher, 1982; Loughlin and Nelson, 1986). The light buff to reddish brown pelage is slightly darker on the chest and abdomen. Naked parts of the skin are black (King, 1954). Adult males have long, coarse hair on the chest, shoulders, and back; the chest and neck are massive and muscular. Newborn pups are about 1 m long, weigh 16-23 kg, and have a thick, dark-brown coat that molts to lighter brown after 6 months. A more detailed description is provided in Loughlin et al. (1987) and Hoover (1988).

B. Life History

Distribution and Movements

Sea lions probably evolved in temperate waters of the North Pacific Ocean (Repenning and Tedford, 1977). The earliest known remains of an otariid are between 10 and 12 million years old (Repenning, 1976). Three to four million year old fossil remains of Steller sea lions have been found in California.

The present range of Steller sea lions (Figure 1) extends around the North Pacific Ocean rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and Bering Sea, along Alaska's southern coast, and south to California (Kenyon and Rice, 1961; Loughlin et al., 1984). In the western Pacific, animals occasionally haul out as far south as Hokkaido Island in Japan.

The centers of abundance and distribution are the Gulf of Alaska and Aleutian Islands. Seal Rocks, at the entrance to Prince William Sound, Alaska, is the northernmost rookery (60°09'N). Most large rookeries are in the Gulf of Alaska and Aleutian Islands (Kenyon and Rice, 1961; Calkins and Pitcher, 1982; Loughlin et al., 1984; Merrick et al., 1987). Año Nuevo Island off central California is the southernmost rookery (37°06'N), although up until 1981 some pups were born at San Miguel Island (34°05'N). Most of the information on Steller sea lion distribution has been collected during summer months. Distribution during late fall and winter is poorly known.

Steller sea lions are not known to migrate, but they do disperse widely at times of year other than the breeding season. Males that breed in California are rarely seen in California or Oregon except for May through August, and appear to spend the non-breeding months in Alaska and British Columbia. During fall and winter in Alaska, sea lions may occur at rookeries and haulouts that are used during the summer; they are also seen near sea ice and islands in the northern Bering Sea. Females generally return to rookeries of their birth to pup and breed (Kenyon and Rice, 1961; Calkins and Pitcher, 1982; Loughlin et al., 1984; Calkins, 1986; Kajimura and Loughlin, 1988). Animals marked at rookeries in the Gulf of Alaska have been sighted in southeast Alaska and British Columbia; some marked in British Columbia have been seen at Cape St. Elias, Alaska; some marked in the eastern Aleutians have been seen in eastern Bristol Bay, Alaska; and some marked in Oregon have been seen in northern California, Washington, British Columbia, and southeast Alaska (Calkins and Pitcher, 1982; Calkins, 1986; R. Brown, personal communication; NMML files). In most cases, resights have been of juvenile animals on haulouts. Pups tagged in the Kuril Islands have been resighted in China's Yellow Sea at the Bo Hai bar, and in Japan as far south as Yokahama (NMML files).

There have been limited studies to develop biological criteria for separating animals in different geographic regions into separate populations. A single study of biochemical variation in Steller sea lions suggested little genetic variation within the Gulf of Alaska (Lidicker et al., 1981). Comparisons are being made among animals from more widely separated locations. The work on this subject is ongoing at the NMML. Since animals disperse widely after the breeding season and intermix with animals from other areas, it is difficult to identify individual animals once away from the rookery as belonging to a specific reproductive population.

Habitat Use

Steller sea lion habitat includes marine and terrestrial areas that are used for a variety of purposes. The most well-known habitats are the rookeries where adult animals congregate for pupping and breeding. Rookeries usually occur on beaches of relatively remote islands, often in areas exposed to wind and waves, where access by humans and other mammalian predators is difficult. Substrates include sand, gravel, cobble, boulder, and bedrock. Rookeries may extend across low-lying reefs and islands, or may be restricted to a relatively narrow strip of beach by steep cliffs. Rocky points may divide the animals using an area into subgroups.

Female sea lions appear to select places for giving birth that are gently sloping and protected from waves (Sandegren, 1970; Edie, 1977). Pups normally stay on land for about 2 weeks, then spend an increasing amount of time in intertidal areas and swimming near shore.

A haulout is the term used to describe areas used by adult sea lions during times other than the breeding season, and by non-breeding adults and subadults throughout the year. Sites used as rookeries in the breeding season may also be used as haulouts during other times of year. Many other rocks, reefs, and beaches are also irregularly used as resting sites. Sea lions are sometimes seen hauled out on jetties and breakwaters, navigational aids, floating docks, and sea ice. Many animals also use traditional rafting sites, which are places where they rest on the ocean surface in a tightly packed group (Bigg, 1985; NMML files).

Although rookeries and haulouts occur in many types of areas, the locations that are used are specific and change little from year to year. Factors that influence the suitability of a particular area may include substrate, exposure, proximity to food resources, tradition of use, and season (Calkins and Pitcher, 1982), as well as the extent and type of human activities in the region (Johnson et al., 1989). Thermoregulatory factors may play an important role in site selection (Gentry, 1970; Sandegren, 1970).

When not on land, Steller sea lions have been seen from nearshore, out to the edge of the continental shelf. Some individuals may enter rivers in pursuit of prey (Jameson and Kenyon, 1977), while in the Gulf of Alaska, they commonly occur near the 200 m depth contour (Kajimura and Loughlin, 1988). They have been caught on fishing lines at depths of 183 m (Kenyon, 1952; Fiscus and Baines, 1966).

Ongoing studies using satellite telemetry are providing detailed information on feeding areas and diving patterns (NMML, unpublished data). Tagging effort has concentrated on adult females in the central Gulf of Alaska and Aleutian Islands. Preliminary analysis of data from six animals tagged in the summer indicated that they stayed close to the rookeries (within 30 km), took brief trips to sea (2 days or less), and made shallow dives (mean depth less than 30 m, with a maximum of 120 m). Data from five animals followed during winter indicate longer trips to sea (up to 4 months), farther offshore (over 450 km), and deeper dives (mean depths up to 84 m, with a maximum of 273 m).

Reproduction

Breeding adult animals, and some subadults, occupy rookeries during the breeding season, which extends from late May to early July (Pitcher and Calkins, 1981; Gisiner, 1985). Some breeding may occur at haulout sites between females which are not giving birth and males which cannot hold territories. Pregnant females arrive at the rookery about 3 days before pups are born (Gentry, 1970). Females frequently return to the same pupping site in successive years, and the pupping site may be the same as or near the site of the female's birth (Sandegren, 1970). Females of reproductive age which were tagged as pups at Rogue Reef, Oregon have been seen at Orford Reef and St. George Reef rookeries (32 km to the north and 56 km to the south, respectively) during the breeding season; one of these females was nursing a pup (R. Brown, personal communication). Copulation generally occurs on the territories at 11 to 14 days postpartum (Gentry, 1970; Sandegren, 1970). Females usually copulate with only one male, not necessarily within the territory where her pup was born (Gentry, 1970; Gisiner, 1985). Once a territory is acquired, a male may occupy it for up to seven consecutive breeding seasons (Gisiner, 1985). Subadult and adult males that are not able to hold territories frequently occupy areas adjacent to rookery areas.

In samples collected during the mid-1980s, 34 of 35 females age 6 years and older had ovulated (Calkins and Goodwin, 1988). Implantation of the embryo occurs late September through early October, after a delay of 3 to 4 months (Pitcher and Calkins, 1981). Implantation is probably linked to the photoperiod 8.5 months prior to birth (J. Tempe, personal communication). Twenty-two of 24 animals (92%) between ages 7 and 20 years were pregnant when they were collected in October (Calkins and Goodwin, 1988). Resorption of the fetus or premature births may occur throughout gestation. Viable births occur from late May through early July (Pitcher and Calkins, 1981). Birth rates, based on the percent of breeding age females pregnant in April to May, are about 60-75% throughout the range (Belkin, 1966; Pitcher and Calkins, 1981; Calkins and Goodwin, 1988). The sex ratio at birth is close to parity but slightly favors males; twinning is rare.

The pregnancy rate of sexually mature females collected in the Gulf of Alaska during April-May 1985 was 60%, which was lower than the 67% found there in 1975-1978, although the difference was not statistically significant (Pitcher and Calkins, 1981; Calkins and Goodwin, 1988). There are no data on reproductive rates prior to 1975.

Females reach sexual maturity between 3 and 6 years of age and may produce young into their early 20s (Mathisen et al., 1962; Pitcher and Calkins, 1981). Adult females are monestrous and most breed annually (Pitcher and Calkins, 1981). Males reach sexual maturity between 3 and 7 years of age and physical maturity by age 10 (Perlov, 1971; Pitcher and Calkins, 1981). Thorsteinson and Lensink (1962) found that 90% of males holding territories on rookeries in the western Gulf of Alaska were between 9 and 13 years of age.

Natural Mortality

Causes of pup mortality include drowning, starvation caused by separation from the mother, crushing by larger animals, disease, predation, and biting by females other than the mother (Orr and Poulter, 1967; Edie, 1977). Pup mortality on rookeries has not been thoroughly studied. The number of juveniles counted at Ugamak Island was much lower in 1985-1986 than in the 1970s, which may indicate that the mortality of pups increases after leaving the rookery (Merrick et al., 1988).

Steller sea lions are probably eaten by killer whales and sharks, but the possible impact of these predators is unknown. The occurrence of shark predation on other North Pacific pinnipeds has been documented, but not well quantified (Ainley et al., 1985).

Calkins and Pitcher (1982) used life tables constructed from samples collected in the Gulf of Alaska in 1975-1978 to estimate mortality rates. The estimated mortality rate from birth to age 3 was 0.53 for females and 0.74 for males. Mortality rate for females dropped to 0.11 by the sixth year and remained at about that level in older age classes. Male mortality rates decreased from 0.14 in the third year to 0.12 in the fifth year. Females may live to 30 years and males to about 20 (Calkins and Pitcher, 1982).

York (in preparation) produced a revised life table for female Steller sea lions using the same data as Calkins and Pitcher (1982) but a different model (based on the Weibull survivor function). The estimated annual mortality from York's life table was 0.22 for ages 0-2, dropping to 0.07 at age 3, then increasing gradually to 0.15 by age 10 and 0.20 by age 20. Population modelling suggested that decreased juvenile survival was the most likely cause of the decline in sea lions in the central Gulf of Alaska during 1975-1985 (York, in preparation).

Feeding and Energetics

Diet studies conducted over the past 15 years show that Steller sea lions eat a variety of fishes and invertebrates; demersal and off-bottom schooling fishes predominate (Jones, 1981; Pitcher, 1981). Harbor seals, spotted seals, bearded seals, ringed seals, fur seals, and sea otters are also occasionally eaten (Gentry and Johnson, 1981; Pitcher and Fay, 1982; D. Calkins, unpublished data).

A small number of sea lions collected at sea, or found dead on shore, in California and Oregon had eaten rockfish, hake, flatfish, cusk eel, other fishes, squid, and octopus (Fiscus and Baines, 1966; Jones, 1981; Treacy, 1985). In the Rogue River, 87% of the observations of prey being eaten at the surface were of lamprey (Jameson and Kenyon, 1977). Feeding on lamprey in estuaries and river mouths has also been documented at other sites in Oregon and California (Jones, 1981; Treacy, 1985). Principal prey identified from stomachs and scats collected in British Columbia included hake, herring, octopus, Pacific cod, rockfish, and salmon (Spalding, 1964; Olesiuk et al., 1990). While these data are not comprehensive, especially for California and Oregon, they do show that rockfish and hake are consistently important components of the diet. In the Kuril Islands, Atka mackerel, sand lance, rockfish, and octopus have been identified as important sea lion foods (Panina, 1966).

Results of major diet studies conducted in Alaska since 1975 are summarized in Table 1. Walleye pollock was the principal prey in all areas and years, with Pacific cod, octopus, squid, herring, flatfishes, and sculpins also consumed. Smaller collections of material from the central Bering Sea and eastern Aleutian Islands also indicated that pollock has been an important food, with octopus, squid, rockfish, herring, cod, flatfish, and other fishes also eaten (Lowry et al., 1982; T. R. Loughlin, unpublished data).

Based on measurements of undigested otoliths from stomachs of 90 sea lions collected in the Bering Sea during 1976-1981, the lengths of walleye pollock eaten ranged from 8.2 to 64.2 cm, with a mean fork length of 29.3 cm (Frost and Lowry, 1986). The estimated mean lengths of walleye pollock consumed ranged from 21.8 to 46.9 cm in nine collections made at various locations in the Bering Sea and Gulf of Alaska during 1976-1986 (Lowry et al., 1989).

Seasonal aspects of prey utilization have not been analyzed in detail. Many reports have lumped samples collected at various times of year which may give a false impression of the overall importance of prey species. Pitcher (1981) noted that in the Gulf of Alaska, salmon and capelin were eaten primarily in spring and summer. In the Kodiak Island area where samples were collected in all seasons, walleye pollock, cod, and octopus were eaten throughout the year (Calkins and Pitcher, 1982).

During the breeding season females with pups feed principally at night (Higgins et al., 1988); territorial males remain on land and fast during the breeding season (Spalding, 1964; Gentry, 1970; Withrow, 1982; Gisiner, 1985).

Recent collections have not been thoroughly analyzed for possible variations in diet among different age and sex classes. Because of large differences in body size, and in the behavior of animals of different reproductive status, such variations in the diet may be substantial (Spalding, 1964). Frost and Lowry (1986) measured otoliths from the stomachs of

88 sea lions collected in the western Bering Sea in March-April 1981, and found that sea lions less than 4 years old ate significantly smaller walleye pollock than did older animals (estimated mean fork length 22.4 cm versus 26.9 cm).

Historical data on stomach contents of sea lions collected in Alaska may indicate some long-term changes in diet. Walleye pollock was not a major food of animals collected at Chernabura Island in 1958 (Mathisen et al., 1962), or in Unimak Pass and other locations in 1960 (Fiscus and Baines, 1966). This is in marked contrast to results from 1975-1978; however, the sampling was not comparable in the various studies (Pitcher, 1981). In 1945-1946, seven of eight stomachs examined from southeastern Alaska and five of seven from the Kodiak-Kenai area contained mostly walleye pollock (Imler and Sarber, 1947).

A more recent comparison has been made of stomach contents in sea lions collected in the Gulf of Alaska in 1975-1978 and 1985-1986 (Calkins and Goodwin, 1988). A major difference was that capelin was one of the main prey species in the earlier collection, but did not occur at all in 1985-1986 (Table 2). This was thought to be in part a result of the timing of collections. The relative importance of octopus and flatfish in the diet was much greater in 1985-1986, while herring and squid were of lesser importance. When the overall diet in the Gulf of Alaska for the mid-1970s is compared to samples from Kodiak in 1985-1986, walleye pollock were eaten more frequently (66% versus 58%) and comprised a greater proportion of the stomach contents (58% versus 42%) in the earlier sample.

If only Kodiak area samples are compared (Table 3), walleye pollock was eaten more frequently in the 1980s than the 1970s (58% versus 39%). Walleye pollock consumed in 1985-1986 were of smaller average size (25.4 cm fork length versus 29.8 cm). Capelin and salmon were both important foods in the mid-1970s but were insignificant items in 1985-1986. The average volume of stomach contents for animals collected in the Kodiak area was much greater in 1975-1978 (1,317 ml) than in 1985-1986 (745 ml).

Although there is information available on feeding rates of pinnipeds in general (e.g., Innes et al., 1987), the food and energy requirements of Steller sea lions are not well known. Keyes (1968) concluded that adult, nonpregnant, nonlactating individuals would require 6-10% of their body weight in food per day. However, this estimate was derived from feeding rates of captive sea lions and may not reflect the energy requirements of free-ranging animals. Daily food consumption by an average individual in the population has been estimated to be about 14.3 kg (Calkins, 1988). The amount of food required to provide for energetic needs can vary greatly depending on the energy content of the food and physiological status of the animal (Innes et al., 1987). Pups grow rapidly during their first weeks of life and require a substantial intake of energy which is supplied by the mother. Steller sea lions pups at Año Nuevo Island consumed 1.5-2.4 liters of milk per day while nursing (Higgins et al., 1988). The milk contained 23-25% fat. Perez and Mooney (1986) determined that the average daily feeding rate for lactating northern fur seals was 1.6 times higher than for nonlactating females.

C. Population Status and Trend

Although there is currently no reliable estimate of the total number of Steller sea lions, index counts of animals present on land at standardized dates and times indicate a major decline has occurred over the past 30 years (Figure 2). Furthermore, a survey throughout the sea lion range in 1989 revealed that the decline is widespread, with a major reduction throughout the area from the Kenai Peninsula to the Kuril Islands (Loughlin et al., 1989; Merrick et al., 1990).

It is difficult to obtain an accurate census of the population because an unknown number of animals are away from the rookery or haulout site and are missed during surveys. Therefore, available counts represent an index of population size, and not an estimate of the total number of sea lions. An estimate of the total population size requires correction factors for missed animals. Correction factors must account for the amount of time the missed animals spend at sea, and the age/sex composition of the uncounted segments of the population. Pup production should also be added to the count for a complete population estimate. Ongoing research using satellite telemetry may provide some of the data needed to calculate correction factors. Based on an analysis of age/sex composition and survival rates, Calkins and Pitcher (1982) suggested that the total number of animals present at the end of the pupping season in the Gulf of Alaska was about 4.5 times the number of pups born. This multiplier was derived from collections made in the mid-1970s and may not be applicable to the current population.

A survey that counted sea lions throughout most of their range was completed in 1989 and the data are currently being prepared for publication by U.S. and Russian biologists. Currently available data on population status and trend for each geographical region are summarized below. However, it must be remembered that these regions are based on geographical and political boundaries, and do not necessarily represent discrete stocks or management units.

Russia (Figures 3 and 4)

A comparison of recent and historic counts of Steller sea lions in the Russian Federation indicates that the present number of animals is about one-third of historic levels (Table 4). In some instances, the decrease in numbers has been accompanied by complete disappearance of rookeries (Perlov, 1991). Numbers of adult and juvenile sea lions at major rookeries and haulouts in the Kuril Islands have declined 74%, from 14,076 in 1969 to 3,615 in 1989 (Merrick et al., 1990). Most of the decline occurred between 1969 and 1974. The numbers since about 1974 appear to have remained stable. Pup numbers have declined 60%, from 3,673 in 1963 to 1,476 in 1989. Based on 1989 counts Burkanov et al. (1991) estimated that the total number of sea lions, including those on haulouts, rookeries and those observed swimming in the water near the site at the time of the survey, along the Kamchatka Peninsula and the Commander Islands was 3,500-3,800. Estimates for this region made in 1982-1985 were 1.6 to 3.5 times larger. This decline is similar to what has occurred in the U.S. portion of the Bering Sea, and is thought likely to continue (Perlov, 1991). There are about 2,000 sea lions on a few small islands in the Sea of Okhotsk, where numbers are reduced from previous levels, but stable (Perlov, 1991).

Alaska (Figures 5 and 6)

The first reported counts of Steller sea lions in Alaska were made in 1956-1960 (Kenyon and Rice, 1961; Mathisen and Lopp, 1963). The results suggested that there were at least 140,000 Steller sea lions in the Gulf of Alaska and Aleutian Islands at that time (Merrick et al., 1987). Subsequent surveys have shown a major decline in numbers, first detected in the eastern Aleutian Islands in the mid-1970s (Braham et al., 1980). The decline appears to have spread eastward to the Kodiak Island area during the late 1970s and early 1980s and westward to the central and western Aleutian Islands during the early and mid 1980s (Merrick et al., 1987; Byrd, 1989). The greatest declines were observed in the eastern Aleutian Islands and western Gulf of Alaska, but declines also occurred in the central Gulf of Alaska and central Aleutian Islands (Table 5). Sighting data collected from 1976-1979 indicated a total of approximately 104,000 sea lions counted in this region.

Counts of adults and juveniles in the region from the Kenai Peninsula to Kiska Island (i.e., the central and western Gulf of Alaska, and the eastern and central Aleutian Islands) declined 63%, from 67,617 to 24,953, between 1985 and 1989 (Loughlin et al., 1990). The greatest decline occurred in the eastern Aleutian Islands, where 10,802 sea lions were counted in 1985 but only 3,145 in 1989 (Table 5). The greatest decline at any one rookery occurred at Seguam Island in the central Aleutian Islands. The number of sea lions counted at Seguam declined 80% from 2,942 animals in 1985 to 602 in 1989; pup counts at Seguam also declined 80% from 1985 to 1989 (Table 6). At Marmot Island (in the Gulf of Alaska), a 38% decline occurred from 1986 to 1989 in the adult count, and 48% in the pup count. Pinnacle Rock rookery in the western Gulf of Alaska showed the smallest decline of adults and juveniles (at 14%). No surveyed location showed a significant increase.

Aerial and ship-based surveys were again conducted in the Kenai to Kiska region in 1990 (Merrick et al., 1991). The total number of adults and juveniles counted was 27,860. Compared to 1989, there was a decreased number of animals counted in the central Gulf of Alaska, and an increased count in the other three regions (Table 5). Between 1989 and 1990 number of adults and juveniles increased at 12 of 25 rookeries counted. Large declines also occurred at some sites, particularly in the area from Sugarloaf to Chernabura Island. Pup counts at Bogoslof and Seguam Islands increased by 29% from 1989 to 1990, while the pup count at Kiska Island decreased by 25% (Table 6). In most cases, the changes in counts from 1989 to 1990 may be within the range of natural fluctuations and variability inherent in the survey techniques, and therefore should not be interpreted as evidence for a trend.

Some of the apparent variability in abundance based on total counts is almost certainly due to variations in the number of sites that are counted in that year. For example, the higher total count in 1990 represented 152 sites, while only 87 sites were counted in 1989, and this produced a lower total count (Loughlin et al., 1990; Merrick et al., 1991). It is obvious that abundance estimates can be biased due to more or fewer sites being counted in a particular year. Therefore, the analysis of relative population size and trend should be based on sites that are counted in every survey. Merrick et al. (1991) presented an analysis of counts from 77 trend sites (rookeries and haulouts) that have been counted during every major survey. A comparison of the count from trend sites in the late 1950s (105,289) with that from 1990 (22,754) showed an overall decline of 78% (Table 7). The total trend site count was similar in 1989 (23,064) and 1990 (22,754), but there was a substantial change in the central Gulf of Alaska where the count dropped from 8,552 to 7,050. The pattern was similar at rookeries and haulouts. Analysis of 1991 counts indicates an additional decline of approximately 5% in the overall number of animals on the trend sites (Merrick et al., 1992).

Data on sea lion numbers in the Kenai-Kiska region from the trend site analysis show a generally similar pattern of decline when compared with data from all sites counted (Table 7). Since the mid-1970s the number counted on the 77 trend sites has comprised 82-92% of the total number counted. In the late 1950s, however, the trend site count was only 75% of the total count. This may be due partly to the fact that the earlier counts were made without regard to time of year, and they may not be directly comparable with later counts which were all made during June.

Rookeries and haulouts in the western Aleutians have not always been counted on the same schedule as areas to the east. A comparison of that region's non-pup counts made in 1988 with data collected in 1977-1980 showed a decline of 65%, from 27,228 to 9,516 (Byrd and Nysewander, 1988). Subsequent counts have indicated a continued decline (Douglas and Byrd, 1990). Counts in 1990 at Buldir Island and Agattu Island showed decreases of 40% and 23% compared with 1988. Alaid Island counts declined 62% from 1984 to 1990.

Counts of sea lions older than pups at Walrus Island (Pribilof Islands) have declined from 4,000-5,000 in 1960 to about 600 in 1982 (Kenyon, 1962; Loughlin et al., 1984). Counts in 1987 and 1988 were less than 500. Pup production at Walrus Island fell from 2,866 in 1960 to about 334 in 1982 and to 50 in 1991 (NMML, unpublished data).

In the region from the Kenai Peninsula east to Cape St. Elias, counts of adult and juvenile sea lions began to decline sometime after 1980 (Table 8). The 1991 count at Seal Rocks was 59% lower than the peak number counted in 1979. At both Seal Rocks and Cape St. Elias the decline appears to have been rapid during 1989-1991. Counts of pups at Seal Rocks, the only major rookery in the area, have ranged from 491 to 799 during 1978-1991, with no detectable trend (ADFG, unpublished data).

Counts of sea lions in southeast Alaska show a stable or possibly increasing trend (Table 9). The number of animals older than pups counted has ranged from 5,391 to 6,962 during 1979-1991. While no real trend is shown by the non-pup counts, pup counts have increased steadily from 2,220 in 1979 to 4,164 in 1991. A new rookery has become established at Hazy Islands, where about 900 non-pups and 30 pups were counted in 1979; this increased to 1,278 non-pups and 808 pups in 1991. More recently, the White Sisters has begun to be used for pupping. An increase in pup production has occurred at Forrester Island with 3,261 pups counted there in 1991, up from 2,187 in 1979 (ADFG, unpublished data). In 1989-1991, Forrester Island was the largest Steller sea lion rookery in the world.

The number of adult and juvenile animals in the Gulf of Alaska and Aleutian Islands formerly represented about 75% of the world population (Gulf of Alaska = 38%; Aleutian Islands = 37%); however, the proportion is changing as the Alaskan portion of the population declines (Braham et al., 1980; Merrick et al., 1987).

<u>British Columbia</u> (Figure 7)

In British Columbia, major Steller sea lion rookeries occur at North Danger Rocks, Cape St. James, and Triangle, Sartine, and Beresford islands. Extensive sea lion reduction programs were conducted at many locations in British Columbia from 1912 through 1966. In 1913, 10,000-12,000 animals (includes pups) were counted; in 1965 the number was about 4,000 (Bigg, 1985). Pup counts in the 1970s and 1980s have ranged from about 1,000 to 1,400 with no identifiable trend. The most recent census was in 1987 when 1,084 pups and 6,109 non-pups were counted (P. Olesiuk, personal communication). Bigg (1988) speculated that a northward shift in distribution may have occurred from rookeries in British Columbia, which could partly explain the increase in sea lion numbers in southeast Alaska.

Washington, Oregon, and California (Figure 8)

There are no Steller sea lion rookeries in Washington State, although animals do occur there during some times of year. Jagged Island and Split Rock are used as summer haulouts, and Umatilla Reef is used during the winter (NMML, unpublished data). Cape Flattery is occasionally used for hauling out. There are no data available that can be used to evaluate trends in numbers of Steller sea lions in Washington.

Counts of Steller sea lions in Oregon have been relatively stable since 1981 at about 2,000-3,000 animals. Statistical analysis of all data collected since 1976 indicates an increase in numbers, but this may be an artifact of improved surveys in recent years (Brown, 1990). Rookeries at Rogue Reef account for 1,000-1,250 non-pups and 200-400 pups; at Orford Reef there are 700-900 non-pups and about 100-200 pups born each year (Table 10). Counts at both localities have been variable, and generally show no strong trend. However, the count of adults and juveniles at Orford Reef declined from 1986 through 1989 coincident with increased sea urchin harvesting activity near the rookery (Brown, 1990). Restrictions of urchin harvest near Orford Reef rookeries appear to have resulted in an increase in counts in 1990 (R. Brown, personal communication).

Numbers in California have declined, especially in southern California (Table 11). San Miguel Island was the southernmost rookery within recent historical record, but no adults have been seen there since 1983 and no births have been recorded since 1981 (R. DeLong, personal communication). Currently the southernmost breeding site is Año Nuevo Island. Historically, peak counts ranged between 1,500 and 2,500. Since 1984, counts there during the breeding season have consistently been below 1,200. Counts in 1988 and 1990 resulted in a total of less than 600 adults and juveniles (Le Boeuf and Morris, 1990; R. Gisiner, personal communication). Año Nuevo Island produces more pups than any other rookery in California. Pup production from 1980-1985 was about 300 pups per year (M. Pearson, personal communication); a minimum of 139 pups was born there in 1990 (Le Boeuf and Morris, 1990). At the Farallon Islands, adult and juvenile numbers during the breeding season have declined from approximately 200 in the late 1970s and early 1980s, to less than 100 individuals in 1989 and 1990 (D. Ainley, personal communication). Pup production has steadily declined over this time; only three pups were born there each year in 1988, 1989, and 1990. It is possible that the Farallon Islands may cease to be a breeding site in the near future. Bonnell et al. (1983) counted approximately 900 non-pups and 117-137 pups at the Sugarloaf/Cape Mendocino rookery during the 1980-1982 breeding seasons. In May 1989, approximately 300 adults and juveniles were seen on Sugarloaf. The 1989 count was made several weeks before peak numbers of sea lion adults and pups are usually attained, and based on seasonal trends in numbers, it is likely that 800-900 adults and juveniles would have been present during June-July. During 1980-1982, about 250 non-pups and 10-25 pups were seen on the St. George Reef rookery each year. A count of 674 non-pups and 124 pups was reported from the St. George Reef rookery in 1990 (R. Brown, personal communication). Statewide, counts between 1927 and 1947 ranged between 5,000 and 7,000 non-pups with no apparent trend, but have subsequently declined by over 50%, remaining at about 2,000 to 2,500 non-pups between 1980 and 1990.

These data, together with a limited number of counts made during other times of year by Bonnell et al. (1983) and Bonnot and Ripley (1948), suggest that there may have been a northward shift in the species' distribution in California. Changes in breeding season numbers have been less pronounced and slower than changes in distribution outside the breeding season, perhaps due to breeding site fidelity. Tagging, satellite telemetry, and coordinated counts with other parts of the species' range are needed to determine the relative contributions of emigration and reduced productivity to the decline in numbers of Steller sea lions in California.

D. Natural Factors Influencing the Population

Predation

Although Steller sea lions are preyed upon by certain other species (e.g., killer whales and sharks), there is no scientific evidence to suggest that the incidence of predation has increased in recent years. It seems unlikely that increased predator activity could explain the recent widespread decline in sea lion numbers.

Parasitism and Disease

Parasites of Steller sea lions include intestinal cestodes; trematodes in the intestine and bile duct of the liver; nematodes in the stomach, intestine, and lungs; acanthocephalans in the intestine; acarian mites in the nasopharynx and lungs; and an anopluran skin louse (Dailey and Hill, 1970; Dailey and Brownell, 1972). Shults (1986) reported 11 species of helminth parasites from sea lions in the Gulf of Alaska, and nine species from the Bering Sea. A severe infection of nematodes can cause stomach ulcers, but the number of deaths attributable to this cause is probably very small. However, there has not been adequate research to assess the nature and importance of parasitism in sea lions.

The prevalence of disease is difficult to evaluate because most specimens analyzed have come from animals that appeared healthy when they were collected. In addition to gastric ulceration mentioned above, histopathological analyses have revealed mild cases of hepatitis, myocarditis, and pneumonia (T. Spraker, personal communication).

Reproductive failure and neonate, juvenile, and adult mortality resulting from disease probably occur in Steller sea lions. Antibodies to two types of bacteria (Leptospira and Chlamydia), one marine calicivirus (San Miguel Sea Lion Virus), and seal herpesvirus (SeHV), which could produce such effects, were present in blood taken from Steller sea lions in Alaska (Barlough et al., 1987; Vedder et al., 1987; Calkins and Goodwin, 1988). Leptospires are spirochete bacteria and are suspected agents of abortions and adult mortality in California sea lions and northern fur seals. Calkins and Goodwin (1988) found a low incidence of Leptospirosis and concluded that it was not a significant factor in the decline of Steller sea lions in the Kodiak area in the 1980s. San Miguel Sea Lion Virus has been associated with reproductive failures or neonatal deaths in California sea lions and northern fur seals (Smith et al., 1974; Gilmartin et al., 1976). Chlamydia had not been studied in sea lions prior to the work of Calkins and Goodwin (1988). These and other agents are currently under study to examine their possible adverse effects on Steller sea lions, but much additional work is needed.

Environmental Change

Sea lion behavior and survival could be influenced by changes in environmental conditions which might affect the suitability of the environment for sea lions. No trends have been observed that relate the decline in Steller sea lion numbers to such changes. Data bases on weather and oceanography in the North Pacific are extensive. York (in press) examined the relationship between sea surface temperature and early survival of Pribilof fur seals. While a significant positive correlation was found, cause and effect relationships could not be identified. A model constructed by Trites (1990a) has shown that thermal conditions on land could affect early survival of fur seal pups, but that the animals generally are able to tolerate the range of conditions to which they are normally exposed. The data that have been collected on Steller sea lions are not adequate for use in such analyses (Anonymous, 1990), and it is likely that attempts to do environmental correlation studies for sea lions would be even more inconclusive than for fur seals. Furthermore, sea lions inhabit an area encompassing approximately 30 degrees of latitude, and they therefore must be able to tolerate a relatively wide range of environmental conditions. It seems very unlikely, overall, that changes in meteorologic and climatologic conditions per se could directly explain the major decline in sea lion numbers that has occurred in the core of their range.

If environmental changes affected the abundance or availability of a necessary food resource, the survival and productivity of sea lions could be reduced. These types of responses by pinniped populations have occurred as a result of El Niño events (Trillmich and Ono, 1991). A study of foraging patterns and energetics of Antarctic fur seals showed a dramatic effect of changes in prey (krill) availability on nutrition and growth of pups (Costa et al., 1989). Lactating females provided their pups with the same amount of milk each time they came ashore regardless of whether food was abundant or scarce. However, in a year when krill were less abundant and more dispersed, feeding trips were almost twice as long (8.4 days versus 4.5 days). This resulted in the pups receiving about half as much milk per day, and correspondingly low pup growth rates. In the year of low food availability, 32% of the pups died, 68% due to starvation. These values were approximately double the normal rates.

Evidence that major shifts have occurred in the abundance of fish and shellfish in the Bering Sea over the past several decades is well documented. Naumenko et al. (1990), for example, note that "in the last four decades the community of pelagic fishes in the western Bering Sea has shown considerable structural change." In the 1950s and early 1960s, the most abundant pelagic species was Pacific herring, whose biomass exceeded 3-5 million metric tons. However, in the late 1970s, walleye pollock biomass increased significantly (from an estimated 0.8 million metric tons to over 3.5 million) and more than doubled the herring biomass. Recent estimates indicate that the walleye pollock biomass has accounted for nearly 85% of the pelagic fish population in that region.

Others have noted major shifts in the abundance of fish and shellfish stocks in the eastern Bering Sea characterized by rapid growth of the salmon, Pacific cod, and flatfish populations in the early 1980s, with corresponding declines in shrimp and crab populations. Rapid increases in the estimated size of walleye pollock stocks in both the Bering Sea and Gulf of Alaska occurred between the 1960s and 1980s (Natural Resources Consultants, 1983; Larkin et al., 1990; Quinn and Collie, 1990).

The factors responsible for producing these changes, however, are not well known. A number of authors note that there has been a general warming in the Bering and Okhotsk seas over the past three decades and theorize that shifts in temperature and wind patterns may have influenced recruitment and fish and shellfish population trends, but supporting oceanographic data are largely absent (Swan and Ingraham, 1984; Khen and Glebova, 1990; Rodinov and Krounin, 1990). Furthermore, many of the population changes in both fish and shellfish have occurred during and following periods of intense fishing activity. Thus, although there is evidence suggestive of changes in the abundance of major fish species and the environment, the causes of these changes and their influence on Steller sea lion population trend are largely unknown. Further studies to examine these relationships would be useful as an aid to evaluating natural versus human factors that may be influencing sea lion population changes.

2. KNOWN AND POTENTIAL HUMAN IMPACTS

Commercial Harvest

There is currently no commercial harvest for Steller sea lions. They were commercially harvested in the eastern Aleutian Islands and Gulf of Alaska from 1959 to 1972 (Merrick et al., 1987). An experimental harvest in 1959 resulted in 616 adult males being taken (Thorsteinson and Lensink, 1962). A total of 45,178 pups of both sexes were harvested in the eastern Aleutian Islands and Gulf of Alaska between 1963 and 1972 (Merrick et al., 1987). The largest harvests were conducted between 1963 and 1972 at Sugarloaf and Marmot islands where 16,763 and 14,180 pups were killed, and between 1970 and 1972 at Ugamak and Akutan islands where 3,773 and 6,036 pups were killed. The pup harvests, which sometimes reached 50% of the total pup production from a rookery, could have depressed recruitment in the short term. This may partially explain the declines at some sites through the mid-1970s. However, it does not explain why numbers declined in areas where no harvest occurred (Merrick et al., 1987), or why declines did not occur until approximately 20 years after the harvests (e.g., at Marmot and Sugarloaf islands).

During the period from 1912 through 1968, thousands of Steller sea lions were killed on rookeries and haulouts in British Columbia (Bigg, 1985). Information on the harvest of sea lions in the Soviet Union is not available.

Subsistence Harvest

The MMPA authorizes Alaska Natives to harvest and use Steller sea lions. This use can continue even if the species is listed as depleted, as long as it is for subsistence purposes and is done in a non-wasteful manner. The ESA also contains provisions that allow for the continued subsistence use of listed species. Both the ESA and the MMPA contain provisions that allow the subsistence harvest of endangered, threatened, or depleted species to be regulated, if necessary.

The archaeological record confirms that coastal Alaska Natives have for centuries harvested and used sea lions for subsistence purposes. Historical sources document continuous use in Alaska since Russian contact. Most parts of the animal were used as food or fashioned into tools, clothing, and decorative crafts. Sea lions historically were and presently are used primarily in areas dominated by a Pacific maritime climate, where they replace the Pacific walrus which fills a similar role in more northern areas.

During the past decade, the subsistence harvest of sea lions has been documented in Prince William Sound, lower Cook Inlet, Kodiak Island, Alaska Peninsula, Pribilof Islands, and to some extent in the Aleutian Islands (Haynes and Mishler, 1991). Less is known about the extent of subsistence uses in Bristol Bay, the Yukon-Kuskokwim Delta, and southeast Alaska. Annual statewide harvest levels have not been systematically documented, but single year estimates or reported harvest data are available for some communities, including: Akhiok (7 in 1989); Atka (15-25 in 1982-1983); Chenega Bay (15 in 1984); English Bay (2 in 1989); Manokotak (15 in 1985); Old Harbor (26 in 1989), Perryville (10 in 1989-1990); Quinhagak (16 in 1982); St. George (35-40 in 1980-1981); St. Paul (35 in 1980-1981); Tatitlek (14 in 1989-1990); and Unalaska (20 in 1981-1982). Sea lions remain an important traditional food resource today in these and other communities. Systematic fieldwork is required to estimate accurately the statewide subsistence harvest and to determine whether the annual harvest levels in these and other communities fluctuate significantly from year to year.

Fishery-related Taking

Many Steller sea lions have been taken incidental to commercial fishing operations in the Bering Sea and North Pacific Ocean. In 1978-1981, the estimated annual mortality for all foreign vessels was 724 animals (Loughlin et al., 1983). That did not include animals taken by U.S. fishermen fishing either in joint ventures, or independently. The incidental take of sea lions by U.S. trawlers in 1982 in the Shelikof Strait (near Kodiak Island, Alaska) walleye pollock joint venture fishery was estimated to be 958 to 1,436 sea lions (Loughlin and Nelson, 1986). The estimated take declined to less than 400 per season in 1983 and 1984, probably due to changes in fishing techniques and the area and times fished. Less than 100 per year were estimated to have been taken during 1985-1987 as the fishery diminished in total fish take and effort (T. Loughlin, personal communication).

Perez and Loughlin (1990) found that about 3,000 Steller sea lions were observed incidentally caught in foreign and joint venture trawl fisheries during 1973-1988. For the period 1978-1988, the observed take was extrapolated with fish catch data to obtain an estimate of 6,543 sea lions incidentally caught. Using observer data and fisheries statistics for 1973-1977, they back-calculated for the period 1966-1977 and estimated that about 14,830 sea lions were killed incidental to trawl fisheries during that period. The total estimated incidental catch of Steller sea lions during 1966-1988 in foreign and joint-venture trawl fisheries was over 20,000 animals. Perez and Loughlin concluded that incidental catch was a contributing factor to the sea lion decline during the 1970s.

In California there has been a small incidental take (less than five individuals per year) in gillnet fisheries for California halibut, flounder, and sharks (Wild, 1986). An experimental shark gillnet fishery operated off Oregon in 1986-1988; one Steller sea lion was recorded taken in 1987. Since 1976 Steller sea lions have been occasionally taken (approximately one every other year) in the joint venture trawl fishery for hake that operates off Oregon, Washington, and northern California (J. Scordino, personal communication).

An observer program mandated by amendments to the MMPA in 1988 requires observer coverage on some domestic fishing vessels. The amount of observer coverage in particular fisheries varies according to the anticipated or documented frequency with which marine mammals are taken incidentally. A final compilation of information from the observer program on incidental catch of marine mammals in 1989 is not yet available, but preliminary results indicate that the level of observed catch of Steller sea lions is much lower than it was previously.

In some areas Steller sea lions are known to have been shot deliberately by fishermen, but it is unclear how such killing may have affected the population. Fishermen have been seen killing adult animals at rookeries, haulout sites, and in the water near boats, but the magnitude of this take is generally unknown. One of the few estimates of shooting mortality is reported by Matkin and Fay (1980) who calculated that 305 Steller sea lions were killed directly (shot) while interfering with fishing operations in the spring 1978 Copper River Delta salmon gillnet fishery. Data from a 1988-89 study of the Copper River salmon gillnet fishery indicated that the level of directed kill of sea lions was significantly less than during 1978 (Wynne, 1990). During the 1960s, Steller sea lions were killed at sites in the eastern Aleutian Islands and used for bait by crab fishermen. This killing may have had a significant effect in local areas and might have caused animals to move away from certain rookeries and haulout sites (Loughlin and Nelson, 1986; Merrick et al., 1987).

Competition for Food

Commercial fisheries target on several of the most important prey species of Steller sea lions. In combination, these fisheries remove millions of metric tons of fish, much of which is potential sea lion food. However, the complexity of ecosystem interactions, and limitations of data and models make it difficult to determine whether fishery removals have influenced the population of sea lions, or any other marine mammal species (Lowry et al., 1982; Harwood and Croxall, 1988; Loughlin and Merrick, 1989).

Changes in the quantity or quality of available prey may influence the health and fitness of individual sea lions, resulting in reduced reproductive potential or perhaps death (Loughlin and Merrick, 1989). Walleye pollock have been shown to be an important prey of Steller sea lions in the Gulf of Alaska, Bering Sea, and North Pacific Ocean (Klumov, 1957; Pitcher, 1981; Calkins and Goodwin, 1988; Lowry et al., 1989). Age-structured population models indicate that since the 1960s, walleye pollock biomass in the eastern Bering Sea has fluctuated twice between 4 million metric tons and 10 million metric tons. Peaks in biomass occurred in the early 1970s and the mid-1980s due to strong year classes in 1965-1968, and 1978, 1982, and 1984 (Bakkala et al., 1987). While the overall biomass of pollock has remained relatively high, low abundance of certain age classes in some years could have resulted in fewer fish available in the size range usually consumed by sea lions (Lowry et al., 1989). Availability of certain sized prey may be particularly important for juvenile sea lions which on average feed on smaller fishes (Frost and Lowry, 1986). During the period 1988-1990 there was a 10-15% annual decline in biomass of walleye pollock in the Aleutian Basin (Niemeier and Kelsky, 1990).

In the Gulf of Alaska, the walleye pollock stock is smaller than in the Bering Sea. Trawl surveys have been used to estimate demersal walleye pollock biomass and hydroacoustics have provided estimates of the off-bottom component of the population. Hydroacoustic surveys showed that the walleye pollock biomass in Shelikof Strait declined from 3.7 million metric tons in 1981 to 0.29 million metric tons in 1989, with a small increase in 1990 (Hollowed, 1991). Gulf-wide bottom trawl surveys indicate that the demersal component of the population has been relatively stable since 1984, ranging between 0.69 and 0.85 million metric tons. Stock assessments based on an age-structured model suggest that walleye pollock biomass in the Gulf increased from 1-2 million metric tons in the late 1970s, peaked in 1982 at about 4 million metric tons, then declined to about the late 1970s level (Hollowed, 1991). The increase was attributed to five consecutive strong year classes from 1975 to 1979. Relatively weak year classes occurred in 1980-1983, 1986, and 1987.

Body sizes of sea lions in the Gulf of Alaska (girth, weight, and standard length) were significantly less for age 1-10 animals sampled in 1985-1986, as compared to the 1970s (Calkins and Goodwin, 1988). This difference was interpreted as a reflection of nutritional stress in sea lions which was caused by changes in prey availability in the Gulf of Alaska ecosystem.

From British Columbia southward to California, hake, rockfish, and herring are important Steller sea lion prey. The expansion of commercial fisheries for these species may be correlated with the decline in numbers of sea lions at major rookeries (D. Ainley, personal communication). Shifts in the abundance and distribution of herring, possibly related to fisheries, may have influenced the distribution and recovery of sea lions in British Columbia (Bigg, 1988).

Fish resource assessment surveys provide the only data available for evaluating the status of sea lion food resources. These surveys, however, encompass large regions and may not reflect the amount, size, and species of prey available in actual sea lion feeding areas. Sampling is usually done in spring or summer and may not provide an adequate measure of prey distribution at important times. Also, commercial fish resource surveys generally do not include or do not adequately sample many potentially important prey species such as capelin, eulachon, herring, squid, and octopus. In spite of these limitations, additional analyses of information contained in resource assessment databases may be of some use in understanding sea lion feeding ecology.

In addition to larger scale changes in abundance of food, fisheries could affect sea lion nutrition by causing localized prey depletion or by disrupting fish behavior as nets pass through schools. Such changes could result in sea lions expending more energy to obtain prey.

<u>Toxic Substances</u>

Organochloride pollutant residues in the tissues of California sea lions have been associated with reproductive failure (DeLong et al., 1973; Gilmartin et al., 1976) and have been shown to cause reproductive failure in harbor seals in the Dutch Wadden Sea (Reijnders, 1987). Contaminants also have the potential to affect the immune system which could make animals more susceptible to disease (P. Reijnders, personal communication).

NMFS has begun analyzing tissues from Steller sea lions collected in Alaska for organochloride pollutant residues and other toxic substances. Preliminary studies found generally low levels of contaminants, with the exception of two young males from southeast Alaska that had relatively high levels of PCBs and DDTs in the blubber (U. Varanasi, unpublished data). Additional analyses are being conducted. A study conducted at the Farallon Islands was inconclusive (Huber et al., 1984). Relatively low levels of cadmium and zinc were found in tissues of sea lions collected from Hokkaido, Japan (Hamanaka et al., 1982).

Sea lions contacted oil in 1989 during the Exxon Valdez oil spill, and analysis of tissue samples indicated some evidence of exposure to hydrocarbons. However, there was no conclusive evidence that exposure to oil resulted in injury or death to sea lions (ADFG, unpublished data).

Entanglement in Debris

Data collected from 1975 to 1985 in the Gulf of Alaska and southeast Alaska showed that Steller sea lions may become entangled in lost and discarded fishing gear, and that closed packing bands and net material (principally trawl net) accounted for the majority of observed entanglements (Calkins, 1985). Animals over 2 years old (of both sexes) were susceptible, although more adult females were observed entangled than males. No records of entangled sea lion pups or yearlings were reported. There were no data presented on the number of animals observed entangled or the rate of entanglement in relation to the Gulf of Alaska or southeast Alaska sea lion population.

A study conducted in the Aleutian Islands during June-July 1985 found that a very low percentage (approximately 0.07%) of observed sea lions were entangled in net or twine; none were entangled in packing bands (Loughlin et al., 1986). The data from the initial study were inadequate to address the magnitude or nature of entanglement of pups-of-the-year since most pups were too young during the survey to have encountered debris in the water or away from the rookery. A follow-up study was conducted during November 1986 to assess the magnitude of entanglement of sea lion pups in the eastern Aleutian Islands. No entangled pups were seen, and only one entangled juvenile was seen out of a total of 3,847 sea lions observed during the study (Loughlin et al., 1986).

In summary, adult Steller sea lions entangled in packing bands and net fragments have been observed, but rarely. Entangled pups and juvenile animals are infrequently observed, but entangled animals may die at sea and thus not be seen on land. Based on existing information, however, it seems unlikely that entanglement in debris is a major factor in the observed population decline.

Disturbance

The possible impacts on Steller sea lions by various types of disturbance have not been specifically studied. Close approach by humans, boats, or aircraft will cause hauled-out sea lions to go into the water. Disturbances that cause stampedes on rookeries may cause trampling or abandonment of pups (Calkins and Pitcher, 1982; Lewis, 1987). The discharge of firearms at or near hauled out animals may have a particularly dramatic effect. Areas subjected to repeated disturbance may be permanently abandoned (Kenyon, 1962). Repeated disturbances that result in abandonment or reduced use of rookeries by lactating females could negatively affect condition and survival of pups through interruption of normal nursing cycles. Low levels of occasional disturbance may have little long-term effect.

There have been relatively few well-documented instances of disturbance. Disturbance of rookeries at Orford Reef, Oregon (R. Brown, personal communication) and the Farallon Islands, California (D. Ainley, personal communication), resulting from the activities of sea urchin fishermen, has been reported. At the Farallon Islands, this disturbance resulted in a distributional shift of a breeding group to a nearby, undisturbed site. The harassment and killing of sea lions in British Columbia (before 1970) resulted in the cessation of breeding at some rookeries and abandonment at others (Bigg, 1988).

Development such as would be associated with Outer Continental Shelf oil exploration and production may result in a substantial amount of onshore and offshore activity in Steller sea lion habitat. Activities such as sea floor mining could disrupt feeding areas, and result in lowered condition, particularly for lactating females and pups. The increased disturbance that may result from such human activities could have subtle, but significant, impacts on recovery of the sea lion population.

3. SUMMARY AND CONCLUSIONS

Although the data available on abundance of Steller sea lions, and changes that have occurred over time, are not as comprehensive as is desirable, it is certain that a major population decline has occurred. The decline has been most dramatic in the core of the species' range, the central and western Gulf of Alaska and Aleutian Islands, where total counts dropped by more than 100,000 animals from 1960 to 1990. Numbers of sea lions have also declined in the central Bering Sea and waters of the Soviet Union. In the region from southeast Alaska through Oregon, Steller sea lion numbers appear to have remained relatively stable, and no significant declines have been noted in recent years. However, the number of Steller sea lions has decreased greatly at rookeries in central and southern California.

Both natural and human-caused factors have been hypothesized as contributing to these declines. Natural changes in the environment may be partly responsible for the decline in numbers of Steller sea lions in some areas. Throughout most of the species' range, census data have been collected only in the past 30 years, and there is no way to know what kind of population fluctuations may have occurred previous to that period. Similarly, there is no way to evaluate whether or not the high population levels of the late 1950s were indicative of the long-term ability of the ecosystem to support sea lions. Factors such as disease and predation may have had an influence on the population, but there is not sufficient information to evaluate their possible impact.

A variety of human activities may have influenced Steller sea lions. It is certain that many thousands of animals were killed in commercial harvests, control programs, fisheries, and subsistence hunts. Marine debris does not appear to have had a major impact on sea lion numbers.

Although studies of chemical pollutant loads are incomplete, the relatively low level of industrial activity in the central portion of the species range would suggest that pollution has not been a cause of the decline. Increased human presence in the marine environment has resulted in the disturbance of important habitats such as rookeries. The development and expansion of commercial fisheries throughout the species' range may have caused detrimental changes in the sea lions' food supply.

The Recovery Team is aware that fur seals on the Pribilof Islands and harbor seals in parts of the Gulf of Alaska have also shown substantial population declines (Fowler, 1990; Pitcher, 1990). Causes for those declines are unclear. Entanglement in debris has contributed to the problem with fur seals (Fowler, 1985), and food limitation of juveniles has also been suggested as a possible factor (Trites, 1990b). Several of the principal prey species of Steller sea lions are the same as those used by fur seals and harbor seals. However, many other life history features and ecological characteristics differ considerably among the three species. The coincidence of these declines in fish-eating pinniped populations emphasizes the need for a broad approach to investigation of the problem and development of solutions.

Overall, it is not clear what factors have contributed to the Steller sea lion population decline, and it is apparent that a great deal of information vital to the effective management of the species is lacking. In spite of these information voids, there is an urgent need to take immediate actions to safeguard against further population declines, and to provide for recovery of the species. Immediate actions that can and should be taken include efforts to reduce human-caused mortality to the lowest level practicable, protection of important habitats through buffer zones and other means, and enhancement of population productivity by ensuring that there is an ample food supply available. Conservation measures implemented when Steller sea lions were listed under the ESA have addressed some of these management needs. Additional management actions are described in the Recovery Plan.

The Recovery Team believes that management designed to provide for recovery of the sea lion population should be based on biological principles and ecological understanding. The research program recommended by the Recovery Team and described in the Narrative Section of this Recovery Plan will require a considerable amount of funds, time, and effort to produce the information needed to design a complete and effective set of conservation measures. Management agencies therefore should not preclude consideration of more immediate conservation measures or management experiments that could further reduce human impacts, or that would respond to proposals by the scientific community designed to evaluate certain hypotheses.

The Recovery Team is aware that some of the research activities proposed may themselves have negative impacts. However, rather than limit the Recovery Plan's range of action by excluding such activities, we have included them if they may result in information that is critical to understanding the sea lion problem. The potential positive and negative impacts should be examined on a case-by-case basis using the best current information at the time scientific research permits are requested.

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5. TABLES

Table 1. Rank order of importance of prey found in the stomachs of Steller sea lions collected in Alaska (based on Combined Rank Index).

RANK	Gulf of Alaska[1] 1975-78 N = 153	Kodiak Area[2] 1985-86 N = 74	Southeast Alaska[2] 1986 N = 14	Bering Sea[3] 1981 N = 86
1	Walleye Pollock	Walleye Pollock	Walleye Pollock	Walleye Pollock
2	Squids	Octopus	Pacific Cod	Pacific Cod
3	Pacific Herring	Flatfishes	Squids	Sculpins
4	Capelin	Pacific Sand lance	Flatfishes	Herring
5	Pacific Cod	Pacific Cod	Pacific Herring	Octopus
6	Pacific Salmon	Pacific Salmon	Pacific Salmon	Flatfishes
7	Octopus	Squids	Octopus	Squids

[1] Pitcher, 1981
[2] Calkins and Goodwin, 1988
[3] D. Calkins, unpubl. data

Table 2. All prey identified from stomachs of Steller sea lions collected in the Gulf of Alaska during 1975-1978 (n = 153) and 1985-1986 (n = 74) (adapted from Calkins and Goodwin, 1988)

	Occurences				Volume			
	1970s		1980s		1970s		1980s	
PREY	No.	%	No.	%	ml	%	ml	%
INVERTEBRATES								
Snails	2	1.3	0	0.0	20	<0.1	0	0.0
Octopus	20	13.1	24	32.4	250	<0.1	14,379	26.0
Squid	35	22.9	3	4.0	15,507	4.2	50	0.1
Mollusc spp.	1	0.7	0	0.0	20	<0.1	0	0.0
Shrimps	8	5.2	2	2.7	100	<0.1	trace	<0.1
Tanner crab	2	1.3	0	0.0	20	<0.1	0	0.0
Spider Crab	1	0.7	0	0.0	10	<0.1	0	0.0
Crab spp.	1	0.7	1	1.4	10	<0.1	trace	<0.1
FISHES								
Herring	16	10.7	2	2.7	76,920	20.6	trace	<0.1
Salmon	6	3.9	2	2.7	19,160	5.1	320	0.6
Capelin	16	10.5	0	0.0	27,755	7.5	0	0.0
Sand Lance	0	0.0	5	6.8	0	0.0	1,580	2.9
Walleye Pollock	102	66.7	43	58.1	217,746	58.3	23,370	42.2
Saffron Cod	2	1.3	0	0.0	815	0.2	0	0.0
Pacific Cod	19	12.4	5	6.8	3,471	0.9	1,205	2.2
Pacific Tomcod	1	0.7	0	0.0	680	0.2	0	0.0
Gadid spp.	2	1.3	0	0.0	60	<0.1	0	0.0
Eelpout	1	0.7	0	0.0	10	<0.1	0	0.0
Rockfish	4	2.6	0	0.0	3,030	0.8	0	0.0
Sculpins	6	3.9	1	1.4	4,960	1.3	325	0.6
Sturgeon Poacher	1	0.7	0	0.0	60	<0.1	0	0.0
Pacific Sandfish	2	1.3	0	0.0	300	<0.1	0	0.0
Flatfishes	7	4.6	10	13.5	1,030	0.3	13,910	25.2
Skates	1	0.7	0	0.0	960	0.3	0	0.0
OTHER ITEMS								
Harbor Seal	1	0.7	0		250	<0.1	0	0.0
TOTALS	261		98		373,184		55,139	

Table 3. Major prey identified from stomachs of Steller sea lions collected near Kodiak 1975-1978 (n = 49) and 1985-86 (n = 74) (adapted from Calkins and Pitcher, 1981 and Calkins and Goodwin, 1988).

	Kodiak 1975-78[1]		Kodiak 1985-86	
	% Frequency	% Volume	% Frequency	% Volume
Walleye Pollock	38.9	22.8	58.1	42.2
Capelin	28.6	43.0	0.0	0.0
Pacific Salmon	8.2	27.9	2.7	0.6
Pacific Cod	18.4	3.4	6.8	2.2
Flatfish	10.2	0.3	13.5	25.2
Octopus	28.6	0.2	32.4	26.0
Mean Volume of Contents	1317 ml		745 ml	

[1] Data shown here are for a subsample of the 153 animals shown in Table 2.

Table 4. Counts of Steller sea lions in Russia during 1988-1989 and prior to the decline in abundance (adapted from Perlov, 1991).

Location	1988-1989	Prior to Decline
Kamchatka	3,500-3,800	10,000-14,000
Kuril Islands	5,000-7,000	15,000-20,000
Commander Islands	2,400-2,600	10,000
Iony Island	1,500	5,000-6,000
Iamskiy Island	900	1,000
Tyulenii Island	200	200
Opasnosti Rock	300	300
TOTAL	13,800-16,300	42,500-52,300

Table 5. Counts and percent declines of adult and juvenile Steller sea lions at all sites in spring and summer 1956 to 1989 in the Aleutian Islands and Gulf of Alaska (from Merrick et al., 1987, 1990, 1991; Loughlin et al., 1990)[1].

YEAR	Central Gulf of Alaska	Western Gulf of Alaska	Eastern Aleutian Islands	Central Aleutian Islands	TOTAL
1956	---	24,320	---	---	
1957	35,150	---	---	---	
1959	---	---	---	28,115	140,115[2]
1960	---	---	52,530	---	
1962	---	---	---	31,040	
1975	---	---	21,221	---	
1976	30,677	9,480	22,142	---	103,976[3]
1977	---	---	23,922	---	
1978	---	14,917	---	---	
1979	---	---	---	41,677	
1984	---	---	9,833	---	
1985	24,389	6,667	10,802	25,759	67,617
1989	9,614	4,435	3,145	7,759	24,953
1990	8,943	5,331	4,875	8,711	27,860
Decline Overall[4]	75%	78%	91%	69%	80%

[1] Dashes indicate that no counts were made

[2] Based on 1956 count for western Gulf of Alaska, 1957 count for central Gulf of Alaska, 1958 count for central Aleutian Islands, and 1960 count for eastern Aleutian Islands

[3] Based on 1976 counts for central Gulf of Alaska, western Gulf of Alaska, and eastern Aleutian Islands, and 1979 count for central Aleutian Islands

[4] Declines calculated from earliest survey date

Table 6. Counts of Steller sea lion pups at sites in the Aleutian Islands and Gulf of Alaska, 1979-1990 (from Early et al., 1980; Calkins and Pitcher, 1982; Merrick et al., 1987, 1990, 1991: Calkins and Goodwin, 1988; Byrd, 1989; Loughlin et al., 1990; NMML files)[1].

ISLAND	1979	1984	1985	1986	1989	1990
Western Aleutians						
Agattu I.	---	---	---	---	907	1,127
Buldir I.	1,142	---	---	---	460	381
Central Aleutians						
Kiska I. (Lief Cove)	---	---	882+	---	293	221
Ayugadak I.	---	---	329	---	---	163
Ulak I.	---	---	1,236	---	---	790
Tag I.	---	---	703	---	---	352
Gramp Rock	---	---	909	---	---	448
Adak I.	---	---	558	---	---	137
Kasatochi I.	---	---	892	---	---	178
Agligadak I.	---	---	>30	---	---	0
Seguam I.	2,475	---	2,635	---	529	684
Yunaska I.	---	---	1,026	---	---	230
Eastern Aleutians						
Adugak I.	---	---	844	---	---	262
Ogchul I.	---	---	172	---	---	---
Bogoslof I.	914	---	1,109	---	358	461
Akutan I.	---	---	1,130	---	---	442
Akun I.	---	---	60	---	---	63
Ugamak I.	---	---	1,635	1,386	---	851
Western Gulf						
Clubbing Rocks	1,419	1,394	---	---	---	---
Pinnacle Rocks	2,013	2,748	---	---	---	---
Chernabura I.	646	200	---	379	---	200
Atkins I.	4,538	2,093	---	1,072	---	433
Central Gulf						
Chowiet I.	5,485	3,207	---	1,731	820	344
Chirikof I.	1,649	1,913	---	1,476	709	607
Marmot I.	6,741	5,751	---	4,381	2,199	---
Sugarloaf I.	5,123	3,114	---	3,077	2,109	1,638
Outer I.	---	---	---	993	557	363

[1] Dashes indicate that no count was made

Table 7. Comparison of counts and percent declines of adult and juvenile Steller sea lions in the central and western Gulf of Alaska and eastern and central Aleutian Islands based on data from all sites counted (and Table 5) and 77 trend sites (from Merrick et al., 1991)[1].

	All Sites		Trend Sites		
YEAR(S)	Number	% Decline	Number	% Decline	Percent of Total on Trend Sites
1956-1959	140,115	--	105,289	--	75
1975-1977	103,976	26	89,100	15	86
1985	67,617	52	55,402	47	83
1989	24,953	82	23,030	78	92
1990	27,860	80	22,754	78	82

[1] Percent declines are calculated from the earlier survey period

Table 8. Counts of Steller sea lions in the eastern Gulf of Alaska, 1976-1991 (ADFG, unpubl. data)[1].

	Location		
	Seal Rocks		Cape St. Elias
YEAR	non-pups	pups	non-pups
1976	1,709	316+	1,628
1978	2,463	545	-----
1979	2,961	491	-----
1984	-----	799	-----
1989	2,159	553	1,883
1990	1,471	571	948
1991	1,220	657	744

[1] Dashes indicate that no count was made

Table 9. Counts of Steller sea lions at rookeries in southeast Alaska, 1979-1991 (ADFG, unpubl. data)[1].

	Location					
	Forrester Island		Hazy Islands		White Sisters	
YEAR	non-pups	pups	non-pups	pups	non-pups	pups
1979	3,121	2,187	893	30	761	3
1982	3,777	2,227	1,268	--	934	--
1989	4,648	2,844	1,462	--	734	--
1990	3,324	2,932	1,187	641	980	30+
1991	3,648	3,261	1,278	808	860	95

[1] Dashes indicate that no count was made

Table 10. Summer aerial counts of Steller sea lions at major rookeries in Oregon, 1975-1989 (from Brown, 1990)[1].

	Location			
	Rogue Reef		Orford Reef	
YEAR	non-pups	pups	non-pups	pups
1975	802	---	716	---
1976	800	---	341	---
1977	815	---	371	---
1978	859	---	677	---
1979	---	---	689	---
1980	914	---	482	---
1981	810	---	736	---
1982	1,389	---	754	---
1983	958	---	603	---
1984	754	340	650	65
1985	1,174	344	559	85
1986	1,230	296	896	---
1987	1,194	200	929	89
1988	1,381	349	691	159
1989	1,001	407	446	181
1990	1,229	463	766	111

[1] Dashes indicate that no count was made

Table 11. Summer counts of adult and juvenile Steller sea lions at major rookeries in California, 1927-1989 (from Bonnott and Ripley, 1948; Bonnel et al., 1983; Pearson, 1987; R. Gisiner, D. Ainley, R. Brown, and B. LeBoeuf, pers. communications)[1].

	Location				
YEAR	San Miguel	Año Nuevo	Farallons	Mendocino	Gt. George
1927	595	1,500	700	700	1,500
1947	950	2,050	750	625	200
1958	37	1,170	941	---	---
1976	10	1,497	200?	---	---
1980	0	1,031	120	859	173
1985	0	1,169	100?	---	---
1990	0	458	<100	800[2]	674

[1] Dashes indicate that no count was made

[2] Estimate derived from May 1989 count of 286 animals

6. FIGURES

Figure 1. Map of the North Pacific Ocean showing the general range of Steller sea lions (stippled area) and the location of major rookeries (arrows).

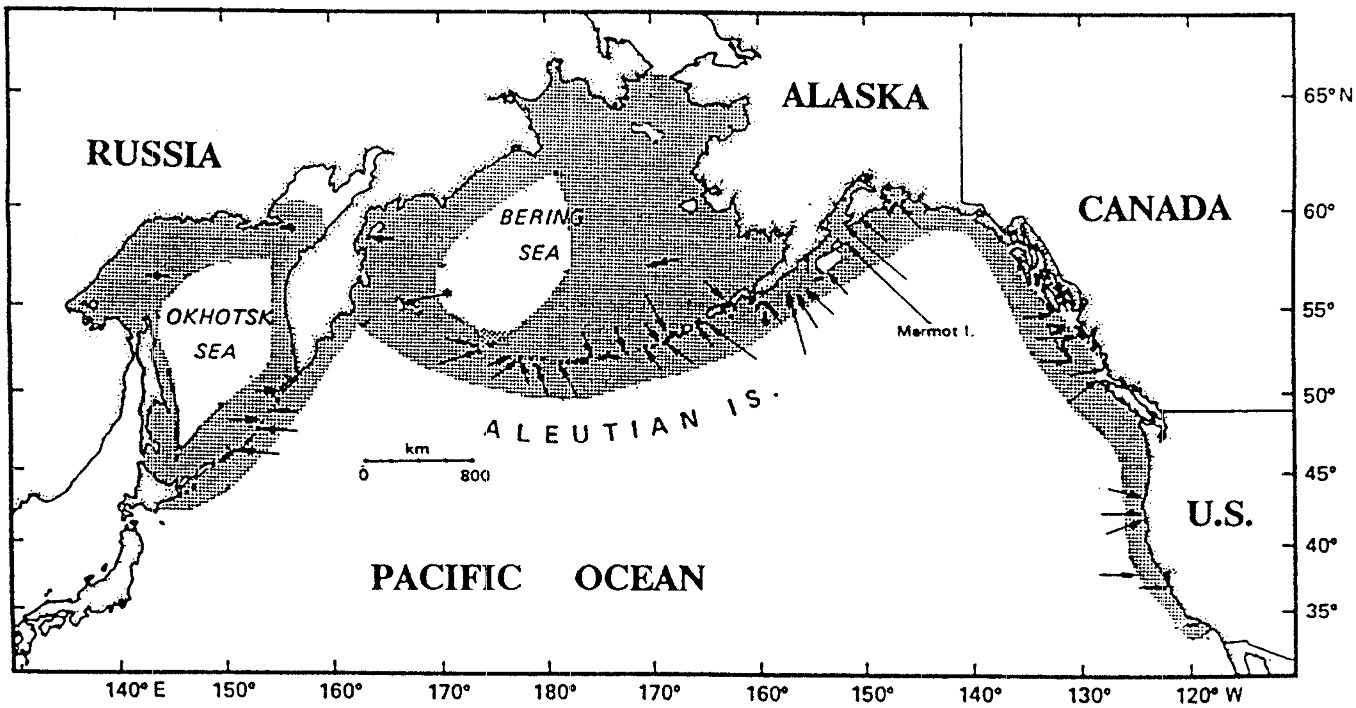


Figure 2. Overall trend in Steller sea lion counts in the region from the Kenai Peninsula to Kiska Island, 1960-1989 (from Merrick et al., 1990).

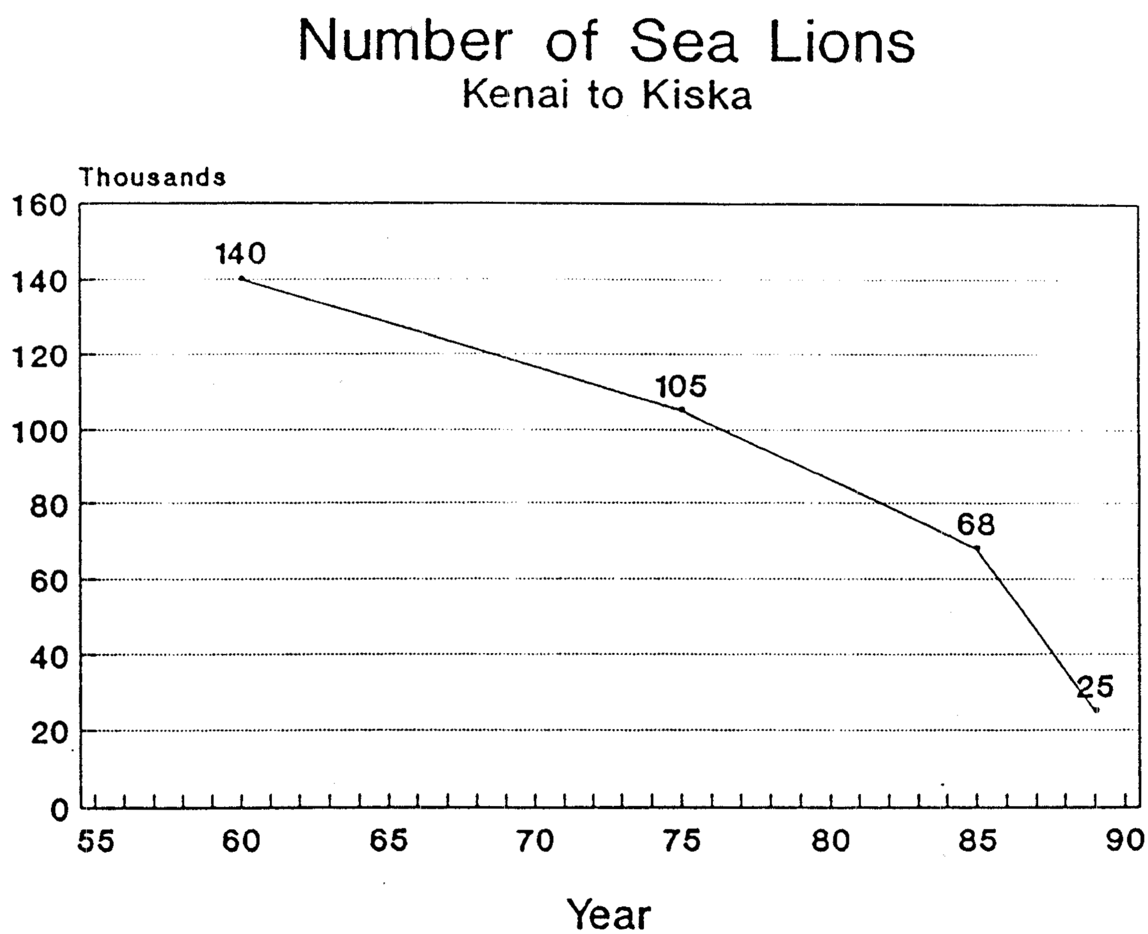


Figure 3. Locations of Steller sea lion rookeries and major haulouts in the Kuril Islands and Okhotsk Sea.

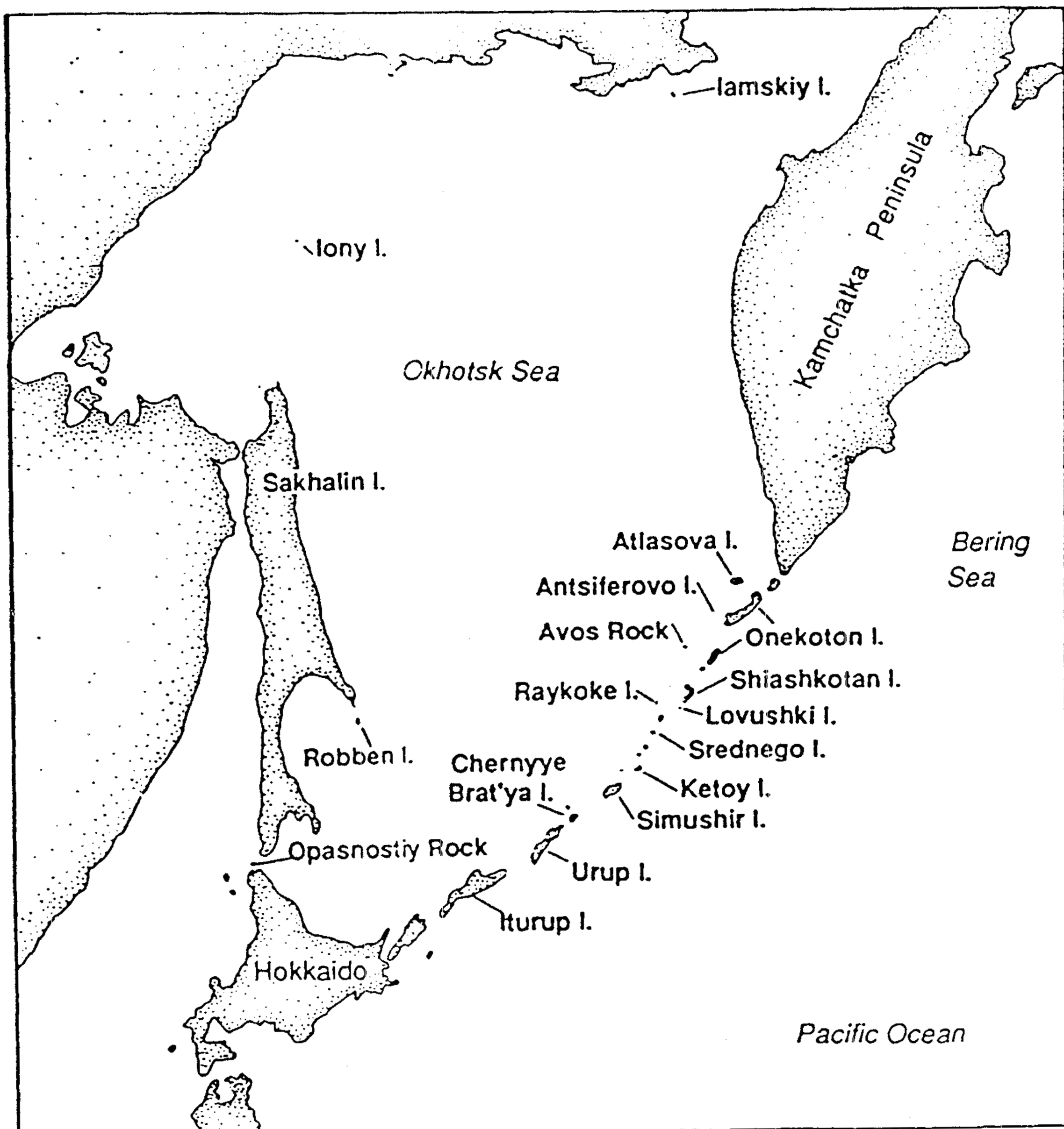


Figure 4. Locations of Steller sea lion rookeries on Kamachatka and the Commander Islands.

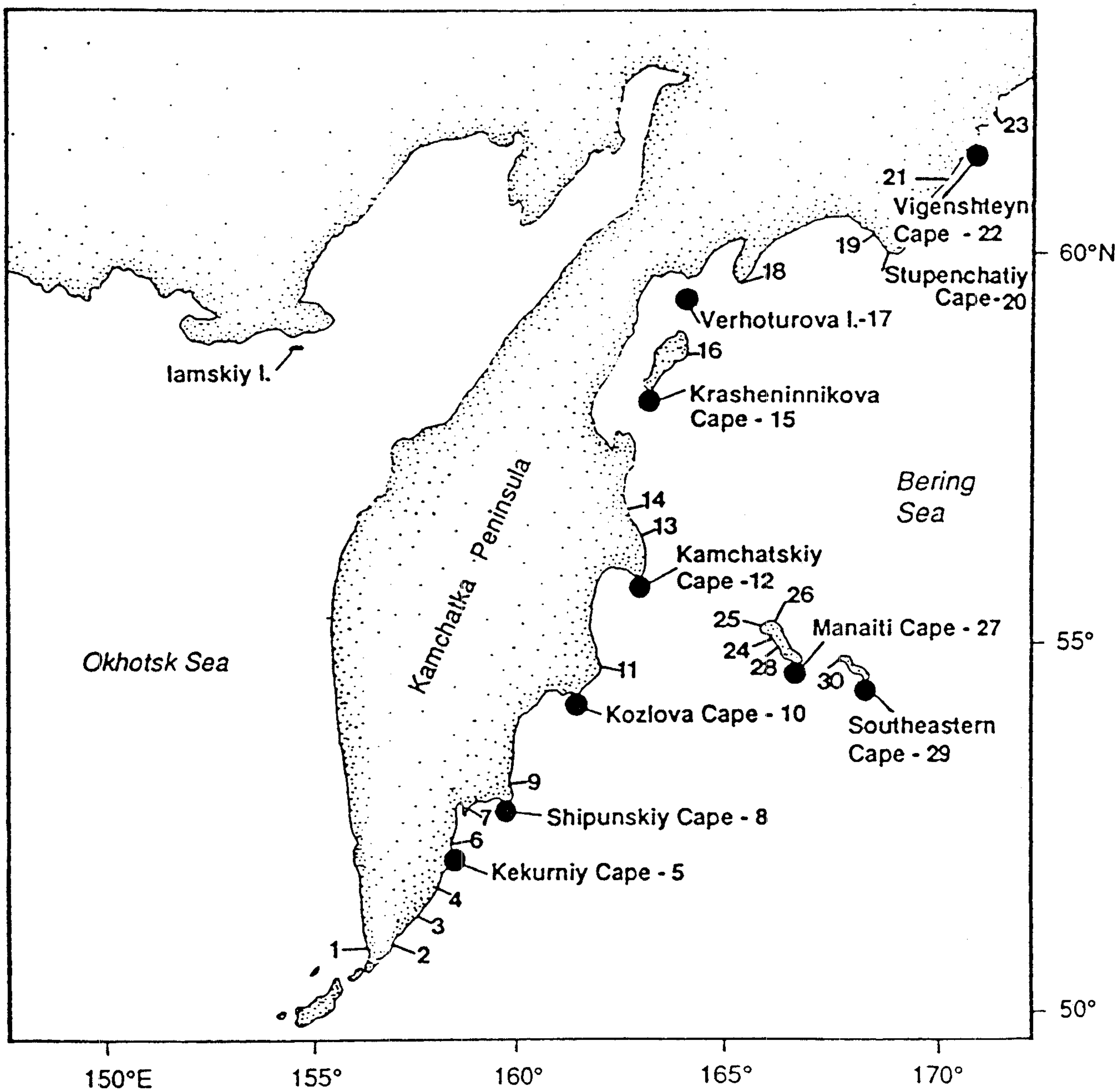


Figure 5. Locations of Steller sea lion rookeries in the Aleutian Islands and Bering Sea.

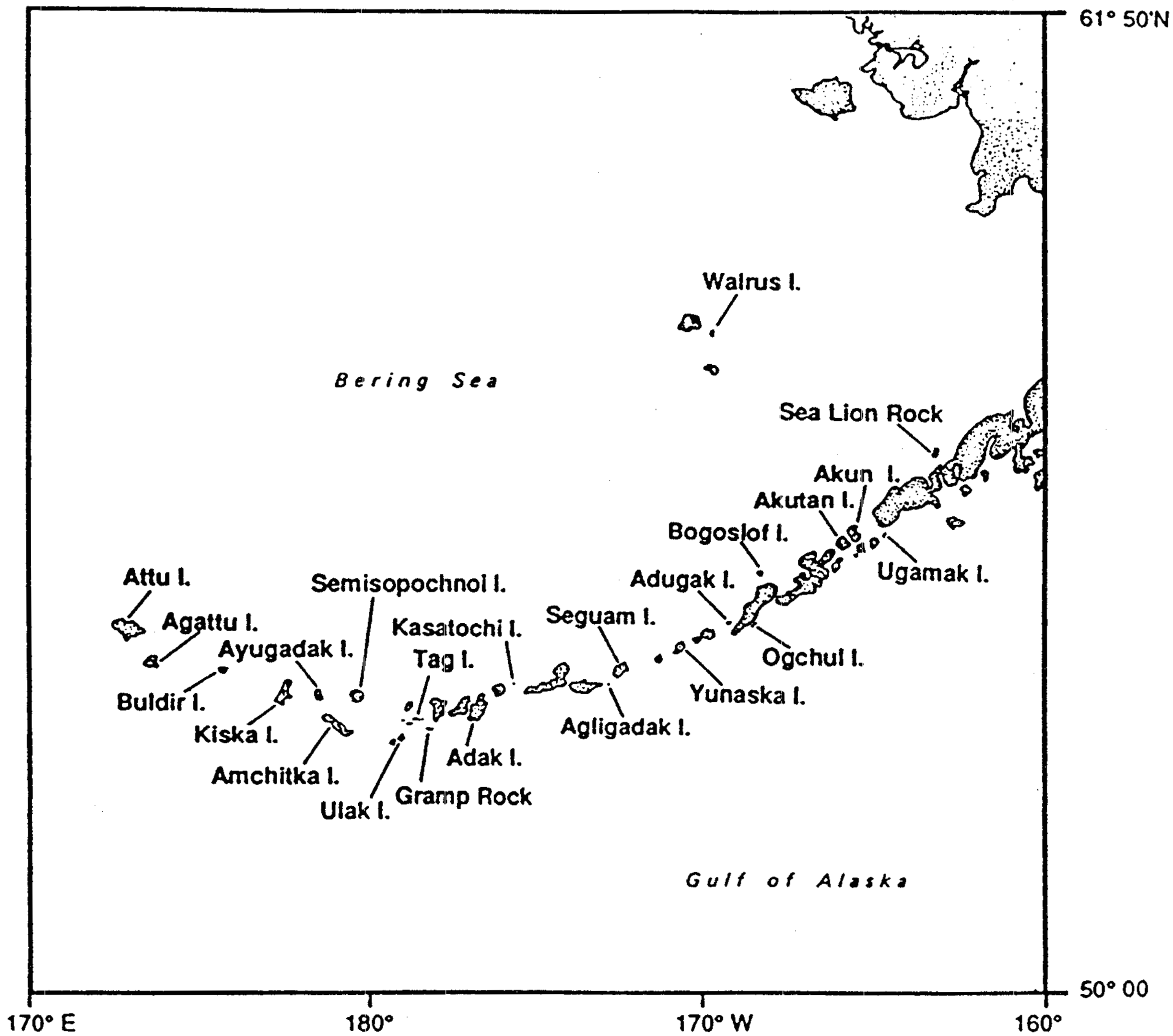


Figure 6. Locations of Steller sea lion rookeries in the Gulf of Alaska and southeast Alaska.

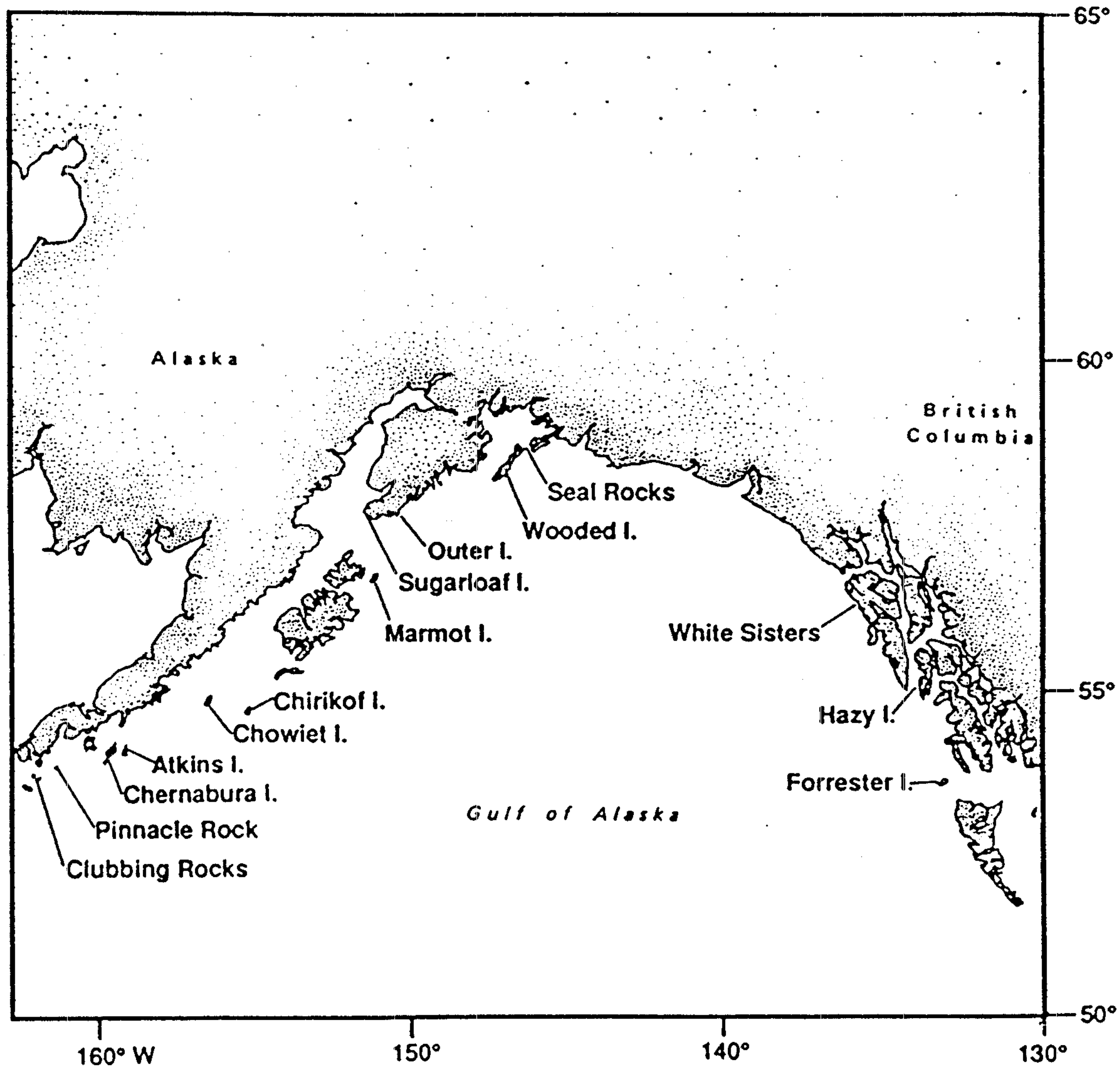


Figure 7. Locations of Steller sea lion rookeries and major haulouts in British Columbia.

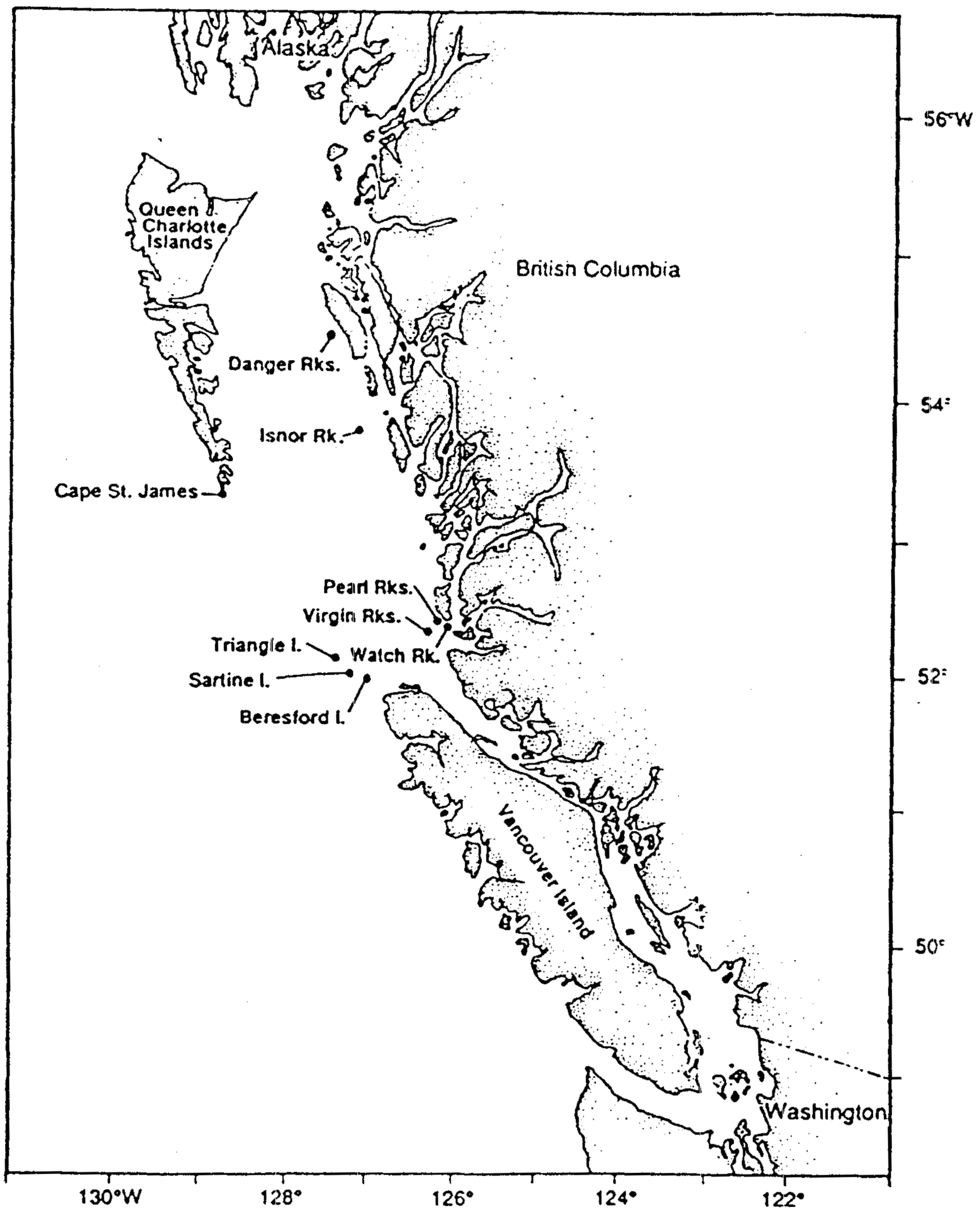
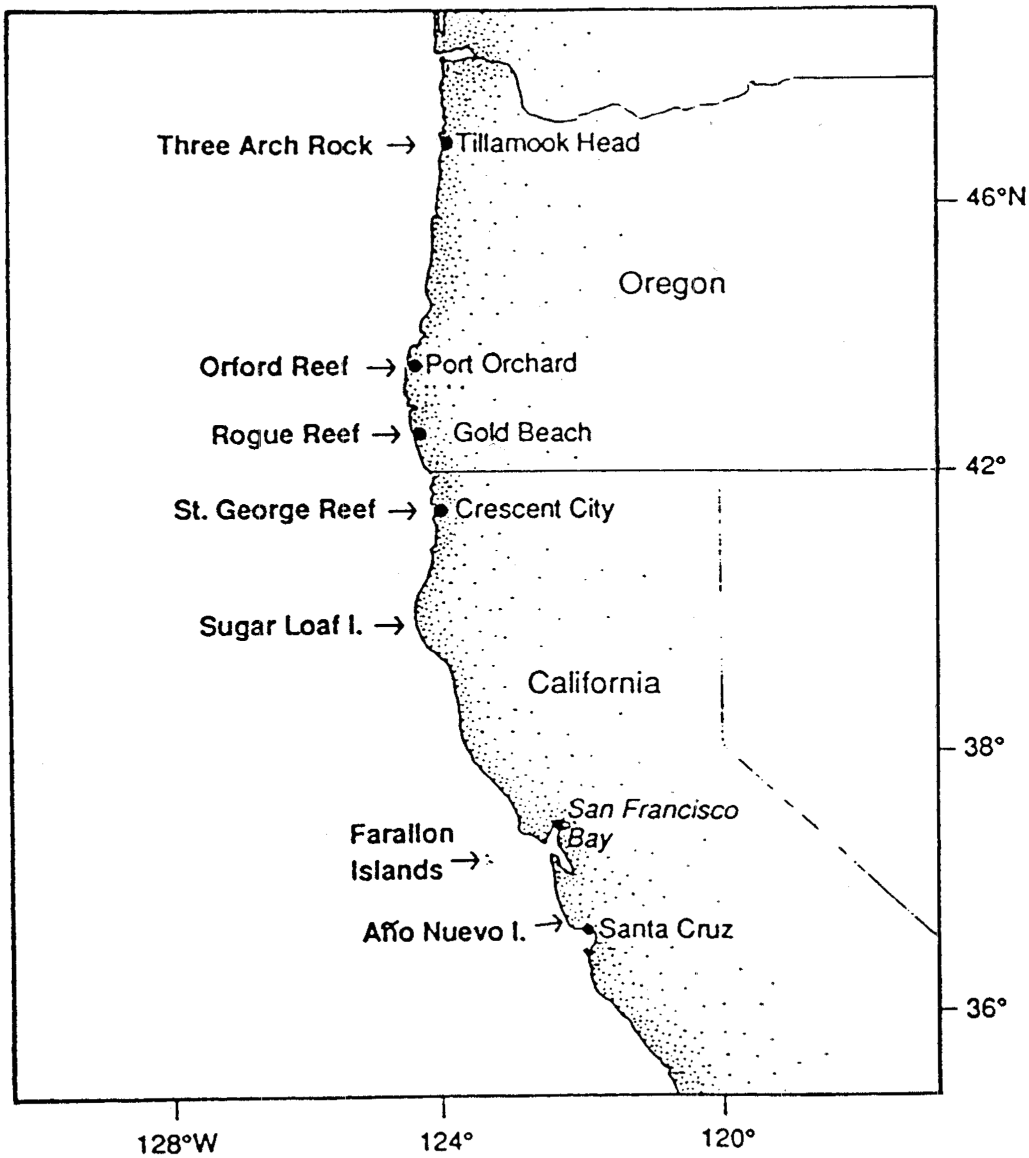


Figure 8. Locations of Steller sea lion rookeries and major haulouts in Oregon and California



PART II

1. RECOVERY ACTIONS AND IMPLEMENTATION

A. Goal and Objectives

The overall goal of this Recovery Plan is to promote recovery of the Steller sea lion population to a level appropriate to justify removal from ESA listings. The primary purpose of the Plan is to propose a set of actions that will minimize any human-induced activities that may be detrimental to the survival or recovery of the population. Immediate objectives are to identify factors that are limiting the population, actions necessary to stop the population decline, and actions necessary to allow the population to increase.

B. Reclassification Criteria for Evaluating Population Status of the Steller Sea Lion

The Recovery Team recommended that reclassification and delisting should consider the following criteria:

(1) Counts and trend in counts of Steller sea lions older than pups (called Adult/Juvenile Trend Count) on rookeries and haulouts in the region from the Kenai Peninsula to Kiska Island (hereafter referred to as the Kenai-Kiska area)(a suggested list of index sites to be included is presented in Appendix A);

(2) counts and trend in counts of pups at index sites within the Kenai-Kiska area (called pup production index)(sites to be included are indicated in Appendix B); and

(3) the status and trend of sea lions in other parts of the species' range.

The Recovery Team further recommended that delisting and reclassification under criterion (1) should consider the current population index in relation to the long-term ability of the Kenai-Kiska area to support Steller sea lions. The Recovery Team recommended that a benchmark figure, representing an estimate of the equilibrium population for the region, should be established and be reassessed, and changed if necessary, as new information becomes available. The Recovery Team recommended an initial benchmark of 90,000 animals older than pups counted on trend sites in the Kenai-Kiska area during the peak of the breeding season (late May-early July). This number is equivalent to the trend site count of animals older than pups in the mid 1970s (89,100) (see Table 7). While a higher trend site count (105,289) resulted from data collected in the late 1950s, the Recovery Team does not believe that is an appropriate benchmark figure. The earlier counts were performed by nonstandard techniques and were so widely spaced in time that it is difficult to use the data to estimate the overall number of animals in the Kenai-Kiska area. Furthermore, pup counts, which provide independent verification of population size and trend, were not conducted prior to the mid 1970s.

It is difficult to propose specific measures by which the status and trend of Steller sea lions in areas other than the Kenai-Kiska region can be evaluated. Existing data sets are of variable quality and completeness, and future research plans are uncertain. The Recovery Team recommended that the evaluation of population status should be based on relatively large regions representing logical geographical units, and each should include several rookeries and contain generally comparable numbers of animals. The regions initially recommended were: (1) Russia, (2) the western Aleutians, (3) eastern Gulf of Alaska, (4) southeast Alaska, (5) British Columbia, and (6) California-Oregon-Washington. The designation of regions should be revised, if necessary, based on results of studies to define biological subspecies or stocks.

C. Application of Evaluation Criteria

The Recovery Team suggested that an objective evaluation of whether and how Steller sea lions should be listed under provisions of the ESA can be made by comparing the most recent data available with the measurable criteria described in the previous section.

The Recovery Team recommended that evaluation criteria should be applied as follows:

(1) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is less than 17 percent of the benchmark value, the species should be listed as **endangered**;

(2) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 17 percent but less than 40 percent of the benchmark value, the species should be listed as **threatened**, <u>except</u>;

(3) if the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 17 percent but less than 25 percent of the benchmark value the species should be listed as **endangered** if one or more of the following situations exists:

(a) The Kenai-Kiska Adult/Juvenile Trend Count has declined by at least 10 percent over 3 or more consecutive survey years,

(b) the overall Pup Production Index (count data combined in 2 year blocks) in the Kenai-Kiska area has declined by 10 percent over the count in the previous 2-year block,

(c) the number of animals has declined by at least 10 percent over a three-year period since 1989 in three or more of the six other regions (Russia, western Aleutians, eastern Gulf of Alaska, southeast Alaska, British Columbia, and California-Oregon-Washington).

It is the intent of NMFS to support the recovery activities outlined in the Recovery Plan. However, concerns associated with the proposed evaluation criteria regarding the quantitative measures for changing status under the ESA require further analysis and discussion. Thus NMFS will not implement Part II, Section 1.C, of the draft recovery plan at this time. NMFS believes that the strategy in this section focuses on small, short-term changes (e.g., in II.1.C(3), a 10 percent decline over 3 years) but neglects an analysis of long-term trends and the effects of stochastic variability. NMFS supports and will evaluate a combination of techniques, like population viability analysis and analysis of data on historical trends, to provide a more robust estimation of the likelihood of extinction. At the conclusion of these analyses, NMFS will reconsider the threshold levels proposed by the Recovery Team, as well as other criteria which emerge as part of the analytical procedure. A final set of criteria will then be established and implemented.

D. Delisting Criteria

Section 4 of the ESA requires that an objective, measureable criteria be incorporated into each Recovery Plan which, when met, would result in a determination that the species be removed from the list. The data currently available on Steller sea lion relative abundance and trend come from aerial photographic surveys of adults and juveniles and land-based counts of pups (see section II.E.3). Preliminary simulation studies conducted at the April 1992 workshop indicate that the confidence interval around the recent aerial estimates of adult and juvenile numbers of sea lions is quite small; therefore, for the present, NMFS will adopt the delisting criteria proposed by the Recovery Team as follows:

(1) If the current Adult/Juvenile Trend Count in the Kenai-Kiska area is greater than 40 percent of the benchmark value of 90,000 animals older than pups, and

(2) the number of animals is stable or increasing in at least three of the six other regions described in section II.B,

then **delist** the species.

Using such a system, a benchmark population of 90,000 and these criteria, delisting would not occur until the Adult/Juvenile Trend Count reached 36,000. However, these criteria will be evaluated as part of the risk analysis to determine their adequacy for long-term protection of the species.

E. Stepdown Outline

Items in this outline are not in order of priority. Priorities are identified in Section II.F.

1. <u>Identify habitat requirements and protect areas of special biological significance</u>

11. Identify current and historical use areas

111. Map, describe, and evaluate rookeries and major haulouts

112. Map, describe, and evaluate feeding areas

12. Determine seasonal use patterns

13. Document effects of disturbance caused by human activities

14. Prepare guidelines and regulations to control potentially disruptive activities

15. Identify and designate "Critical Habitat" areas

2. Identify management stocks

   21. Conduct visual marking/tagging studies

      211. Tag and brand pups on selected rookeries

      212. Monitor rookeries for occurrence of marked animals

   22. Determine if biological parameters indicate different stocks of sea lions

   23. Compile and analyze data

3. Monitor status and trend of sea lions

   31. Develop statistically valid survey procedures

   32. Conduct Alaska statewide survey every year

      321. Conduct aerial survey of adults and juveniles at all rookeries and major haulouts

      322. Conduct pup counts at selected rookeries

   33. Conduct surveys of pups and non-pups at rookeries in California and Oregon every other year

   34. Conduct range-wide survey every 5 years

      341. Conduct aerial survey of adults and juvenile at all rookeries and major haulouts

      342. Conduct pup counts at selected rookeries

4. Monitor health, condition, and vital parameters

   41. Examine and sample dead animals from rookeries, incidental take, subsistence harvests, and those located by stranding networks and carcass surveys

   42. Collect and sample animals

   43. Develop methods for non-lethal sampling

      431. Develop and evaluate capture techniques

      432. Develop indices of condition

44. Conduct studies on rookeries

441. Determine sex and age class of animals on shore

442. Determine rates of pup production and mortality

443. Tag and brand pups and adult females

444. Monitor status of tagged animals

445. Obtain measurements and samples using non-lethal techniques

45. Compile a catalog of all tissues and other samples

46. Conduct laboratory analysis of samples for diseases and parasites, contaminant levels, and nutritional status

47. Compile and analyze data

5. <u>Assess and minimize causes of mortality</u>

51. Determine causes of mortality and their relative contributions to total mortality

511. Implement/expand stranding networks

512. Survey selected areas for dead animals

513. Monitor incidental take in commercial fisheries

514. Investigate entanglement in debris

515. Determine and monitor level of subsistence take in Alaska

516. Evaluate causes and extent of other deliberate killing

517. Evaluate mortality caused by non-human predators

52. Minimize injury and mortality

521. Develop and implement methods to reduce incidental take

522. Develop non-harmful deterrents for use by commercial fishermen

523. Improve and continue programs to minimize marine debris

524. Develop methods to reduce loss rate in subsistence harvests

53. Review and revise recommendations for maximum allowable levels of lethal take

6. Investigate feeding ecology and factors affecting energetic status

61. Investigate sea lion feeding ecology

611. Describe foods eaten by sea lions

6111. Collect and analyze stomach contents

6112. Collect and analyze scats

612. Determine food and energy requirements

613. Investigate feeding areas and feeding strategies

6131. Identify feeding areas

6132. Investigate diving behavior and feeding cycles

614. Assess significance of various prey

6141. Characterize geographic and seasonal patterns of prey availability and utilization by sea lions

6142. Determine nutritional value of prey

615. Compile and analyze data

62. Investigate interrelationships between prey abundance and sea lion growth and productivity

621. Measure growth and productivity in areas with different food availability

622. Develop models for individual and population energetics, growth, and productivity

63. Determine effects of fisheries on sea lion prey

631. Measure effects of fisheries on sea lion prey in feeding areas

632. Model effects of fishing on prey composition, distribution, abundance, and behavior

64. Ensure adequate food availability in feeding areas

641. Regulate fishing areas, seasons, and types of operations

642. Regulate fishery catches

7. Implement Recovery Plan and coordinate recovery activities

71. Establish a Steller sea lion recovery coordinator staff position

72. Maintain the Steller Sea Lion Recovery Team

73. Monitor Section 7 ESA requests for consultation

74. Develop mechanisms for international conservation efforts

741. Distribute Recovery Plan to other involved nations

742. Develop bilateral or multilateral conservation agreements

75. Conduct information and educational programs

76. Enforce regulations

761. Develop and improve systems for reporting violations

762. Provide adequate and effective field enforcement programs

F. Narrative

1. Identify habitat requirements and protect areas of special biological significance

As indicated in the introduction, a great deal is known about the major land areas used by sea lions during summer. Nevertheless, available data for most sites include only general descriptions of locations. More detailed delineation and evaluation are needed to determine how best to minimize potentially disturbing activities, and for documenting changes in habitat characteristics and use patterns. Once assembled this information will be difficult to summarize, analyze, or access manually, and therefore a computer database needs to be developed. Desirable characteristics of such a database include ease of access, ability to evaluate variables, and capability for overlay mapping. Managers of areas used by sea lions need rapid access to information for regulating potentially disturbing uses, and researchers could use the files to look for patterns that might help explain reasons for observed population trends. The compiled information should be made available in the form of a catalog.

Certain habitats such as rookeries are of obvious importance to the Steller sea lion population and will need careful protection. It is not clear whether all haulouts and other use areas are of equal biological importance. Also, it is likely that the various parts of the current overall range are of different biological significance to the population. To the extent possible, the importance of these various habitats and regions should be evaluated in conjunction with the collection and cataloging of data.

11. Identify current and historical use areas

111. Map, describe, and evaluate rookeries and major haulouts

The database/catalog should include all areas where pups are currently being born or where they have been produced within the past 20 years. Current and historical counts of pups and non-pups should be tabulated, and historical and modern rookery boundaries should be delineated as accurately as possible. Available photographs should be included to facilitate inter-year comparisons of the extent of area used at occupied sites.

Haulouts should be identified in the database/catalog. All available counts should be included in the database; however, at intensive study sites, only the average and range of counts for a particular time period (i.e., season) need be included in the catalog.

The significance of rookeries and haulouts should be evaluated based on factors such as the current and historical numbers of animals using them, their contribution to overall and regional population productivity, distance from adjacent rookeries or haulouts, etc.

112. Map, describe, and evaluate feeding areas

In order to properly manage sea lions and their habitat it will be necessary to identify the areas where they go to feed. With existing data it will probably only be possible to identify a few general areas that are used for feeding. Observers on fishing vessels may provide additional anecdotal information about at-sea distribution of sea lions. Aerial and shipboard surveys, particularly in the vicinity of selected rookeries, could also provide useful information. However, monitoring with aid of satellite telemetry holds the greatest promise for delineation of major feeding areas.

All available data should be used to map and describe feeding areas as specifically as possible. Emphasis should be put on sex/age classes thought to be likely to experience nutritional problems (e.g., juveniles). Once feeding areas have been identified, their significance should be evaluated based on the number of animals using them, location relative to rookeries, etc. Much of the data required for this purpose will be collected in the studies described in Section 6.

12. Determine seasonal use patterns

Seasonal patterns of sea lion use are known for a few intensively monitored terrestrial sites, but most past research on this topic has focused on the timing of use at rookeries in summer. There is very little information available on seasonal use of nearshore and open ocean habitats. Direct observations of sea lions on a year-round basis is impractical at most major use areas; however, time-lapse photography could provide a means to gather information about the patterns of abundance of animals on shore at a number of relatively accessible sites. Site visits by researchers and management personnel conducting other activities at times of year other than the breeding season could provide valuable information on distribution, dispersal, and seasonal movements. Nevertheless, telemetry, both satellite and conventional (VHF), may be the best way of describing in detail the seasonal habitat use patterns of individuals on shore and at sea. Although much of this information may be obtained in conjunction with other activities (e.g., Section 613), specific research projects may be required at certain areas.

13. Document effects of disturbance caused by human activities

Much information on the possible effects of disturbance caused by human activities is contained in unpublished sources. Information about the causes and impacts on sea lions of disturbance caused by human activities (e.g., noise from aircraft, boats, or other vehicles; shooting; habitat alterations; etc.) should be archived and summarized. An effort should be made to carefully document the response of sea lions to disturbance in areas where such observations can be readily made (e.g., at rookeries in California and Oregon). Little is known about disturbance of sea lions in feeding areas other than the intentional or incidental take associated with commercial fishing operations. Instances of disturbance should be recorded by observers who are now in place on commercial fishing vessels. New information that is gathered should be incorporated into a data base.

Human activities that might contribute to the population decline should be described by area and evaluated in relation to population trends of Steller sea lions in management units (see Section 2).

14. Prepare guidelines and regulations to control potentially disruptive activities

Some regulations, such as buffer zones around certain rookeries, are currently in place to control human activities that may affect sea lions and their habitats. Based upon information collected in Section 13, regulations and guidelines should be developed and/or revised to minimize potential impacts of human activities. Buffer zones may be the best way to limit disturbance around rookeries and major haulouts. Major feeding areas at sea may also need to be protected from human disturbance through the prohibition or control of certain activities (e.g., shooting). Specific guidelines or regulations should address disturbance that may be caused by vessels (commercial and sport fishing, tourist, research, and recreational), aircraft (private, charter, and military), and activity on the ground (tourists, researchers, motorized vehicles, and industrial activities). The Steller sea lion recovery coordinator (Section 71) should take a lead role in developing and working to assure implementation of the necessary regulations.

15. Identify and designate "Critical Habitat" areas

All rookeries, major haulout sites, and important feeding areas identified in Sections 111, 112, and 113 should be considered for designation as "critical habitat." When areas are designated, they should be large enough to ensure that potential impacts can be controlled and minimized. The seasonal nature of use patterns (Section 12) should, if applicable, be documented when critical habitat designation is made.

2. Identify management stocks

Steller sea lions are widely distributed and recent population changes have been different in various parts of the species' range. Causes of the decline and measures necessary to halt it and start population recovery may vary from location to location. If it is possible to identify more than one stock of sea lions within the overall range, then management actions will have to consider differences in abundance and status of each stock. Even if biologically discrete stocks do not occur, it may be desirable to designate management units in order to facilitate development and application of conservation measures.

Existing data from tagged animals suggest that a considerable amount of movement occurs, both among areas within Alaska, and between Alaska and regions to the south. Studies should be done to delineate home ranges, fidelity to rookeries and haulouts, amount of population interchange between prospective management units, and predominant activities within units. These aspects should be examined with regard to sex, age, and reproductive status of sea lions.

This section describes use of visual marking/tagging and analysis of biological parameters to identify management stocks. Telemetry studies such as that described in Section 613 can provide detailed information on movement patterns. However, such information usually covers a relatively short time span because of limitations of battery life and transmitter attachments. A telemetry study is not recommended specifically in this Section because short-term movements are of lesser importance when considering stock discreetness. However, information that is collected in telemetry studies should also be considered in the designation of management units.

21. Conduct visual marking/tagging studies

Since 1975, several thousand Steller sea lions have been marked with brands and tags. Since these marks may persist for many years, they can give an indication of the long-term rate of interchange of animals among areas, as well as the degree of fidelity to particular locations such as rookeries. Such studies are limited because they provide information only on marking and resighting locations and not on where marked animals have been in the interim. Also, the activity involved in marking large numbers of animals is intrusive and will cause some disturbance to rookeries. Nonetheless, when done in conjunction with other activities (e.g., Section 44) valuable information may be obtained without creating an unacceptable impact. Studies may be required to evaluate the effectiveness and impacts of various marking and tagging methods, as well as to test new techniques such as use of passive integrated transponder chips.

211. Tag and brand pups on selected rookeries

Using appropriate techniques, pups should be tagged and branded at selected rookeries in the western Gulf of Alaska (e.g., Marmot and Sugarloaf islands), eastern Aleutians (e.g., Bogoslof and Ugamak islands), central and western Aleutians (e.g., Seguam and Kiska islands), and southeast Alaska (Forrester Island). These are areas experiencing different levels of population decline. Factors that should be considered when planning and conducting tagging and branding studies are tag loss, legibility of tags or brands, injury and mortality possibly associated with branding, disturbance effects to rookeries during branding or tagging, and procedures for mitigating disturbance. This study should be done in conjunction with studies described in Section 44.

212. Monitor rookeries for occurrence of marked animals

Monitoring for marked animals should be done throughout the species' range in conjunction with studies described in Sections 12, 322, 33, 342, and 44. Special effort should be given to monitoring in the central Gulf of Alaska to obtain information from sea lions that were branded in 1975 and 1976 and will soon no longer be part of the reproductive population, and from animals branded in 1987 and 1988 that are now approaching reproductive age.

22. Determine if biological parameters indicate different stocks of sea lions

The degree of genetic interchange among animals in different regions is the most important factor in stock identification. Morphometric and genetic comparisons can give an indication of stock discreetness, which can then be used as a basis for delineating or adjusting management units. Limited studies of genetic variation in Steller sea lions that have been conducted do not conclusively show whether or not there is more than one population or stock (Lidicker et al., 1981).

Techniques that show promise for identifying management stocks include morphometric analyses, protein electrophoresis, DNA analyses, and analyses for regionally varying trace chemicals. Additional techniques may become available in the future. Materials (e.g., blood, skin, liver, or other tissues) and data required for these analyses may be obtained from existing collections (see Section 45) or from sampling programs described in Sections 41, 42, 43, 443, and 61. Although these sources are expected to provide adequate sample sizes for most analyses, it is possible that additional sampling programs will have to be developed. Those sampling programs, if needed, should conform to the criteria set forth in Sections 42 and 43.

23. Compile and analyze data

Data should be analyzed to determine whether or not management stocks can be identified. Stock boundaries should be described, if possible, and the degree of interchange with other stocks should be quantified. When analyzing movement data, consideration should be given to sex, age, and reproductive condition of the marked animals.

This Section refers only to data analysis relating to the identification of management stocks. Other specific data analyses are identified in Sections 47 and 615. It should be noted, however, that the compilation, evaluation, and dissemination of data generated by efforts described in this plan should not be overly compartmentalized. The task of facilitating analysis, presentation, and distribution of data should be a responsibility of the Steller sea lion Recovery Plan coordinator (Section 71).

3. Monitor status and trend of sea lions

Currently, the status and trend of Steller sea lions is monitored using two primary methods: aerial photographic surveys of large segments of the population on rookeries and haulouts, and pup counts at selected rookeries.

Aerial surveys are conducted by flying over each rookery or haulout and photographing the animals present. The surveys are timed to coincide with seasonal and daily periods when high numbers of animals are on shore, i.e., during the breeding season in mid June/early July and between 10:00 a.m. and 4:00 p.m. Aerial surveys have been limited to one-time counts of the hauled out population. The counts do not enumerate those animals which were at sea during the survey, or provide a measure of variability which is required for statistical analysis of the data. However, this survey method provides a useful index of abundance, and the results can be compared over time to evaluate population trend.

In addition to aerial surveys, pup counts have been conducted at rookeries in late June and early July. Adults go to the water temporarily while people are on the rookery counting pups. Although small numbers of pups may be missed (including those not yet born and those already able to accompany adults into the water), this type of count is treated as a total count. Pup counts are used to measure productivity because they reflect the total number of parturient females. However, caution must be exercised when generalizing about population trends based solely on pup counts. A declining number of pups in the population could be indicative of a declining total population, a decline in fecundity, a decline in the number of reproductively active females, or a combination of these and other factors.

Both the pup counts and aerial surveys should be continued in order to monitor status and trend of sea lions throughout their range. In addition, a method should be developed that will allow abundance and trend in specific areas to be measured with statistical confidence.

31. Develop statistically valid survey procedures

A single count, even when made during the most stable attendance period, only produces an estimate of the number of animals present at a given time and does not provide any measure of variability. Repeated counts of the same area are needed to provide a basis for calculating variances and confidence intervals. This type of data is particularly necessary in order to quantify population trend (i.e., the rate at which numbers are declining or increasing). Repetitive count data are now available for some locations. These data should be analyzed to provide a preliminary assessment of the survey design requirements. Repeated surveys should then be conducted daily over a broad area (e.g., a portion of southeast Alaska). The study design should account for tidal stage and other factors that may affect hauling out behavior. Once statistically valid survey methods are developed, they should be incorporated into the monitoring program in addition to methods presently in use.

32. Conduct Alaska statewide survey every year

Alaska is the center of distribution and abundance for Steller sea lions, and counts made in Alaska have been used as an index of the overall status of the species. Numbers have not declined in southeast Alaska, but have declined in most of the remainder of the state. Frequent monitoring of the distribution and number of Steller sea lions throughout Alaska is required to maintain a current knowledge of the population trend in various regions. It is particularly important to monitor carefully the Prince William Sound area, since it appears that the decline may recently have spread to that area.

321. Conduct aerial survey of adults and juveniles at all rookeries and major haulouts

All rookeries and major haulout sites from Forrester Island to at least Agattu Island should be surveyed using established methodology (i.e., flying at approximately 500-800 feet altitude, 0.25 miles offshore, and 80 knots air speed). Surveys should be flown between 10:00 a.m. and about 4:00 p.m., from about June 10-30. The number of animals present should be estimated and photographs taken for subsequent counting in the laboratory. New techniques (e.g., high resolution video cameras) should be evaluated to improve methods.

At least two survey crews will be required, one for southeast Alaska and Prince William

Sound, and another for areas to the west of Prince William Sound. Within the region from the Kenai Peninsula to Kiska Island, special effort should be made to ensure that counts are obtained at all trend count sites identified in Appendix A.

322. Conduct pup counts at selected rookeries

Pup counts are an important measure of the status and trend of the population-but they are relatively difficult to obtain. Counts from aerial or vessel surveys are not reliable because pups frequently are under boulders or cliffs, or are obscured by other animals. The most reliable counts of pups are obtained from land, usually by slowly walking through the rookery which causes the adults to move toward the water while the pups remain higher on the beach. At some sites, reliable counts can be obtained by looking down on the rookery from cliffs or bluffs. Optimal dates to count are from about the last week of June through the first week of July. Access to the sites must be by ship, helicopter, or in a few cases, float plane.

Pup counts should be conducted at selected sites in Alaska in order to maintain a current level of knowledge on status and trends of sea lions for management and research planning. The Team recommends doing pup counts at each rookery only every other year to minimize disturbance. During even numbered years pup counts should be done at Seal Rocks, Sugarloaf Island, Chowiet Island, Chernabura Island, Clubbing Rocks, Ugamak Island, and Akutan Island. During odd numbered years, counts should be done at Outer Island, Marmot Island, Chirikof Island, Atkins Island, Pinnacle Rock, Akun Island, Bogoslof Island, and all rookeries in southeast Alaska (see Appendix B). These sites may be visited by helicopter or ship. Because of cost and difficulty of access, we do not recommend biennial pup counts at rookeries in the central and western Aleutian Islands. Pup counts in those areas would be made every 5 years as part of the range-wide survey (Section 34). Additional pup counts could be made in those areas in the course of other activities, such as those described in Section 44.

33. Conduct surveys of pups and non-pups at rookeries in California and Oregon every other year

The number of Steller sea lions in parts of California has declined greatly. In Oregon, sea lion numbers have fluctuated but shown no strong trend. Since human activities may be affecting animals in California and Oregon, and because factors responsible for population changes may be different than in Alaska, complete surveys of pups and non-pups should be conducted at least every other year.

Some rookeries are currently being surveyed more or less regularly by various personnel and agencies. There is a need, however, to coordinate surveys so that they include all rookeries in California (Año Nuevo Island, Farallon Islands, Cape Mendocino, and St. George Reef) and Oregon (Rogue Reef and Orford Reef). Methods used should be designed to give data that are comparable to that described in Sections 321 and 322. However, techniques may have to vary somewhat due to specific conditions (e.g., topography and access limitations) at each location, and to fit the characteristics of existing programs.

34. Conduct range-wide survey every 5 years

Information on status and trend of the entire population is needed to guide changes in listing categories, to facilitate area management, and to help establish research priorities. Because animals may move from one area to another, results from surveys done in separate parts of the range during different years can not necessarily be combined. Therefore, in order to monitor the status and trend of the population as a whole it is necessary to conduct surveys throughout the entire range of the species during the same year. This has been attempted only once, in 1989, when all areas except British Columbia and California were counted. Conducting a range-wide survey is an international effort and will require cooperation and support of investigators and agencies in the United States, Canada, and Russia.

341. Conduct aerial survey of adults and juveniles at all rookeries and major haulouts

Surveys should be conducted using the methods described in Sections 321 and 33. Because of the large area to be covered, six separate survey crews will be required as follows: (1) California, Oregon, and Washington; (2) British Columbia, southeast Alaska, and eastern Gulf of Alaska; (3) central and western Gulf of Alaska, and eastern Aleutian Islands; (4) central and western Aleutian Islands; (5) Kamchatka; and (6) Kuril Islands. Rookeries in the Okhotsk Sea and Commander Islands (and perhaps Kamchatka and the Kurils) may need to be surveyed by land or ship because of the difficulties in obtaining aircraft for surveys in Russia.

342. Conduct pup counts at selected rookeries

Counts should be conducted using the methods described in Sections 322 and 33. Important index rookeries that should be counted are listed below, by region (see also Appendix B).

California, Oregon, and Washington ---all known rookeries
British Columbia --------------------- all known rookeries
southeast Alaska --------------------- all known rookeries
eastern Gulf of Alaska ------------- Seal Rocks
central Gulf of Alaska ------------- Outer Island, Sugarloaf Island, Marmot Island, Chirikof Island, Chowiet Island
western Gulf of Alaska ------------- Atkins Island, Chernabura Island, Pinnacle Rock, Clubbing Rocks
eastern Aleutian Islands ----------- Ugamak Island, Akun Island, Akutan Island, Bogoslof Island
central Aleutian Islands ----------- Yunaska Island, Seguam Island, Ulak Island, Kiska Island
western Aleutian Islands ----------- Buldir Island, Agattu Island
Bering Sea ---------------------------- Walrus Island
Russia ---------------------------------- all sites that can be visited by ship

The selection of these rookeries is preliminary and should be changed if other sites are determined to be more important. Because of the alternate year counting schedule for index rookeries described in Section 322, some sites will not be counted in the year of the range-wide survey (see Appendix B). For those rookeries, data from the previous year should be used in compiling an estimate of range-wide pup production.

4. Monitor health, condition, and vital parameters

The health and condition of individual Steller sea lions may be one of the most important factors to monitor in relation to the population decline and recovery. Condition of individuals will affect their survival and reproductive output (i.e., vital parameters) which in turn will influence population status and trend. Initial efforts to develop life tables (Calkins and Pitcher, 1982; York, in preparation) should be continued and expanded. Successful and accurate assessment of the factors contributing to the population decline requires good life-table data to provide quantitative measures of the impact of a given factor on productivity and mortality. Likewise, the degree of success of management efforts is ultimately assessed by the effect on mortality and productivity. Previous studies have collected a variety of measurements and samples that can be used in this evaluation (e.g., Calkins and Goodwin, 1988). Additional data and samples should be collected in conjunction with other programs to address specific research needs. Standardized protocols should be used for collection and storage of specimens, and materials should be archived for future analyses. New techniques should be developed, evaluated, and applied as appropriate.

41. Examine and sample dead animals from rookeries, incidental take, subsistence harvests, and those located by stranding networks and carcass surveys

The various programs that will be conducted to evaluate rates and causes of mortality (Section 51) will provide access to dead sea lions for examination and sampling. Dead pups should be collected at intensive study sites established under Section 44 whenever this is possible without disturbance to normal rookery activities. Carcasses opportunistically recovered should be examined and sampled to the maximum extent possible. Animals taken incidentally in commercial fisheries and by subsistence hunters can be sampled when very fresh, and efforts should be made to seek the cooperation of fishermen and subsistence hunters in gaining quick access to dead animals. People collecting specimens should be trained, and should be provided with necessary protocols.

Measurements, teeth, reproductive tracts, and tissue samples made available by studies described in Sections 22, 432, 445, 46, 611, and 621 should be collected and analyzed to assess and monitor general condition and reproductive status. Collection and analysis of reproductive tracts from female sea lions is particularly important for monitoring critical vital parameters. Standard techniques (Pitcher and Calkins, 1981) should be used to determine reproductive status of each individual. Data should be used to determine ovulation rates, pregnancy rates, and age of sexual maturity. Whenever possible, blood and tissue samples should be collected for use in studies of disease, contaminants, and DNA analysis for stock identification (see Sections 22 and 46).

42. Collect and sample animals

Given the rapidity of population decline in some areas and the threatened status of the species, lethal collection of sea lions to obtain samples or data is not desirable. Limited lethal collections may, however, be deemed necessary at some future time for the acquisition of certain kinds of crucial data that may not be obtainable from other techniques. Careful consideration of the question of lethal collection is particularly relevant in the case of the Steller sea lion because some of the most significant data concerning the decline of the species and the possible causes of the decline came from animals collected in the late 1970s and early 1980s. For example, the report from the April, 1990 U.S.-U.S.S.R workshop on Steller sea lions states: "... some of the most enlightening information on the possible causes of the decline, and how the decline is affecting population structure, came from collections of animals in the 1970s and 1980s by the ADFG. In those studies, changes in physical size of individuals of known age and possible changes in age distribution and pregnancy rates were observed. These types of data are important in considerations of the factors affecting the population and its relative health. Collections may be required in the future if adequate samples cannot be obtained from commercial fisheries observer programs or through other sources." (Anonymous, 1990, p. 9).

Decisions to employ lethal sampling techniques should address the possible impact of sampling on the local population, the deficiencies of any alternative non-lethal collecting techniques, and the significance of the data to be derived from the collection.

43. Develop methods for non-lethal sampling

Whenever possible, non-lethal sampling should be used to monitor health, condition, and vital parameters. In addition to existing methods, efforts should be made to develop or adapt techniques not yet tried on Steller sea lions. It is recognized that some techniques (e.g., chemical immobilization) may pose a risk of mortality. Such incidental mortality must be accepted under the same criteria set forth for lethal sampling: the potential cost of the technique should not exceed the anticipated benefit to the species from knowledge derived from the sampling technique.

A variety of studies require temporary restraint of animals. The large size and vigilance of Steller sea lions may limit the usefulness of some capture and restraint techniques developed for smaller or more approachable pinnipeds. Although few Steller sea lions are currently maintained in captivity, the possibility of research with captive animals should also be considered.

The increasing use of telemetry devices and other techniques to sample free-ranging individuals should be given high priority, because these techniques minimize potentially disturbing interactions with the animals and provide data from animals under the most "natural" conditions possible.

431. Develop and evaluate capture techniques

In recent years, there has been a great deal of work done on techniques for capturing and immobilizing marine mammals. Techniques for chemical immobilization of Steller sea lions and closely related otariids have been investigated (Loughlin and Spraker, 1989; Boyd et al., 1990). However, some mortality does occur even with the best methods currently available, so efforts to improve techniques should be continued. Emphasis on improving techniques should not be taken to imply that special studies need to be conducted for that specific purpose. It should be possible to do most development and evaluation of new techniques during research conducted for other purposes (e.g., Section 613).

432. <u>Develop indices of condition</u>

Various measurements may be used singly and in combination to evaluate the physical condition of individual sea lions. Methods currently in use include body weight (compared to age or length), length/girth ratios, and directly measured blubber thickness (Calkins and Goodwin, 1988). In addition, there are recently developed techniques for assessing condition that may be more suitable for some situations or that can provide measures particularly sensitive to certain aspects of condition not reflected by body size and subcutaneous fat stores (e.g., Huntley et al., 1987). These include, but are not limited to, isotopic tracer techniques for assessing body composition and metabolism, ultrasound and electrical conductivity measures of body fat, measures of lactation energy exchange, and a variety of blood chemistry measures associated with specific aspects of condition (e.g., anemia, immune response, ketone bodies, humoral enzyme levels). Expert advice on this field should be solicited and a complete plan for condition assessment should be developed based on multiple indices of condition. Data on condition indices will most likely be collected at intensive study sites described in Section 44. Samples from dead animals will be obtained by activities described in Section 41.

44. <u>Conduct studies on rookeries</u>

Observational studies of sea lions on land can yield a wealth of data that can be used to evaluate status and condition. Data should be collected as part of a complete program at selected intensive study sites. The program at intensive study sites should include population monitoring efforts (Sections 441 and 442), monitoring of mortality specified in Section 51, sampling from dead animals described in Section 41, and collections of stomach contents and scats described in Section 611. In addition, observations of certain behaviors on the rookery can also serve as indices of health, condition, and vital parameters. For example, copulations over the course of the breeding season can indicate the relative proportion of nulliparous females being recruited into the local breeding population because these females tend to copulate early in the breeding season (Gisiner, 1985). Average tenures of territorial males may be reduced in comparison to other years or other areas if males are in poor condition, since males rely on stored fat reserves while on a territory. Other observational data which are relatively easy and inexpensive to obtain might serve as an index of individual or population condition values that are difficult to measure directly because they require lethal collection or handling of large numbers of animals.

Intensive studies should be undertaken each year for the next 5 years at sites in Oregon (Rogue Reef), southeast Alaska (Forrester Island), the Gulf of Alaska (Marmot Island and Chirikof Island), and the eastern Aleutians (Ugamak Island). Because of the expense and logistic difficulties of transporting and maintaining camps in the central and western Aleutians, intensive studies for this area should be conducted every 3 years (perhaps 1992 and 1995). Suggested study sites in the central and western Aleutians should include at least two of the following: Seguam Island, Kiska Island, Buldir Island, and Agattu Island. Choice of specific sites will depend on a number of variables, including, but not limited to, access to adequate numbers of animals, year-to-year stability of the site, potential for disturbance to animals or disruption of other research activities, and requirements of data comparability between sites or between years. Selection of specific sites should therefore be done by qualified persons who are familiar with the sites and other relevant factors.

441. Determine sex and age classes of animals on shore

Daily or weekly counts broken down into age/sex classes should be made by experienced observers at selected index sites during the summer breeding season (approximately mid-May to mid-August). If field camps are maintained outside the breeding season, counts should continue to be made to provide information on seasonal variation in use of sites. Frequent counts by experienced observers approach the accuracy of aerial photographs. Such counts have been used to verify aerial counts and as a source of data if aerial counts are not feasible. The age/sex composition of groups on the study site provide site-to-site and between-year comparative data on male:female ratios, female:pup ratios, and female:juvenile ratios. These data serve as indicators of possible changes in individual condition, sex-related differences in survival, fecundity, and other life history parameters. More intensive follow-up studies can then be focused on potential problems revealed by the dynamics of age/sex classes at intensive study sites.

Observations of mother-pup attendance patterns should also be conducted. Female attendance patterns in closely related otariids have been shown to be correlated with female condition and food availability. For example, during the 1983 El Niño climatic disturbances, female attendance patterns and pup condition in California sea lions and Galapagos fur seals were altered by climatically induced food shortages (Trillmich et al., 1986; Ono et al., 1987). Data on attendance patterns may also be obtained from telemetry packages placed on breeding females (see Section 613).

Data on mother-pup attendance patterns should be combined with lactation energetics data (Section 445) to provide a more complete picture of the foraging ecology of reproductive females. These data are important for data compilations and models of foraging ecology in Sections 612, 614, and 62.

442. Determine rates of pup production and mortality

Currently, counts made by researchers walking through rookeries and displacing the adults are probably the best measure of pup production. Such counts are usually very accurate and may yield numbers of pups 30% or more higher than counts made with adults present. The activity results in some disturbance and potential pup mortality, and for that reason this type of pup count is done infrequently at a limited number of sample sites. Some counts may be conducted in conjunction with pup tagging or marking efforts that may also temporarily displace adults.

Section 322 describes a coordinated program of alternate-year pup counts at selected sites in Alaska. The sites listed for regular, biennial pup counts include the intensive study sites; activities at the intensive study sites should therefore be coordinated with the needs of Section 322. Additionally, at intensive study sites, repeated counts of pups should be conducted without disturbing the animals, as part of the daily or weekly counts described in Section 441. Such counts, made over the duration of the breeding season, may approach the accuracy of single counts with adults removed, although it might be desirable in the early years of this plan to perform comparison of the two counting methods at some intensive study sites.

Pup mortality (see Section 512) also can be most accurately and easily monitored by a shore-based observer who examines the rookery daily or weekly throughout the season.

443. Tag and brand pups and adult females

Section 21 also recommends tagging/marking efforts to determine dispersal and seasonal movement patterns of animals from different management units. This should not be taken to imply that there should be two separate, mutually exclusive tagging/marking programs; Sections 21 and 443 simply emphasize different data aspects of a single tagging/marking program. Any tagging/marking proposal should be considered in light of its ability to be coordinated with other activities (e.g., pup counts and field physiology studies requiring animal capture and restraint); its probability of being followed by studies that can make use of the potential data yielded by animals marked to reveal age, sex, place of birth, and individual identity (the types of activities proposed in Sections 2 and 4 of this plan); and the potential impacts of disturbance resulting from tagging/marking activities.

Pups may be tagged in conjunction with counts (see Sections 322, 33, and 342). Females immobilized for attachment of telemetry equipment or other experimental procedures should also be tagged (Sections 445 and 613). There are limitations to the benefits derived from tagging. It is usually difficult, if not impossible, to re-tag animals older than pups. Tag loss and abrasion of identification numbers over time can therefore seriously reduce the effective number of individually identifiable animals. In addition, most tags are difficult to read under normal field conditions, even if they are still in place and possess legible markings. Nevertheless, tags are inexpensive and easy to put on. Color-coded tags can provide data on the rookery of origin of animals sighted at various locations even after the tag markings are worn off. The accumulated tag sighting data can provide information on the extent of dispersion from various sites, the seasonal movements of individuals from a given site, and the relative amount of immigration from one site to other intensive study sites. Such information should be useful in determining stock identity (Section 2) and seasonal use patterns (Section 12).

Branding is more expensive, the equipment is more cumbersome, and marking does not proceed as quickly or easily as tagging. Nevertheless, branding or some other means of producing long-lasting, easily read individual identification should be considered as a means of providing much needed life table data on recruitment and age-specific reproductive rates. Branding pups to indicate rookery and year of birth has produced valuable information even though the branded animals were not individually identified (Calkins and Pitcher, 1982). Pups were branded with individual identification marks in 1987 and 1988 on two beaches at Marmot Island, but one of the beaches was later abandoned by the sea lions as the population declined (Anonymous, 1990) and the marked animals apparently dispersed (although surviving animals may still return to the branding site or other monitored sites as they come of breeding age).

444. Monitor status of tagged animals

Long-term studies of tagged, branded, or naturally marked animals can be used to estimate such vital parameters as age of first reproduction, age specific pup production, site fidelity, ontogeny of male territory acquisition, cohort survivorship, non-breeding range of individuals, and others. It should be noted, however, that some of these studies may require sample sizes larger than can be practically attained.

Prolonged follow-up studies are required to develop life table data for long-lived species with low fecundity such as the Steller sea lion. In addition, public reporting of sightings of marked animals should be encouraged through public education and informational programs (see Section 75).

445. Obtain measurements and samples using non-lethal techniques

Techniques developed and evaluated in Section 43 should be applied at the intensive study sites, in coordination with other activities. Programs that have potential for disturbance may need to be conducted away from sites being monitored for regular counts or being used for ongoing behavioral studies. Measurements and samples required by other programs should be collected in conjunction with the activities planned in this Section in order to reduce the number of capture efforts required to fulfill all research and monitoring goals (e.g., tissue sampling for Section 22 studies, tagging and branding for Section 21 and 443 studies, attachment of radio-tags for Section 613 studies, and food habits sampling in Section 611 could all be performed during captures for condition assessment and energetics studies under this Section).

45. Compile a catalog of all tissues and other samples

Previous research has resulted in the collection of a considerable number of tissues and other samples from Steller sea lions. Most of this material is currently held by ADFG or NMML. Some, but not all, of this material has been analyzed. All of the existing material should be centrally cataloged so that it may be available for completion of ongoing analyses or for additional analyses that are required later. The catalog should include the location of samples, their condition, and whether or not any analysis has been conducted on them. Documentation should indicate the protocols used in making collections. To this catalog will be added the samples generated by efforts described in Sections 22, 41, 445, 511, 611, and 612. Steps should be taken to ensure that samples are being properly archived.

46. Conduct laboratory analyses of samples for diseases and parasites, contaminant levels, and nutritional status

Arrangements should be made with appropriate laboratories that can provide reliable, timely, and cost-effective analyses of samples. In many cases, the data collection procedure, sampling, and analysis may be carried out by a single agency or contractor. Criteria should be established for prioritizing samples for analysis. The types of analyses to be performed will be determined by the needs of programs instituted under Sections 41, 42, 445, 51, and 61.

47. Compile and analyze data

Data collected in current and future research should be analyzed and reported in a timely manner. Reports should be thoroughly referenced and follow standards of organization to facilitate comparison with existing reports. As much as possible, data should be presented in peer-reviewed periodicals and other open publications to ensure that research programs benefit from regular peer commentary.

To the maximum extent possible, current and future research efforts should collect data in such a way that they can be compared with historical data. Studies may need to be conducted to calibrate results from newly developed techniques with those obtained by previous methods. Data analyses should examine trends over time and attempt to correlate observed changes with physical, biological, or human induced changes in the environment.

Analyses of data should also emphasize correlations between regional differences in sea lion population trends with regional differences in other factors, such as physical oceanography, food resources, human activities (fishing, tourist activities, etc.). Factors that are correlated with declining regional populations can help identify the causes of declines, which in turn will lead to more effective management efforts.

5. Assess and minimize causes of mortality

Regardless of the causal factors of the current decline, the goal of population recovery requires a major effort to decrease mortality wherever possible. Furthermore, the decline in Steller sea lion numbers must eventually be traced to specific sources of mortality and/or reductions in productivity; this can only be done by quantitative assessments of the causes of mortality.

51. Determine causes of mortality and their relative contributions to total mortality

511. Implement/expand stranding networks

Marine mammal stranding networks have provided valuable data on mortality for several marine mammal and bird species. Examples include episodic outbreaks of leptospirosis and San Miguel sea lion virus in California sea lions and gillnet mortality of seabirds and harbor porpoises in central California. As illustrated by these examples, stranding networks may be valuable for determining causes of illness, injury, or death within an area as well as year-to-year changes in the number or location of affected animals. Data from stranding networks are usually not used to determine the relative contribution of a specific agent of mortality to total population mortality because some agents may be more likely than others to produce strandings and subsequent recovery of animals by stranding networks. Also, because of the large size and relative inaccessibility of much of the Steller sea lion range, and the relative rarity of Steller sea lion strandings, information derived from stranding networks may not be very extensive for this species.

Existing organizations and individuals should be informed that Steller sea lion strandings are of particular significance. Data that are obtained should be cataloged and maintained by a central agency, and should be kept up to date through annual or semi-annual mailings to stranding networks, state fish and game agencies, etc. A possible approach would be to request that stranding networks notify a designated office (e.g., the regional stranding program coordinator), and a trained group of people who might respond to strandings.

Personnel examining stranded animals should endeavor to determine the cause of death or injury, and look especially for evidence of interactions with humans (e.g., bullet wounds or net marks). Besides indicating the presence of potential agents of mortality, the opportunity to examine sick or injured animals may lead to better field diagnosis of sick or injured animals that are not stranded. Maintaining stranded individuals in captivity for further study or treatment may be practical only for younger, smaller individuals. Rehabilitation and release may be of value in the recovery of very small populations, but it is not likely that such an effort would make a significant contribution considering the current numbers of Steller sea lions.

Dead animals, even those that are decomposed, can be valuable sources of data. High priority should be attached to the reporting of stranded sea lions regardless of condition. A priority list for observations, measurements, and specimens to be collected should be made available to state fish and game agencies, Federal research and management teams, and other appropriate groups and individuals within the Steller sea lion range.

512. <u>Survey selected areas for dead animals</u>

During studies at selected index sites (see Section 44), personnel should have the materials and training to: (1) determine approximate age/sex and location of all dead animals observed; (2) perform field necropsies to determine causes of pup mortality on the rookeries and collect tissue samples needed for other studies (Sections 22 and 41); and (3) properly store and transport collected materials for laboratory analysis (Section 46). Under some circumstances it is recognized that the cost of recovery may exceed the value of potential data from the dead animal; for example, dead pups should be counted and sampled during pup counts when pups have been separated from adults, but rookeries should not be disturbed solely to recover dead pups (see Section 442 for discussion of methods for determining pup mortality).

Efforts should also be made to identify sites where there is an high probability of being able to locate and sample dead animals. This effort will need to be coordinated with activities of stranding networks (Section 511), aerial survey crews (Sections 32, 33, and 34), field enforcement (Section 76), and other field activities. If identified sites are not visited regularly as part of the activities listed above, it may be desirable to conduct special field efforts to examine and sample dead animals.

513. <u>Monitor incidental take in commercial fisheries</u>

The mechanisms for reporting incidental takes and ensuring compliance are provided in the MMPA and NMFS regulations. Additional effort should be devoted to emphasizing the significance of these data for Steller sea lions. Specific methods for assuring maximum compliance in reporting, and for proper sampling of animals and storage of specimens should be developed. To increase their cooperation and compliance fishermen should be encouraged to take an interactive role in developing strategies for reporting takes. Educational programs aimed at fishing organizations and communities (see Section 75) would be a particularly useful forum for developing workable monitoring procedures.

514. <u>Investigate entanglement in debris</u>

Current observations of sea lions at sea and on land indicate that entanglement in debris is infrequent. There should be a continued effort to estimate the relative number of entangled animals in stranding data, by observers aboard vessels at sea, and during field research activities such as pup counts (Sections 322, 33, and 342) and observations at intensive study sites (Section 44). When possible, the entangling material should be identified as this may provide clues about the circumstances under which sea lions become entangled. Literature surveys should be conducted regularly to update information on related marine mammal and bird entanglement incidents, and surveys of occurrence of entangling materials (packing bands, net fragments, etc.) at sea. Data should be used to support efforts to mitigate mortality (see Section 523).

515. Determine and monitor level of subsistence take in Alaska

Available data on subsistence take of sea lions in Alaska has recently been summarized (Haynes and Mishler, 1991). A statewide subsistence harvest survey should be conducted to provide more current and accurate estimates of regional and total harvest levels. Subsequently, annual monitoring should be done at locations where substantial numbers of sea lions are being taken. Observers should determine the numbers and age/sex of animals taken, numbers killed or injured but not recovered, methods used to take, etc. In addition to monitoring activities, personnel interacting with subsistence hunters should seek cooperation in obtaining measurements and samples required by Sections 22, 41, and 611.

516. Evaluate causes and extent of other deliberate killing

Enforcement programs (Section 76) and educational programs (Section 75) should yield information about specific instances of deliberate killing not associated with subsistence hunting. Follow-up on reports of deliberate killing are needed to determine the causes of such mortality (see Section 41) and how prevalent such incidents are. Once sources of deliberate killing are identified, programs should be developed to eliminate this source of mortality.

517. Evaluate mortality caused by non-human predators

Known marine predators of Steller sea lions include killer whales and sharks. Observations of predation have been sporadic and opportunistic. Rookeries do not appear to be regularly patrolled by killer whales. It would therefore be difficult to develop a reliable estimate of predation for a specific location or rookery. Even at sites where marine predators (white sharks and killer whales) are easily sighted from shore, such as the Farallon Islands in California, it has not been possible to develop quantitative assessments of the extent of predation or its possible impact on pinniped populations (D. Ainley, personal communication).

Potential terrestrial predators include brown and black bears, and to a lesser degree foxes, bald eagles, ravens, and gulls (the latter four probably prey only on injured or abandoned pups that would likely die anyway). There is no record of bears contributing regularly or substantially to sea lion mortality.

During the current population decline reports of predation have not increased, and it is therefore unlikely that predation has contributed substantially to the problem. Nonetheless, opportunistic observations of predation can and should be made in conjunction with intensive study programs (Section 44) and other field activities.

52. Minimize injury and mortality

It is clear that human activities have caused injury to and mortality of many thousands of Steller sea lions (e.g., Perez and Loughlin, 1990). Steps should be taken to improve the data base in this area, and at the same time reduce all human-related mortality and trauma to the maximum extent possible.

At present, the causes and extent of natural mortality are not known. As research outlined in this plan progresses, data may reveal agents of natural mortality (e.g., disease) that could be controlled to facilitate population recovery. Currently, however, no programs for attempting to reduce natural mortality are identified.

521. Develop and implement methods to reduce incidental take

Gear modification programs should be considered for fisheries where the incidental take of sea lions can be identified with specific gear types. Current data, however, tend to indicate that sea lion mortality in fishing gear is more a function of area and feeding activity than it is of the gear itself. For example, incidental take is higher when fishing is conducted at night (Loughlin and Nelson, 1986).

Particular attention should be paid to the timing and location of fisheries where sea lion mortality is known to occur. Fishery management regulations may be able to shift the location or timing of those fisheries to reduce the incidental take of sea lions, with little or no impact on the overall commercial catches of fish. Changes in regulations to alter the time and area where fish may be taken may, however, impact current and traditional fishing patterns and could affect the economic return from the fisheries.

Available data should be reviewed annually to determine where the likelihood of incidental take is greatest, and to identify alternative areas or times where those fisheries could operate. If necessary, new regulations or modifications to existing regulations should be developed and implemented. Educational programs (Section 75) should include active involvement of fishermen in development of techniques to reduce and eliminate incidental takes.

522. Develop non-harmful deterrents for use by commercial fishermen

Existing regulations prohibit fishermen from shooting at or near sea lions to keep them away from their gear or catch. Alternative methods for displacing pinnipeds, such as seal bombs, killer whale sounds, and taste aversion, have been tried, but they have generally not been very successful (e.g., see Mate and Harvey, 1987). Fishermen are therefore left with the very real problem of sea lions damaging their gear and catch, and little or nothing they can legally do. Some additional effort should therefore be devoted to finding new non-harmful means of keeping sea lions away from fishing operations, perhaps with support provided by the fishing industry. For example, Sasakawa (1989) reportedly was able to keep Steller sea lions away from submerged setnets by using explosive sounds. However, Sasakawa did not describe the possible physical effects of the explosions on sea lions, and that is a factor that must be considered before such techniques can be used.

Part of the current problem is that some fisheries, for example the pollock roe fishery, produce large amounts of readily available fish (target species, bycatch, and waste) that provide an easy food source attractive to sea lions. Aversive techniques intended to deter sea lions from coming near boats and gear must therefore overcome the positive reinforcement supplied by the readily available fish. Continued attention should be given to procedures that will reduce this attractant.

It should also be recognized that one of the possible causes of the current decline of Steller sea lion numbers is poor individual condition leading to increased mortality and reduced pup production. It may therefore impede recovery of the population if sea lions are kept away from food resources because those resources are also being harvested by a commercial fishery. It may be more appropriate to consider other management techniques (e.g., Section 521) to mitigate incidental takes and gear damage rather than using methods that drive sea lions away from food sources.

523. Improve and continue programs to minimize marine debris

While entanglement in debris has not been shown to be a major factor in sea lion mortality, some animals do become entangled in net fragments and packing bands. The educational program within the fishing industry, including all support units, to totally eliminate the at-sea discard of materials that may cause marine mammal entanglement should be continued. Entanglement of fur seals in net fragments is decreasing (Fowler and Ragen, 1990), but efforts to further reduce or eliminate this problem should be continued. Foreign fishing and support vessels may be major sources of packing bands and scraps of netting. Efforts should be made to have input at the international level through the International Convention for the Prevention of Pollution from Ships (MARPOL) and related organizations, through the NMFS Marine Entanglement Research Program. Educational programs (Section 75) should stress the harmful effects of marine debris.

524. Develop methods to reduce loss rate in subsistence harvests

Not all sea lions killed or injured in subsistence hunts are recovered. Changes in capture methods, areas, or timing may reduce the loss rate (and disturbance to rookeries and haulouts that may result from hunting). A program to work with one or more of the major subsistence communities should be developed to explore solutions.

53. Review and revise recommendations for maximum allowable levels of lethal take

Maximum allowable levels of lethal take should take into consideration subsistence, commercial fisheries, research, and other human-related sources of killing. Current information indicates that commercial fisheries and subsistence hunters take the vast majority of animals. Allowable levels of take should be established based on abundance and trend (determined and monitored as described in Section 3) in appropriate management units (identified in Section 2). If necessary, mechanisms should be developed to allocate portions of the total allowable take among various general categories (e.g., incidental take, subsistence, research).

The maximum legal incidental take of Steller sea lions under the MMPA as amended in 1988 was set at 1,350 animals annually. The Emergency Interim Rule listing sea lions as threatened reduced the allowable incidental take to 675 in the area west of 141° west longitude.

No specific rationale was given for either number. Although percentage of the index count apparently was not the basis for setting and modifying incidental take limits, the allowable level amounted to about 2.2%-2.7%. NMFS is currently working on an overall plan for setting allowable levels of incidental take for marine mammals that will apply to all species including Steller sea lions, and a draft regime has been proposed (NMFS, 1991). This proposal will be revised and submitted to Congress for their consideration during MMPA reauthorization in 1993. If necessary, takes in fisheries should be divided by region, season, and gear type to prevent high takes in one fishery or region from overburdening or closing other fisheries.

The ESA allows the continued subsistence harvest of threatened or endangered species by Alaska Natives, but such taking may be regulated if it negatively affects the species. Levels of subsistence harvests (documented in Section 515) should be evaluated in relation to the current condition of the stock (Sections 2 and 3). If regulation of the harvest is deemed necessary, the communities taking Steller sea lions should be included in the process of setting the overall harvest limits and the distribution among villages (as is done with bowhead whales by NMFS and the Alaska Eskimo Whaling Commission). Animals killed and lost should be included in any limit set on subsistence take.

Because there is no sustainable yield from a depleted, declining population, there is no biologically defensible basis for estimating maximum allowable removals for regions where sea lions are declining. Since sea lions are declining in the area from the central Gulf of Alaska through the Aleutian Islands, efforts should be made to minimize all sources of mortality in this region until such time as population recovery begins. Efforts should also be made to see that, whenever possible, any allowed lethal takes provide information that will aid in recovery of the population. In areas where sea lion numbers are stable or increasing, allowable removals can be calculated based on biological factors such as abundance and productivity.

6. <u>Investigate feeding ecology and factors affecting energetic status</u>

Although the sea lion diet as a whole is diverse, in particular areas a single species may comprise as much as 50% of their food for certain periods. Such species are usually locally concentrated or form schools or aggregations in particular areas at certain times. Examples include herring, walleye pollock, hake, and rockfish.

Many of the prey eaten by Steller sea lions are species that also are taken in commercial fisheries. It is unclear at present whether and how particular fisheries may affect the ability of sea lions to obtain an adequate supply of food. Fluctuations in abundance of fish and shellfish stocks in Alaska have been well documented in recent years (e.g., Naumenko et. al., 1990; Megrey and Wespestad, 1990). However, the influences of predators, commercial harvests, and environmental factors on fish stock abundance are poorly understood. Sea lions may be able to alter the mix of prey in their diet in response to changes in prey abundance, but the degree to which they can switch, and the possible costs of such switching, are unknown.

Correlations of sea lion population changes with gross estimates of fish catches have not provided much insight into sea lion-fishery interactions (Loughlin and Merrick, 1989). Comparisons of the condition of sea lions collected in the Gulf of Alaska in the mid-1970s and the mid-1980s suggested that animals collected in the latter period were nutritionally stressed

(Calkins and Goodwin, 1988), but the data do not allow the identification of specific problems. Nonetheless, it is obvious that rapid recovery of the sea lion population will require that animals have optimal feeding conditions.

It may be necessary to implement management actions to ensure that food supplies, especially in critical areas and times, are adequate to stop the decline and then support a growing sea lion population. In many cases, additional information will be needed to design properly focused and effective management measures. The actions that must be taken to obtain the necessary information and to implement appropriate measures are described below.

61. <u>Investigate sea lion feeding ecology</u>

One of the principal reasons for investigating sea lion feeding ecology is to understand the interaction between food availability and the status and trend of the sea lion population. Additional information is needed on the sea lions' nutritional requirements, and on how much prey is available seasonally and spatially to meet those requirements. Correlation of changes in feeding habits with population changes in specific areas can be informative, but will require long-term studies. Comparisons of feeding habits among areas where sea lion populations are showing different trends may be particularly valuable.

The existing data on sea lion feeding ecology are largely restricted to a description of the diet. This description has resulted mostly from the examination of stomach contents of animals collected for scientific purposes, and from stranded animals. Considering the current status of the sea lion population, it is unlikely that large scientific collections can be justified in most areas at this time. Therefore, it is essential that alternative methods of describing and monitoring changes in the sea lion diet be developed.

Understanding the interactions between sea lions and their food resources requires additional information beyond a description of characteristics of prey being eaten. Recently developed techniques that allow the investigation of energetics and nutritional physiology of free ranging animals should be applied to sea lions where possible. Telemetry and other devices should be used to describe diving behavior and characteristics of feeding cycles, and to identify feeding areas. Models need to be developed to integrate information on sea lion feeding and energetics with factors that may influence prey populations. Such models can be used to identify areas of significant interaction and to evaluate the possible effectiveness of potential management actions.

611. <u>Describe foods eaten by sea lions</u>

To provide direction for ecological and process studies, it is necessary to know what foods are being consumed by sea lions. In addition to the specific identity of prey, the size (or age) classes that are being eaten must be determined. Ideally, such data should be obtained for all age/sex classes of sea lions in all areas and seasons. The data should be used to compare prey utilization among different regions and to monitor changes from year to year in a particular area. To evaluate differences between age classes, areas, seasons, or years, sampling and analysis must allow statistical testing.

6111. Collect and analyze stomach contents

Stomach contents should be collected from dead sea lions whenever possible (see Section 41). Potential sources of material include beachcast carcasses, animals incidentally taken in commercial fisheries, and animals taken by Alaska Natives. Animals taken in commercial fisheries are of particular interest, since it is likely that their stomachs will contain fresh food remains, and the location where they were feeding will be known. However, sea lions caught by fisheries may be more likely to have been feeding on the target species, and this bias must be taken into account during analysis of results.

The entire stomach contents should be collected from every animal incidentally taken in commercial fisheries as part of observer programs. Intestinal contents should also be collected and examined for prey remains. Samples collected from these sources may not reflect the exact diversity or relative proportions of prey species eaten by the sea lion population, and small sample sizes may preclude statistical treatment of the data. They may nonetheless be useful for comparisons among areas and over time. While other methods (e.g., Section 6112) may produce larger sample sizes, analysis of stomach contents will give data that are the most comparable with data collected in previous years.

Obtaining samples of stomach contents from live sea lions by gastric lavage (putting fluid into the stomach and pumping it out) would require animals to be anaesthetized. The technique could be tested on sea lions that are anaesthetized for other purposes (Sections 445 and 613). However, the drug levels currently used when animals are handled for attaching telemetry equipment are too low to allow them to be lavaged. Higher drug levels result in an increased chance of death, which may preclude use of lavage techniques unless alternative immobilization methods are developed (see Section 431).

Sample analysis should determine the identity of prey and their relative importance in the sample (by number, weight, and/or volume). Diagnostic hard parts should be used for identification of contents where necessary. Original sizes of prey consumed should be determined by measuring intact organisms and appropriate hard parts such as otoliths.

6112. Collect and analyze scats

Hard parts of prey may pass through the gastrointestinal tract and appear in scats. Although there are biases associated with differential digestion and passage and it is usually not possible to determine which individual produced a particular scat, valuable information on diet composition can be obtained from scat analysis (e.g., Olesiuk et al., 1990). Physical characteristics of the substrate may preclude scat collection in some locations, but some specific areas may be suitable for sampling. Relatively large sample sizes can be obtained and used to monitor changes or trends in prey utilization. Scat collecting should generally be done in conjunction with other activities (e.g., Sections 322, 33, 342, and 443) in order to minimize potential disturbance.

Scat analysis requires careful separation of the hard parts of prey from non-diagnostic material in the feces (Bigg and Olesiuk, 1990). Once separated, hard parts should be identified and measured in the same manner as those obtained from stomach contents.

612. Determine food and energy requirements

For the Steller sea lion population to recover, the proper amounts and types of food must be available to individuals during critical periods. A large combined biomass of assorted prey species does not necessarily indicate an adequate food supply, since some of the species may be nutritionally poor at times or energetically costly to catch. To ensure a food supply of adequate quantity and composition, it is necessary to know the sea lions' nutritional requirements and their costs of obtaining prey. Isotopic studies and other techniques should be used to measure the food intake and energy expenditure of free-ranging animals (see Section 432). Such studies may be conducted in conjunction with intensive on-site study programs (Section 44). Studies of captive animals may be useful to develop and validate techniques, as well as to provide a more detailed picture of nutritional requirements for some age/sex classes. Results from captive studies must be used with caution since they may overestimate nutritional requirements (Innes et al., 1987).

Foraging costs will vary with location (due to transit times and prey dispersion) and with the type of prey (due to differences in difficulty of capture). Therefore, whenever possible, energetics studies should be done in conjunction with programs at intensive study sites (Section 44), studies on feeding areas and diving behavior (Section 613), diet composition (Section 611), and prey availability (Section 6141). Animals that have been injected with isotopes can be studied with satellite telemetry to measure the costs of foraging under different circumstances. This information on the dietary needs and energetics of the sea lions should then be compared to the abundance, nutritional characteristics, and distributions of various prey species throughout the year (Section 614).

It would be desirable to collect baseline data on food and energy requirements for all age and sex classes at a variety of locations throughout the year. Initial emphasis should be put on juveniles (especially pups after weaning) and adult females. If other age/sex classes are determined to be experiencing nutritional stress, then foraging studies should emphasize those groups. Studies should be designed to detect changes in foraging effort over time, as well as to allow comparisons of areas with different population status (Section 3) and patterns of prey availability (Section 6141).

613. Determine feeding areas and feeding strategies

Determining the locations, time of day, and depths at which sea lions feed will enhance efforts to assess and monitor the abundance and composition of their prey resources. When coupled with simultaneous studies of prey distribution and abundance (Section 6141), it will also help determine the degree and type of competition between sea lions and commercial fisheries and to identify which areas and depths constitute critical foraging habitat (see Sections 112 and 15). Continued monitoring will reveal how variable these feeding areas are and may provide an indication of the species' ability to change location or depth in response to changing prey availability.

6131. Identify feeding areas

It will be difficult to identify the areas used by Steller sea lions for feeding. Observations of sea lions feeding at sea can pinpoint feeding locations and, when made from boats, sampling of the prey is also possible. However, such data have an inherent bias associated with the activities of the observation platform (e.g., salmon fishing boats are very likely to encounter sea lions feeding on salmon). Aerial or shipboard surveys of standardized tracks avoid this bias but may have a much lower probability of encountering sea lions. Another approach that has been used with pinnipeds is to track individuals by using satellite, radio, or sonic tags. While these methods are expensive, labor intensive, and cause some disturbance to the animals, they provide the most accurate and detailed information about feeding areas and transit routes.

For wide-ranging species such as Steller sea lions, satellite telemetry is the most appropriate technique currently available for identifying feeding areas. Satellite tags should be applied to an adequate sample of animals at selected locations throughout their range. Because of the limited duration of tag function, it will be necessary to apply them at different times of year in order to obtain coverage for all seasons. Satellite tags will also provide data that will be useful for studies described in Sections 1 and 2.

6132. <u>Investigate diving behavior and feeding cycles</u>

Sea lions alternate feeding trips at sea with stays on land. The timing and duration of these cycles can vary with age, reproductive status, time of year, and food availability. Observations of changes in feeding cycle characteristics among sea lions of a given age or reproductive status may therefore provide an indication of changes in food availability.

Characteristics of dives can be determined by using devices that record time and depth. In situations where animals may easily be captured and handled, relatively inexpensive time-depth recorders can be deployed and recovered. However, considering the problems with handling Steller sea lions, incorporation of time-depth measurements in satellite packages appears to be the most appropriate method currently available.

Satellite tags allow very precise monitoring of feeding cycles because the likelihood of overlooking animals when they are ashore is minimal. However, they are expensive and potentially can affect the feeding patterns of the animals to which they are applied. Because large sample sizes are usually required to detect changes in feeding cycle patterns, naturally scarred, branded, and flipper tagged animals should be monitored in addition to those with radio or satellite tags (in conjunction with Section 44). Because animals are not always seen when they first come ashore, attendance pattern data from telemetry and direct observations are not entirely comparable (e.g., observational studies tend to give longer at-sea times) but information from both sources can be useful. Because lactating females return to land frequently to nurse their pups, their attendance patterns on the rookeries can be relatively easily monitored, especially if some animals are marked (see Section 443).

Measurement of time on shore and at sea should be compared among areas and years. Because foraging effort may vary in addition to the amount of time at sea, energetics studies (Section 612) should be conducted concurrently with studies of feeding cycle patterns. Changes in feeding cycle patterns should be analyzed for correlations with commercial fisheries catches and with rates of abortion, mortality, and copulation (Section 44).

614. Assess significance of various prey

Determination of the significance of a particular food to sea lions requires more than simply knowing its relative contribution to the diet. Certain prey may occur in particular circumstances in which they can be captured efficiently with little cost. It is likely that the caloric value of prey varies with age, sex, and season of the year. These factors may interact to make the availability of particular prey items of critical importance for sea lion nutrition at certain times and places. Additional data are needed to address the significance of individual prey species.

6141. Characterize geographic and seasonal patterns of prey availability and utilization by sea lions

Sampling programs should be based on the analysis of existing diet information (Section 615) and additional information on seasonal prey use that is obtained from studies described in Section 611. Potential prey availability should be estimated in areas where animals are known to be feeding (Section 6131) by using hydroacoustics, nets, underwater cameras, or other appropriate techniques. Sampling should be designed to give estimates of prey availability in actual feeding areas, as opposed to broad geographic regions. Annual patterns of prey availability should be determined using these data. In addition, measurements of parameters such as density and depth of prey, and distance from the rookery or haulout, are necessary to evaluate foraging costs. Prey sampling in areas adjacent to identified feeding areas would help determine why animals feed in certain locations and not in others.

While some of the information described in this Section may be obtained during standard NMFS resource assessment cruises, adjustments will have to be made to techniques and the distribution of effort to satisfy the data requirements for sea lions.

6142. Determine nutritional value of prey

The nutritional value of a particular type of prey can be viewed as the net energy obtained by its capture and assimilation. An assessment of net nutritional value requires the integration of costs of swimming to and from feeding areas and diving to capture prey (Sections 612 and 613), with information on the amounts and characteristics of prey caught on a feeding trip.

Many marine organisms show large variations in caloric content and essential nutrients, often associated with maturation and production of eggs. For example, adult females just prior to spawning may have a very high caloric value, while spent (post-spawning) individuals contain much less energy. Where not already known, patterns of caloric and nutrient variation should be documented for major sea lion prey species that are identified in Section 611, using specimens obtained in Section 6141.

Digestibility influences assimilation efficiency and can therefore affect the actual nutritional value of prey. Available data indicate that pinnipeds in general have high assimilation efficiencies, and additional investigation of this factor may not be necessary for

Steller sea lions. If further studies are necessary they will probably require the use of captive animals.

615. Compile and analyze data

The information that is generally available on sea lion feeding ecology is contained in a number of published papers and agency reports (e.g., Pitcher, 1981; Calkins and Goodwin, 1988). A considerable amount of information exists that has been only partially analyzed and has not been reported. All available information, including that from Russia and Canada, should be reviewed, analyzed, and presented in a comprehensive report. Results of that report should be used to assess the current state of knowledge about sea lion feeding habits, and to guide the design of future research.

A thorough analysis of existing data is required to identify all the areas that are appropriate for comparisons over time. The review of historical data on sea lion feeding should compare regions of differing population status and trend, where possible. Comparisons of current and historical data will need to allow for ecosystem changes that may have occurred over time.

It is unlikely that the existing data base will allow definitive comparisons to be made. Future collections and analyses should take advantage of the variations in population status and trend throughout the sea lion range in order to gain insight into the interactions between feeding and population parameters. To the maximum extent possible, current and future research efforts should collect data on sea lion feeding in a way that it can be compared with historical data.

62. Investigate interrelationships between prey abundance and sea lion growth and productivity

While the dynamics of the Steller sea lion population may be affected by a variety of factors, growth of individuals and productivity of the population are likely to be limited by food availability at some point. Field studies have demonstrated the role of food in regulating population productivity in many terrestrial ecosystems (e.g., McCullough, 1979; Skogland, 1985). However, marine mammals foraging in complex marine ecosystems pose tremendous problems for such studies. El Niño events have provided some insight into the role of food in limiting pinniped productivity (Ono et al., 1987).

A variety of techniques are available for assessing the abundance of marine fishes and invertebrates. However, these techniques have been developed by fishery managers to assess overall stock sizes, and may not measure prey abundance in the areas and times of importance to sea lions. Existing data sets should be examined for information on local prey abundance. Future data collection efforts and analyses may need to be designed specifically to address questions of relevance to Steller sea lion feeding ecology.

621. Measure growth and productivity in areas with different food availability

Once analyzed, existing data on sea lion biology and the distribution and abundance of fish stocks should be used to select study areas (e.g., Ugamak Island, Marmot Island, Forrester Island, and Rogue Reef). Variables other than food availability must be considered in area selection and evaluation of results (e.g., predation, disease, and migration costs). A variety of parameters, including pup production and survival (Sections 3 and 442), sex/age class distribution (Section 441), and individual size and condition (Sections 432 and 445), should be measured in these areas. Satellite telemetry should be used to define the areas used for feeding (Section 613), and data should be collected on foods being consumed (Section 611). Standard resource assessment techniques, modified as necessary, should be used to monitor the abundance and characteristics of prey in the feeding areas (Sections 6141 and 6142).

As an alternative to, or in addition to, use of study areas with natural variations in prey resource characteristics, fisheries could be regulated as a means to manipulate food availability (see Section 64). Design of such a manipulative study should take into account information on prey identity (Section 611), feeding areas (Section 6131), and food requirements (Section 612). It would be necessary to monitor the abundance of prey in the study area (Section 6141) in order to measure the actual effect of regulations on prey resource availability.

622. <u>Develop models for individual and population energetics, growth, and productivity</u>

One or more models will be required to integrate the information described under Section 621 and related Sections. A model or models should be developed to help assess the energetic needs of sea lions, and how variations in availability of food as a whole, and of individual prey species, may affect nutritional status of individuals. The influence of nutritional status on growth, condition, reproductive performance, and survival should be modelled. As a final step, models should be used to help assess how variations in individual parameters may affect population status and trend.

Models should be designed so that they not only integrate existing data but can also be used in a predictive mode to project how variations in prey availability may affect the status and trend of sea lions in various areas.

63. <u>Determine effects of fisheries on sea lion prey</u>

The abundance of commercially harvested fish stocks is known to fluctuate, sometimes declining drastically. In most cases the role of fishery removals in such stock declines is unclear. However, it is clear that some stock fluctuations have been due to overfishing (Pruter, 1976; Megrey and Wespestad, 1990).

In addition to gross changes in long-term overall abundance, fisheries may affect sea lion food availability by changing small scale distribution, abundance, and behavior of prey. Intensive pulse fisheries clearly reduce the density of fish in specific areas. The activities of boats and gear may cause changes in the behavior and characteristics of prey aggregations. Subtle ecosystem changes may accompany large human-induced removals of major species.

631. <u>Determine effects of fisheries on sea lion prey</u>

Traditional fishery assessments usually attempt to gather broad scale information on stock abundance. Data are gathered at the times and areas when sampling can be conducted most efficiently. Results of such assessments may be used to track overall changes in stock sizes, but they are of limited value for assessing changes in prey availability in sea lion feeding areas. Data that have been and are being collected using hydroacoustics may be very useful for identifying localized concentrations of fish that can serve as sea lion prey.

The influence of fisheries on prey in the actual areas used by sea lions for feeding can be addressed in two ways. Detailed assessments of short- and long-term effects can be conducted in feeding areas before, during, and after fishing activities occur (feeding areas will be identified by studies described in Section 613). Alternatively, comparisons can be made of prey stock characteristics in similar areas that are and are not fished (see Section 621). Some of the data required for these comparisons may be collected in studies described in Section 6141. However, additional sampling (e.g., time series that span the course of fishing activity) will be necessary to assess changes in prey stocks that may be specifically attributable to fishery removals. Special attention should be given to the depth distribution of the species and size classes of prey needed by sensitive age/sex classes of sea lions (e.g., juveniles).

632. Model effects of fishing on prey composition, distribution, abundance, and behavior

Models may prove useful for evaluating the possible effects of fishing on prey availability. Current models used for stock assessment should be applied to specific areas to look at how removals affect abundance of various age classes of prey. Data from field studies will be needed for the development and testing of models that describe effects on prey distribution, abundance, and behavior. Models should be designed so that they can be used to predict how various levels and types of fishing may influence availability of prey for sea lions.

64. Ensure adequate food availability in feeding areas

For the Steller sea lion population to grow (i.e., recover), measures must be taken to ensure that food availability is not limiting. Fish stocks must be assessed and monitored on a local basis along with certain parameters of the sea lion population. Where prey abundance is low, or where the sea lions show signs of nutritional stress, prey availability must be increased, if possible. The types of prey available and the energetic cost of obtaining the prey should be acceptable in all critical feeding areas. If a fishery is having detrimental effects on prey availability, either through removals of target species or bycatch, additional regulation of the fishery may be necessary. Coordination among agencies and organizations involved in development of necessary regulations should be provided by the Steller sea lion Recovery Plan Coordinator (Section 71).

641. Regulate fishing areas, seasons, and types of operations

In some instances, it may be possible to reduce competition between commercial fisheries and sea lions by changing fishing areas, seasons, time of day, and types of operations. Studies should be initiated on the amount and species of fish, including bycatch, taken by fisheries under various conditions. These results should be compared to studies of sea lion feeding ecology (Sections 611, 612, and 613) to determine the extent of overlap, especially for any age/sex classes that are likely to be food limited (e.g., weaned pups or lactating females). Where alterations in operations can reduce competition, appropriate changes should be initiated and the sea lions monitored for responses (see Section 621).

642. Regulate fishery catches

Development of fishery management policies and plans must take into account the types and amounts of food needed to support a recovering sea lion population. The mechanism by which sea lion food requirements are accounted for in the calculation of acceptable commercial harvest levels should be explicitly described. Where appropriate, a specific portion of the acceptable biological catch should be set aside for sea lion consumption. Alternatively, natural mortality estimates used in models should be modified to ensure that predator consumption is adequately provided for. If there are signs that prey availability is being reduced by a fishery such that it is a limiting factor in the recovery of the sea lion population, then restrictions should be placed upon the commercial fisheries' allowable catches to the extent necessary to ensure adequate prey. Quotas for catches should be set on a regional and seasonal basis for each stock of each prey species identified as important (Section 614). If certain age/sex classes of sea lions are found to be especially food limited, then special efforts should be made to regulate total allowable catches in their feeding areas.

In addition to regulatory needs described above, it may be desirable to manipulate fisheries as part of experiments to determine the influence of food supply on sea lion growth and productivity. Studies of this type are discussed in Section 621.

7. Implement Recovery Plan and coordinate recovery activities

The principal responsibility for implementation of the Steller Sea Lion Recovery Plan lies with the NMFS Office of Protected Resources. Recovery actions will need to be coordinated with the NMFS regional offices and other involved resource management agencies and user groups. The Steller Sea Lion Recovery Team should be used to evaluate the ongoing recovery program, and to recommend changes including updates to the recovery plan. International coordination may also be necessary in order to implement an effective recovery program. Education and enforcement are critical components of the overall recovery effort.

71. Establish a Steller sea lion Recovery Plan Coordinator staff position

NMFS should hire a full-time person to coordinate recovery efforts for Steller sea lions. Duties of the Steller sea lion Recovery Plan Coordinator should include:

a. Coordinate all aspects of NMFS sea lion recovery efforts, such as evaluation and development of regulations, designation of critical habitat, and Section 7 consultations;

b. Provide liaison with regional Fishery Management Councils, state fishery managers, FWS wildlife refuge managers, enforcement agencies, researchers, and other interested parties;

c. Publish annual activity reports and work plans;

d. Facilitate and coordinate research activities, including development of scopes of work for contracts;

e. Coordinate data management and assist with data analysis and distribution.

72. Maintain the Steller Sea Lion Recovery Team

NMFS should continue to fund the costs for operation of the Steller Sea Lion Recovery Team. The Team should conduct an annual review of information from research and monitoring programs and recommend changes in research programs and management strategies, where necessary. The annual review should be completed in time to make recommendations for research and management for the following year. The Steller Sea Lion Recovery Plan Coordinator and other management agency representatives should attend Team meetings to provide coordination and agency input. The Team should revise and update the recovery plan at appropriate intervals.

73. Monitor Section 7 ESA requests for consultation

Existing personnel in NMFS who deal with ESA Section 7 requests should also deal with consultations relative to Steller sea lions. This should be done in collaboration with the Steller sea lion Recovery Plan Coordinator.

74. Develop mechanisms for international conservation efforts

The United States, Canada, and Russia have a particular interest in conservation of Steller sea lions since virtually all rookeries occur within their territorial seas. Because sea lions move freely across the boundaries separating these nations, conservation efforts put in place by each nation should be closely coordinated. Conservation measures may be of some significance to other nations (e.g., Japan, Taiwan, Poland, Peoples Republic of China, and North and South Korea) that conduct commercial fisheries or other activities in areas where sea lions occur. Those nations should be made aware of measures that are in place, and the need to ensure that their citizens act accordingly. Where appropriate (e.g., during range-wide surveys), close coordination of research activities is also desirable.

741. Distribute Recovery Plan to other involved nations

Copies of the approved Steller Sea Lion Recovery Plan, and other information such as implementation plans, should be sent to appropriate agencies and organizations in the Soviet Union, Canada, Japan, Taiwan, Poland, Peoples Republic of China, and North and South Korea.

742. Develop bilateral or multilateral conservation agreements

NMFS should work with the Department of State to develop and implement agreements with Russia and Canada to coordinate conservation efforts for Steller sea lions. Joint research programs to look at interchange of animals between areas, and for comparison of biological characteristics and population parameters among regions are needed. Some of the management issues that should be considered include adequacy of protective regulations, and mechanisms for allocating allowable take of sea lions between jurisdictions.

75. Conduct information and educational programs

Many of the regulations that are put into place to protect Steller sea lions will apply to all members of the public. Public affairs personnel in responsible agencies should plan and implement well-rounded public awareness programs that describe the status of sea lions and the protective regulations that are in place. The public should be made aware that they can aid in the recovery effort by reporting violations of regulations, injured or stranded animals, and other relevant information. Types of coverage that might be effective include news releases, mail-outs, signs, public service announcements, interpretive programs, films, and environmental education lesson plans featuring sea lions.

Since fishermen in many areas may interact with Steller sea lions on a regular basis, it is particularly important that they be made aware of and kept informed about sea lion conservation efforts. Information can be distributed as part of ongoing regulatory programs (e.g., in logbooks and regulation books), as well as through media directed specifically at the fishing industry (e.g., trade magazines). Mail-outs to permit holders and signs posted in boat harbors may also be effective. Materials and trained personnel should be made available to assist industry in developing its own additional educational programs. Fishermen and their representatives should be encouraged to become involved in the development, evaluation, and implementation of sea lion conservation measures.

76. Enforce regulations

Regulations that are currently in place and that may be developed have a great potential for assisting in the recovery of the Steller sea lion population. The prohibition on shooting at or near sea lions, if enforced, could greatly reduce the number of animals lost to the population each year due to human-related factors. Elimination of this unnecessary and avoidable source of mortality should be given very high priority.

Members of the Recovery Team did not have the expertise to consider the mechanisms and costs of enforcement programs in detail. Although enforcement of wildlife regulations in vast regions, such as the waters off Alaska, is a very difficult task, existing personnel and programs could, if properly directed, provide significant benefits for sea lions. It is clear that enforcement of sea lion regulations and conservation measures would benefit greatly by increased cooperation and coordination among various agencies, including NMFS, the State of Alaska Fish and Wildlife Protection, and the USCG. In order to emphasize the importance of this item, the Recovery Team is specifically recommending that funds be provided for a person to coordinate Steller sea lion enforcement efforts.

761. Develop and improve systems for reporting violations

In addition to its role in directly protecting animals, enforcement of regulations is important as an educational tool. For example, if sea lions can be shot or harassed with impunity, an educational program is not likely to reach the offenders who are the major source of shooting mortality. Successful enforcement of regulations is greatly dependent on information derived from the public. A toll-free telephone number for reporting violations is useful, as is a guarantee of anonymity to informants if they so desire. A reward system for information leading to successful prosecution of offenders has been used by the State of Alaska for fish and wildlife violations and has been quite successful (project Safeguard). All field personnel associated with Federal, state, and local resource management and enforcement agencies should be made aware of regulations and procedures for reporting violations. Trained observers should be placed in areas where people are most likely to interact with sea lions.

762. Provide adequate and effective field enforcement programs

Effective enforcement of regulations requires extensive field work and is expensive. In areas where fisheries are thought to pose significant problems, field camps ashore might be the most effective enforcement technique. Such camps would have to be within sight and sound of fishing operations, and equipped with the means to get to offenders rapidly. There is a history of harassment and deliberate shooting in certain fisheries that take place near important sea lion haulouts.

Control of human activity within prohibited areas around breeding grounds and haulouts is necessary and will take extensive patrol work. Care must be taken that the patrols themselves are not disruptive to sea lion breeding and feeding patterns. Careful coordination of enforcement efforts between Federal, state, and local authorities is necessary, as are educational programs within the agencies to overcome differences in approach and, in some areas, the lack of understanding of the seriousness of the sea lion population decline. Enforcement agents of all the agencies involved with the fisheries should be knowledgeable enough about the population status and the laws protecting sea lions to be able to work with and advise the industry, and to recognize and report violations.

When information is gathered that is likely to result in successful prosecution and conviction of violators, such cases should be given high priority by NMFS enforcement. It is essential that violators are prosecuted in a timely fashion so that the seriousness of regulations and the effectiveness of enforcement are made evident.

G. Implementation Schedule

As recovery plans are developed for each species, specific recovery tasks are identified and prioritized. As new information warrants, these plans, including tasks and priorities, will be reviewed and revised. In addition, funding and implementation of the tasks identified in recovery plans will be tracked in order to aid in effective management of specific recovery programs. NMFS believes that periodic review and updating of plans and tracking of recovery efforts are important elements of a successful recovery program. Information from tracking and implementing recovery actions and other sources will be used to review plans and revise them as necessary.

Recovery tasks within the Steller Sea Lion Recovery Plan are prioritized 1-3. The Recovery Team has deemed that a Priority 1 ranking is given to the highest priority tasks within this plan, and is given to those actions necessary to monitor the decline of, or to prevent the Steller sea lion, a species facing a high and continued magnitude of threat, from further declining. Within this recovery plan, Priority 1 tasks are characterized as being either administrative (A), management (M) or research (R).

STELLER SEA LION IMPLEMENTATION SCHEDULE

Plan Task	Task #	Priority	Task Duration	Resp. Agency	Est. Fiscal Year Costs (thousands of $) FY 1	FY 2	FY 3	FY 4	FY 5	Comments
Map rookeries and haulouts	111	3	2 yrs	NMFS	20	20				
Map and describe feeding areas	112	2	2 yrs	NMFS						done with 111
Determine seasonal use patterns	12	2	3 yrs	NMFS		30	10	10		
Document effects of human disturbance	13	2	continuing	NMFS	10	10	10	10		
Prepare guidelines and regulations	14	1A	continuing	NMFS						included w/ 13 and 71
Identify and designate critical habitat	15	1A	continuing	NMFS						included w/ 11 and 71
Tag and brand pups	211	2	3 yrs	NMFS						included w/ 443
				ADFG						
				ODFW						
Monitor for marked animals	212	2	continuing	NMFS						included w/ 322,33,
				ADFG						342 and 44
				ODFW						
				PRBO						
				UCSC						
				DFO						
				VNIRO						
				FWS/NWR						
Determine stock identity	22	2	4 yrs	NMFS	80	50	50	50		
Compile/analyze data for section 2	23	2	continuing	NMFS	10	10	10	10	10	
Develop survey procedures	31	1R	5 yrs	NMFS	50	75	75	75	75	
Survey adults and juveniles in AK	321	1M	every year	NMFS	85	85	85		85	FY 4 included w/ 341
				ADFG						
Count pups in AK	322	1M	every year	NMFS	150	150	150		150	FY 4 included w/ 342
				ADFG						
Survey pups and non-pups in CA and OR	33	1M	every 2 yrs	NMFS	25		25		25	FY 4 included w/ 341,
				ODFW						342
Conduct range-wide survey of adults/juveniles	341	1M	every 5 yrs	NMFS				150		
				ADFG						
				ODFW						
				DFO						
				VNIRO						
Conduct range-wide pup counts	342	1M	every 5 yrs	NMFS				250		
				ADFG						
				ODFW						
				DFO						
				VNIRO						
Examine and sample dead animals	41	2	continuing	NMFS	15	15	15	15	15	
Collect and sample animals	42	2	1 yr							no cost estimate
Develop capture techniques	431	2	continuing	NMFS	5	5	5	5	5	
Develop condition indices	432	2	continuing	NMFS						included w/ 445
Determine sex/age of animals on rookeries	441	2	5 yrs	NMFS	100	100	100	100	100	
Determine pup production and mortality	442	2	5 yrs	NMFS						included w/ 441
Tag and brand pups and females	443	2	continuing	NMFS			40	40	40	
Monitor tagged animals	444	2	continuing	NMFS						included w/ 441
Obtain samples using non-lethal techniques	445	2	5 yrs	NMFS	50	50	50	50	50	
Compile a catalog of samples	45	2	continuing	NMFS	20	5	5	5	5	
Analyze samples	46	2	continuing	NMFS	200	50	50	50	50	
Compile and analyze data for section 4	47	2	continuing	NMFS	10	10	10	10	10	
Implement/expand stranding networks	511	3	continuing	NMFS	20	20	20	20	20	
Survey areas for dead animals	512	2	continuing	NMFS	30	30	30	30	30	
Monitor incidental take	513	1M	continuing	NMFS						included w/ ongoing
										programs
Investigate entanglement in debris	514	3	continuing	NMFS						included w/ 322,332,
										44
Determine and monitor subistence take	515	1M	continuing	NMFS	75	50	50	50	50	
				ADFG						

IMPLEMENTATION SCHEDULE Page 2					Est. Fiscal Year Costs					
	Task		Task	Resp.	(thousands of $)					
Plan Task	#	Priority	Duration	Agency	FY 1	FY 2	FY 3	FY 4	FY 5	Comments
Evaluate other deliberate killing	516	1A	continuing	NMFS						included w/ 76
Evaluate mortality by non-human predators	517	3	continuing	NMFS						included w/ 322,332,
										44, and 511
Reduce incidental take	521	1A	continuing	NMFS	15	15	15	15	15	
Develop non-harmful deterrents	522	3	continuing	NMFS	15	15	15	15	15	
Minimize marine debris	523	3	continuing	NMFS						included w/ ongoing
										programs
Reduce loss rate in subsistence harvests	524	2	3 yrs	NMFS						included w/ 515, 751
				ADFG						
Recommend maximum allowable take	53	1A	continuing	NMFS						included w/ 71
Collect and analyze stomach contents	6111	2	continuing	NMFS	10	10	10	10	10	
Collect and analyze scats	6112	2	continuing	NMFS	10	10	10	10	10	
Determine food requirements	612	1R	2 yrs	NMFS	200	100				
Determine feeding areas and strategies	613	1R	4 yrs	NMFS	250	250	250	250		
Characterize prey availability	6141	2	2 yrs	NMFS		200	200			
Determine caloric value of prey	6142	2	1 yr	NMFS		60				
Compile and analyze data for section 6	615	2	continuing	NMFS	20	10	10	10	10	
Measure growth and productivity	621	2	3 yrs	NMFS		1000	1000	1000		
Develop models for energetics	622	2	3 yrs	NMFS		20	20	20		
Measure effects of fisheries on prey	631	2	3 yrs	NMFS		150	150	150		
Model effects of fishing on prey	632	2	3 yrs	NMFS	20	20	20			
Regulate fishing areas/seasons/operations	641	1A	continuing	NMFS						included w/ 71,
				NPFMC						ongoing programs
				ABF						
Regulate fishery catches	642	1A	continuing	NMFS						included w/ 71,
				NPFMC						ongoing programs
				ABF						
Establish sea lion recovery coordinator	71	1A	continuing	NMFS	100	100	100	100	100	
Maintain sea lion recovery team	72	2	continuing	NMFS	25	25	25	25	25	
Monitor Section 7 ESA consultations	73	1A	continuing	NMFS						included w/
										ongoing programs
Distribute recovery plan to other nations	741	3	continuing	NMFS						no significant cost
Develop international agreements	742	2	continuing	NMFS						included w/ 71,
				DOS						other programs
Conduct information/education programs	75	1A	continuing	NMFS	150	150	150	150	150	
				ADFG						
				CDFG						
				ODFW						
				DFO						
				PSMFC						
Develop systems for reporting violations	761	2	continuing	NMFS						included w/ 762
Provide field enforcement programs	762	2	continuing	NMFS	125	125	125	125	125	
				USCG						

2. APPENDICES

APPENDIX A. List of rookeries and haulouts to be counted annually and used in analysis of Steller sea lion population trend (see Sections II.B and E.321) (from Merrick et al., 1991).

Trend Count Site	Rookery	Haulout
Central Gulf of Alaska		
S. Ushagat I.		X
N. Ugashat I.		X
Ugashat I.-rocks to south		X
Sugarloaf I.	X	
Latax Rocks		X
Sea Lion Rocks		X
Long I.		X
Marmot I.	X	
Kodiak I.-Cape Chiniak		X
Kodiak I.-Cape Barnabas		X
Two-headed I.		X
Sitkinak I.-Cape Sitkinak		X
Chirikof I.	X	
Chowiet I.	X	
Ugaiushak I.		X
Sutwik I.		X
Western Gulf of Alaska		
Spitz I.		X
Bird I.		X
Clubbing Rocks	X	
Pinnacle Rock	X	
Sea Lion Rocks		X
Nagai I.		X
Chernabura I.	X	
Atkins I.	X	
Castle Rock		X

APPENDIX A (Cont.). List of rookeries and haulouts to be counted annually and used in analysis of Steller sea lion population trend (see Sections III.B and E.321) (from Merrick et al., 1991).

Trend Count Site	Rookery	Haulout
Eastern Aleutian Islands		
Amak I.		X
Sea Lion Rocks	X	
Amak I.-offshore rocks		X
Ugamak I.	X	
Round I.		X
Akutan I.-Cape Morgan	X	
Akutan I.-Reef Point		X
Akun I.	X	
Bogoslof I.	X	
Umnak I.		X
Adugak I	X	
Vsevidof I.		X
Ogchul I.	X	
Central Aleutian Islands		
Chuginadak I.		X
HerbertI.		X
Carlisle I.		X
Kagamil I.		X
Yunaska I.	X	
Chagulak I.		X
Amutka I.		X
Seguam I.-Saddleridge	X	
Seguam I.-Other		X
Agligadak I.		X
TanadakI.		X
SagigikI.		X
Amlia I.-East Cape		X
Amlia I.-West Cape		X
Atka I.-Cape Korovin		X
Atka I.-North Cape		X
Salt I.		X
Kasatochi I.	X	
Ikiginak I.		X

APPENDIX A (Cont.). List of rookeries and haulouts to be counted annually and used in analysis of Steller sea lion population trend (see Sections III.B and E.321) (from Merrick et al., 1991).

Trend Count Site	Rookery	Haulout
<u>Central Aleutian Islands (cont.)</u>		
Anagaksik I.		X
Little Tanaga I.-SE Point		X
Little Tanaga I.-Straits		X
Adak I.-Cape Moffet		X
Adak I.-Argonne Point		X
Adak-Lake Point	X	
Gramp Rock	X	
Ulak I.	X	
Amatignak		X
Dinkum Rocks		X
Unalga I.		X
Kavalga I.		X
Skagul I.		X
Tag I.	X	
Ugidak I.		X
Amchitka I.-Ivakin Point		X
Amchitka I.-East Cape		X
Ayugadak I.	X	
Kiska I.-Cape St. Stephens	X	
Kiska I.-Lief Cove	X	

Appendix B: List of selected rookeries and schedule for conduct of Steller sea lion pup counts (see Sections E.322, 33, and 342). Sites to be included for monitoring trend in pup production in the Kenai-Kiska region are indicated by an asterisk.

Rookery	1991	1992	1993	1994	1995
California					
all rookeries		X		X	
Oregon					
all rookeries		X		X	
British Columbia					
all rookeries		X		X	
Southeast Alaska					
all rookeries	X		X		X
Eastern Gulf of Alaska					
Seal Rocks		X		X	
Central Gulf of Alaska					
Outer Island*	X		X		X
Marmot Island*	X		X		X
Chirikof Island*	X		X		X
Sugarloaf Island*		X		X	
Chowiet Island*		X		X	
Western Gulf of Alaska					
Atkins Island*	X		X		X
Pinnacle Rock*	X		X		X
Chernabura Island*		X		X	
Clubbing Rocks*		X		X	
Eastern Aleutian Islands					
Akun Island*	X		X		X
Bogoslof Island*	X		X		X
Ugamak Island*		X		X	
Akutan Island*		X		X	

Appendix B (cont): List of selected rookeries and schedule for conduct of Steller sea lion pup counts (see Sections E.322, 33, and 342. Sites to be included for monitoring trend in pup production in the Kenai-Kiska region are indicated by an asterisk.

Rookery	1991	1992	1993	1994	1995
Central Aleutian Islands					
Yunaska Island				X	
Seguam Island				X	
Ulak Island				X	
Kiska Island				X	
Western Aleutian Islands					
Buldir Islands				X	
Agattu Island				X	
Bering Sea					
Walrus Island				X	
Russia					
all rookeries				X	

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