Steller Sea Lion (*Eumetopias jubatus*)

Steller sea lions are found along the rim of the North Pacific Ocean from the Channel Islands in southern California to Hokkaido, Japan, and north into the Bering Sea and Sea of Okhotsk. Their center of abundance has been in the Aleutian Islands and Gulf of Alaska where historically nearly three-fourths of all Steller sea lions inhabiting U.S. territory were found. Steller sea lions haul out on land to mate, bear their young, nurse, avoid predators, and rest (Fig. 25). The location of rookeries is probably based on proximity to food sources, protection from terrestrial and marine predators, topography, surf conditions, and other factors. Steller sea lions are generally considered nonmigratory although some individuals, particularly juveniles and adult males, may disperse widely outside the summer breeding season. Most adult

Figure 25. Steller sea lion rookery. (Photo courtesy of the National Marine Fisheries Service.)

Table 5. Counts of adult and juvenile (nonpup) Steller sea lions at U.S. rookery and haul-out trend sites[1] by region[2], 1975–2002

	Gulf of Alaska			Aleutian Islands			Western Stock in Alaska	Southeast Alaska
Year	Eastern	Central	Western	Eastern	Central	Western		
1975	—	—	—	19,769	—	—	—	—
1976	7,053	24,678	8,311	19,743	—	—	—	—
1977	—	—	—	19,195	—	—	—	—
1979	—	—	—	—	36,632	14,011	—	6,376
1982	—	—	—	—	—	—	—	6,898
1985	—	19,002	6,275	7,505	23,042	—	—	—
1989	7,241	8,552	3,800	3,032	7,572	—	—	8,471
1990	5,444	7,050	3,915	3,801	7,988	2,327	30,525	7,629
1991	4,596	6,270	3,732	4,228	7,496	3,083	29,405	8,621
1992	3,738	5,739	3,716	4,839	6,398	2,869	27,299	7,555
1994	3,365	4,516	3,981	4,419	5,820	2,035	24,136	9,001
1996	2,132	3,913	3,739	4,716	5,524	2,187	22,211	8,231
1997	—	3,352	3,633	—	—	—	—	—
1998	2,110	3,467	3,360	3,841	5,749	1,911	20,438	8,693
1999	1,952	—	—	—	—	—	—	—
2000	1,975	3,180	2,840	3,840	5,419	1,071	18,325	9,862
2002	2,500	3,366	3,221	3,953	5,480	871	19,391	9,951

[1] "Trend" sites are selected sites that are counted regularly to provide an index of trends in population abundance.
[2] Sources are NMFS (unpublished data and a 20 September 2002 memorandum to the record from J. Sease regarding Steller sea lion survey results, June and July 2002) and Sease, J. L., and T. R. Loughlin, 1999, Aerial and land-based surveys of Steller sea lions (*Eumetopias jubatus*) in Alaska, June and July 1997 and 1998; U.S. Department of Commerce, National Oceanographic and Atmospheric Administration Technical Memorandum NMFS-AFSC-100.

sea lions return to their birth site for reproduction. The various rookeries are therefore considered a "metapopulation" (i.e., a population consisting of smaller populations) with limited exchange between sites.

Trends in Abundance

In the 1950s worldwide abundance of Steller sea lions was estimated at 240,000 to 300,000 animals. Since then, abundance has declined severely throughout the central and western part of the species' range (Table 5). The western population has declined by about 85 percent since the mid- to late 1970s, and at some sites sea lions have nearly disappeared. The decline was first noted in the eastern Aleutian Islands, but then spread westward and eastward to include all areas west of 144ºW longitude (i.e., Cape Suckling, approximately 100 km east of Prince William Sound, Alaska). The rate of decline appears to have been most severe in the late 1980s when the number of sea lions in the central and western Gulf of Alaska and eastern and central Aleutian Islands dropped precipitously. Counts have generally continued to decline since then.

Over the last decade, counts in the central and eastern Gulf of Alaska declined at an average of about 8 to 10 percent annually. In the far-western region of the Aleutian Islands, only 871 adults and juveniles were counted in 2002, compared with 2,869 in 1992, indicating a decrease of 70 percent in a single decade. The large decrease in the count for the western Aleutian region and the continuing decline of the total western population (overall, about 4 percent annually) heighten concern for the status of this population and underscore its vulnerability. For the U.S. western population, counts of animals older than pups were generally higher

in 2002 than in 2000 (5.5 percent at trend sites), but pup counts continued to decline. Additional counts are needed to determine if the decline is continuing.

Counts of Steller sea lions in Russia reveal a similar decline over the past three decades. Counts in Russian territory have been infrequent and limited, but recent data suggest that abundance at rookeries in the Sea of Okhotsk and some regions of the Kuril Islands may be stable or increasing slightly, but counts at rookeries on the Kamchatka Peninsula are still depressed and some rookeries have been abandoned altogether.

In contrast to the observed trends of the western population, combined counts from the eastern population (along the western coast of North America east and south of Prince William Sound) have increased at about 1–3 percent annually over the last three decades. The observed population growth in this region reflects recovery from periods of intentional sea lion killing in the early to mid-1900s.

Status under the Endangered Species Act

The National Marine Fisheries Service has lead responsibility for management of Steller sea lions. Its research and management partners include the Alaska Department of Fish and Game, North Pacific Fishery Management Council, University of Alaska, Alaska SeaLife Center, North Pacific Universities Marine Mammal Research Consortium, Alaska Sea Otter and Steller Sea Lion Commission, the tribal governments of the Pribilof Islands, and a number of other nongovernmental entities including environmental organizations.

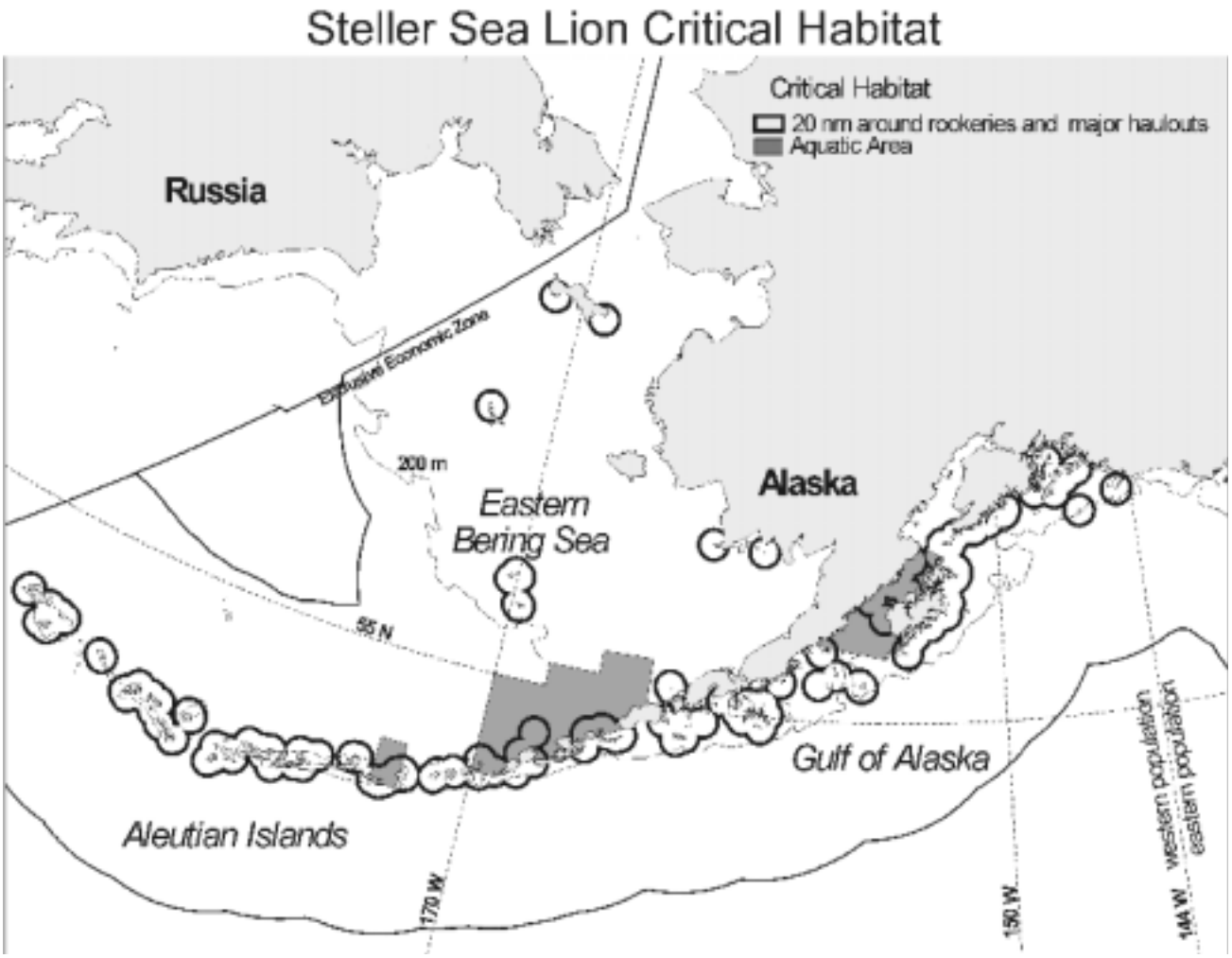

Figure 26. Steller sea lion critical habitat.

In 1990 the Service designated the Steller sea lion as threatened under the Endangered Species Act. At the recommendation of the Marine Mammal Commission and others, the Service established the Steller Sea Lion Recovery Team in 1990 and adopted the Steller Sea Lion Recovery Plan in 1992 to help guide recovery efforts. The designation in 1990 treated the species as a single population. In 1993 critical habitat was designated as (1) all waters within 20 nmi (37 km) of rookeries and major haul-out sites west of 144ºW longitude; (2) three special foraging areas in Shelikof Strait, the southeastern Bering Sea, and Seguam Pass in the central Aleutian Island chain; and (3) waters and lands within 0.9 km (3,000 feet) of rookeries and major haul-out sites east of 144ºW longitude (Fig. 26).

Subsequent research indicated that the species consists of at least two populations distinguishable on the basis of geography, demography, and genetic composition. On 5 May 1997 the Service therefore published final rules designating the population west of 144ºW longitude (Fig. 26) as endangered while maintaining the threatened status for the population east of that line. The Steller Sea Lion Recovery Team and the Marine Mammal Commission supported those revisions. The Service concluded that it was not necessary to modify designated critical habitat for Steller sea lions, but noted that it was reassessing the effectiveness of existing protective measures with a view toward improving them.

Causes of the Decline

The causes of the decline of the western population of Steller sea lions have been a matter of extensive debate and controversy. Available baseline information on the population prior to the mid-1970s is sparse. As noted in a recent National Research Council report (see below), "...the cause, or causes, of the early phase of the sea lion decline will likely remain a source of speculation and debate." Existing information does not indicate that disease, pollution, and entanglement in marine debris have been significant contributors to the decline. Some recent evidence suggests that sea lions in Alaska have relatively large contaminant levels, but the evidence is not consistent with the geographic pattern of the decline. Known contributing factors include commercial harvests of sea lions from the late 1950s to the early 1970s, subsistence harvests by Alaska Natives, other legal and illegal killing (which has not been and probably cannot be quantified), killer whale predation, and incidental catch in the trawl fisheries in the Bering Sea and the Gulf of Alaska and other fisheries. Suspected contributors to the decline include natural environmental changes and competition with commercial fisheries.

Existing data and analyses indicate that the decline of the western population has resulted from poor growth and survival of juveniles and low reproductive success. The evidence for poor juvenile growth and survival is based on field observations and population modeling. The evidence for low reproductive success is based on observations of low pregnancy and birth rates, slow growth (leading to older age at maturity), and changes observed in the age structure of the population. These data are all consistent with the hypothesis that nutritional stress has been an important part of the cause of the decline.

In the late 1990s debate regarding the causes of the nutritional stress focused on the relative importance of fisheries versus natural environmental changes as they may affect the quality and quantity of prey available to sea lions. Scientists recognized the potential for competition between fisheries and Steller sea lions in the late 1970s and early 1980s when fishery management plans were being developed. In the last three years Congress has appropriated more than $100 million to investigate the decline of Steller sea lions. Results of that largely increased research effort have yet to bear light on the debate. An alternative hypothesis has been that the sea lion decline was due to a shift in environmental conditions that led to a change in available prey to species that are of less nutritional value to sea lions. Distinguishing between these two possibilities has been difficult because both may have similar effects on sea lions and because the existing fishery management strategy allows fishing throughout the regions of concern and does not provide suitable control regions for comparing environmental versus fishery-related effects.

Recently killer whale predation also has been suggested as an explanation for the decline of sea lions, or at least their failure to recover. One "cascade" hypothesis posits that the killing of large numbers of large cetaceans in Alaskan waters from the 1950s to the 1970s reduced prey for transient (mammal-eating) killer whales. The killer whales

then shifted their foraging patterns by increasing predation on Steller sea lions and other smaller marine mammals. As sea lion numbers declined, the killer whales increased predation on sea otters, thereby causing their abundance to decline. Another hypothesis is that killer whales are impeding recovery of Steller sea lions irrespective of any cascade effects initiated by whaling. Although this is a plausible hypothesis and there is no doubt that some killer whales prey on sea lions, there is little direct evidence that the rate or amount of predation has been a significant factor in the sea lion decline in the Bering Sea/Aleutian Islands region or the Gulf of Alaska. Recent surveys indicate that there are few transient killer whales in the waters around the Aleutian Islands, particularly when compared with the number of transient killer whales in Southeast Alaska where sea lion numbers are growing. As noted in the earlier section on killer whales, research on killer whales is being expanded and will require continued support to determine the role and status of killer whales in North Pacific marine ecosystems.

Multiple factors have contributed to the sea lion decline, with the importance of different factors changing over time (e.g., commercial harvesting, incidental mortality in fishing gear). Much of the debate regarding "the cause" has pitted one factor against another, but the causes are most likely not mutually exclusive. For example, if Steller sea lions are nutritionally stressed, they may spend more time foraging at sea, thereby increasing their vulnerability to predators such as killer whales. If natural oceanographic changes have reduced the quantity and quality of prey available to sea lions, then they may be more vulnerable to competition with fisheries. Thus, focusing on a single cause belies the complex interactions leading to the decline of the western population of Steller sea lions. In 2002 two review panels were convened to consider potential causes of the sea lion decline. Their reports are summarized at the end of this section.

Steller Sea Lion Subsistence Harvests and Co-Management

For centuries Alaska Natives have hunted Steller sea lions for subsistence. Little is known about historic harvest levels. From 1992 to 2001 the National Marine Fisheries Service contracted with the Alaska Department of Fish and Game to conduct a statewide assessment of annual subsistence harvests of Steller sea lions and harbor seals. The assessment was based on household surveys in 60 coastal villages where sea lions or harbor seals were taken for subsistence purposes. In 2002 funding was provided to the Alaska Native Harbor Seal Commission to conduct this assessment. The harbor seal commission will continue to use household surveys as its basic harvest monitoring tool but is initiating some changes to increase confidence in the accuracy of the surveys.

Virtually all sea lions taken in the subsistence harvest are from the western population. The majority are taken around the Pribilof Islands in the Bering Sea. Harvesting also occurs near Akutan and Kodiak Islands and in Prince William Sound. The estimated number of Steller sea lions harvested in Alaska in recent years declined from 549 in 1992 to 178 in 1998, 164 in 2000, and 198 in 2001 (Table 6). A survey was not conducted in 1999 and the survey estimate for 2002 is not yet available.

In July 2000 and June 2001 the National Marine Fisheries Service signed co-management agreements with the tribal governments of St. Paul and St. George Islands (the only inhabited islands in the Prbilofs). The agreements cover both Steller sea lions and northern fur seals and establish two six-member co-management councils (one for each island) composed of three representatives from the Service and three from the tribal authority. The councils develop annual management plans for the subsistence harvests, identify monitoring and re-

Table 6. Estimates of Steller sea lions harvested and struck and lost in the annual subsistence harvest by Alaska Natives, 1992–2001

Year	Harvested	Struck and Lost	Total
1992	370	179	549
1993	348	139	487
1994	336	80	416
1995	307	32	339
1996	152	34	186
1997	146	18	164
1998	131	47	178
1999	—	—	—
2000	142	22	164
2001	156	42	198

Source: Alaska Department of Fish and Game.

search needs, and provide for local decisionmaking on the harvests, including which rookery or rookeries to harvest, the numbers to be taken, and the timing of the harvests. Under the agreements, tribal ecosystem officers oversee the harvests to ensure that they are humane and nonwasteful. Measures are being taken to reduce the number of animals struck and lost, fully utilize harvested animals, accurately monitor hunting effort, and obtain biological samples in support of research efforts. Finally, the agreements provide for gradual transfer of some National Marine Fisheries Service activities related to monitoring and management of fur seal and sea lion rookeries and haul-out areas; removal of marine debris from the rookery/haul-out areas and, when possible, disentangling animals caught in debris; management of tourist and other public interactions; and providing mentors and employment opportunities for local youth and adults regarding natural resource research and management.

From 2000 to 2002 representatives of the National Marine Fisheries Service met intermittently with the Alaska Sea Otter and Steller Sea Lion Commission, the Aleutians East Borough, and the Alaska Department of Fish and Game, Subsistence Division, to consider real-time harvest monitoring at sites where most harvesting occurs. Such an approach integrates annual community-based monitoring of these primary sites with information from biennial statewide surveys. The goal is increase the accuracy of estimated harvest levels, particularly for the Steller sea lion. The Alaska Sea Otter and Steller Sea Lion Commission and the Aleutians East Borough would participate by coordinating the community-based harvest monitoring in much the same manner as the tribal governments in the Pribilof Islands are monitoring harvests at those islands.

The Alaska Sea Otter and Steller Sea Lion Commission is also preparing a draft co-management agreement to present to the National Marine Fisheries Service during the first half of 2003. The draft agreement will call for an expansion of the role of the Commission and recognition of the tribal government as an equal partner with respect to subsistence harvesting as well as other management issues for Steller sea lions.

Fisheries Management and the Debate Regarding Fishery Effects

The Alaska groundfish fisheries are managed under fishery management plans required by the Magnuson-Stevens Fishery Conservation and Management Act. The plans are developed by the North Pacific Fishery Management Council and the National Marine Fisheries Service. Because they establish the conditions under which the fisheries are conducted, the plans ultimately determine the nature and extent of fishery effects that may occur on the associated marine ecosystems, including listed species and critical habitat. The Service and the Council are required to assess the potential environmental effects of the fisheries in accordance with the National Environmental Policy Act and the Endangered Species Act.

Fisheries managers have been aware of the potential for competition between Steller sea lions and the Alaska groundfish fisheries since the development of the fishery management plans in the late 1970s and early 1980s. Between 1990 (when the species was first listed under the Endangered Species Act) and 1998 the Service took a number of actions and established a number of regulations to reduce possible effects of commercial fisheries on Steller sea lions. Those measures are too detailed to list here, but they generally have aimed to provide protection from competition in areas around rookeries and haul-out sites and to spatially and temporally disperse the fisheries to avoid the potential for localized depletion of prey.

At the same time, questions were raised regarding the suitability and sufficiency of those actions to protect these ecosystems in general and Steller sea lions in particular. From 1998 to the end of 2002 debate over the adequacy of fishery measures intensified further and involved a range of actions by the Service and the Council, section 7 consultations under the Endangered Species Act, supplemental environmental impact statements under the National Environmental Policy Act, lawsuits, and external reviews by outside scientists. The chronology of these events from 1998 to the end of 2001 is described in the Commission's 2001 annual report.

On 8 January 2002 the National Marine Fisheries Service published in the *Federal Register* an

emergency interim rule implementing measures pertaining to the effects of Alaska groundfish fisheries on the western population of Steller sea lions. The measures had been developed by a committee convened by the North Pacific Fishery Management Council to address concerns about fishery effects as described in two documents—a November 2000 programmatic biological opinion on the fishery management plans and a second opinion in October 2001 that was based on telemetry information describing sea lion distribution at sea and foraging patterns. The emergency interim rule was to be in effect through 8 July 2002 but on 16 May 2002 was extended to 31 December 2002.

On 22 February 2002 Greenpeace, the American Oceans Campaign, and the Sierra Club submitted a supplemental complaint against the Service alleging inadequate management of the Alaska groundfish fisheries and their effects on Steller sea lions. On 24 April 2002 the plaintiffs filed their motion challenging the November 2000 and October 2001 biological opinions, including the reasonable and prudent alternative developed by the Council's committee, passed with some modification by the Council, and accepted and implemented by the Service. A reasonable and prudent alternative is a recommended action developed during section 7 consultations to avoid a conclusion that the action would likely jeopardize the species or adversely modify its critical habitat. The plaintiffs asserted that the measures incorporated into the reasonable and prudent alternative of the October 2001 biological opinion were less-protective than those in the November 2000 opinion and that the Service had failed to explain how the less protective measures would avoid jeopardizing the western population or adversely modifying its critical habitat. The plaintiffs also challenged the Service's contention that the large-scale reductions in prey availability occurring as a direct result of the fishery's harvest strategy would not likely jeopardize the species or adversely modify its habitat.

On 4 September 2002 the National Marine Fisheries Service published in the *Federal Register* a proposed rule to implement the measures devised by the Council on a permanent basis (i.e., 2003 and beyond).

On 21 November 2002 a report entitled "Scientific Review of the Harvest Strategy Currently Used in the BSAI [Bering Sea/Aleutian Islands] and GOA [Gulf of Alaska] Groundfish Fishery Management Plans" was presented to the Council (see below under "Related Reviews."

On 18 December 2002 the U.S. District Court for the Western District of Washington ruled on three claims in the lawsuit against the National Marine Fisheries Service. The court ruled that the Service had not acted in an arbitrary and capricious manner when it concluded in its November 2000 biological opinion that the overall harvest strategy and the global control rule do not cause jeopardy and adverse modification. However, the court did rule that certain elements of the Service's October 2001 biological opinion were arbitrary and capricious. The November 2000 and October 2001 opinions differed in a number of respects but particularly with regard to the level of protection provided around rookeries and haul-out sites. In the 2001 opinion the Service put forth a zonal approach that subdivided critical habitat to provide differing levels of protection based on telemetry studies of sea lion foraging patterns. The court ruled that the Service failed to account for known nearshore bias in these data and therefore had failed to rationally connect its zoning approach to the available data. The court also found that the Service had failed to conduct the required analysis of the effects of fishing within the proposed zones with respect to the jeopardy and adverse modification standards required by the Endangered Species Act. For those reasons, the court remanded the 2001 biological opinion back to the Service. At the end of 2002 representatives of the two parties met to decide a course of action subsequent to the court's ruling. An agreement was reached that the fisheries would go forward as planned based on measures stemming from the reasonable and prudent alternative of the October 2001 biological opinion, and that the Service would have until June 2003 to revise its biological opinion in accordance with the court's order.

Recovery Planning and Research

Recovery Planning—The National Marine Fisheries Service, Steller Sea Lion Recovery Team, Alaska Department of Fish and Game, North Pacific Universities Marine Mammal Research Consortium, Alaska SeaLife Center, and North Pacific Fishery Management Council are conducting research on the Steller sea lion and its decline. The recovery team completed a recovery plan, adopted by the Service in 1992, and then focused primarily

on research needs related to the decline. Between December 1997 and February 1999 the recovery team held two meetings and four workshops to consider past and future research directions. The workshops focused on four main areas: behavior, telemetry studies, physiology, and foraging ecology. The motivation for these workshops and other recovery team recommendations was to provide a basis for updating research and recovery objectives in the revised recovery plan. In general, those recommendations emphasized that Steller sea lion research efforts should be considered in a broader ecological or ecosystem context; the research agencies should develop a strategic plan to guide and coordinate research efforts; the plan should include a Steller sea lion model with both demographic and bioenergetic components; research should be continued and expanded on life history patterns (particularly with respect to pups and juveniles), vital rates (reproduction and survival), age structure, physiological condition, and foraging ecology; management and research efforts should address the effects of fisheries managed by the state (e.g., salmon and herring) as well as federally managed fisheries; pollock removals from critical habitat should be reduced; adaptive management strategies should be developed to assess the efficacy of existing protection measures including exclusion zones; and methods for assessing subsistence harvests of Steller sea lions should be improved.

In October 2001 the National Marine Fisheries Service reconstituted the Steller Sea Lion Recovery Team, which then met in January, March, August, and November 2002. At its January meeting the team reviewed the recovery planning process under the Endangered Species Act, the Service's recovery planning guidelines, activities of the previous recovery team, draft terms of reference for the team, and current research efforts related to Steller sea lions. Revision of the recovery plan is the team's primary task. At its March meeting the team reviewed its final terms of reference, genetics research to characterize Steller sea lion population structure, and recovery criteria using population viability analysis and indicator checklists. The team then had additional discussions regarding revision of the recovery plan. At its August meeting, the team reviewed research budget projections; ongoing research efforts by the Alaska Department of Fish and Game, National Marine Fisheries Service, and Alaska SeaLife Center; and the research permitting process. The remainder of the meeting focused on developing recovery criteria and revising the recovery plan. The November meeting focused primarily on revision of the plan, but also included additional review of population viability analyses and genetic research indicating that two distinct population segments may exist within the current western population.

Research—At the Marine Mammal Commission's 2001 annual meeting, staff from the National Marine Fisheries Service provided an overview of research related to Steller sea lions being conducted in 2001. In fiscal year 2001 Congress increased the Service's funding for Steller sea lion research from $4.85 million in 2000 to $43.15 million. The Service dispersed this funding among 25 research institutions for a total of about 150 different studies. More than half ($27.3 million) of the total 2001 budget was provided to research organizations outside the federal government. A research coordinator was appointed at the Service's Alaska Fisheries Science Center, and coordination meetings were held in January, July, and September 2001. Research themes included studies to investigate Steller sea lion life history, foraging, and vital rates; fish stock assessment; ecosystem composition and dynamics; predation by killer whales and sharks; disease and contaminants; and other anthropogenic effects. A substantial portion of the 2001 funding ($15 million) supported about 30 competitive grants. Those grants were aimed at investigating hypotheses about the effects of fishing, environmental change, disease, contaminants, predation, and other anthropogenic factors.

The total research budget in 2002 was about the same ($40.15 million), but a larger portion ($25.65 million) was directed to federal agency research. The Service used 2002 funds to support nearly 200 research projects, all of which were consistent with the general research framework developed the previous year. A number of research coordination meetings were held in 2002, with focus on modeling, evaluation of killer whale predation, fatty acid analyses of sea lion prey, and the presence and effects of contaminants.

The increase in funding resulted in a corresponding increase in applications for scientific research permits received by the National Marine Fisheries Service. Historically, although a number of research agencies and organizations have conducted research on Steller sea lions, the research

has been authorized under three permits held by the National Marine Mammal Laboratory, Alaska Department of Fish and Game, and the Alaska SeaLife Center. As a result of the new funding and a competitive grants process for dispersing a portion of those funds, the National Marine Fisheries Service received 12 permit applications over a two-year period.

Taken together, the research permits requested authorization to harass, capture, sample, or otherwise take a total number of sea lions equivalent to several times the maximum population estimate, including the capture and handling of approximately 18 percent of the estimated number of pups born each year. On 27 July 2001 and again on 2 August 2002 the Marine Mammal Commission wrote to the Service to raise concerns and make recommendations regarding the potential for adverse effects resulting from the marked increase in Steller sea lion research. The Commission's letters noted that unless carried out in a well-designed and integrated manner, the adverse effects of multiple projects may confound an already complex investigation into causes of the decline of the western population. For that reason, the Service should, among other things, review research permits carefully to ensure that research projects are essential, well designed, and carried out by suitably experienced personnel; avoid unnecessary duplication of research activities and ensure coordination of efforts, including sharing of data; identify potential adverse effects of research projects; monitor those effects (both to determine if, when, and how adverse effects occur and also because such effects may affect interpretation of research results); and assess the cumulative significance of adverse effects. In particular, the Commission encouraged completion of the recovery plan, which should serve as the overall guide for the research effort.

In compliance with the National Environmental Policy Act, the Service prepared an environmental assessment on the proposed issuance of the new permits and modifications of the existing permits. The assessment was signed in June 2002 with a finding of no significant impact. The finding was based, in part, on the requirement that all research participants cooperate in the development of a plan for research collaboration and monitoring. The plan was intended to provide a framework to ensure that (1) the research does not involve unnecessary duplication and will not result in unnecessary harassment of sea lions, (2) potential adverse effects are minimized, (3) information on the cumulative and synergistic impacts of the research is collected, and (4) future research addresses the conservation and recovery needs of the Steller sea lion. In November 2002 the Service also issued a biological opinion on the proposed research. The opinion concluded that the issuance of the proposed permits was not likely to jeopardize the continued existence of the endangered western population or threatened eastern population or result in the destruction or adverse modification of their critical habitat.

The substantial funding for Steller sea lion research in 2001 and 2002 should provide important insights into possible causes of the decline and the nature of North Pacific marine ecosystems. Summaries of much of the research conducted in 2001 and 2002 were to be presented at a symposium in early January 2003.

Marine Mammal Commission Recommendations

Since 1998 much of the debate about effects of the Alaska groundfish fisheries on Steller sea lions has focused on the question of whether the two compete for the same prey resources. The potential for competition has been assessed on the basis of two questions: (1) do the fisheries and sea lions use the same resources (same prey or target species, in the same geographic regions, during the same seasons, of the same size, from the same depth), and (2) is removal of those resources by the fisheries contributing to the decline of the western Steller sea lion population or impeding its recovery. The first question has been confirmed for pollock, Atka mackerel, and Pacific cod fisheries.

The second question has been addressed by considering the potential for fisheries to cause local depletion of prey relative to the needs of Steller sea lions. That is, the term "local depletion" has been used to describe a reduction in available prey occurring as a result of fishing concentrated in time (within a given season or year) or space (particularly in Steller sea lion critical habitat) and of sufficient magnitude to diminish foraging success of sea lions and, consequently, their ability to reproduce and survive. The potential for such depletion cannot be evaluated directly for several reasons: (1) information on prey stocks is not sufficiently accurate and precise to reliably assess their

local distribution and abundance; (2) stock assessments have been conducted during the summer, and stock distributions change between the time of assessment and the fall, winter, and spring seasons, when most fishing occurs; and (3) the absolute abundance and density of prey needed to support a recovery of the Steller sea lion population is unknown. Because the absolute abundance or density of prey, and fisheries-induced changes in such, cannot be described reliably by season and location, relative measures of change have been used to indicate the potential for local depletion. Specifically, local depletion has been considered more likely when a local harvest rate significantly exceeds the overall harvest rate or when various measures of the fisheries (e.g., catch per unit effort) indicate a detectable and significant reduction of the target stock during a particular fishing season in a particular area.

The manner in which the concept of local depletion has been analyzed to date leads to two important concerns. First, because the potential for local depletion has been evaluated only in the context of annual fishery effects, the assumption is made that long-term fishery effects (i.e., those that occur over more than one year) do not contribute to local depletion. This is important because, under a fishing strategy based on maximum sustainable yield (MSY), the long-term goal of fisheries is to reduce spawning biomass of target stocks to approximately 40 percent of the level expected in the absence of fishing. In fact, the harvest strategy that the Service and the Council use in these fisheries is based on the assumption that reducing the prey stock by 80 percent (i.e., to 20 percent of its expected level in the absence of a fishery) does not jeopardize the western population of Steller sea lions or adversely modify its critical habitat. Furthermore, this assumption is applied to a whole suite of groundfish stocks that are prey of sea lions.

The assumption that such changes do not have significant ecological effects was formalized in the global harvest control rule used by the Council and the Service to determine the appropriate fishing mortality rate for the target stock and incorporated into the reasonable and prudent alternative of the November 2000 programmatic biological opinion. The rule, in modified form, was also included in the substitute alternative developed by the Council's reasonable and prudent alternative committee. The assumption that it is ecologically safe seems questionable. A November 2002 report to the North Pacific Fishery Management Council suggested that such a reduction could propagate through the food web and cause large changes in other populations. The Marine Mammal Commission does not believe that the assumption has been adequately analyzed in either section 7 consultations or in environmental impact statements on the fisheries. In its letters of 31 July 2001 and 19 October 2001 to the Service, the Commission commented on these analytical shortcomings and recommended that the Service conduct the required analyses of the ecological effects of the MSY-based fishing strategy used to manage these fisheries.

The second concern regarding the assessment of localized depletion is that the appropriate baseline for assessing fishery effects is, in essence, the environment under fished, or status quo, conditions. The draft supplemental environmental impact statement on the fisheries evaluated the effects of various alternatives relative to the environment as it currently exists under fished conditions. In its 31 July 2001 letter to the Service, the Marine Mammal Commission noted that comparisons of alternatives based on the status quo may indicate potential effects relative to current conditions, but may not indicate the full effects of the alternatives because the comparisons fail to account for the long-term effects of fishing under the MSY-based fishing strategy. For that reason, the Commission recommended that the Service revise its supplemental environmental impact statement to include a no-fishing alternative to ensure that a proper baseline is used for assessing and disclosing the full effects of different fishery management alternatives.

The concept of local depletion of prey has also been a central concern in developing reasonable and prudent alternatives. The measures composing these alternatives have been designed to (1) avoid competition for prey in areas around sea lion rookeries and haul-out sites, particularly during the winter when sea lions appear to be most vulnerable to reductions in prey availability; (2) disperse fishing spatially (in accordance with the distribution of the stock) over the remaining area of the fishery; (3) disperse fishing temporally during the remainder of the year; and (4) linearly reduce fishing mortality when the target stock spawning biomass is between 40 and 20 percent of the expected

level in the absence of fishing and prohibit fishing when it drops below 20 percent of that reference level.

In its 19 October 2001 letter to the Service, the Marine Mammal Commission pointed out that the first three principles noted above are based largely on temporal and spatial measures that may mitigate within-year effects of the fisheries but do not address long-term effects of catch levels set under an MSY-based fishing strategy. The global harvest control rule determines harvest rate on the basis of current stock biomass relative to expected biomass in the absence of fishing. It assumes that spawning biomass of the target stock can be reduced by 60 to 80 percent without significant ecological consequences. However, the analytical rationale necessary for this assumption and for ensuring that the fisheries are not likely to cause jeopardy to Steller sea lions has not been provided.

In addition to the above recommendations regarding analysis of the MSY-based fishing strategy and incorporating a no-fishing alternative into the programmatic supplemental environmental impact statement for analytic purposes, the Marine Mammal Commission's 19 October 2001 letter made three other recommendations to the Service. The first pertained to the Service's ability to correlate specific management measures to actual changes in the rate of sea lion population growth (or decline). In its October 2001 biological opinion on the conservation measures developed by the Council's reasonable and prudent alternative committee, the Service based its no-jeopardy determination on an analysis of expected growth rates under the alternative in the November 2000 biological opinion. The analysis assumed an understanding of the efficacy of management measures that does not accurately reflect the uncertainty associated with the Service's ability to explain the past decline of the western population or predict the near-term population trend. Because the analysis may therefore mislead decisionmakers and the public regarding the confidence they can have in the proposed reasonable and prudent alternatives, the Commission recommended that the Service revise its supplemental environmental impact statement either to include a basis for the implied level of understanding or to more accurately reflect the uncertainty associated with the expected effects of the measures being considered.

In its 19 October 2001 letter to the Service the Commission also pointed out the general need for explicit descriptions of important uncertainties regarding fishery effects, the studies needed to address those uncertainties, and the power of existing studies to detect and explain significant effects when they occur. Finally, the Commission noted important uncertainties regarding the telemetry data and the assumptions made by the Service in support of its new strategy for protecting sea lions and their prey around rookeries and haul-out areas. The Commission recommended that the Service review its interpretation of the satellite telemetry data and corresponding protective measures in light of (1) the uncertainties associated with the existing data and (2) its obligation to assure that the western population of Steller sea lions is not jeopardized and its critical habitat not adversely modified by the effects of the groundfish fisheries.

Related Reviews

During the last two years the North Pacific Fishery Management Council commissioned three reviews related to possible causes of the Steller sea lion decline and potential effects of the Alaska groundfish fisheries.

National Academy of Science—In December 2002 a panel convened by the National Academy of Science, National Research Council, released the executive summary of its report entitled "The Decline of the Steller Sea Lion in Alaskan Waters: Untangling Food Webs and Fishing Nets." The panel was convened at the request of Congress through the North Pacific Fishery Management Council. The summary divided potential causes into those that may affect sea lions (1) from the top down (i.e., from higher in the food web such as predation by killer whales or sharks, incidental catch in fishing gear, illegal shooting or subsistence harvests in excess of reported levels, pollution, or disease) and (2) from the bottom up (e.g., reduced availability or quality of prey due to fisheries or climate regime shifts, nonlethal factors affecting sea lion foraging efficiency, or pollutants extracted through the food web).

The summary concluded that "[i]n the existing body of information about Steller sea lions, there is no conclusive evidence supporting either the bottom-up or top-down hypotheses." The panel

also concluded that bottom-up hypotheses invoking nutritional stress are unlikely to represent the primary threat to recovery and that top-down sources of mortality (e.g., predation on sea lions) appear to pose the greatest threat to the current population. The panel also concluded that "there is insufficient evidence to fully exclude fisheries as a contributing factor to the continuing decline." It noted that resolution of this conflict requires a management approach that not only improves the chances for recovery of the western population of Steller sea lions but also facilitates scientific study of associated management measures. The summary listed a number of possible approaches for investigating the effects of fishing on Steller sea lions, including their preferred approach — contrasting rookeries around which fishing would be prohibited with rookeries around which fishing would be allowed.

The summary noted that multiple factors probably contributed to the early phases of the decline, but the data are insufficient to identify or describe them fully. It also stated that finer-scale spatial analysis would be required to understand region-specific causes of the decline. Finally, the summary listed a number of key areas in need of research and monitoring including population trends, vital rates, critical habitat, environmental conditions, and the feeding habits and population size of sea lion predators.

November 2000 Programmatic Biological Opinion—The North Pacific Fishery Management Council convened a panel of four independent scientists to review the November 2000 programmatic biological opinion prepared by the National Marine Fisheries Service on the effect of the Alaska groundfish fisheries management plan on Steller sea lions. In its report, completed in September 2001, the panel concluded that the fisheries may have negative effects on Steller sea lions, but that few data are available to assess the key hypotheses and most of the data indicating effects is circumstantial. It also noted that much of the data indicating potential effects is outdated and that the factors driving the current decline could be entirely different from those that were most important in the earlier stages of the decline. The report noted the lack of crucial information on vital rates and sea lion distribution and expressed skepticism about the utility of scat studies as a tool for monitoring seasonal trends in sea lion diets.

With regard to the design of field experiments to investigate Steller sea lion/fishery interactions, the panel was pessimistic about the utility of a research design in the November 2000 opinion. The design was based on subdivisions of critical habitat into fishing zones and no-fishing zones. The panel also considered a range of response variables that could be used to investigate these interactions and concluded that it would be very difficult to distinguish fishery effects from ecosystem effects and the effects of other fish predators. The panel questioned whether large-scale manipulative experiments were timely, given the limited fine- and meso-scale data on sea lion foraging and the effects of fishing on prey behavior but also noted that the desire to learn whether fishing is having an effect on sea lions may outweigh the desire to conduct preliminary studies leading to the large-scale experiment.

With regard to reports on other stressed pinnipeds, the panel was unaware of direct evidence that prey depletion by fisheries had affected the demography of seal populations although it noted that there is clear evidence that environmentally induced changes in prey availability have had such effects. The review indicated that demographic or population changes from prey reductions either are clearly apparent without scientific study or are relatively subtle and require time series of monitoring data. It also noted that changes had occurred in first-year survival of affected pinnipeds in all the examples identified.

With regard to the draft biological opinion on the conservation measures developed by the Council's reasonable and prudent alternative committee, the panel expressed little confidence in the new analyses of telemetry data as a sound basis for drawing conclusions about the effectiveness of the reasonable and prudent alternative on the population dynamics of Steller sea lions. It attempted to simulate the effects of the proposed measures but concluded that there were considerable doubts about the reliability of such simulations. The panel noted that under all the alternatives simulated, local populations at the western and eastern extremes of the range were predicted to continue their decline over the next 20 years. The panel reviewed the biomass ratio estimate used by the Service to

address the question of whether the fishery caused adverse modification of critical habitat. It concluded that this analysis did not address the central issue of local depletion and is inconsistent with the Service's position that such depletion is a likely cause of the recent decline of sea lions. They concluded that the biomass ratio analysis has little merit with respect to the assessment of adverse modification.

With respect to research recommendations, the panel gave priority to assessing population trends and vital rates, and better understanding of mechanisms underlying the current decline in the western population of Steller sea lions. Research recommendations (not in order of priority) were listed as monitoring trends in population size and distribution, estimating vital rates, investigating the temporal and spatial scales of foraging, investigating sea lion diet, modeling efforts to integrate foraging and reproductive energetics, retrospective data analysis, and investigating the hypothesis of local depletion of prey.

$F_{40\%}$ Fishery Harvest Strategy—In November 2002 the Council received a report from a different committee of seven scientists it had convened to provide an independent scientific review of the current harvest strategy implemented in fishery management plans for the Bering Sea/Aleutian Islands region and the Gulf of Alaska. The purpose of this review was to examine, among other things, the ecosystem effects of maintaining fished populations at or near 40 percent of their expected levels in the absence of fishing, also known as the $F_{40\%}$ fishery harvest strategy. The North Pacific Fishery Management Council uses this strategy to determine catch levels for Alaska groundfish. The panel concluded that in a single-species context, the use of the $F_{40\%}$-based approach appears to have worked well for most of the fished stocks in the Bering Sea/Aleutian Islands region and the Gulf of Alaska. Rockfish and pollock in the Gulf of Alaska were noted as exceptions. The review cautioned that species that have low productivity or episodic recruitment may be particularly vulnerable to this system for determining catch levels. With respect to ecosystem effects, the panel concluded that the current harvest strategy "makes only a slight adjustment for *possible* ecosystem needs" and that the procedure for doing so is ad hoc.

The panel noted that fishing to achieve maximum sustainable yield in a single-species context "will inevitably reduce the equilibrium biomass very substantially from the unfished condition, and will inevitably shift considerably the age and size structure of the target stock. These changes to the target stock *could* propagate through the food web, and effect large changes in the populations of other species." (Emphasis in original.)

The panel further noted that

> (a) harvest management strategy, such as $F_{40\%}$, that by design reduces the biomass of the target stock ... by a large fraction, will, all other things being equal, reduce the total consumption by higher trophic levels by a similar large fraction, and we would expect the predator populations to be reduced accordingly.... And, in fact, all other things often are not equal, especially in ecosystems, and there are a variety of mechanisms whereby the reduction in target stock biomass by a harvest strategy such as $F_{40\%}$ could cause a more than proportional reduction in the populations of predators dependent on those same stocks for prey.

The panel noted that the level of protection required for species that prey on target fish stocks is a policy decision. In this regard, the Magnuson-Stevens Fishery Conservation and Management Act is not sufficiently explicit with respect to conflicts between utilization of fishery resources and protection goals. Finally, the panel noted the importance of marine reserves in management aiming to take into account ecological and ecosystem considerations and emphasized the importance of systematic and well-designed monitoring to an ecosystem-based management approach.