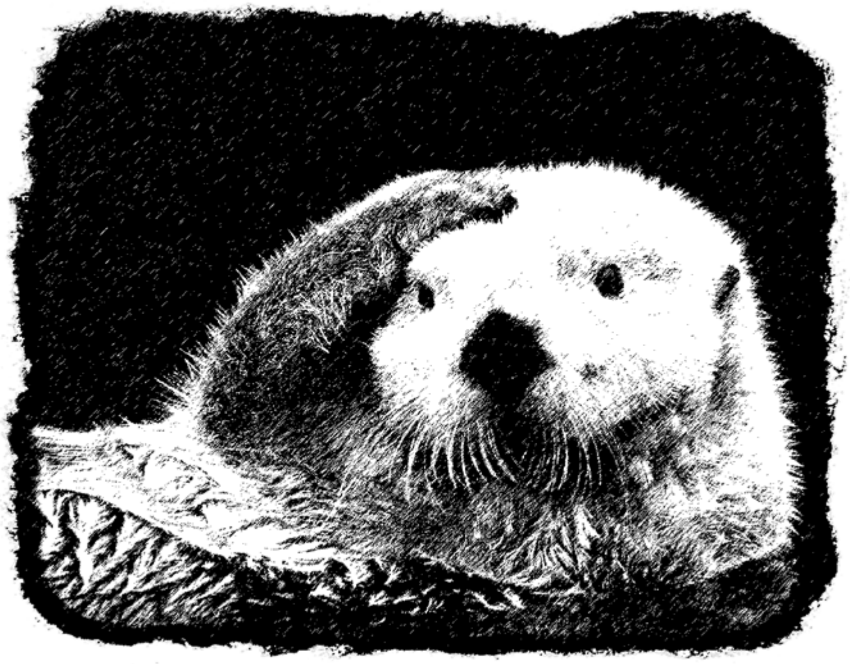
Southwest Alaska Sea Otter Decline Workshop



Summary Report

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EXECUTIVE SUMMARY

On April 3-4, 2002, the U.S. Fish and Wildlife Service (FWS) hosted a workshop in Anchorage, Alaska, on the southwest Alaska sea otter population decline. Experts from diverse fields met to review the evidence of the decline, discuss research strategies to investigate threats to recovery, develop plans for monitoring population trends, and identify important components of sea otter habitat. Although there are questions about the overall magnitude and geographic extent of the decline, the trend is clear: the sea otter population has undergone a dramatic population decline throughout most of southwest Alaska in the past 10-15 years. Within this area, the most intensively-studied region is also the most remote. Research during the 1990s at several islands in the western and central Aleutian islands indicated that the decline is the result of increased adult mortality. There was no evidence that starvation, disease, contaminants, human harvest, or commercial fishing activities were responsible for the decline. A significant increase in observed attacks by killer whales, a stable sea otter population in the protected waters of Clam Lagoon on Adak island, and relatively few beachcast carcasses suggested that predation by killer whales may be the cause of the decline in the Aleutian islands. To date, similar studies have not been conducted in other regions of southwest Alaska.

The FWS is currently evaluating all available information to determine if sea otters in southwest Alaska should be listed as a threatened or endangered species under the Endangered Species Act (ESA). Should the FWS determine that an ESA listing is warranted, it will be several years until a Recovery Team is formed and a recovery plan is developed and implemented. In the interim, the recommendations from this workshop will serve as an aid to guide sea otter research and monitoring activities in southwest Alaska. These recommendations are summarized in Table 1 of this report.

This report documents the discussions that occurred during the workshop; it is not intended as a comprehensive reference on the biology of sea otters in southwest Alaska.

INTRODUCTION

On August 22, 2000, the U.S. Fish and Wildlife Service (FWS) designated the sea otter population in the Aleutian Islands as a candidate species under the Endangered Species Act (ESA). This decision was based on aerial and skiff survey data which showed that a dramatic, widespread population decline had occurred throughout the Aleutians during the past 10-15 years. Since the designation of the Candidate Species status, FWS received petitions for listing the sea otter as endangered under the ESA, and also as depleted under the Marine Mammal Protection Act (MMPA). These actions have generated significant interest in this subject.

After designating sea otters in the Aleutian Islands as a candidate species, the FWS Alaska Region 7 requested funding in Fiscal Year 2001 for the preparation of a proposed rule for listing under ESA. Due to other listing priorities nation-wide, funding was not allocated for a sea otter proposed rule in Fiscal Year 2001. As the maximum geographic extent of the decline had not been conclusively determined, FWS conducted additional aerial surveys along the Alaska Peninsula and in the Kodiak archipelago for comparison with baseline data from 1986, 1989, and 1994. The results of these surveys revealed that sea otter populations had declined throughout much of southwest Alaska. Based on this additional information, FWS allocated funds in Fiscal Year 2002 for the preparation of a proposed rule to evaluate whether sea otters in southwest Alaska should be listed as threatened or endangered under the ESA. If the proposed rule finds that sea otters in southwest Alaska warrant an ESA listing, a final rule will be published within one year.

OBJECTIVES

In April 2002, the FWS hosted a workshop on the sea otter decline in southwest Alaska. The specific objectives for this workshop were to solicit professional opinions on: 1) research priorities for sea otter studies in southwest Alaska; 2) plans for monitoring future population trends; and 3) habitat requirements necessary for the designation of critical habitat for sea otters in southwest Alaska (Appendix A). Workshop participants included interested experts from diverse fields (Appendix B). This report summarizes the discussions and recommendations from the workshop, and will help guide future research and monitoring activities for sea otters in southwest Alaska.

BACKGROUND INFORMATION

In order to facilitate meaningful discussions among the participants, it was important to present results from the most recent sea otter population surveys and research activities in southwest Alaska. Four presentations were made on studies conducted in the Aleutian Islands, Alaska Peninsula, Kodiak archipelago, and the Commander Islands in Russia. Summary text from these presentations follows, with copies of Powerpoint presentation slides are included in Appendix C. Additional background information about the sea otter decline in southwest Alaska was provided to participants during the workshop (Appendix D).

Sea Otter Decline in the Aleutian Islands (James Estes, USGS)

History

In 1740, sea otters were abundant in the Aleutian Islands. By 1911, they were virtually gone with the exception of two remnant populations in the Rat and Delarof island groups. By the 1970's the population had recovered through much of the archipelago. This recovery began as a slow process of recolonization but once sea otters became established at an island, the populations grew rapidly, with an estimated rate of increase of 17-20% per year. The first evidence of the decline was seen in the early to mid-1990s at Adak island. Although there was no question that it was a dramatic decline, it was unknown whether this was localized to Adak. A review of historical data revealed similar patterns at Amchitka, Kagalaska, Little Kiska, where an overall population decline of 85-90% was evident.

Review of the data from several comprehensive aerial surveys of sea otters throughout the Aleutians conducted in 1965, 1992, and 2000 showed that although the major island groups had previously supported sea otters at varying densities, the population has since declined to a common low density. While there may be some uncertainty about overall abundance from these survey data, the overall trend is clear. The estimated annual rate of decline from 1992 -2000 ranges from 9-25% per year.

The current decline appears to fit a mortality model based on comparison of survivorship data from 55 tagged animals at two locations in Adak (Clam Lagoon, a protected area, and Kuluk Bay, an outer coast, open water area). Rates of reproduction appeared to be unchanged, and if anything, were slightly increased. Telemetry data showed that there was virtually no interchange of sea otters between the two areas. Until 2001, the number of sea otters in Clam Lagoon remained relatively constant, while there was a consistent decline in numbers of otters in Kuluk Bay. After 2001, there was some indication that animals may have moved out of Clam Lagoon, possibly in response to increased prey availability in Kuluk Bay.

The onset of the sea otter population decline was estimated by hindcasting the trend based on skiff-survey data for islands that were believed to have been at equilibrium density in 1965. Assuming an exponential decline function, it appears that the decline in the Aleutians began in the mid-1980s to early 1990s.

Kelp Data

Kelp is main photosynthesizer in the nearshore ecosystem, accounting for approximately 75% of organic carbon fixation. The kelp-sea urchin-sea otter ecosystem has been studied extensively at both Adak and Amchitka. Basically, the ecosystem at both locations has changed from a kelp-dominated system to an urchin-dominated system. Data from the 1980s and 1990s indicates that sea urchin abundance and biomass had increased while kelp densities decreased. In conclusion, there has been a rapid kelp forest phase shift, sea otter prey (urchins) is abundant, and food web effects are apparent (fish abundance is low in areas where kelp forests are absent). As sea otters preferentially rest in kelp beds, it is unclear what effect the loss of this resting habitat may have on sea otters.

Sea Otter Demography/Behavior

Sea otter mass-length ratios were higher in the 1990s as compared to the 1960s, although this difference was not statistically significant. There is no evidence that sea otters are nutritionally stressed at the areas studied within the Aleutians. Foraging behavior, measured as percent feeding success, has increased during the 1990s. The size of urchins consumed, as determined from scat samples at Adak and Amchitka, has increased from the late 1980s to late 1990s.

Contaminants

Contaminants are present in the nearshore environment throughout the Aleutians. Data from blue mussels collected from the Aleutians through southeast Alaska indicate low-level concentrations of PCBs at most sampling locations. There are some “hot spots” of high PCB concentrations evident at Sweeper Cove on Adak, Dutch Harbor on Unalaska island, and Amchitka. Excluding these locations from the analysis, PCB levels in samples from southeast Alaska are actually higher than southwest Alaska sites. Although concentrations of DDT were very low in the Aleutians, they were statistically significantly higher than samples from southeast Alaska. An ongoing study at Adak is looking at PCB levels in mussels, fish, and bald eagle eggs. In all three types of samples, elevated PCB levels can be found near "hot spots," with an inverse relationship between PCB concentrations and distance from these "hot spots." Levels of DDT in bald eagle eggs were generally lower than PCBs, but more uniform throughout the Aleutians. These levels appear to be correlated with breeding seabird locations, which may act as a reservoir for these compounds. Also, DDT:DDE ratio was relatively high, which is indicative of recent use of parent compound.

Summary

It is likely that we will never be able to identify the cause of the current sea otter decline with certainty. The current theory of killer whale predation is based on a "weight of evidence" approach. Evidence that supports this theory include: 1) a significant increase in the rate of observed killer whale attacks on sea otters; 2) stable sea otter numbers in a protected area (Clam Lagoon on Adak) as compared to exposed areas; 3) lack of evidence for other causes (body condition, food availability, scarcity of carcasses). Given this lack of certainty, researchers and managers should keep an open mind, respond to new information as it becomes available, and remain flexible with respect to research and management strategies. The decline in sea otter abundance is also an ecosystem issue. Associated ecological changes seen throughout western Alaska include: 1) decreases in various pinniped species (Steller sea lions, harbor seals, and fur seals); 2) decline of fisheries; and 3) a documented ocean regime shift.

The National Research Council is currently reviewing the cause of the Steller sea lion decline in an effort to determine if it is due to commercial fisheries or the regime shift. Preliminary conclusions appear to favor a "top-down" scenario (i.e. predator) as opposed to a "bottom-up" scenario (i.e. food limitation). A new hypothesis regarding the decline of several species of marine mammals in the north Pacific traces the ultimate cause to the harvest of great whales in the decades following World War II. By the early 1970s the biomass of great whales had been reduced by 95%. This theory holds that the removal of great whales prompted killer whales to begin feeding on other species of marine mammals. Declines in harbor seal populations became evident in the early 1970s, Steller sea lions in the 1980s, and sea otters in the 1990s. The most recent population estimate indicates that approximately 4,000 killer whales may inhabit the area within 200 miles of the Aleutians. It is estimated that perhaps 10% of these killer whales may be marine mammal-eating transients. The data supporting this theory is still under review.

Sea Otter Aerial Surveys of the Alaska Peninsula, 1986-2001 (Douglas Burn, FWS)

After the April 2000 sea otter survey in the Aleutians was completed, it was apparent that the geographic extent of the current decline had not been determined. Working eastward, FWS conducted additional aerial surveys of sea otters along the Alaska Peninsula for comparison with baseline information collected in 1986 and 1989.

Quarterly surveys from fixed-wing aircraft on both the north and south sides of the Alaska Peninsula were conducted in 1986. These surveys included strip transects in offshore areas, as well as transects that followed the shorelines of 23 islands on the south side of the Peninsula (Sanak, Caton, and Deer Islands, as well as the Pavlof and Shumagin island groups). In 1989, the south side of the Alaska Peninsula was surveyed in advance of oil spilled from the *Exxon Valdez*. This survey was conducted from rotary-wing aircraft, and covered the same island shorelines as the 1986 surveys. In addition, the shoreline of the Alaska Peninsula from Cape Douglas to False Pass was also surveyed in 1989.

In May 2000, FWS replicated the 1986 survey of offshore areas along the north side of the Alaska Peninsula. In April and May 2001, FWS replicated the 1986 survey of offshore areas on the south side of the Peninsula. FWS also surveyed the shoreline of the Peninsula from Cape Douglas to False Pass and the shorelines of the 23 islands surveyed in 1986 and 1989. The three data sets allow for multiple comparisons: 1) offshore areas (1986, 2000-2001); 2) island shorelines (1986, 1989, 2001); and 3) Alaska Peninsula shoreline (1989, 2001).

Sea otter abundance declined in offshore areas between 1986 and 2000-2001. On the north side of the Peninsula, the largest concentrations of sea otters observed in May 2000 were located in Port Moller and Nelson Lagoon. While this area appeared to have increased in abundance relative to the 1986 survey, the north Alaska Peninsula study area declined by an estimated 27-49% overall. Sea otter abundance in the offshore areas on the south side of the Peninsula have also declined by over 90% since 1986.

Counts of sea otters along the shoreline of the 23 islands surveyed also declined during this period. In 1986, observers counted a maximum of 2,167 otters at these islands. In 1989, the count had fallen to 1,589. By April 2001, only 402 otters were counted at these islands, representing an 81% decline since 1986.

Sea otter counts along the southern shoreline of the Alaska Peninsula from False Pass to Kupreanof Point also show evidence of a decline. In 1989, observers recorded 818 sea otters along this section of shoreline. In 2001 only 511 were recorder in this area, representing a 38% decline. Sea otter counts also declined in the section of coastline from Kupreanof Point to Castle Cape, but the number of sea otters observed during both surveys was very low (48 in 1989, 25 in 2001). It is not clear why this section of coastline has such low sea otter densities. In the easternmost portions of the Alaska Peninsula from Castle Cape to Cape Douglas, sea otter counts increased slightly between 1989 (1,766) and 2001 (2,115), perhaps suggesting an eastward extent of the decline.

While sea otter abundance in Port Moller, Nelson Lagoon and the coastline from Castle Cape to Cape Douglas appear to have increased slightly, the overall trend indicates that a substantial decline has occurred on the Alaska Peninsula during the past 10-15 years. Because these comparisons are based on a variety of survey methods and study areas, there is a need for standardization before additional population monitoring surveys are conducted.

Sea Otter Population Surveys in the Kodiak Archipelago (Angela Doroff, FWS)

During the 1980s, the sea otter population was rapidly expanding around Kodiak Island and large groups of sea otters were frequently observed in the Raspberry Strait area. In the mid-1980s sea otter pup survival was one of the highest documented for sea otters in Alaska. Range expansion continued, and by 1989 all of Shuyak and Afognak islands and the northern portion of Kodiak island had been repopulated by sea otters. Sea otters had also reoccupied Chigniak and Uyak bays, but had yet to return to southwestern portion of Kodiak Island. The sea otter population in the Kodiak archipelago was estimated as 13,526 individuals in 1989 with further range expansion expected. Results of a 1994 aerial survey of sea otters in the Kodiak archipelago showed abundance estimates declined by 27% since 1989, and no additional range expansion had occurred. Similarly, a June 2001 survey showed no range expansion, and abundance had declined by 56% since 1989. The range of sea otters was similar between the last two surveys, with lower densities observed in 2001. Although several large groups of sea otters (>20) were observed in 1994, no large groups were observed in 2001. If active range expansion were occurring, it is likely that large rafts of sea otters would occur at the periphery of the range, and that some of these large rafts would have been observed during the 2001 survey.

Factors that may limit population growth include low survival and fecundity rates, food limitations or otherwise poor quality habitat, and disease. Sea otter survival and reproduction were studied in the southern Afognak and northern Kodiak islands from 1986 to 1990. Adult and pup survival rates were high, and abundant food resources and relatively sheltered pupping areas were cited as contributing to these relatively high survival rates. Harvest by humans was listed as the primary source of known mortalities. Food limitation was not evident in benthic surveys of sea otter prey in the mid-to late 1980s. The size and biomass of bivalves decreased relative to the number of years that habitat had been occupied by sea otters, however, sea otter prey was available throughout the sea otter range within the study areas. Since 1989, there have been no documented cases of disease outbreaks in the Kodiak archipelago. The FWS and the Alaska Sea Otter and Steller Sea Lion Commission jointly administer a program to conduct necropsies and collect tissue samples from subsistence-hunted sea otters. Of the 24 sea otters sampled in the Kodiak area, there have been no observed anomalies. In conclusion, factors that would likely be causing an otherwise healthy population to be in decline in the Kodiak region have not yet been identified.

Status of Sea Otter Populations at the Commander Islands (Aleksander Burdin, Alaska SeaLife Center)

The sea otter population in the Commander islands appears to be stable as of the last survey in 2001. The Commander islands should be considered as a single unit as there is evidence for movement between the Bering and Medny islands. For example, in 2001 number of otters at Bering decreased by approximately 30% while numbers at Medny increased by approximately 30-40%. The latest count of sea otters in the Commander Islands was 4,100 sea otters in 2001. Since surveys were begun, the lowest count was 600 animals.

Russian scientists believe that the sea otter population at the Commander islands was at carrying capacity in 1991. They documented a mortality event in 1990 when hundreds of sea otters died, mostly from starvation. Normal mortality levels appears to be around 200 animals per year.

It is unknown whether the sea otter population decline in southwest Alaska could eventually reach the Commander islands. Unlike the Aleutian islands, pinniped populations have not declined in the Commander islands. Because of their proximity to the western Aleutians, comparative studies at the Commander islands could serve as a comparison (control) for studies in southwest Alaska.

At the time of the workshop, the status of the sea otter population immediately to the east of Cape Douglas, Alaska, was unknown. Although sea otters in Prince Williams Sound had been extensively surveyed during the 1990s with no evidence of a decline during that period, recent information for lower Cook Inlet and the Kenai Fiords was lacking. During the summer of 2002, these areas were surveyed by staff of the U.S. Geological Survey, Biological Resources Division, Alaska Science Center. Results suggest that the sea otter population in Kachemak Bay and Kenai Fiords has been relatively stable since the previous survey in 1989. On the west side of Cook Inlet, it was estimated that nearly 7,000 sea otters inhabit the Kamishak Bay area.

THREATS TO POPULATION RECOVERY

As stated earlier, we may never know the cause of the southwest Alaska sea otter population decline with any degree of certainty. There may have been more than one factor responsible for the decline, these factors may have been different in different areas within southwest Alaska, and they may have changed over time. It is also possible that the factors that caused the decline are no longer in effect, and that different factors may have a role in limiting recovery of the population. One of the major objectives of this workshop was to evaluate the role of possible causes of the decline and their potential impacts to recovery.

A. Reproduction

i. Pup productivity

Reproduction has never been documented as a problem in any sea otter population studied over the years. The earliest age at first reproduction for females is approximately two years. Information on reproduction can be assessed using two types of data: 1) studies of marked animals over a period of time (known as "longitudinal" studies); and 2) surveys that record observations of females with pups. At present, there are no ongoing longitudinal studies of sea otters in southwest Alaska, although historical data exist for the Aleutians and Kodiak archipelago. The current low densities of otters in the Aleutians may prohibit future longitudinal studies because it may be difficult to obtain sufficient sample sizes. Surveys that record females with pups are ongoing at some sites in the western and central Aleutians. In all sea otter populations studied, the ratio of pups to breeding females has been relatively consistent, however apparent differences have been noted in overall recruitment. Reproduction in sea otters seems to follow a "bet hedging" scenario. Otters will reproduce regardless of environmental conditions and take the chance that the pups will survive. In light of this fact, weaning success may be a more important estimate of productivity. Weaning success rates at Adak in 1995 and 1996 were normal while the population decline was occurring.

In areas with depressed population numbers, there is a potential for negative density dependence. This situation can occur when a population reaches a low enough level that individual males and females have a reduced likelihood of finding one another and mating. Although sea otters recovered from very low numbers following protection in 1911, the current situation is somewhat different. Following commercial hunting, sea otters remained at scattered remnant colonies. At present, sea otters are distributed throughout southwest Alaska, but at low densities.

ii. Juvenile Survival

Survival to weaning and also post-weaning survival do not appear to have contributed to the current population decline, but could potentially be a factor in recovery. Post-weaning survival of sea otters can be used as an indicator of population status or health. Sea otters from age 6 months to 2 years are considered to be juveniles. Sea otters typically have a good survival rate from 2 years old to approximately 10-15 years old. The typically observed pattern of mortality for sea otters in Alaska consists primarily of pups and older adults.

Preliminary contaminant analysis of blood samples from captured sea otter pups does not indicate a problem, although data analyses has not been completed. Resolution of these data may not be sufficient to determine any localized contaminant affects on reproduction or juvenile survival.

Recommendations

- Estimate productivity and juvenile survival rates in other areas of southwest Alaska.

B. Survival/Mortality

i. Disease

1. Natural

Animals in a wild population are expected to have some level of disease. The epidemiological characteristics of a potential disease that could cause a population decline with a pattern similar to that observed in the Aleutians would be a novel, highly fatal, and directly contagious disease. Morbillivirus probably has these characteristics, but it would be likely that some infected animals would be observed hauled out, especially considering the level of human presence at certain research sites in the Aleutians. The fact that sea otter carcasses have historically been found at certain beach sites in the Aleutians is indicative that recovery of carcasses can be expected. Moribund animals often haul out and die on shore, as opposed to in the water.

For a potential disease to kill sea otters in such a way that few carcasses would be recovered, it would be expected to invoke an extremely short illness period, and be highly contagious. Some degree of mixing among animals would be required for animal-to-animal transmission. That mixing or contact could include species other than otters (such as pinnipeds) if more than one species was susceptible to infection.

The geographic and temporal patterns of the current population decline does not appear to fit a disease-based model. Pinniped mortality events caused by disease typically last weeks to months, rather than several years. The longevity of a disease event within a population would depend on several factors including frequency of transmission.

If the current sea otter decline was caused by disease, it would be expected that some animals would have survived; therefore, serology might be a valuable tool to document disease exposure. Serum collected from 66 sea otters in the Aleutians was screened for various infectious diseases with negative results.

In order to rule out disease as a cause of the decline, it would be best to examine both living and dead sea otters. Samples from live animals could be collected in conjunction with other studies that require live capture. Collecting samples from dead sea otters would be more difficult. In remote, unpopulated areas, carcasses are quickly scavenged. Specimens recovered during spring carcass surveys typically represent over-winter mortality, and are likely unsuitable for investigation of disease. The skulls and skeletons recovered during these carcass surveys provide only information on age and sex composition. Fresh carcasses collected through the biosampling program jointly administered by FWS and the Alaska Sea Otter and Steller Sea Lion Commission have not been routinely sampled for disease exposure.

The role of biotoxins, such as paralytic shellfish poisoning (PSP) and domoic acid, as a potential contributing factor in the sea otter decline is unknown. Although PSP is monitored in some commercial shellfish operations, these substances have not been systematically monitored throughout Alaska. One suspect sea otter from Seward was tested for domoic acid and was found to be negative.

Although there is no evidence that disease has played a role in the current sea otter population decline, there is concern that it could potentially affect recovery. At this time, there is limited information on disease and parasite exposure or cause-specific mortality in Alaska sea otter populations.

2. Contaminants

Levels of DDT and PCBs are elevated at point sources in a few locations and attenuate at increasing distances. Preliminary contaminant data on blood samples from 80 live-captured sea otters from Aleutians is not a cause for concern. Analyses of liver and kidney tissues from five beachcast sea otters showed elevated PCBs and organochlorines, which was not unexpected as the source of these samples were from locally contaminated areas. Although cadmium was elevated in some of these samples, overall levels of heavy metals in these otters were not noteworthy.

The level of contaminant monitoring may not be sufficient to determine if there are any reproduction or pup survival problems associated with hot spots of contamination. Sea otter pups have been observed in contaminated harbors, and both individuals and mother/pup pairs forage over both contaminated and uncontaminated sites. Long-term studies are needed to further address these issues, but may not be possible in highly depleted areas.

There is no evidence of radioactivity effects from underground nuclear tests at Amchitka. Sea otter skulls from Amchitka and Adak islands have been analyzed for radionuclides, but differences between pre- and post-test otters appear to be a function of dietary differences.

In conclusion, there is no direct evidence to suggest that contaminants have played a role in the current sea otter population decline, however they may have the potential to limit recovery.

Recommendations

- Collect blood samples for serology opportunistically during studies that handle live animals.
- Necropsy and sample fresh carcasses whenever possible.
- Monitor the role of contaminants and biotoxins.

ii. Starvation

There is no evidence that starvation due to prey limitation has played a significant role in the current decline, but it may be a concern for recovery. In recent years, few sea otter carcasses have been recovered in the Aleutians, even in protected areas or catchment beaches. For example, Karl Kenyon used to find carcasses at various locations in the Aleutians. He described this pattern of mortality as "starvation decline" which occurred in late winter and early spring. Researchers in the 1970s through early 1990s also found carcasses of older animals in a pattern similar to Kenyon.

It is important to consider nutritional quality of prey items as well as prey abundance. Differences in nutritional quality between soft- vs. hard-sediment communities, and urchins barrens vs. kelp beds should also be considered. Calorimetry information exists for some prey types. Energy content of sea urchins are highly seasonal. Sea otters have adaptable food habits with an ability to use a variety of prey that are available.

Historical information about sea otter prey is somewhat patchy. In the past, there was intensive monitoring at 300-400 sites in the Aleutians, but these sites are now only monitored opportunistically. These sites could easily be incorporated into a regular monitoring plan in the future. There is not much historical data available for the Alaska Peninsula. Studies on prey availability were conducted at Kodiak and the Shumagin Islands in the late 1980s. There is little information available for the southern end of Kodiak Island. Beyond the area of the decline, there is abundant prey data for Prince William Sound. Information from the Commander Islands indicates that sea otter diets are variable, consisting of sea urchins, molluscs, and fish.

It cannot be assumed that prey availability is uniform throughout southwest Alaska. For example, there are considerable differences between Clam Lagoon (soft sediment) and the outer coast of Adak (rocky substrate). Although the interaction between sea urchins and kelp is well documented, the presence or absence of kelp beds may not be a clear indicator of prey availability. It is difficult to determine whether urchins are healthier in kelp beds. In some areas kelp beds have both a benthic canopy and a surface canopy. If only the understory is gone, the area may appear healthy on the surface, but is essentially an urchin barren.

Body condition may be difficult to use as an indicator for habitat quality. Length-weight ratio may only be a useful indicator once a situation of resource limitation is reached. If prey limitation were to hamper recovery, evidence of starvation would be expected. It may be possible to use the Commander islands as a model for a food-stressed population. A comparison of animals from Bering Island and Prince William Sound showed a reduction in weight in the Commanders as densities increased. Interpretation of length-weight ratios can be complicated by reproductive status of the animal; therefore it is easier to interpret these data from males or sexually immature females.

It is not clear whether some measure of body condition can be determined from blood chemistry. There is a large database on blood parameters, but this information has not been comprehensively reviewed.

Although there is no evidence that prey limitation is a contributing factor in the current sea otter decline, there was reluctance from some workshop participants to dismiss this as a possible factor in the decline. Historical sites with rocky substrates could be monitored in the Aleutians, but past data for soft-sediment areas are lacking. Data on soft-sediment prey communities exists for the Kodiak archipelago, Prince William Sound, and southeast Alaska. It may be valuable to repeat studies in soft-sediment habitats in Kodiak.

Recommendations

- Resample prey abundance at historical sites in the Aleutian islands and supplement with new sites representing all available substrate types.
- Assess prey availability in other areas of southwest Alaska.
- Conduct sea otter foraging studies.
- Monitor indicators of body condition.

iii. Predation

1. Killer whales

The leading hypothesis regarding the sea otter population decline identifies predation as the most likely cause, with killer whales as the most likely predator. Although the various lines of evidence for killer whale predation have been studied in the western and central Aleutians, it is important to conduct similar investigations elsewhere in southwest Alaska, such as the eastern Aleutians, Alaska Peninsula, and Kodiak archipelago.

It is important to make a distinction between killer whale attacks and actual predation. Not all attacks are successful, therefore some sort of forensic evidence that the animal is consumed is needed. It is possible that attacks that would be better characterized as harassment may be mistaken for predation. Craig Matkin, a killer whale biologist in Alaska with over twenty years of observation experience, stated that he has never seen a killer whale actually consume a sea otter.

Although there has never been a direct study of killer whale predation on sea otters, the "weight of evidence" supports the current hypothesis. It would be difficult to plan a study based on direct observations of predation, especially now as the sea otter population is low. The killer whale predation hypothesis has a fair number of skeptics. While modeling was considered by some to be the most compelling evidence of killer whale predation, there is criticism of some of the assumptions used in the model.

Several approaches for investigating the effects of killer whale predation on sea otters were discussed. One approach would focus on "refuge" habitats where sea otters might be safe from killer whales. Potential locations include Clam Lagoon and Shagak Bay on Adak, and Canoe Bay and Izembek Lagoon on the Alaska Peninsula. It would be necessary to first determine if an area is actually a refuge from killer whales. Telemetry studies would reveal sea otter movements and mortality patterns, similar to the work conducted in Clam Lagoon on Adak.

Direct observational studies could be initiated in areas not yet experiencing a sea otter population decline, such as the Commander islands. As large amounts of observational effort would be necessary, it may be difficult to gather sufficient direct observational evidence of predation. Killer whales can be difficult to follow, particularly in remote areas. For example in the central Aleutians and Shemya Island, killer whales were observed to be present for a period of weeks, then absent for months. Because of this unpredictability, killer whale attacks on sea otters in the Aleutians have been observed at different times throughout the year. In addition to the difficulties inherent in the observations themselves, it may also be difficult to extrapolate minimal data to the entire southwest Alaska sea otter population. For example while survey data indicates a sea otter population decline in Kodiak, there have been no reports of killer whale attacks/predation. Conversely, while killer whale attacks/predation have been observed in Prince William Sound, the sea otter population appears to be stable there. These inconsistencies are not limited to sea otters alone. Although information suggests harbor seals are the preferred prey of killer whales, their numbers have recently increased around Kodiak

Rather than relying on extensive surveys to locate killer whales for observation, it may be possible to use telemetry to follow their movements. Some killer whales have been tagged in Norway. It was noted that there was an ongoing live-capture effort in Russia to collect killer whales for public display. The feasibility of using this live-capture operation to possibly tag and release animals was discussed. Development of a remotely-attached telemetry package was discussed as an alternative to expensive and logistically complicated live-capture operations.

The NMFS has developed a killer whale predation model for Steller sea lions. Beginning this year, the model will include new information from observational field studies. Modeling approaches are not without limitations. For example, it would be difficult to quantify what percentage of the overall killer whale diet consists of sea otters. One suggested approach is to apply the model that was used for killer whale/sea otter predation in the Aleutians to Prince William Sound where more data exists. While this idea has some merit, some means of quantifying the amount of observer effort is required.

One promising new research technique uses biochemical analysis to determine prey items. Biopsies collected from killer whales could be analyzed for stable isotopes and fatty acid signatures.

It was pointed out that while a better understanding of specific predation patterns is interesting, we should not lose sight of management issues and applications. Under the current management regime, it seems highly unlikely that any form of predator control could be instituted. Given the limited amount of funding currently available for sea otter studies, specific research on killer whale biology may not be a high priority. Instead, collaboration with ongoing NMFS studies would be a more productive way to leverage funding.

2. Sharks
   The issue of shark predation has been raised in the Steller sea lion decline. Both salmon sharks and sleeper sharks go to the surface to feed. Although two ongoing NMFS studies to examine stomach contents of sleeper sharks found Steller sea lion and harbor seal remains, it is unclear if prey were taken alive or scavenged. Greenland sleeper sharks are known to take live seals. To date, no sea otter remains have been observed in sleeper shark stomach contents. Shark attacks on sea otters in California are well-documented. Hundreds of carcasses have been recovered with shark bite wounds. The subtle nature of the wounds suggests that most of these may be mistaken attacks. There have been some anecdotal observations of salmon shark predation on sea otters in Alaska. There is reportedly high concentrations of sharks in near Kodiak, and the role of shark predation in the decline should be considered in this area.

3. Other predators
   Raven and brown bear predation on sea otters has been documented in Russia. In addition to scavenging carcasses, bald eagles may prey on sea otter pups. While bald eagle predation could potentially be a consideration during recovery; sea otter populations have previously recovered in the presence of eagles. Information from bald eagle nests from the Aleutians indicate that sea otters are taken in low numbers. On Kodiak Island, where eagles are monitored regularly, predation patterns may differ from Aleutians.

Recommendations

- Identify potenial sea otter “refuge” habitats in southwest Alaska and monitor sea otter populations in those areas.

- Encourage ongoing NMFS studies of killer whale and shark predation, especially development of remotely-attached telemetry package for killer whales.
- Consider other potential factors in the "weight of evidence" approach for other areas in southwest Alaska.

iv. Fisheries

1. Competition

   Information from the Alaska Department of Fish and Game direct "fish ticket" database indicates that competition between sea otters and commercial fisheries is likely not a significant concern at this time. Sea otter diets are variable and unlikely to be limited by any commercial fishery. With the exception of a small dive fishery in Kodiak, there are currently no established sea urchin fisheries in southwest Alaska. In recent years there has been discussion of initiating a sea urchin fishery in the Aleutians. New sea urchin fisheries could have an effect on sea otter recovery. Once established, there is a tendency to protect fisheries for economic and political reasons. For example, over-exploitation of cod in the Gulf of Maine caused an increase in sea urchins, and the resulting urchin fishery was rapidly depleted.

2. Entanglement

   Documented rates of entanglement of sea otters in fishing gear are relatively low, and does not appear to be a contributing factor in the current decline. Much of this information comes from the National Marine Fisheries Service (NMFS) self-reporting program. In Alaska, the NMFS Observer Program includes reporting on marine mammal species managed by the FWS. The NMFS Observer Program will be monitoring the salmon set net fishery in Kodiak in 2002 and 2003. Salmon set nets are tended and entangled otters are generally released alive.

   There have been incidental reports of interactions between sea otters and crab pot fisheries in the Aleutians and southeast Alaska, but the level of interaction has not been significant. Other fisheries with the potential for interactions with sea otters include the Bering Sea and Aleutian island groundfish trawl and the Bering Sea and Gulf of Alaska finfish pot fisheries. There is also some concern about interactions with mariculture activities for oyster, scallops, mussels, and clams.

3. Other considerations

   In addition to competition and entanglement issues, other effects of the seafood industry such as cannery processing wastes should also be considered. At several locations in Alaska, sea otters and other marine mammals are attracted to processing outfalls as a source of food, resulting in changes of feeding habits, habituation, and nuisance problems. Sea otters in particular have suffered negative effects from feeding on pollock and cod waste during winter months at a cannery in Cordova, Alaska. Since fish is not normally a substantive component of the sea otter diet, use of this opportunistic food source resulted in significant health effects from parasitic infections and fish bone impactions of the digestive tract.

Recommendations

- Contract ADF&G to analyze the potential for competition between commercial fisheries and sea otters.
- Work with NMFS to monitor rates of entanglement of sea otters in commercial fishing gear.

v. Human Harvest

1. Subsistence

   Section 101(b) of the MMPA allows coastal Alaska Natives to harvest marine mammals, including sea otters, for cultural and traditional uses. The Service has operated the marine mammal Marking, Tagging and Reporting Program (MTRP) since October 1988. The MTRP requires that sea otter pelts and skulls are tagged within 30 days of the date of kill. There is no charge to the hunter to have the items tagged, but the tagger, who is typically a village resident, is paid a set fee per item tagged. Untagged pelts cannot be legally accepted by commercial tanneries. Although there is no way to estimate compliance with the MTRP, program administrators believe that most of the sea otters taken in the subsistence harvest are tagged.

   Harvest information from the MTRP indicates that most of the sea otters are taken in southcentral and southeast Alaska. Over the past decade, annual harvest levels averaged 2 per year in the Aleutians, 1-6 per year along the Alaska Peninsula, and around 60 per year from the Kodiak archipelago. These levels are approximately 10% of the annual statewide harvest, which ranged from 600-800 otters in recent years.

2. Illegal Harvest
   A recent case of illegal sea otter harvest in Kodiak involved approximately 50 pelts. Over the years, there have been reports of fisherman and sea urchin divers shooting sea otters in southeast Alaska. It seems unlikely that illegal harvest/poaching could have occurred on the scale necessary to produce the sea otter population decline. Otters are taken for their pelts, and large numbers of products made from sea otter fur have not been observed on the world market.

3. Other Considerations
   There was concern that although sea otters in southwest Alaska are under consideration for an ESA listing, the current draft stock assessment report calculates the Potential Biological Removal (PBR) for this stock as 1,076 animals. If sea otters are eventually listed, it will be important to make it clear that PBR should not be misconstrued as a level of "allowable take."

Recommendations

- Model the effects of harvesting (legal and illegal) on the sea otter population in southwest Alaska.

MONITORING POPULATION TRENDS

There was general agreement that established sea otter population trend sites in the Aleutians should continue to be monitored. These surveys are conducted from small skiffs surveying along the periphery of kelp beds. Skiff surveys work well in areas such as the Aleutians that have relatively confined habitat, but it is unclear if they would be useful in other areas such as Raspberry Strait in Kodiak. Although skiff surveys have been used in Prince William Sound (following the *Exxon Valdez* oil spill) there is some question about the appropriateness of the technique there.

The amount of variance in a single index survey is unknown; therefore, multiple replicates at each site may be necessary to improve the accuracy of the data. It is important to remember that skiff surveys are only indices of abundance, not actual abundance estimates. Within the context of the ESA, indices of abundance may not be useful in setting recovery goals. To estimate abundance, some measure of the proportion of sea otters not detected by observers is required. As sea otters are scarce in many areas, it may be difficult to develop correction factors to estimate the proportion not detected by observers. This was a problem for ground-truthing the 2000 Aleutian Islands aerial survey. Skiff survey estimates were used as an estimate of actual abundance, with the recognition that even these surveys likely did not detect 100% of the sea otters present.

The issue of sea otter distribution presents several challenges to survey design. Surveys should sample both high and low density areas; the current bias is toward high density areas. Survey design should also consider problems caused by changes in distribution. It is preferable to survey complete islands (rather than just portions) to limit the effect of changes in distribution. If possible, more than one trend site per study area or island group would be preferable.

Previous sea otter surveys in southwest Alaska were not part of a comprehensive, coordinated effort. As a result, the baseline data for comparison were collected using a variety of aerial and skiff survey methods. For logistical and safety reasons, some methods are not suitable for areas such as the Aleutians and north side of the Alaska Peninsula. Prior to initiating long-term monitoring of the population, a comparative study of survey methods would be useful.
Remote sensing, such as aerial photography and videography, are currently being used in some marine mammal surveys. The relatively small size of sea otters would make them a difficult target for remote sensing.

Recommendations

- Monitor population trends at existing index sites in the western and central Aleutians.
- Establish and monitor new index sites in southwest Alaska.
- Conduct periodic broad-scale aerial surveys using the technique best suited to the study area.
- Coordinate survey efforts with Federal and State agencies and local communities where feasible.
- Conduct a comparative study of aerial and skiff survey methods.
- Convene a workshop to specifically address survey methods prior to conducting additional broad-scale aerial surveys.
- Conduct carcass surveys concurrent with population surveys where feasible.

CRITICAL HABITAT

If sea otters are listed under the ESA, critical habitat will be designated, if prudent. Critical habitat is defined as the physical and biological features essential to conservation of the species. These features include: 1) space for individual and population growth for normal behavior; 2) cover or shelter; 3) food, water, air, light, minerals, or other nutritional or physiological requirements; 4) sites for breeding and rearing offspring; and 5) habitats that are protected from disturbances or are representative of the historic geographical and ecological distributions of a species.

One of the primary factors influencing sea otter distribution is water depth. As sea otters are benthic feeders, they are typically found in relatively shallow water. In most parts of Alaska shallow water occurs relatively close to shore. One notable exception is the portion of Bristol Bay along the Alaska Peninsula, where shallow water, and large rafts of sea otters, occur miles from shore. Another important feature of sea otter habitat are enclosed bays and fiords that provide shelter from rough seas. A current sea otter survey technique uses criteria of water depth, proximity to shore, and sheltered areas to stratify the study area into high and low density habitat. High density habitat is defined by: 1) water depths less than 40m; 2) distance to shoreline less than 400m; and 3) bays and fiords less than 6km across. Low density habitat further defined by: 1) water depths between 40-100m; and 2) distance to shoreline from 400-2,000m.

Unlike some pinniped species (such as Steller sea lions) that feed over broad areas of the sea, and congregate at rookeries to breed and haulouts to rest, sea otters tend use the same general areas for all of these activities. This characteristic makes the identification of specific areas within all possible sea otter habitat as “critical” somewhat problematic.

The southern sea otter in California was listed as threatened under the ESA prior to the critical habitat requirement. At this time, critical habitat has not been designated for the southern sea otter. The southern sea otter Recovery Team has had extensive discussions regarding potential critical habitat for the Southern sea otter. As diseases that originate in land-based mammals (for example, toxoplasmosis from feral cats) may limit recovery of southern sea otters, the Recovery Team has recently considered the inclusion of adjacent terrestrial lands as part of critical habitat.

Refuge from predators could be considered an element of critical habitat. Although Clam Lagoon on Adak is a good example of one such area, determination of refugia throughout southwest Alaska may be difficult. As a result, it is questionable if sufficient refuge areas exist to affect recovery.

Various approaches to defining critical habitat for sea otters were suggested, including:

> Areas in southwest Alaska that currently support large numbers of sea otters could be considered critical. There is likely greater benefit from protection of currently occupied habitat rather than unoccupied habitat. The limited amount of survey data provide only "snapshots" of current distribution. As these surveys were typically conducted during periods of good weather, they may present a biased picture of sea otter distribution.
>
> Areas where remnant populations existed could be considered critical. It seems more likely that the location of remnant populations in 1911 was more a function of previous hunting effort than habitat characteristics.
>
> Determine the amount of habitat area (number of islands, length of coastline, etc.) that would be needed for recovery of population. This approach does not address how to determine which specific areas should be included within critical habitat.
>
> Select a percentage of each island group as critical habitat. The exact locations would be flexible and determined at a later time. Once again, this approach does not address how to determine which specific areas should be included within critical habitat.
>
> Identify an acceptable level of risk for population recovery, then include enough area to provide that level.
>
> Select sites that could support populations on a long-term basis. For example, areas that could support a viable population unit of 1,800-2,000 animals could be considered critical.

These suggestions illustrate a general misunderstanding between the biological concept of "habitat that is critical" for a species, and the statutory definition of critical habitat. Critical habitat is based on the concept of primary constituent elements (PCEs), which are "those physical and biological features of a landscape that a species needs to survive and reproduce." Once defined, PCEs can then be mapped in a Geographic Information System to delineate areas of critical habitat. In the case of sea otters, the challenge of this approach is to determine what rationale should be used to define PCEs that select some subset of all suitable habitat that should be considered critical habitat. Discussions during the workshop did little to resolve this dilemma.

ACKNOWLEDGMENTS

The FWS thanks all the workshop participants for their time and expertise, and for their commitment to the conservation of sea otters in Alaska. Special thanks to Jim Estes, Douglas Burn, Angela Doroff, Aleksander Burdin, Jim Bodkin, Nancy Thomas, Craig Matkin, Lianna Jack, and Sue Detwiler for leading discussions during the workshop. The workshop was facilitated by Mary Lynn Nation and Anthony DeGange, who recorded the discussions and kept them focused on the topic at hand. We also thank Linda Comerci, John Haddix, and Ellen Baier for logistical support during the workshop.

TABLE 1. Recommendations for research and monitoring activities.

Topic	Recommendations
Reproduction	• Estimate productivity and juvenile survival rates in other areas of southwest Alaska.
Disease	• Collect blood samples for serology opportunistically during studies that handle live animals. • Necropsy and sample fresh carcasses whenever possible. • Monitor the role of contaminants and biotoxins.
Starvation	• Resample prey abundance at historical sites in the Aleutian islands and supplement with new sites representing all available substrate types. • Assess prey availability in other areas of southwest Alaska. • Conduct sea otter foraging studies. • Monitor indicators of body condition.
Predation	• Identify potenial sea otter "refuge" habitats in southwest Alaska and monitor sea otter populations in those areas. • Encourage ongoing NMFS studies of killer whale and shark predation, especially development of remotely-attached telemetry package for killer whales. • Consider other potential factors in the "weight of evidence" approach for other areas in southwest Alaska.
Fisheries	• Contract ADF&G to analyze the potential for competition between commercial fisheries and sea otters. • Work with NMFS to monitor rates of entanglement of sea otters in commercial fishing gear.
Human Harvest	• Model the effects of harvesting (legal and illegal) on the sea otter population in southwest Alaska.

Monitoring Population Trends	• Monitor population trends at existing index sites in the western and central Aleutians. • Establish and monitor new index sites in southwest Alaska. • Conduct periodic broad-scale aerial surveys using the technique best suited to the study area. • Coordinate survey efforts with Federal and State agencies and local communities where feasible. • Conduct a comparative study of aerial and skiff survey methods. • Convene a workshop to specifically address survey methods prior to conducting additional broad-scale aerial surveys. • Conduct carcass surveys concurrent with population surveys where feasible.

Figure 1. Southwest Alaska place names identified in text.

Southwest Alaska Sea Otter Decline - Workshop Outline

USFWS Regional Office, 1011 E. Tudor Road, Anchorage, Alaska 99503
April 3-4, 2002

DAY 1

1. Background Information
   - a. Welcome (Smith)
   - b. Workshop Logistics (DeGange/Nation)
   - c. Objectives of Workshop (Meehan)
   - d. Aleutian Islands (Estes)
   - e. Alaska Peninsula (Burn)
   - f. Kodiak Archipelago (Doroff)

2. Threats to Population Recovery
   - a. Reproduction
     - i. Pup productivity
     - ii. Juvenile Survival
   - b. Survival/Mortality
     - i. Disease
       - (1) Natural
       - (2) Contaminants
     - ii. Starvation
       - (1) Prey Abundance
       - (2) Body Condition
     - iii. Predation
       - (1) Killer Whales
       - (2) Sharks
       - (3) Other predators
     - iv. Fisheries
       - (1) Competition
       - (2) Entanglement
     - v. Human Harvest
       - (1) Subsistence
       - (2) Illegal Harvest

DAY TWO

3. Monitoring Population Trend
    a. Abundance Surveys
        i. Trend Sites
            (1) Existing Sites
            (2) New Sites
        ii. Large Areas
            (1) Aleutians
            (2) Alaska Peninsula
            (3) Kodiak
    b. Other indices

4. Defining Sea Otter Critical Habitat
    a. Shallow water
    b. Nearshore areas
    c. Bays/lagoons
    d. Substrate
    e. Kelp beds

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