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Local and Traditional Knowledge of the Nature and Extent of Interactions between Fishermen and Steller Sea Lions in the Gulf of Alaska and Bering Sea

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Fishermen’s Knowledge of the Nature and Extent of Interactions between Fishermen and Steller Sea Lions in the Gulf of Alaska and Bering Sea Prior to 1990 and Observations of Environmental Change in the Region

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Abstract

Abundances of marine mammal populations changed dramatically in the Bering Sea and Gulf of Alaska over the past century. Some of these changes are attributed to known ecological or human-caused events, but considerable uncertainty surrounds others, such as the decline of the western stock of Steller sea lions in the 1970s and 1980s. In the case of sea lions, one factor that has been identified but poorly studied is mortality from shooting by fishermen and others. Documenting information about the nature and extent of such shooting, together with its spatial and temporal characteristics, may provide valuable insights into the causes of the decline and the potential for recovery. In addition, commercial fishermen and regional residents are likely to have a great deal of knowledge about historical ecological events and conditions, including climate regime shifts, which have not been documented to date. Ecological knowledge is particularly sparse prior to routine fish stock assessment surveys in the 1970s (Bering Sea) and 1980s (Gulf of Alaska). Interviews that we conducted with selected fishermen and regional residents in the Kodiak, Cold Bay/Sand Point, and Seattle areas have added much information to our knowledge base. A preliminary reconstruction of mortality by fishery based on these interviews suggests that, apart from the Shelikof Strait trawl fishery in the 1980s, shooting practices do not appear to have changed appreciably from the 1950s to the 1970s. Thus, shooting mortality appears to be unable to account for a major portion of the unexplained mortality during 1974-1990. We are currently in the final stage of our project in which we are analyzing fishery data in combination with our newly acquired information on shooting to more fully investigate hypotheses about shooting-related mortality as a potential leading cause of the decline of the western stock of Steller sea lions. The final stage of our analysis was held up by a lengthy delay in obtaining data from the Alaska Department of Fish and Game, which experienced a loss of staff and a crash of the computer system containing the landings database. However, as of mid January 2009, we are in receipt of all requested data and we will complete our project and Final Report in the coming months. As our conclusions are pending the completion of these our analyses, we request that our work should be considered preliminary and not cited.

Introduction

Steller sea lions (Eumetopias jubatus) are found throughout the North Pacific Ocean from the Channel Islands in Southern California to northern Hokkaido, Japan (Loughlin
et al. 1984). In Alaska, Steller sea lions are broadly distributed throughout Gulf of Alaska, Aleutian Islands, and Bering Sea (Fig. 1). In U.S. waters, two stocks have been recognized with a demarcation at 144° W; an eastern distinct population segment (DPS) extends south from throughout Southeast Alaska, British Columbia, and along the U.S. west coast, and a western DPS extends throughout the central and western Gulf of Alaska, Aleutian Islands and Bering Sea. Steller sea lions that breed in Asia are considered part of the western DPS. Although juveniles and adult males are wide ranging, evidence for little interchange of breeding females between stocks comes from genetic analyses (Bickham et al. 1996) and resightings of marked animals (Raum-Suryan et al. 2002). However, two new rookeries in Southeast Alaska were colonized recently by females from both the eastern and western DPS (Gelatt et al. 2007).

Figure 1. Principal federal regulatory areas for groundfish fisheries off the coast of Alaska extending to 200 nm offshore (solid, wavy lines). The yellow shading shows the general distribution of Steller sea lions throughout the region and the dotted red vertical line at 144° W separates the eastern and western distinct population segments. This figure was modified from www.fakr.noaa.gov/rr/figures.htm.

The eastern and western DPS have disparate historical population trends (Angliss and Outlaw 2008). Pup production consistently increased throughout the range of the eastern stock in the past 25 years or more with the exception of two rookeries in California that experienced sharp reductions (Pitcher et al. 2007). Overall abundance of the eastern DPS increased at an average of 3.1% per year since the 1970s and stock
abundance is thought to be as high as it was in the previous century (Pitcher et al. 2007).

In stark contrast, the western DPS, as indexed by counts of adult and juvenile Steller sea lions in the core Kenai-Kiska index area, declined 86% over the second half of the 20th century (NMFS 2007, Angliss and Outlaw 2008). The decline was not uniform in time and space (Fig. 2a). Counts at Kenai-Kiska trend sites declined 38% from the late 1970s to 1985, 63% from 1985 to 1989, 33% from 1990 to 2000, and increased 12% from 2000 to 2004. The decline was first detected in the eastern Aleutian Islands in the mid 1970s (Braham et al. 1980) and then spread east to the central Gulf of Alaska and west to the central and western Aleutians Islands. The rate of decline varied over time by area (Fig. 2b). While a lack of complete population surveys between the late 1970s and 1990 provide no information on variability in mortality rates over a 14-year period, surveys of smaller areas, such as the eastern, central and western Gulf of Alaska (GOA) and eastern, central and western Aleutian Islands, provide more insights into mortality rate changes over time (Fig. 2b). For instance, an increase in the rate of decline during the mid to late 1980s is particularly evident in the central and western GOA and eastern Al (Fig. 2b). Sea lions in the eastern Gulf of Alaska declined sharply in the early 1990s at the same time the rate of decline slowed in most other areas. Since 2000 the strongest increases in abundance occurred in the eastern and western Gulf of Alaska and eastern Aleutian Islands, whereas declines continued in the western Aleutian Islands and central Gulf of Alaska.

Causes of the declines of the western DPS of Steller sea lions have been the focus of intense debate and research. A Steller Sea Lion Research Initiative (SSLRI), created by the U.S. Congress in 2001, funded the National Marine Fisheries Service (NMFS), Alaska Department of Fish and Game (ADF&G), and many partner agencies, universities and institutions. Studies on at least eight major hypotheses regarding the decline of the western DPS Steller sea lion included: removals by large-scale fisheries, effects of climate regime shifts on sea lion prey, predation by killer whales and sharks, direct takes, subsistence harvests, incidental takes and entanglements in fishing gears, disease, and the effects of pollution and biotoxins (NRC 2003).

Despite much research, the decline of the western DPS of Steller sea lions remains incompletely understood. On the one hand, some research indicates that sea lions were nutritionally stressed in the 1970s and 1980s. Supportive evidence includes reduced growth (Perez and Loughlin 1991, Calkins et al. 1998, Castellini and Calkins 1993) and high rates of reproductive failure (Pitcher et al. 1998). Population models implicate low rates of juvenile survival in the original decline (York 1994), but mark-resight models suggest that survival of all ages was low (Ken Pitcher, ADF&G, Anchorage, AK, pers. comm.). On the other hand, nutritional limitation is not well supported by many comparative studies of animals sampled from the declining western DPS and the increasing eastern DPS in the 1990s (see overviews by Kruse et al. 2001, NRC 2003). As a result, a National Research Council study concluded that top-down factors were most likely, including predation, shooting, subsistence harvest, incidental take, and disease (NRC 2003).
Figure 2. (a) Counts of non-pup (juvenile and adult) Steller sea lions from rookery and haulout trend sites by region and (b) average annual rate of decline for the eastern Al, central and western GOA combined, and total western stock since the late 1970s (data source: Table I-1 in NMFS 2007).
Among the top-down factors identified by NRC (2003), shooting by fishermen and others is perhaps the least-well investigated potential factor in the decline. Little information is available about shooting by fishermen and others, as distinct from subsistence harvests for food. With this in mind, our study attempts to reconstruct patterns of shooting prior to 1990, when shooting of sea lions to protect fisheries and gear became illegal, in order to evaluate the likelihood that such shooting played a substantial role in the decline. In addition, we asked fishermen to describe any environmental changes or other noteworthy phenomena they have observed.

**Background**

Here, we provide a summary of the known history of shooting of Steller sea lions in Alaska summarized version of their review based on the review by Kruse and Springer (2006). Sea lions have been harvested in Alaska since indigenous peoples inhabited coastal areas. Archeological evidence for harvests of sea lions by Alaska Native peoples dates back at least 3,000-4,000 years (Laughlin 1980). Some historical harvests have been documented in the northern Gulf of Alaska, including Prince William Sound, Kenai Peninsula, and Kodiak Archipelago (Haynes and Mishler 1994). Traditional sea lion products include meat (food), hides (kayaks), intestines (rain coats), stomachs (boot uppers), flippers (boot soles), and bladders (fishing floats and sacks for oil storage).

After outside contact, sea lions were killed by Russians and non-native Americans for several purposes. Large numbers of sea lions were killed in the 1800s by Russians in the Aleutian Islands for their furs and skins. They were also killed on the Pribilof Islands for their furs and to reduce their abundance and to create space on beaches for fur seals. Also, sea lions were killed to provide cheap food for fox farms. Fox farming started in the Semidi Islands (southwest of Kodiak) in the 1880s, and by the 1890s operations were established on islands of the Kodiak Archipelago and Prince William Sound. At its peak, 485 fox farms operated in coastal areas of Southeast and Southcentral Alaska; salmon, sea lions, harbor seals, and porpoises provided were used as feed.

Fishery conflicts with marine mammals date back to the first commercial fisheries in Alaska and include predation of catches, gear damage, and incidental take. In the 1880s, sea lions were observed to “prey upon cod, frequently taking them from the line” near Kodiak (Bean 1887). Sea lions are reported to eat fish from sablefish and halibut longlines, herring and salmon gillnets, salmon troll gear, and groundfish trawls (Hoover 1988a,b). Sea lions may damage fishing gear, particularly set nets (gillnets) used to catch some species of salmon. Steller sea lions may be incidentally taken by fisheries, as well. Perhaps the most remarkable situation involving sea lion takes involved a joint-venture fishery for pollock in Shelikof Strait (Gulf of Alaska) in the mid 1980s. This fishery involved roe-stripping and discarding carcasses (a practice banned in 1990), which attracted sea lions to the area. In this fishery, trawls were retrieved by catcher
vessels and were towed at or near the surface, capturing sea lions in the process. An estimated 1,211-2,115 sea lions were incidentally caught and killed over three years, 1982-1984 (Perez and Loughlin 1991). These estimates do not include animals that may have been taken by domestic vessels nor those that may have been shot and killed by fishermen.

Because of concerns about damaged gear and lost harvests, the Territorial Legislature of Alaska began a predator control program for seals in 1927. The program included a bounty (Lensink 1958) and the Alaska Department of Fisheries, the territorial precursor to the Alaska Department of Fish and Game (ADF&G), employed hunters to kill animals with rifles and “depth charges.” The Federal government was involved in predator control, as well, particularly for Steller sea lions. Although numbers are vague, it is likely that a small percentage of the population was killed, although kills on individual rookeries in some years were very large (James Brooks, ADF&G, retired, pers. comm., 2001).

An interesting anecdote describes the shooting of sea lions by American pilots stationed in Alaska during the 1940s: “the big PBYs ... they’d come through the narrows ... a hundred feet off the water and they’d open up those big fifty caliber guns shooting at the sea lions on Triplet Islands. I was sitting there on the beach ... and here are these tracers hitting the sea lions and the bluffs with great big sparks flying. The sea lions were dropping off the top of the islands. And man, you talk about slaughter” (Ed Opheim, Kodiak, pers. comm., 2001).

Bounty programs were abandoned and replaced with experimental harvests to control sea lion populations during 1959-1972. In 1959, 616 sea lions, mostly males, were killed from Kodiak to the eastern Aleutian Islands (Thorsteinson et al. 1961). During 1963-1972, 45,178 pups were killed (Merrick et al. 1987). Undoubtedly, the Marine Mammal Protection Act of 1972 caused some reduction in shooting, but it still permitted the shooting of animals to be shot in declines in the number of sea lions shot. Not until 1990, when Steller sea lions were listed as “threatened” under the Endangered Species, did it become illegal under any circumstances to discharge firearms near sea lions.

Objective/hypothesis

The objective of this project is to gather local and traditional knowledge from commercial fishermen and regional residents concerning the nature and extent of interactions between fishermen and Steller sea lions, with additional reference to regime changes and other ecological information that will advance our understanding of marine mammal population dynamics in the region. A specific focus of the project is Steller sea lions. There is some evidence that commercial fishermen shot large numbers of sea lions in decades past (e.g., Ed Opheim, Kodiak elder, interviewed by Gordon Kruse in 2001). However, others were implicated, including U.S. Navy pilots stationed in Alaska during the 1940s. Also, historically, sea lions were harvested by fox farmers. Thousands of sea lions were killed as bycatch during a joint-venture pollock fishery in Shelikof Strait in the 1980s (Perez and Loughlin 1991), and some fishermen reported
that large numbers were also shot to protect catches and gear during this unique fishery (NRC 2003). Prior to 1990, shooting of sea lions and defense of commercial catches and gear from depredation was legal and condoned by state and federal government agencies. However, such information on sea lions kills has never been examined in detail or quantified in any way. In the course of interviews with commercial fishermen in the Seattle area and fishermen and local residents in Kodiak and Cold Bay/Sand Point, we aim to test several hypotheses about interactions among fishermen and sea lions, as well as ecosystem response to climate regime shifts:

Fishermen-Sea Lion Interactions

H_{SL-0}: The impact of shooting of Steller sea lions by commercial fishermen and others cannot be determined.

H_{SL-1}: Shooting of Steller sea lions by commercial fishermen and others can be reconstructed in terms of spatial and temporal dynamics, including estimates of numbers of animals killed.

H_{SL-2}: Shooting of Steller sea lions by commercial fishermen and others may account for some of the population decline in the 1970s and 1980s, as evaluated by the spatial and temporal characteristics of such shooting.

Regime Shifts

H_{R-0}: Substantive information about regime shifts and other significant ecological events in the Gulf of Alaska and Bering Sea region cannot be obtained from commercial fishermen and regional residents.

H_{R-1}: Major changes have occurred in the abundance and distribution of various species in the region, and at least some of these changes can be documented from the experience and knowledge of commercial fishermen and regional residents.

H_{R-2}: Understanding of the nature, extent, potential causes, and implications of significant ecological changes can be enhanced by drawing on the knowledge of commercial fishermen and regional residents.

Methods

Selection of Respondents

We sought fishermen who could tell us about activities in the 1970s and 1980s, during the Steller sea lion decline and before the ban on shooting. We also sought respondents who could, collectively, provide information on a range of fisheries and areas. Given the potential sensitivity of the topic for both individuals and for the fishing industry generally, we first contacted representatives of various fishermen’s
organizations and asked them to make initial contact with most of our respondents. This step may have introduced some degree of bias (see below), but it also removed individuals who for any reason were reluctant to discuss sea lion shooting or who might not have been willing to provide accurate answers. Industry representatives were also generally aware of patterns of shooting by the different fisheries, and thus were able to help us identify respondents who could speak about those times, places, and fisheries where shooting of sea lions was particularly noteworthy. A small number of respondents were identified through chain referral (one respondent suggesting others to contact) or by direct contact by the researchers.

In the end, we interviewed 36 individuals in 30 separate interviews (see below). Twenty-four interviews were conducted in person in four locations (Seattle, Kodiak, King Cove, and Sand Point), and six were conducted by telephone. Between them, the 36 respondents had a total of 1,075 years in which they had fished in Alaska waters, for an average of 29.86 years per person, plus in some cases additional experience in the fishing industry elsewhere or in other roles than at sea. The range of experience and the number of respondents who fished per decade are given in Tables 1 and 2. The number of interviews in which each gear type or fishery was discussed is given in Table 3. Although respondents were asked to provide their fishing history, this information was not complete in all interviews due to time and other constraints, and we believe it is therefore more accurate to assess diversity of gear types and fisheries by number of respondents addressing a given gear type or fishery rather than by their participation in that gear type or fishery.

**Interview Method**

We used the semi-directive interview method (Huntington 1998), in which researchers have a list of topics to discuss or open-ended questions to stimulate a conversation, rather than a fixed questionnaire. The interviews generally began with a review of the individual’s fishing history, then moved to descriptions of sea lion shooting practices in the various fisheries, and finally to discussions of environmental change and other topics. In practice, the topics were often mixed throughout the interview as respondents remembered events or details or made associations between different phenomena. In this way, the goal of the semi-directive method is to allow the respondent the freedom to pursue the connections that he or she sees, rather than limiting responses to a set of questions prepared in advance.

Because shooting of Steller sea lions is now a sensitive topic, we asked about awareness of shooting or observations of shooting rather than personal participation in shooting. Some respondents nonetheless described their own activities in the first person, whereas others spoke indirectly. Both types of response were easily distinguished from second-hand accounts or hearsay, and most fishermen were careful to introduce second-hand information as such. Although we were not going to use respondents’ names in any publications or presentations, some respondents were willing to provide their names and addresses so that we could send copies of the draft and final reports, whereas others preferred to have us keep no record of their identities.
In all cases, the purpose of the study was explained and informed consent was obtained, consistent with ethical principles of human-subjects research.

In two cases, we interviewed more than one person at a time. For the purposes of reporting the experience of our respondents (Tables 1 and 2), we counted each individual separately. For the purposes of reporting results (Table 3 and Results section), we counted both multi-person interviews as a single response, the same as all the individual interviews. In some instances, more than one person in the group may have given the same information, but it was impossible to determine how many would have done so. Our approach errs on the side of under-counting, which seems the preferable alternative in compiling the results.

Potential for Bias

In addition to the inherent uncertainty of reconstructing decades-old events from memory, there are several potential sources for upward and downward bias in the data we gathered.

Upward bias may have come from selection of respondents, in that our industry contacts may have asked individuals who were known to have shot many sea lions. It may also have come from a desire by some fishermen to identify shooting as the cause of the decline, thus exonerating current practices and perhaps leading to less stringent regulations regarding fisheries-sea lion interactions. Stories of shooting sea lions circulated widely among fishermen when those practices were common, making it difficult then and now to distinguish separate descriptions of what may have been the same original event and also difficult to determine whether original events had been exaggerated in the telling. Finally, several respondents pointed out that, while there was considerable shooting at sea lions, it was difficult in most cases to determine how many animals were actually hit and how many died. Descriptions of shooting activities may thus over-represent actual mortality.

Downward bias may have come from reticence of respondents to describe in full activities that are no longer considered acceptable. Following one interview, we learned from a third party that the individual had omitted details from his descriptions of events, apparently finding once the interview had begun that he was unable to provide all the information he knew about. The difficulty in estimating mortality from shooting could also lead to underestimation, if fishermen concluded that most shots missed. Sea lion carcasses typically sink, so the lack of evident mortality may have led to such a conclusion in some cases. Finally, participants in some fisheries may have wished to shift blame to other fisheries or areas and thus have underreported their fishery’s role in shooting.

Based on the diversity of responses we obtained and the wide range of estimates of shooting prevalence and mortality, we feel comfortable ruling out any conscious effort by respondents to provide inaccurate information, either over- or under-reporting for any reason. Omission of information may have occurred, as in the one case noted above,
but we have no reason to believe it was common. Many descriptions were consistent with contemporary information or across several interviews in different locations. Unconscious bias, for example inaccurate estimates of mortality rates from shooting events, may have led to some of the wide ranges of estimated mortality provided by different respondents. Our results report a range of potential shooting mortality, which we believe reflects the degree of uncertainty resulting from such potential sources of bias as well as the vagaries of memory and the degree to which practices varied by individual, vessel, and location.

Analytical Approach

Converting stories into numbers is rarely straightforward or entirely reliable. We have taken three approaches to analyzing qualitative and quasi-quantitative descriptions to assess the likelihood that shooting of sea lions was a substantial part of the population decline.

First, we worked from the interview responses to estimates of mortality. We began by characterizing the degree of shooting in a particular fishery or location, using terms such as “modest,” “moderate,” and “high.” Then, based in part on any quantitative estimates that respondents provided, we converted those terms into numerical ranges of shooting per vessel or setnet site. We multiplied these ranges by the number of vessels or sites in that fishery to give the estimated range of overall mortality. In cases where respondents estimated total mortality associated with the fishery, we were able to check the results to see if they were broadly consistent. We compared our estimates with calculations of the mortality needed to account for the decline to determine if our estimated figures appeared capable of explaining the decline.

Second, we worked backwards from calculations of the amount of mortality needed to explain the decline. Knowing that a certain number of sea lions would have had to have been shot allowed us to assess, based on information from the interviews, whether it was likely that shooting by a given fishery or by all fisheries combined would have produced that level of mortality. If the necessary mortality was implausible given the information from the interviews, we would be comfortable ruling out shooting (at least by that fishery) as a substantial cause of the decline.

Finally, we used qualitative descriptions of trends to determine if the spatio-temporal pattern of shooting in any way matched the spatio-temporal pattern of the sea lion decline. For example, shooting at rookeries was particularly difficult to quantify, but may not have changed a great deal between the 1950s and 1970s. In addition, after 1972 the commercial harvest of some 4000 sea lions per year ended, meaning that shooting mortality would have had to have increased by more than that amount to have had a larger impact than it had prior to 1972. Qualitative descriptions of trends allowed us in both cases to examine the likelihood that shooting practices matched the decline.
Fishery Data Analyses

The interviews were intended to provide some information about historical rates of shooting of Steller sea lions by type of fishery. To attempt to estimate the potential magnitude of total shooting mortality, we sought data on fishing activity for selected fisheries thought to interact with sea lions. We selected two indices of fishing activity: numbers of vessels and fishery landings. In the case of salmon fisheries, the number of permits is a better index of fishing effort than fishing vessels. Further, we focused on specific fisheries by gear type, which included salmon set net, salmon drift gillnet, crab pot, shrimp trawl, and groundfish trawl, pot and longline. Data were acquired from all four ADF&G regions (Fig. 3). However, as regions 2-4 best matched the geographic distribution of the western DPS, we excluded fishery landings from region 1 from our analysis.

Owing to a severe ADF&G staffing shortage (two deaths among computer services staff and inability to refill vacant positions) and a fatal crash of the computer system housing ADF&G fish ticket data, our request for fisheries landings data requested on September 20, 2007 was completed on January 6, 2009. Owing to this and the complexity of the data, analyses of fishery data presented here are very preliminary and restricted to graphical depiction of trends in fishing effort.

Figure 3. Map showing the four regions used to manage commercial fisheries in Alaska. (Source: Alaska Department of Fish and Game, Commercial Fisheries, Juneau, AK).
Results

Shooting of Steller Sea Lions

Shooting of Steller sea lions is associated with several fisheries in different forms. Many, but not all, fisheries shot sea lions to protect the catch or gear. Within fisheries, there was typically great variation in practices over space, time, and vessel. Some participants in perhaps all fisheries shot sea lions as pest control or for recreation, separate from shooting to protect catches or gear. Here, we begin with descriptions of shooting and mortality estimates associated with protecting the catch or gear for various gear types and fisheries. Then we describe shooting at rookeries, haulouts, or otherwise separate from actual fishing operations. Third, we discuss attitudes and related information that helped made shooting of sea lions prior to the 1980s an acceptable and at times laudable practice. We conclude with an attempt to estimate mortality associated with each gear type and fishery, compiling those estimates into a range of overall mortality from shooting.

Shooting by Fishery

Trawl

Trawl fisheries encompass a range of locations and species. Interactions with Steller sea lions appear to have been concentrated in two areas, the Aleutian Islands and Shelikof Strait. Other trawl fisheries appear to have had minimal interactions with sea lions in terms of bycatch, sightings, and shooting during fishing activities. Some fishermen said that in the Bering Sea trawl fishery, for example, boats are more dispersed and are farther from shore than in the Aleutians and in Shelikof Strait, which may explain the lack of sea lion presence.

Table 1. Range in years of experience per respondent (n = 36).

<table>
<thead>
<tr>
<th>Years of experience</th>
<th>Number of Respondents</th>
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<tbody>
<tr>
<td>0-10</td>
<td>4</td>
</tr>
<tr>
<td>11-20</td>
<td>3</td>
</tr>
<tr>
<td>21-30</td>
<td>16</td>
</tr>
<tr>
<td>31-40</td>
<td>6</td>
</tr>
<tr>
<td>41-50</td>
<td>4</td>
</tr>
<tr>
<td>51+</td>
<td>3</td>
</tr>
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Table 2. Number of respondents active per decade (n = 36).

<table>
<thead>
<tr>
<th>Decade</th>
<th>Number of Respondents Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940s</td>
<td>2</td>
</tr>
<tr>
<td>1950s</td>
<td>5</td>
</tr>
<tr>
<td>1960s</td>
<td>11</td>
</tr>
<tr>
<td>1970s</td>
<td>27</td>
</tr>
<tr>
<td>1980s</td>
<td>30</td>
</tr>
<tr>
<td>1990s</td>
<td>24</td>
</tr>
<tr>
<td>2000s</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 3. Number of respondents addressing shooting associated with various gear types or fisheries (n = 30, but note that most respondents addressed more than one fishery).

<table>
<thead>
<tr>
<th>Gear Type or Fishery</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trawl</td>
<td>20</td>
</tr>
<tr>
<td>Seine</td>
<td>17</td>
</tr>
<tr>
<td>Gillnet</td>
<td>8</td>
</tr>
<tr>
<td>Set net</td>
<td>11</td>
</tr>
<tr>
<td>Crab</td>
<td>19</td>
</tr>
<tr>
<td>Shrimp</td>
<td>4</td>
</tr>
<tr>
<td>Longline</td>
<td>14</td>
</tr>
<tr>
<td>Cod Pot</td>
<td>1</td>
</tr>
</tbody>
</table>

Three respondents spoke about Aleutian Islands trawling. One noted that there was substantial bycatch in the 1980s, estimating an average of 15 sea lions per tow and one to three tows per day. This respondent said that bycatches were especially common at Unimak and Seguam Passes, noting that it was a rare day without a sea lion in the net. He said “we took out part of a generation.” Other independent respondents disagreed, noting minimal bycatch even when close to the rookery at Seguam Pass. Differences in reported bycatch may reflect different experiences (deckhand vs. skipper), different times of the year, different target species, or different years. Sea lions were not as aggressive as they were in Shelikof Strait (see below). By nearly all reports, shooting appears to have been modest at best.

Thirteen respondents described interactions with sea lions in the joint venture pollock fishery in Shelikof Strait in the 1980s. In addition a bycatch estimated at 1,211-2,115 over the period 1982-1984 (Perez and Loughlin 1991), fishermen reported widespread and intensive shooting of sea lions. Sea lion behavior during this fishery was described as highly aggressive, with animals appearing in large numbers when the trawl
hydraulics started, then riding the codends of nets up the stern ramps of vessels and ripping fish from the net. Sea lions were particularly abundant at night. The practice of towing the codend near the surface while awaiting delivery to processors was largely responsible for the high bycatch rates in the early years of this fishery. Changes in net configuration and practice helped reduce bycatch, as fishermen were penalized financially for having sea lions in their nets. Another factor was the discarding overboard of fish after stripping the roe, which may have attracted sea lions to the ships. One fisherman noted that eulachon were abundant there at that time and thought the sea lions might have been there initially for the eulachon.

Perceived damage to nets and loss of catch, if nets burst, was in part responsible for the response of fishermen to the behavior of the sea lions. Although not all boats shot sea lions, enough did so that some fishermen described the scene as resembling a shooting gallery. Some boats were known to be particularly well armed. Converting shooting behavior to mortality involves considerable uncertainty. Several fishermen noted that determining if a bullet hit an animal was difficult, much less determining if the animal was killed. Estimates of mortality rates range widely from a fraction of bycatch to roughly two to three times the bycatch levels. One fisherman estimated that five to six sea lions were shot for each night tow, with about 40 night tows per season. This equates to 200-240 animals killed per vessel, if the figures are representative of the fleet. Another fisherman noted that shooting was more common among vessels delivering to processor ships, because those delivering to shore stations did not tow the cod end behind the boat for any length of time.

Seine

Seining is practiced for salmon and for herring. Sixteen respondents addressed salmon seining and six addressed herring seining. Sea lions are known to swim into the purse seine and eat fish, but they usually swim out over the cork lines on their own when the net gets small. Shooting a sea lion in the net typically meant having to get the animal out of the net, which was a nuisance unless the fisherman wanted the sea lion meat for subsistence or for crab bait. Sea lions could make holes in nets, which would need to be repaired. Some shooting took place, but was generally considered to be modest per vessel. One fisherman reported shooting 25-40 sea lions per year in Bristol Bay to keep them from damaging nets and for pest control, whereas others reported little shooting.

Gillnet

Gillnetters faced a larger challenge than seiners and seem to have had particular trouble in the Aleutians and along the Alaska Peninsula (four responses). Sea lions would rip salmon from the net, leaving a hole that would need to be repaired. Harbor seals, by contrast, would bite the heads off the fish but leave the net intact. Shooting sea lions was often considered essential to a successful catch. The goal of shooting, however, was to get the animals away from the nets, not necessarily to kill them. With many vessels in the vicinity, many fishermen used shotguns with #2 pellets to reduce the risk of ricochets hitting another boat or person. The noise from the shotgun blast
would cause the sea lion to move away, accomplishing the fisherman’s goal. Some fishermen noted that gillnetting could not be done alone because the sea lions would be too hard to keep away. Shooting was common through the early 1970s, but then decreased as the number of sea lions declined.

Gillnetting for salmon in Bristol Bay (two responses) and for herring around Kodiak (one response) apparently had few sea lion interactions. Shooting may have occurred in Bristol Bay, but apparently not at the rate it did along the Alaska Peninsula. In the herring fishery, a respondent noted that that fishery mostly took place at night, whereas the sea lions fed primarily in early morning or early evening.

Setnet

Setnetters use gillnets anchored to the shore rather than from a vessel. Ten respondents addressed setnetting around Kodiak and one talked about setnetting on the Alaska Peninsula. Around Kodiak, sea lion interactions were highly variable depending on location and salmon species. Sockeye salmon runs attracted more sea lion activity than did those of pink salmon. Deep inside bays, few sea lions were present. Near capes and points, however, fishermen faced a considerable challenge protecting their catches and their gear. Some fishermen had to abandon their sites because of sea lion pressure. In response, fishermen at such locations often shot sea lions, sometimes constructing platforms or shelters on land from which to shoot. One respondent estimated mortality at a few hundred per year around Kodiak, based on a few animals being shot at each setnet site on average.

Along the Alaska Peninsula, one respondent noted that shooting of sea lions was common throughout the 1950s to 1970s to protect gear and catches. He estimated the mortality at no more than 100 animals per year. Shooting tapered off in the 1980s as sea lion numbers decreased and fishermen realized that a problem might be looming.

Crab

Nineteen respondents addressed crab fisheries. Relatively few sea lions were seen or shot during actual crabbing activity, but there were other interactions. Sea lions were occasionally shot for use as hanging bait. Respondents gave differing reports about the utility of sea lions for this purpose, some noting that they made good bait for certain crab species and others describing them as not worth the amount of effort required to retrieve them and cut them up for bait. Prior to the introduction of the polyfoam “sea lion” buoy, sea lions were also known to puncture buoys used to mark crab pots, resulting in damage to the buoy and sometimes the loss of a crab pot. For this reason, many crab fishermen shot sea lions on sight. One fisherman estimated mortality from the Bering Sea/Aleutian Islands fleet at 500-1,500 animals per year, but it was not clear whether that included incidental shooting at other times or just shooting during crab fishing. Other fishermen reported relatively slight mortality during crab fishing. The differences may reflect individual experiences on different boats. Some fishermen said
that there was little free time for shooting during crabbing, whereas others said some crabbers shot sea lions at every opportunity.

**Shrimp**

Four respondents described shrimp fishing, noting that interactions during fishing were low. Nonetheless, general attitudes about sea lions pervaded the shrimp fishery as well, so that some shrimp fishermen participated in opportunistic shooting of sea lions.

**Longline**

Sea lion interactions during longlining appear to have varied. Out of fourteen respondents, most reported few interactions with sea lions. An exception appears to have been the Bering Sea in the 1960s and perhaps into the 1970s. Sea lions would strip halibut bellies and some fishermen would shoot them or use small explosives to scare them off. Other fishermen reported little shooting, noting that the Bering Sea in April required giving full attention to fishing rather than other activities. None of the respondents indicated high levels of shooting during longlining, noting also that shooting and hitting animals were two different things. Several respondents did note that killer whales pose the major problem for longliners.

**Cod Pot**

One respondent discussed cod pot fishing, noting no interactions with sea lions in this fishery.

**Shooting at Rookeries and Elsewhere**

Twenty-five out of 30 respondents described shooting at rookeries, haulouts, and other opportunities separate from the conduct of a specific fishery. Most of this shooting appears to have arisen from the general view that sea lions were pests (see below). Opportunistic shooting appears to have been widespread, ranging from the occasional shooting of sea lions that swam within range to dedicated trips to rookeries and haulouts for the purpose of killing as many animals as possible. Shooting at rookeries and haulouts took place before the fishing season, in part as a way of preparing for fishing, and also on weather days and during other pauses in fishing or while traveling past an aggregation of sea lions. Some fishermen took every opportunity to shoot sea lions, whereas others shot at sea lions less frequently and some not at all. Descriptions of shooting events at rookeries and haulouts suggest significant mortality, but determining how many animals were killed was difficult at the time and all but impossible now. One respondent said he probably killed “hundreds and hundreds” in the 1970s, and that he knew ten others who did the same. How many individuals did so is difficult to estimate. If we take this report at face value, we can estimate at least 10 vessels killing perhaps 100 animals each per year in the 1970s.
Of significance to our study, no respondents indicated that shooting at rookeries and haulouts became more common in the 1970s or 1980s. To the contrary, shooting levels may have been relatively consistent from at least the 1950s through the 1970s, after which they reportedly declined as sea lions became fewer and fishermen became concerned about repercussions for the fishing industry. Some fishermen thought these shootings could account for a significant portion of the decline, whereas others thought they had little effect on the overall population. The latter group noted that extensive shooting prior to the 1970s had had little apparent effect on abundance.

As noted in the Methods section, some respondents emphasized the importance of distinguishing between shooting events and shooting stories. Discussions of shooting sea lions were relatively common when fishermen gathered at processing plants or harbors. Some individuals may have repeated stories as their own; others may have exaggerated the extent of shooting or mortality. Nonetheless, respondents agreed that shooting at rookeries and haulouts had been substantial, reports that are confirmed by contemporary accounts.

**Attitudes towards Sea Lions**

Ten respondents described attitudes towards sea lions prior to the 1980s. They were generally regarded as pests with little or no use. Some fishermen, apparently based on information from government agency biologists, regarded sea lions as parasite hosts. Most fishermen regarded them as competitors for fish and as a potential source of gear damage. Prior to the 1980s, with government and other encouragement, fishermen shot sea lions as a matter of course. Some respondents noted that despite these levels of shooting, no population change was apparent. The decline of sea lions has caused some change in attitudes expressed because (1) fewer sea lions means less of a problem, (2) potential negative impacts on fisheries, and (3) threat of enforcement action against anyone shooting sea lions. Whether underlying attitudes have changed is another matter, but some fishermen did note their enjoyment of watching sea lions and their admiration for their efficiency as predators.

Along with attitudes towards sea lions prior to the 1980s was the prevalence of firearms on fishing vessels. Seven respondents noted that a large number of boats carried guns, many of them with high-powered rifles including semi-automatics. Many vessels took large quantities of ammunition and shot at any target that presented itself, from driftwood to seagulls to sea lions. Many fishermen also combined fishing and hunting trips or used their vessels to go hunting. In the 1980s, attitudes changed and the industry became more “business-like” in the words of one respondent. For safety reasons, most vessel owners forbade guns.
Estimated Mortality

Changes in Shooting Rate

The descriptions above indicate considerable uncertainty in reconstructions of mortality from shooting of sea lions by fishermen. Nonetheless, we will attempt to capture the range of potential mortality based on information gathered. This information will be assessed and compared with previous estimates of mortality from shooting. Whether such an attempt at a quantitative estimate of shooting mortality is useful or not, a very preliminary reconstruction of mortality by fishery suggests that apart from the Shelikof Strait trawl fishery in the 1980s, shooting practices (i.e., shooting rates) did not appear to change appreciably from the 1950s to the 1970s.

Trends in Fishing Effort

Owing to the very recent acquisition on fishery data from ADF&G, we have only begun to explore trend in fishing effort and landings as indicators of the potential magnitude of interactions between various fisheries and sea lions. Initial analysis focused on total fishing effort as an indicator of the number of platforms by which fishermen had opportunities to shoot sea lions. We analyzed data on the number of vessels for groundfish and crab fisheries and number of permits for salmon fisheries. In our first-cut analysis, we estimated the maximum number of vessels (or permits) as the sum of the vessel (or permit) fishing per region by year. Because a given vessel (or permit) may have been fished in more than one region in a given year, this index may overestimate the number of unique vessels (or permits). On the other hand, one vessel operating in multiple ADF&G regions per year had multiple opportunities to interact with sea lions. We estimated the maximum number of vessels (or permits) for ADF&G regions 2-4 (Fig. 3), which matches the geographic distribution of the western DPS of Steller sea lions reasonable well (Fig. 1).

The passage of the Magnuson Fishery Conservation and Management Act of 1976 prompted an “Americanization” of the groundfish fisheries off Alaska. With the exception of longline fisheries for halibut and sablefish that were dominated by U.S. domestic fishermen, groundfish trawl fisheries were almost exclusively prosecuted by foreign fishing vessels from Japan, Russian, and other nations prior to the 1980s. The 1980s was a decade of transition involving joint-venture fisheries in which U.S. domestic fishermen caught the fish and delivered codends to floating foreign processing ships. With the build up of domestic fishing and processing capacity, foreign groundfish fishing was phased out of the U.S. exclusive economic zone off Alaska by the early 1990s.

ADF&G fish ticket data on numbers of groundfish trawlers, longliners and pot fishing vessels show the increase in fisheries participation by domestic fishermen (Fig. 4). The trend from low numbers of groundfish fishing vessels prior to 1985 to higher numbers after 1990 (Fig. 4) is not consistent with trends in sea lion mortality rates (Fig. 2b). Because of the very low reported rate of sea lion shooting from groundfish pot and longline vessels and post-1990 trawl vessels, a relationship was not expected. Perhaps
plots of the number of joint-venture trawl vessels operating in the Shelikof Strait and counts of sea lions on nearby rookeries and haulouts might indicate localized effects.

Figure 4. Maximum number of groundfish trawl, pot, and longline vessels fishing in the region occupied by the western stock of Steller sea lions during 1969-2008. Maximum number is the sum of vessels fishing in each region and may include duplicate counts. (Source data: Gail Smith, Alaska Department of Fish and Game, Commercial Fisheries, Juneau, AK).

Owing to common historical reports of shooting of sea lions at setnet sites, we were curious about potential trends in fishing effort as indicated by the number of salmon permits. However, the number of setnet and drift gillnet permits has remained remarkably stable over time. Trends in numbers of setnet permits indicate a very slight increase from 1975 to 1990 and a steady, moderate decline through 2008. Numbers of drift gillnet permits were remarkably constant until slight decline, which began in the late 1990s.

Maximum numbers of crab fishing vessels have varied widely since 1969. This reflects the combination of various boom and bust crab fisheries for red king crab, Tanner crab, and Dungeness crab. Although shooting was reported particularly in the red king crab fishery in the Kodiak area, trends in vessels participating in the red king crab fishery off Kodiak are unlikely to reveal trends matching those of sea lion declines, because the Kodiak king crab fishery collapsed and has been closed since 1983.
Changes in Total Mortality from Shooting

Our first-cut analysis suggests little evidence that shooting was the leading cause of the sea lion decline. Not only are there no apparent consistent trends of shooting rate for specific fisheries that are consistent with sea lion rates of decline (Fig. 2b), but trends in fishing effort provide inconsistent time trends, as well. So, aside from the joint-venture pollock fishery persecuted in Shelikof Strait in the late 1970s to mid 1980s that may well have affected local rookeries and haulouts, information gathered from interviews of fishermen and fishery data do not support the hypothesis that shooting was a leading cause of the decline in the western DPS of Steller sea lions. Whether shooting played a contributing role after other factors had precipitated a decline is another question. Nonetheless, shooting mortality appears unable to account for a major portion of the unexplained mortality found by the NRC (2003) from 1974-1990.
Figure 6. Maximum number of crab vessels fishing in the region occupied by the western stock of Steller sea lions during 1969-2008. Maximum number is the sum of permits issued in each region and may include duplicate counts. (Source data: Gail Smith, Alaska Department of Fish and Game, Commercial Fisheries, Juneau, AK).

Environmental Changes

Overview

As noted in the Methods section, we asked fishermen about their observations of the environment, particularly with regard to changes over time. Our intent was to explore the degree to which fishermen could provide information to complement or supplement existing scientific and other available observations of the marine system near Alaska. We were particularly interested in observations from the 1970s and earlier, when scientific survey work was less commonly undertaken and records are far sparser. We did not expect to document comprehensively the information that fishermen might be able to provide, but rather to determine if further studies with fishermen might be productive for various topics. Our results were perhaps limited because most of the interview time was spent discussing sea lion shooting and related observations. By the time the interviews turned to environmental changes, respondents often seemed ready to draw the interview to a close rather than to embark on a new and potentially vast topic of discussion. Future interviews dedicated to environmental change, particularly if they have a specific focus, may be able to gather more information that we did. Nonetheless, the fishermen’s observations we did obtain shed some interesting additional light on sea lions and other important marine phenomena.
Twenty-three respondents provided information about sea lions beyond what was described above. One respondent noted that he had not seen Steller sea lions in Southeast Alaska in the 1970s. When he went to Kodiak, it was a novelty to see them. Six respondents indicated that sea lions were abundant around Kodiak and to the west through the mid 1970s. Nine respondents described declines beginning in the late 1970s and continuing through the 1980s, implying a period of higher abundance before that. In some areas, sea lions apparently disappeared over a brief period. Some unusual behaviors were reported, too, such as the presence of sea lions 80 miles to the east of Kodiak in winter. Not all fishermen agreed that there had been a large decline in sea lions, suggesting that changes in distribution were the cause of the apparent decrease in numbers.

Seven respondents described increases in sea lions in the 2000s, noting that they have moved into new areas and have become more abundant in areas where they have always been. One respondent specifically mentioned seeing more pups and juveniles. Not all fishermen shared the view that there have been recent increases in sea lion numbers. Several fishermen described aggressive behavior by sea lions in recent years, particularly in Kodiak Harbor.

Twenty-five respondents spoke about killer whales. Ten described a large increase in killer whale numbers throughout the region. One fisherman noted that in the 1970s it was noteworthy to see a killer whale. The increase was particularly noticeable in the late 1980s, and large numbers of killer whales are still present. Several fishermen described huge groups of killer whales—“as far as the eye could see”—on some occasions, such as Shelikof Strait in 1988 and on the southern side of the Alaska Peninsula in 2002 and 2005.

Seventeen respondents described killer whale predation on sea lions. Many have witnessed such predation, and the reports ranged from apparently isolated incidents to more frequent and regular events, particularly at Seguam and Amukta Passes in the Aleutians. Several fishermen described killer whales trying to climb the stern ramp of a trawler in an apparent attempt to flee killer whales. Six respondents described killer whales preying on sea lions in Kodiak Harbor, which has apparently become a regular occurrence in recent years. Five fishermen have seen killer whales preying on large whales. Three have seen predation on sea otters, and three have seen predation on harbor seals.

Eleven respondents described interactions between killer whales and fisheries, particularly longliners. Killer whales are especially attracted to black cod and sometimes halibut. They can strip a longline (unlike sea lions, which may take a few fish). Killer whales are regarded as highly intelligent (though with variation between pods), having learned the habits of fishermen and how to take fish from a line very efficiently.
Eleven respondents reported that the populations of large whales are increasing rapidly throughout the Gulf of Alaska and Bering Sea. Some respondents indicated that increasing whale populations may lead to more conflicts with fishermen. Large whales can make holes in nets if they happen to swim through them, “like a person walking through a spiderweb.” Sperm whales have learned to take fish from longlines, one fisherman saying, “three sperm whales will eat a third of your catch.”

Five respondents described changes in sea otter populations. They were uncommon prior to the 1960s and 1970s, then increased sharply. In the 1980s, they began to spread from the west side of Kodiak to the east side. Three respondents said sea otters are thriving around Kodiak, whereas one respondent said they have declined in the Aleutians.

Seven respondents spoke about harbor seals. Four indicated a sharp decline since the 1970s. Two said that they have been recovering since the 1990s, whereas the other two indicated no recovery so far. Respondents noted a parallel in timing with the sea lion declines. One fisherman said the harbor seal decline was harder to explain, as there was little or no bycatch and far less shooting of seals than sea lions. Respondents described interactions with fisheries differently, two saying that harbor seals pose problems for fisheries and others suggesting that they pose little threat. The difference might reflect different fisheries or different locations. In gillnet fisheries, harbor seals cause less damage than sea lions because seals bite the heads off fish without damaging the net, whereas sea lions rip the fish out of the net and leave a hole.

Five respondents spoke about seabirds, but gave mixed reports. The comments often described different species or regions. One fisherman reported more short-tailed albatross in the Bering Sea west-southwest of St. Matthew Island. Another reported few albatrosses, no change in shearwaters or fulmars, but more of “everything else.” Another reported more of some land or nearshore birds (hawk owls, merlins, puffin). Another reported declines in all seabirds (tufted and horned puffins, cormorants, gulls, kittiwakes) around Old Harbor, Kodiak, since the 1990s.

Fish Stocks

Thirteen respondents spoke about cod. In the 1920s and 1930s, cod were abundant. By the end of World War II, cod had disappeared. Fishermen noted that overfishing was unlikely to have been the cause of this decline. In the early 1970s, finding a cod as bycatch was a big event, and the cod would be cooked for dinner. In the late 1970s, cod started increasing again and were abundant by the 1980s. More recently, some fishermen see a decline in cod again.

Ten respondents described pollock trends. Pollock were uncommon in the 1940s and 1950s, but increased dramatically starting in the mid-1970s. One fisherman described catching four-inch fish one year and having to look them up to identify them as pollock. The next year, the fish were eight inches long, and then cod and pollock were everywhere and shrimp had disappeared. One fisherman ascribed this change to the
imposition of the 200-mile limit, which removed foreign trawlers and allowed cod and pollock to rise sharply. Pollock appear to be abundant today, although they cannot be caught from the Old Harbor, Kodiak, dock the way they could prior to the 1980s. In the Bering Sea, the pollock fleet has moved northwards, but this may be in response to regulations or to the number of trawlers competing for pollock stocks in that region.

Five respondents spoke about herring. They have declined in many areas, starting in the 1970s. Herring used to be abundant around Kodiak, but no longer. In the late 1980s, pollock trawlers north of Unimak Pass in summer caught herring in 500-ton balls, but that had stopped by the mid-1990s. Two respondents noted that declines in herring would have large impacts on the rest of the food web, including sea lions.

Three out of four fishermen who mentioned mackerel said they have increased in abundance in the eastern Aleutians and around Kodiak. The fourth noted a slight decline in the western Aleutians, but said it might be a function of where fishing is allowed rather than a change in the fish stock itself. One respondent said that lingcod were not caught around Kodiak in the 1970s, but have become more abundant lately.

Six respondents described increases in dogfish, sleeper, and salmon sharks. The sharks eat fish on longlines, particularly halibut and cod, and also get caught on the hooks, after which they can become entangled in gear, which is difficult to untangle. One fisherman reported that in 1975 he caught no sharks, even though his lines were out for 24-36 hours with octopus as bait. Today, in a 12-hour set, he will catch numerous sharks and lose up to half his catch to sharks. One fisherman reported cutting open the stomach of a 7-8 foot sleeper shark near Dutch Harbor and finding one whole octopus and 19 octopus beaks. Sleeper sharks up to 16 feet long have been seen. One fisherman estimated that he caught at least 30,000 pounds of sleeper shark in 2006. Sleeper sharks are caught below the 40-fathom line, although one was reported caught in a setnet in 2006. Dog sharks are caught inside 70 fathoms. Ten years ago, they were not caught in setnets, but are now caught with some regularity, apparently attracted by the fish in the net. Dog sharks come in waves and are not consistent in numbers and distribution, but have been generally common in the last 4-5 years. They are particularly plentiful at the south end of Shelikof Strait, to the point that halibut longlining can no longer be done in that area.

Ten respondents discussed crab. King crab were abundant in the 1970s, likely increasing throughout the decade. In 1980 and 1981, however, king crab disappeared. Some fisherman blamed overfishing, noting that many vessels entered the fishery when catches and prices were high in the late 1970s and that crab bycatch was highest in the crab fishery. In the early 1980s, the bairdi crab fishery had high bycatch of juvenile king crabs, which may have prevented the latter from recovering. One fisherman noted that there is no information about crab abundance from the 1930s when cod stocks were high. Another expects that crab will return soon along with shrimp, while cod and pollock will decline. Two respondents noted that sea otters can keep crab stocks down, whereas when sea otter pressure declines, crabs may recover, as has happened recently with Dungeness crabs.
Little information was given about forage fish. One respondent noted that Pacific saury have increased in the last 5-6 years in the Gulf of Alaska. Another noted that needlefish were common in the shrimp fishery in the 1970s. A third said that forage fish numbers do not seem to have changed much around Kodiak.

Four fishermen discussed bycatch. One noted that bycatch of rockfish in the mackerel fishery increased in 2006, but noted that it is too soon to determine if this is a trend. Another said that chum salmon bycatch in the Bering Sea is increasing, but that the timing suggests the salmon are not Alaska fish. One fisherman said that squid bycatch was high in the late 1980s, then down, but high again in 2006. The fourth respondent said that jellyfish were abundant during the shrimp fishery in the 1970s. Starfish (brittle stars?) were common in Barnabas, Pavlof, Kiluda, and Cold Bays (the last after the demise of the king crab). He noted finally that crab and bycatch were inversely related, so that for example increased bycatch of arrowtooth flounder meant fewer crab and vice versa. In the compass rose area of Bristol Bay, there were always arrowtooth flounder as well as basket stars.

_Ecosystem Change_

Nineteen respondents described changes affecting or involving several species or phenomena or that otherwise reflected broad ecosystem changes rather than single-species effects. Some of the single-species changes described above may also reflect ecosystem change.

Five respondents indicated that there have been warm and cold cycles that drive changes in ecosystems. One of these individuals noted additionally that there is considerable variability within each cycle. One respondent noted that in his childhood (the 1940s), winters had been considerably colder and longer than now, with more snow and ice to play on.

Thirteen respondents noted cycles of cod, pollock, and shellfish over time. As noted earlier, cod were abundant in the 1930s, then disappeared, then returned in the late 1970s. In between, crabs and shrimp were abundant. One respondent pointed out that in addition to cycles there have been serial depletions of many marine resources, such as large whales, salmon, crab, and cod. He said that some of these have recovered whereas others have not.

Ten respondents talked about the effects of fishing pressure on fish stocks and ecosystem dynamics. Several said that past fishing pressure, particularly by foreign trawlers from the 1950s until the imposition of the 200-mile limit in the 1970s, kept stocks of sole, pollock, cod, and mackerel low, which in turn allowed shrimp and crab to flourish. Some of these respondents reported that the foreign trawl fleet had had much larger catches than reported, as indicated by the large number of vessels involved, all of which had to support their activities. This fleet also reportedly had substantial bycatch of species such as king salmon. The removal of the foreign fleet from the 200-mile zone
allowed their target species to recover, leading to the loss of prey species such as shrimp. Sea lions were also affected, having flourished from both the discards of the trawl fleet and the abundant shrimp. Herring also declined at the time the foreign fleet left, meaning a substantial overall loss of food for sea lions. The sea lion decline as well as declines in seabirds started at this time.

Several other changes or observations were reported. Tuna have been caught near Kodiak, grunion have been seen, and a dead sunfish was sighted. Scallops were not see in Alitak Bay on Kodiak during the shrimp fisheries in the 1970s, but are abundant now.

Regulations and Research

Not surprisingly, fishermen had a great deal to say about regulations and about research, although we initiated discussions on neither topic. Fourteen respondents addressed some aspect of one or both topics. Two fishermen praised Alaska’s salmon management, although one noted that the cessation of outgoing fry counts makes it hard to gauge salmon numbers in advance, so that the fishery will become more dependent on in-season management. Other responses indicated ambivalence about the management of other fisheries. There are conflicts among gear types and fisheries over allocations and bycatch, annoyance about measures designed to protect sea lions, concern about bycatch, and frustration about the political nature of fisheries management. One respondent noted that the observer program has greatly reduced bycatch. Two respondents expressed concern about allocation battles and the potential for overfishing if and when rockfishing opens up.

Many responses indicated appreciation for fisheries research, but also some lack of confidence in certain results and conclusions. One fisherman noted with appreciation an earlier research program that involved fishermen in documenting sightings of killer whales. Others regarded sea lion counts as unreliable because they were conducted over too short a period. The actions of some researchers at or near sea lion rookeries were also criticized, the fishermen noting that they are forbidden to come near the areas to avoid disturbance, whereas researchers travel by boat or even helicopter right to the rookery, leading to stampedes of animals. Respondents also indicated that understanding the dynamics of a complex ecosystem is challenging, and that some management actions may have unintended consequences or be based on flawed understandings and thus unnecessarily harm fishermen.

Future Plans

Owing to the very recent acquisition of fishery data, the information collected during this project will be analyzed more completely in comparison to trends in the fisheries and the western DPS of Steller sea lion. We will examine indices of fishing effort (numbers of fishing vessels and permits) and landings for the broad region occupied by the western DPS of Steller sea lions, as well as some specific analyses in certain specific areas of interest, such ADF&G region 4. Analyses of fishery data are difficult, because of
changes in data collection methods and ADF&G statistical areas over time. Also, there is no verification of statistical areas and management areas provided on fish tickets, so errors in reporting exist. Our draft final report will be completed in the coming months and we will circulate a draft report to respondents who participated in our study, prior to finalizing our analysis. As the analysis is ongoing, work reported here is preliminary and should not be cited until our final report is submitted. Subsequently, we will prepare a manuscript for submission to a peer-reviewed journal, which will combine our findings with those from a closely coordinated companion study undertaken by Michael Turek of ADF&G.

References


