WHAT IS CAUSING THE NORTHERN FUR SEAL DECLINE?
A LITERATURE REVIEW AND CRITICAL ANALYSIS

A Proposal To:
Pollock Conservation Cooperative Research Center

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Abstract

Fur seals on the Pribilof Islands have been declining for 40 years, and losses since the early 1970s remain unexplained. A number of possible causes have been investigated. Some factors have been considered and rejected, and others are still being debated. Current leading hypotheses include effects of commercial fisheries and climate change on prey availability in the Bering Sea, and predation by killer whales. Steller sea lions, harbor seals and sea otters have also experienced large population declines in areas that are important to northern fur seals (i.e., the western GOA, Aleutian Islands and the Bering Sea). Therefore, we propose to review the life history strategies and influential factors affecting northern fur seals in the Bering Sea, where they reproduce and raise pups, and in the N. Pacific, where female and juvenile fur seals migrate and overwinter for about eight months each year. We will compare fur seal ecology to that of Steller sea lions, harbor seals and sea otters in the North Pacific to help evaluate which factors may be important in the fur seal decline on the Pribilof Islands. Such a review will enable us to make recommendations about hypotheses and questions that need further research. This literature review and critical evaluation will ultimately be of benefit to the conservation of fur seals, the rational management of commercial fisheries, and an understanding of the effects of climate change and predation on individual species and on marine ecosystems.

Background and relevance to research priorities

Introduction

The northern fur seal population on the Pribilof Islands has declined by over 50% during the past 40 years and losses since the 1970s remain unexplained. Knowledge of the life history strategies of fur seals, as well as information about the direct and indirect effects of factors in the North Pacific and Bering Sea, are essential in evaluating why the population is still decreasing. In this proposal, we review the problem, briefly describe some of the possible causes, and outline a method to review factors so that recommendations for future research can be made. This will ultimately be of benefit to the conservation of fur seals, the rational management of commercial fisheries, and an understanding of the effects of climate change and predation on individual species and on marine ecosystems.

The problem

The Pribilof Island population of northern fur seals has experienced three major declines since they were discovered by Russian fur hunters in the 1700s. The first two severe depletions were caused by unregulated harvests, first by the Russians in the 1700s and early 1800s and later by the Americans and Japanese in the late 1800s and early 1900s. In both instances, management regulations were implemented and the population recovered. In fact, fur seals on the Pribilof Islands had rebounded from a low of 200,000-300,000 in 1911 to about 1.5 million by the mid 1950s (e.g., Kenyon et al. 1954, Lander and Kajimura 1982). It was after a short period of stability, which occurred in the late 1940s and the first half of the 1950s, that the third and most recent decline began.

That decline was caused by an experimental female harvest implemented in 1956 to maximize the productivity of the herd. Although the folly of this program was
recognized within several years and it was halted in 1968, the population has continued to shrink, and was designated as “depleted” under the marine mammal protection act in 1988. Based on abundance estimates that were made in August 2004, the National Marine Mammal Laboratory (NMML) concluded that pup production declined at a rate of 6.2% per year on St Paul Island and 4.5% per year on St. George Island since 1998 (Towell 2004).

Possible causes

There are three general reasons that could explain the population decline: decreased survival of one or more age classes, decreased number of births, and emigration from the area. In the case of the northern fur seals on the Pribilof Islands, 70% of the population decline that occurred between 1956 and the late 1960s can be explained by the female harvest, which obviously reduced female survival and the number of births; however, factors responsible for the remaining 30% of the decline in that period and that have caused the population to continue to fall since then remain in question (York and Hartley 1981, Trites and Larkin 1989). There is evidence that emigration alone could not cause the magnitude of the decline, so research has focused on reasons that could cause decreases in survival and/or reductions in the number of births.

Several factors could effect survival and birth rate. Disease, heavy metal and synthetic organic contaminants, and parasites could all reduce survival and birth rate in a population, as well as increase vulnerability to other factors; however, these possible causes have been examined and generally rejected (e.g., NRC 2003). Anthropogenic effects from subsistence hunting, commercial harvests, and incidental takes in fishing gear have also been investigated and rejected. In the early 1970s there was some evidence that entanglement in fishing debris was a factor, although in more recent times this is thought to not be important (Fowler 1987, Swartzman et al. 1990).

The three most widely debated possibilities are:

• climate change—a compelling case has been made for its effect on marine productivity, community composition, and fluctuations in forage fish population abundances in the N. Pacific, where fur seals spend eight months each year, and in the Bering Sea, where they come to give birth, breed, and raise their pups in summer and fall (e.g., Francis et al. 1998, Hare and Mantua 2000).
• competition with commercial fisheries—foraging locations of adult female fur seals at the Pribilofs overlap extensively with areas targeted by the pollock fishery in the Bering Sea (Robson 2004), and adult females regularly consume commercial sized pollock as well as juveniles (Gudmundson et al. 2006).
• predation—fur seals are consumed in considerable numbers by transient killer whales during the breeding season in the vicinity of the Pribilof Islands, and in spring and fall as they migrate through the Aleutian Island passes between the Bering Sea and the open North Pacific Ocean (J. Durban unpubl. data, A. Springer unpubl. data).
**Background**

Northern fur seals are found around the North Pacific Rim from Japan to California. In the summer, they are associated with six rookery sites—the Pribilof Islands, Bogoslof Island, and San Miguel Island in the U.S., and the Commander Islands, Kuril Island and Robben Island in Russia (Fig. 1). The Pribilof Islands and the resources in that vicinity support the largest fraction of the worldwide population.

Adult males are the first to arrive at rookery sites each summer. They arrive in May, establish territories and fast while defending their territory for about 50 days. Adult females typically arrive in early to mid July, give birth to a pup within a few days and remain onshore for the perinatal period, which usually lasts about seven days. At the end of the perinatal period, females return to the water and begin alternating between foraging trips at sea and suckling periods on shore with their pup. This lasts until November when pups are weaned and the winter migration period begins. During the winter, fur seals migrate into the North Pacific where they remain pelagic and utilize productive areas such as the North Pacific transition zone and shelf edge upwelling regions (Fig. 2). Juvenile animals follow similar migration movements as adults; however, they are not constrained by reproduction.

The most energetically demanding periods in the lives of fur seals are during development, growth, and reproduction. It is during these times that changes in ecological factors could have the most effect. Female fur seals carry most of the energetic costs of reproduction, during both gestation and lactation; however, lactation is by far the period of greatest energy demand. During lactation females not only have increased energy expenditures but they are also constrained in their foraging strategies because of the need to return to their pups on land. In addition, while development and growth are important to sub-adults as well as pups, pup growth in the
first year is critical to its survival. Pups within the first year have a low survival rate near 50% and heavier pups tend to do better post-weaning (Lander 1981). Therefore, female fitness is not only related to pup development and growth during the perinatal period, but is also related to pup survival after weaning. Factors that affect females can therefore have a great effect on the population.

While the population on the Pribilof Islands has been decreasing in recent years, the population on Bogoslof Island has been increasing exponentially (Ream et al. 2000). This contrast in population trajectories creates a natural setting to examine factors that could be causing the population decline. The foraging behaviors of female fur seals from the Pribilof Islands and from Bogoslof Island, and the physiological consequences to mothers and their pups of differing strategies, are being investigated in the project Consequences of Fur Seal Foraging Strategies (COFFS) funded by NPRB, and some interesting patterns have emerged (e.g., Fig. 3). Females from the Pribilof Islands take on average 7-day foraging trips, and either make deep dives on the shelf for pollock and other shelf forage fish, or shallow dives at the shelf break or in the oceanic domain for vertically migrating, oceanic species such as squid and deep-sea smelt. Females foraging from Bogoslof Island on average take 1.5-day foraging trips and make shallow dives in the oceanic domain. In general, females from St. Paul need to travel farther and longer than females from Bogoslof to meet their energy requirements. As a consequence, pups feed more frequently and grow faster on Bogoslof. It is not yet known if these contrasting strategies and consequences have demographic significance.

Northern fur seals are not the only marine mammal that has experienced population declines in the North Pacific in the recent past. Harbor seals, sea otters and Steller sea lions have similar ranges around the North Pacific Rim and while each species has experienced some regional population stability or growth in recent years, they all underwent large population declines in the western GOA, Aleutian Islands and the Bering Sea. Populations of all three species in this area collapsed by 80-90% over intervals of 10-15 years since the early 1970s (e.g., NRC 2003, Springer et al. 2003). The western stock of Steller sea lions was listed as endangered under the marine mammal protection act in 1997. In many cases, these species and fur seals utilize resources and are exposed to similar elements within the same ecosystem. Therefore, while it is prudent to investigate the life history strategies and the factors affecting each species separately, it is equally important to understand if there are similarities in these declines and if there is
any one factor, or multiple factors, that could be affecting more than one, if not all, of them.

Summary

If past population fluctuations are any indication, the Pribilof Island population can recover from this most recent decline if the cause or causes are discovered and if management decisions can be made to remedy the situation. There have been a range of studies that have been conducted over the years to investigate northern fur seal life history strategies, foraging ecology, vital rates, fisheries impacts, ecosystem factors, anthropogenic affects, predation, disease, and contaminants. A review and critical analysis of these factors will help eliminate some hypotheses and focus research in areas that still need more examination. Comparisons will be made to similar information on other species of marine mammals that have declined in recent years. This directly relates to the PCCRC research priority to identify factors that are influencing the population dynamics of northern fur seals.

Objectives

1. Review the natural history of northern fur seals and other marine mammal species that have experienced similar declines in the North Pacific.
2. Review and critically evaluate literature, reports, models and hypotheses that relate to factors that could be affecting northern fur seals, and other species of marine mammals, in the North Pacific and Bering Sea.
3. Summarize the findings and conclusions
4. Make recommendations for future work and list hypotheses that still need to be tested.

Methods

A thorough review of the natural history of northern fur seals, and of Steller sea lions, harbor seals, and sea otters, will be made to understand how factors may affect individuals and populations. This review will be made from published literature on each species and will include studies on aspects of life history and behavior.

There are a large number of factors that could cause a population to decline. The first step, therefore, will be to make a broad list of those factors and evaluate them to determine if they have known effects on northern fur seals, on any other fur seal species, otariid, or pinniped, or on the ecosystem in general. Studies relating to foraging ecology, vital rates, fisheries interactions, ecosystem factors, anthropogenic effects, predation, disease, contaminants, and management will be considered. Peer-reviewed literature, grey literature, reports, conference proceedings and stated but not published models will be used.

To determine which factors have the greatest likelihood of being involved in the current population decline on the Pribilof Islands, a more rigorous critical analysis of the findings will be made. Factors that have been well researched and shown to not be important will be identified, and factors that are thought to have some effect will be elaborated. If there is a possible combination of factors, that will also be noted. The
geographic extent of the review will include the N. Pacific from the Transition Zone and coastal upwelling regions of the Pacific Northwest, where fur seals winter; the Gulf of Alaska, through which they migrate; and the Bering Sea, where they breed and raise their pups. A summary of findings and conclusions will be compiled in the end. From this, recommendations about which hypotheses and questions need further research will be made.

References

Trites, A.W. and Larkin and P.A. 1989. The decline and fall of the Pribilof fur seal

**Timeline**

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**Previous work funded by PCCRC**

Springer has been funded by PCCRC to:
- Support graduate student S. Whitney in his MS research on jellyfish diets. The
data are being prepared for publication and Whitney’s thesis after a sabbatical he
took to start a family.
- Examine the relationship between diet, stress hormones, and population trend in
the western stock of Steller sea lions with A. Kitaysky. A final report was
submitted and a manuscript has been prepared.