

Do Steller Sea Lions Have Enough To Eat?

Annual Progress Report

To

Pollock Conservation Cooperative Research Center

From

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Introduction

This project was proposed as a comparison of sea lion diets and physiological stress at two rookeries in the eastern Bering Sea, Walrus I. (Pribilof Is.) and Bogoslof I. (eastern Aleutian Is.). Following recommendations by the PCCRC board, the scope of the comparisons was expanded to include other rookeries in the eastern Aleutians and western Gulf of Alaska (GOA). The question asked was, "Do sea lions have enough to eat?" and was aimed at addressing the hypothesis of food limitation as a cause of the decline in the western stock.

Approach

We combined two approaches to answer this question. One approach was to refine estimates of diet at the Pribilofs and elsewhere. We have detailed information on diets of sea lions from the Pribilofs in the past 8 years that has come from a biosampling program of animals taken in the subsistence harvest. Collection of stomachs has allowed us to estimate diets based on the frequency of occurrence of prey, the numbers of individuals, and their fresh mass. We proposed to further improve on this information by determining the energy density of the prey, since the underlying theme of the food limitation hypothesis is that the various species of prey consumed by sea lions have higher or lower nutritional values, in large part because of differences in fat content. Few data were available on the fat content of prey species of large sizes typically taken by sea lions on the Pribilofs, so we undertook the proximate analysis of such prey obtained for us by T. Bittner from the commercial halibut fishery at St. Paul in summer 2000 and 2001 and from the National Marine Fisheries Service (NMFS) during their winter and summer 2001 trawl surveys in the eastern Bering Sea.

Similarly detailed data on contemporary diets of sea lions are not available from any other location in Alaska. There is information, however, that comes from scats routinely collected at sea lion rookeries and haulouts by the National Marine Mammal Laboratory (NMML) and other investigators. Prey remains contained in scats provide an index of diet in terms of the frequency of occurrence of prey species. Numbers of individuals and their sizes cannot be determined. Information on diets as estimated from scats is available from NMML on their web site and through personal communication from B. Sinclair and T. Loughlin.

The other approach was to assess the physiological condition of sea lions at the various rookeries by measuring levels of corticosteroids in feces: corticosteroids are hormones produced by the adrenal gland in response to stress. We were provided with subsamples from scats collected by NMML in summer 2000 and winter 2001 in the eastern Aleutians and western GOA. We obtained additional samples from scats at Bogoslof I. in summer 2000 in collaboration with our related study entitled "Regime Forcing and Ecosystem Response" (ReFER: funded by the North Pacific Marine Research Initiative) and at Otter I. (Pribilofs) in spring 2001. In addition to these, we have obtained colon contents (incipient scats) from sea lions killed by hunters at St. Paul I. in 2000 and 2001.

- eating big fish (comm. size)
3-4 yr. old pollock
P-eel big

- "other" category is
mostly sculpin
- mostly non-fatty fish
- maybe St. Paul (Prib) don't have much to eat
- not herring, salmon, Ar. mackerel

Results

Diets

We have begun the processing of 97 individual fish and octopus of 9 species for nutritional content. All have been taken through the stage of lipid extraction and await only the determination of protein content. These samples include species collected in both summer and winter to provide information on seasonal changes in quality. We have approximately 50 more individuals of 5 species of fish and squid to process.

The fat content of most fishes we have extracted so far are in keeping with general patterns reported in the literature for younger age classes of these species. For example, adult pollock, Pacific cod, yellow Irish lords, and rock sole were lean, while subadult king salmon were fat. An important exception is adult Atka mackerel, which were extremely fat in late winter. Young age classes of Atka mackerel have been found to be lean, and in the absence of data for appropriate sized individuals, the species has been considered to be of comparatively low nutritional value to sea lions.

We have also compiled diet data as determined from scats collected in the past decade from 7 rookeries in the eastern Aleutians and western GOA (Fig. 1). We applied a preliminary estimate of nutritional quality to the frequency of occurrence of individual species to obtain a single index value of the quality sea lion diets at each location.

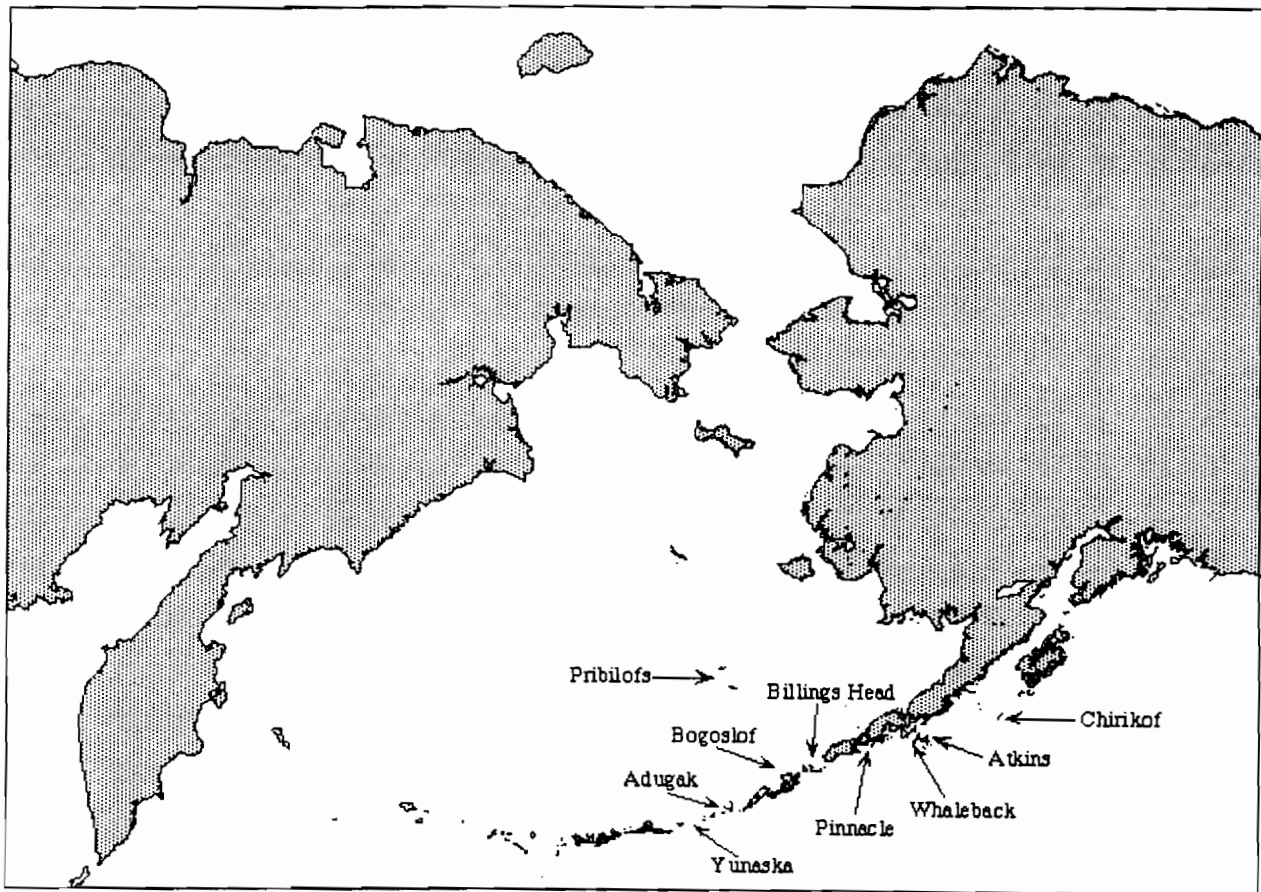


Figure 1. Locations of sea lion rookeries and haul out (Whaleback) discussed in the text.

Stress

We have analyzed approximately 180 scat samples collected in summer 2000 from the same 7 rookeries and 1 haulout for corticosterone, the corticosteroid derivative present in scat. These samples have also been analyzed for androgen, estradiol, and progesterone.

Corticosterone levels, and thus stress, varied between locations (Fig. 2). To understand

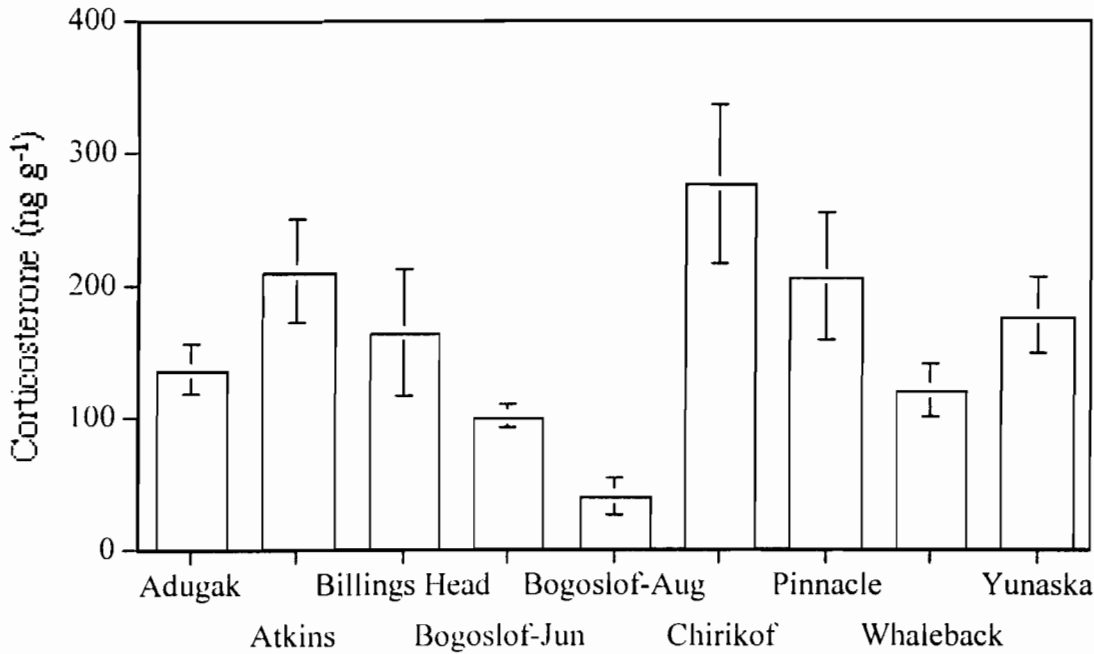


Figure 2. Mean concentration of corticosterone (SE) in scats of sea lions collected in summer 2000 from rookeries and 1 haulout (Whaleback) in the eastern Aleutian Islands and western Gulf of Alaska.

the possible significance of such variability, we calculated the rate of decline of sea lions at each location and compared those rates to the mean levels of corticosterone. We predicted that the rates of decline would be proportional to stress levels in animals if conditions remained the same over the entire interval. The relationship was consistent with that prediction: corticosterone levels rose as the rate of decline rose (Fig. 3).

- *Conclusions:*

- While, salmon & Mackerel dominate diet of SSL in E. Aleutians, not decline
- most likely large fish
- stress levels of SSL at rookeries ^{in summer} were proportional to stress levels.
- support ~~level~~ level as theory for decline.
- ~~think~~ ~~was~~
- whether was affecting level web & ecosystem - steel vests

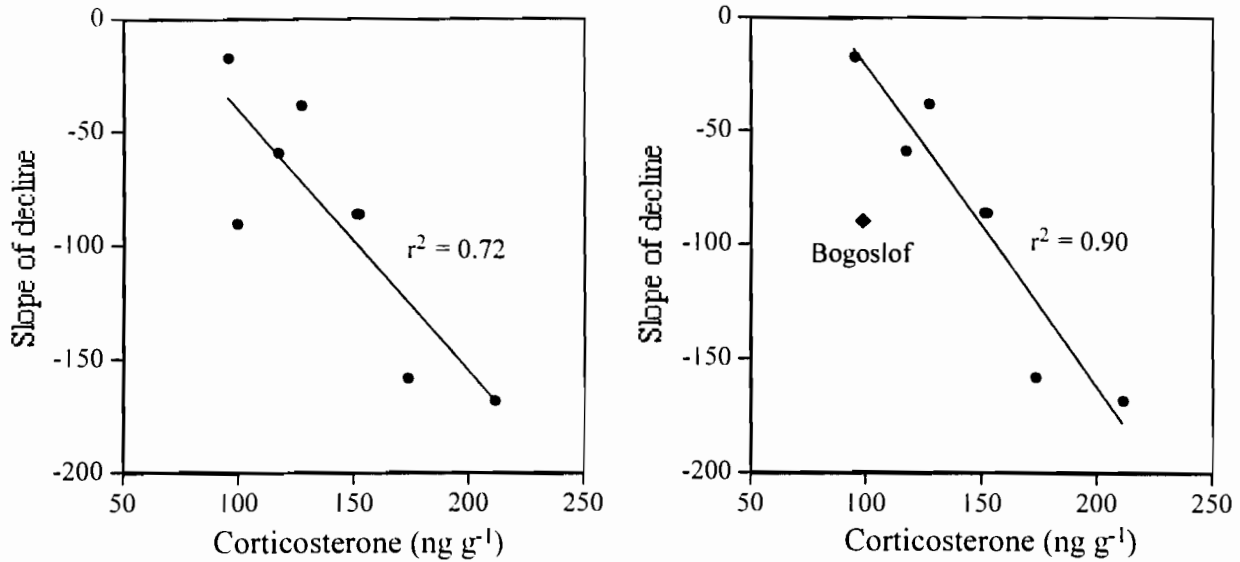


Figure 3. Relationship between sea lion stress, as measured by corticosterone in scats, and the rate of decline at locations in the eastern Aleutian Islands and western Gulf of Alaska. Regression in right hand panel excludes Bogoslof I.

Stress can be caused by several things, including chronic disturbance, contamination, disease, and poor nutrition. To address the possible relationship between stress and diet, we compared corticosterone levels at each location to the preliminary diet quality index value we calculated. We predicted that stress would increase as diet quality decreased. This prediction also was confirmed (Fig. 4).

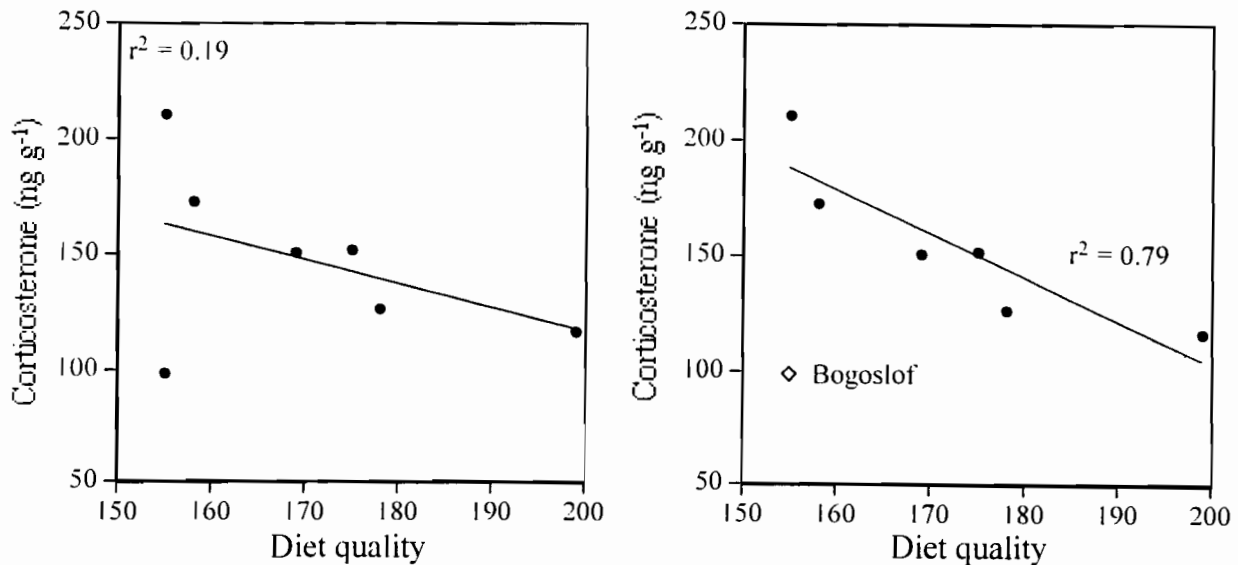


Figure 4. Relationship between sea lion diet quality and stress at locations in the eastern Aleutian Islands and western Gulf of Alaska. Regression in right hand panel excludes Bogoslof I.

or correlations between diet, stress decline might be symptomatic of undrains in the ecosystem.

These preliminary relationships support the hypothesis that low quality diets are physiologically stressful to sea lions and lead to population declines. If they hold up after refinement and scrutiny, they imply that conditions during the past decade of slow but steady decline of sea lions in the western stock still exist, and could lead to a prediction that sea lions will continue to decline until conditions in the environment improve.

The relationships also highlight Bogoslof I. as a location with characteristics different from the others. That is, stress levels in sea lions at Bogoslof I. are unusually low despite diets that in the past decade have not been highly nutritious. Corticosterone levels in animals there were the lowest of all locations in June 2000, and declined during the course of the summer (Fig. 2). This pattern was consistent with observations we made of markedly lower stress levels of fur seals and seabirds there than at the Pribilofs that summer (results from ReFER). Although sea lions have declined at Bogoslof in the past 2 decades, the abundance of fur seals and sea birds there have increased greatly: the fur seal population is in exponential growth. Indeed, were it not for the rapid expansion of the area of the island fur seals occupy, sea lions numbers likely would not be as depressed as they are, since they typically lose out to fur seals in competition for space (T. Loughlin pers. com.).

One possible explanation of the discrepancy between stress and diet at Bogoslof is that information obtained over the past decade on diets may not be representative of current diets. This possibility can be addressed when scat samples collected there in summer 2000, and from which we took our aliquots for corticosterone analyses, have been analyzed for diet information.

Continuing work

We have been given aliquots of scats collected from these rookeries, satellite rookeries, and nearby haulouts in winter 2001 and await aliquots from summer 2001. We will receive additional samples from winter and summer 2002. All samples from the Pribilofs, eastern Aleutians, and western GOA obtained in 2001 will be processed together in one batch for consistency once we receive the outstanding aliquots from NMML. The data will be compared to the summer data.

We will complete the proximate analyses of prey and use the data to refine our preliminary diet quality index. Additional prey may be requested from NMFS, which will conduct winter and summer trawl surveys in the eastern Bering Sea again in 2002.

We continue to obtain samples from the subsistence harvest of sea lions on the Pribilofs, which include stomachs and colon contents. Once we have a sufficient number for rigorous comparisons, we will look for possible relationships between stress, age, sex, diets, and season of harvest.

We are striving to secure funding to continue the focused studies at Bogoslof I. and the Pribilofs. The compelling differences in conditions at these two locations, as demonstrated by contrasting population trends of fur seals and seabirds and by low stress levels in these species and sea lions, continue to provide a rich opportunity to gain a better understanding of food web production processes and ecosystem behavior in this important region of Alaska.

- size of fish determines lipid content - bigger → more.
- got scat samples for stress hormone levels.
- Calculated diet index for each site -
- compared diet index to stress index - correlated except for Bogoslof.
- " stress to date of decline = correlated. " " "