Foraging Behavior and Energetics of Adult Female Steller Sea Lions

Russel D. Andrews
University of British Columbia, Department of Zoology, Vancouver, B.C., Canada

Donald G. Calkins
Alaska SeaLife Center, Seward, Alaska

Randall W. Davis
Texas A&M University, Galveston, Texas

Brenda L. Norcross
University of Alaska Fairbanks, Institute of Marine Science, Fairbanks, Alaska

Katja Peijnenberg and Andrew W. Trites
University of British Columbia, Department of Zoology and Marine Mammal Research Unit, Vancouver, B.C., Canada

May 2001

The current decline in the population of Steller sea lions (SSL) in western Alaska may be attributable to food shortages in critical areas. Unfortunately, the feeding ecology of SSLs is poorly understood. Population modeling suggests that a decline in juvenile survival is a likely explanation for the recent SSL population decline. Such an increase in juvenile mortality could be due to the inability of mothers to adequately nourish their pups during lactation, or could be due to weaned juveniles not being able to successfully forage on their own. Other pinniped species have been observed to respond to apparent nutritional stress by increasing female foraging trip durations during lactation and/or increasing energy expenditure during foraging.

Studying the foraging behavior and energetics of pups and lactating females should reveal whether SSLs are food stressed in the areas where

their numbers continue to decline. Predictions from such a nutritional stress hypothesis include: (1) lactating female SSLs will increase their foraging effort in the area of population decline, and this may be reflected in increased energy expenditure or a change in diving strategy, such as less time spent resting; (2) foraging trip durations will be longer in the area of decline; (3) and sea lions in the area of decline will travel for a longer period of time or cover greater distance before successfully finding and ingesting prey.

Captive juvenile SSLs at the Vancouver Aquarium were used to develop and validate the use of stomach temperature monitoring in order to determine the timing and quantity of prey ingestion (indicated by precipitous drops in stomach temperature). Estimation of the quantity of ingested prey was complicated by many factors (e.g., body temperature and stomach heat flux changes, movement of the stomach temperature transmitter [STT] within the stomach, diverse prey size and shape, potentially concomitant water ingestion, and insulation of the STT by previously swallowed prey) and suffered a large margin of error. Determination of the timing of ingestion, however, was much more accurate, at least for the first few ingestion events in a bout of feeding. Initial deployments on wild SSLs demonstrated that prey were consumed on all foraging trips. However, long periods of time often elapsed and large distances were covered between successful foraging events. The preliminary work demonstrated that knowing where sea lions traveled and dove does not necessarily allow one to distinguish productive feeding areas from unproductive ones.

In June 1997, we conducted a test of the hypothesis that the current SSL decline is due to nutritional stress. SSLs were studied at two of the central Aleutian Islands, Seguam and Yunaska, and at the Forrester Island rookery complex in southeast Alaska. In the central Aleutians, 5 lactating SSL were captured and instrumented as described above. Four of these were recaptured, but one sea lion had lost her instrument package, resulting in the recovery of three foraging records from this area. Near Forrester Island, 10 lactating SSL were captured and instrumented. Five of these were recaptured and all resulted in successful data recordings. During the research cruise near Forrester Island, real-time satellite tracking data on the at-sea locations of sea lions were relayed to a vessel conducting a fish assessment around Forrester Island, and a similar fish assessment occurred around Seguam Island that summer.

Although a great deal of variability in foraging behavior was observed (both at the individual and rookery level), some basic differences between SSLs from different regions can be identified. Trip durations and the percent time spent at sea were much shorter for SSLs from Seguam Island compared to those from the Forrester Island rookery. Dives at Seguam Island were shorter and shallower, but more frequent than those at Forrester Island The short trips at Seguam Island generally consisted of a single bout of uninterrupted dive cycles while at Forrester Island the trips were broken into dive bouts of varying length separated by periods spent trav-

eling or resting at the surface. However, on average, the percent of a trip spent submerged was not significantly different. Another measure of foraging effort, the vertical travel distance per unit time at sea, was about 1.5 times greater for SSLs at Forrester Island. The at-sea field metabolic rates, however, were similar for both groups. Data on the time and distance elapsed from departure on a foraging trip until commencement of "foraging dives" shows that at both rookeries SSLs appear to begin searching for prey very soon after entering the water. However, the mean time from departure to first prey ingestion, identified by the stomach temperature record, was about five times longer for SSLs at Forrester Island than at Seguam Island. The rough estimation of prey intake rate at Seguam Island was about two times greater than at Forrester Island. Therefore, it would appear that in 1997, adult female SSLs at Seguam Island found suitable prey more quickly, and once they found it were able to ingest it at a much higher rate than SSLs at Forrester Island.

The higher prey capture rate of SSLs at Seguam apparently allows these sea lions to spend shorter periods away from their pups and thereby spend a greater proportion of total time suckling their pups. This may account for the nearly two times greater pup growth rates measured in the central Aleutians compared to Forrester Island (E. Brandon and R.W. Davis, Texas A&M University, Galveston, unpubl. data). The fish abundance assessments conducted at these two rookeries concurrent with the SSL monitoring may provide some insight into the differences in prey capture rate. Catch per unit effort for the fishing vessel at Seguam and another central Aleutians rookery was much higher than that at Forrester Island.

The following factors restrict our ability to make inferences concerning either the past or current SSL population decline, from this limited comparison of the foraging ecology of SSLs in both declining and stable populations: (1) extremely small sample sizes, (2) the possibility of adverse effects of the instruments on foraging behavior and energetics, (3) the difference between the current rate of decline compared to the larger rate from 1979 to 1990, (4) density dependent effects on individual foraging success (reduced population size implies reduced intra-specific competition), (5) and the potential interannual variations in many environmental parameters (e.g., the 1997 El Niño and the anomalous conditions in the Bering Sea that year). However, the direct comparison between two similarly handled groups should allow some general conclusions about SSL foraging behavior to be drawn. From this study it appears that a directly measured difference in prey availability may account for the observed difference in prey capture rate. This greater capture rate by SSLs at Seguam Island may partially explain the greater pup growth rates observed there compared to Forrester Island. The lack of a single highly abundant prey species and the larger SSL population at Forrester Island may result in longer search times for Forrester Island SSL. An important value of this and the related studies to date is that we were able to demonstrate a correlation between prey availability, foraging success, and pup growth, a pa-

rameter that is potentially indicative of future survival and therefore adult female reproductive success.

Acknowledgments

This research was funded by the North Pacific Marine Science Foundation and the National Oceanic and Atmospheric Administration through grants to the North Pacific Universities Marine Mammal Research Consortium, the National Marine Mammal Laboratory, and the Alaska Department of Fish and Game. Critical field support was also received from researchers from the National Marine Mammal Laboratory, NMFS, NOAA; Alaska Department of Fish and Game; University of Alaska Fairbanks; and University of California at Santa Cruz.