Early Maternal Care and Pup Survival in Steller Sea Lions

A Remote Video Monitoring Project in the Northern Gulf of Alaska

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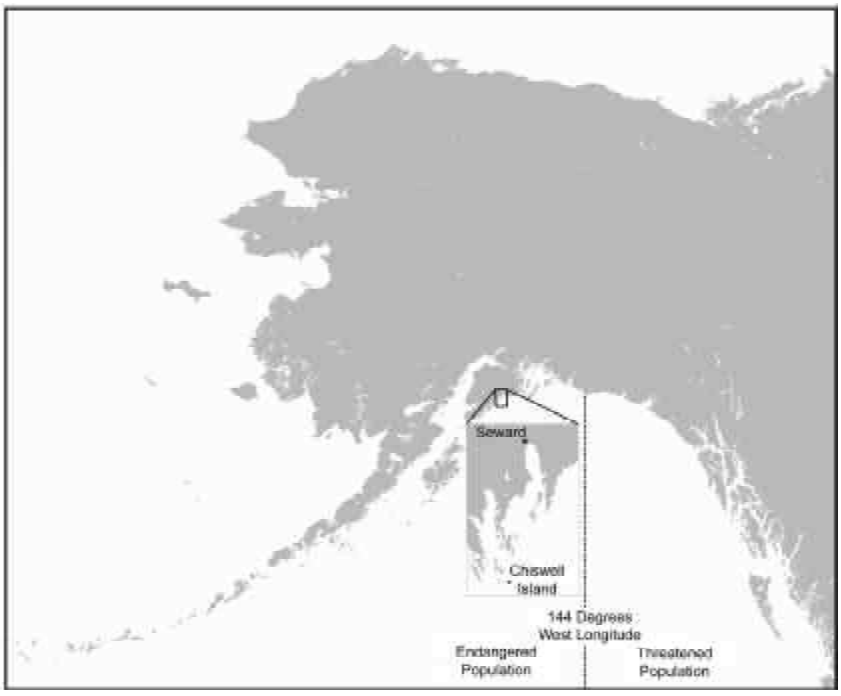
The endangered western population of Steller sea lions that occurs within and adjacent to several of Alaska's National Parks (Anaikchak National Monument and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park, and Lake Clark National Park and Preserve) has undergone a major population decline over the last several decades. In an effort to understand the mechanics of the decline, the Alaska SeaLife Center, in cooperation with National Fish and Wildlife Foundation, the National Marine Fisheries Service, and the Ocean Alaska Science and Learning Center, is studying, through the application of remote cameras and field research, the behavioral ecology of this species throughout its range. One component of the study is investigating the importance of early maternal care to young Steller sea lions.

Early maternal care in mammalian species is a key factor affecting the health and survival of young well into their future. Increased time and energy spent caring for offspring generally translates into stronger, healthier, and socially well-adapted individuals. However, many species, including Steller sea lions, must forsake the care of their offspring for varying intervals of time in order to obtain food. Steller sea lions, like other eared seals, give birth to one pup on land and remain with the newborn for a period of time ranging from a few days to a few weeks before returning to forage at sea. This interval, termed the perinatal period, can indicate how well the mother was able to feed prior to giving birth. For one year or more after the perinatal period, female sea lions alternate foraging trips at sea with time spent on shore resting and nursing their pup. The periodicity of this alternating cycle between foraging and caring for the young predominantly depends

A remotely controlled camera spies on Steller sea lion behavior at Chiswell Island in the Gulf of Alaska.



Location of the Chiswell Island Steller sea lion rookery and the delineation between the eastern (threatened) and western (endangered) populations.

on the mother's ability to obtain sufficient food near the home site. For instance, if the abundance or quality of prey near a sea lion rookery is depleted, longer foraging trips to sea would be expected, with less time available to care for pups. This example is one of the hypotheses put forth to explain the decline of the western stock of Steller sea lions in Alaskan waters.

Dramatic declines in Steller sea lion abundance began in the early 1970s and prompted the listing of the species as threatened under the U. S. Endangered Species Act in 1990. Continued declines in central and western Alaska, west of 144°W longitude, resulted in a 1997 decision to up-list this western stock of Steller sea lions to endangered status. There are at least three broad hypotheses for explaining the observed declines:

- Commercial fishing effects from entanglements, incidental catches, or competition for sea lion prey;
- Ecosystem changes resulting in alterations in the abundance, distribution, or quality of prey species available, or alterations of some form of critical habitat; and
- Predation, primarily by killer whales, which may have shifted to preying more upon sea lions after other large prey items such as baleen whales were removed from the ecosystem by hunting.

Other hypotheses that are thought to be less likely reasons for the decline include disease, pollution, subsistence use, and redistribution. However, some of these are under renewed investigation.

Food quality, quantity, or availability can be affected by the first two hypotheses and should be reflected in how much time and energy female sea lions expend in pup care. Several maternal investment studies conducted in recent years have provided evidence along these lines.

The purpose of our study was to assess various aspects of maternal care in Steller sea lions using a remotely controlled camera system to continuously observe sea lion behavior. We were also able to observe probable and actual causes of pup mortality due to predation and storms.

Study Methods

Our study focused on a small Steller sea lion rookery at Chiswell Island in the northcentral Gulf of Alaska. Remotely operated cameras were first installed on this island in October 1998 by See-More Wildlife Systems, Inc. of Homer, Alaska. The cameras were used initially to monitor the utilization of this rookery by different age and sex classes and for observations of marked or otherwise identifiable animals. Additional cameras were later placed on nearby island haulouts to broaden the study of sea lion population dynamics in this area.

Currently ten cameras on Chiswell Island and nearby haulouts are operated from the Alaska SeaLife Center (ASLC) in Seward, Alaska. Each camera is equipped with 12- to 18-power optical and 180- to 300-power digital zoom lenses mounted in fully weatherproof housings and with remotely controlled pan, tilt, zoom, and windshield wiper/washer functions. Audio and video signals are sent via cable to a central control tower on Chiswell Island, which transmits the images and sound approximately 35 miles to ASLC via microwave transmission. The cameras and control tower are powered by a 12-volt battery system charged by solar and wind power. At ASLC, audio and video signals are viewed and recorded in real time with typical television monitors and VCRs, while commands for controlling the cameras are sent from custom-made software running on a desktop computer. This technology allows us to observe the sea lions in their natural habitat without disturbance and without impairment by the extreme weather conditions that often occur in the Gulf of Alaska.

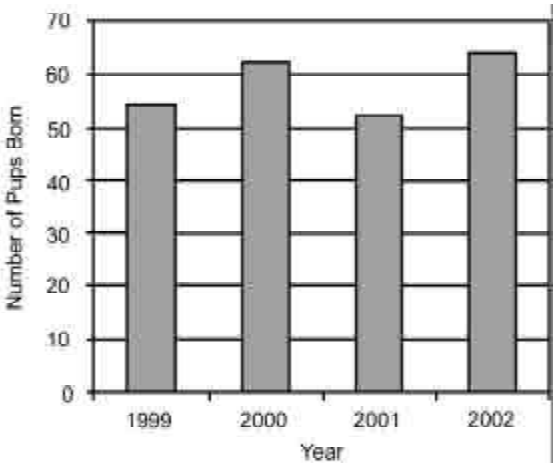
The first few years that this system was in place, daily population counts were conducted and pupping success and survivability were esti-

mated. In the spring of 2001, we expanded our research to include a detailed maternal investment study. During this portion of the study we monitored approximately thirty individually recognizable females during 2001 and 2002, from their arrival in late May, when they gave birth, through early August in order to estimate maternal investment by recording the amount of time spent nursing and the duration of foraging cycles. We were also able to determine some causes of early pup mortality by watching these animals from dawn until dusk during the long summer daylight hours.

Maternal Care

The number of Steller sea lion births on Chiswell Island during the past four years has shown a biannual cycle, with more births occurring during even-numbered years. In 1999 there was one stillborn and one pup that died very shortly after birth, and in 2001 there were two stillbirths. Only one stillbirth occurred during 2000 and one during 2002. The observations of stillbirths are not significant on their own but lend credence to an overall pattern in maternal dynamics at this rookery.

Birthdates of Steller sea lion pups on Chiswell Island ranged from May 23 to July 4 during the years 1999–2002, except for one stillbirth on May 20, 2001. The consistency we have observed in timing of births, which is common in most animals living at high latitudes, is likely the result of evolutionary selection for coinciding births with food abundance and optimal weather conditions. However, the timing of births varies between years and throughout the range of Steller sea lions. Births were generally earlier in 2001 than in 2002. Paired comparisons of 16 known females that had pups during both years showed a significant three-day difference, averaging June 8 in 2001 and June 11 in 2002. The variability for those 16 females was 0 to 11 days, showing some plasticity in the timing of giving birth. This may result from variation in their ability to locate sufficient prey from year to year, or it may be caused by some other, not so obvious, cue. Pupping was also more synchronous in 2002, with the range of birth dates seven days shorter than in 2001. Factors controlling the consistent timing of births in marine mammals have rarely been studied; it has been assumed that this is simply a function of normal biological variation. Our data suggest that there may be physiological and behavioral controls over the timing of pupping, which warrant further study.

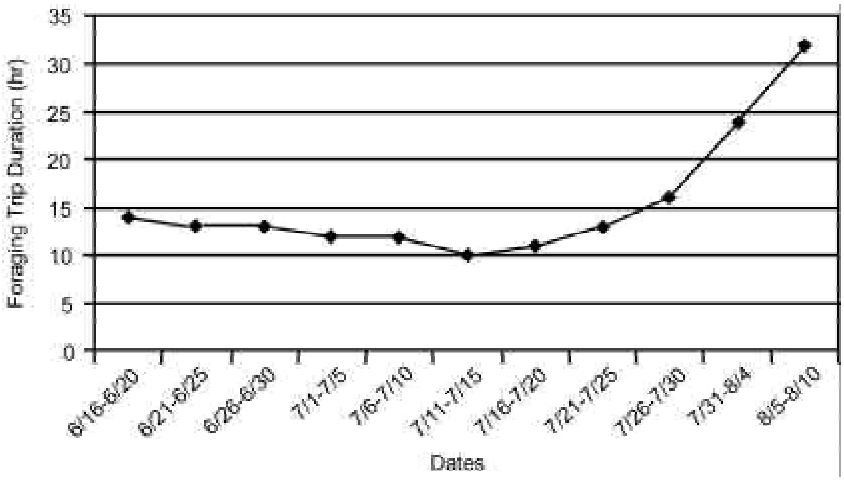


Numbers of Steller sea lions born at Chiswell Island, 1999–2002.

During years of poor food availability, female sea lions tend to have a relatively short time between giving birth and the subsequent foraging trip to sea (the perinatal period). It is likely that they have insufficient energy reserves to meet early lactation needs and therefore must replenish them sooner in poor food years than in years of good food availability. This has been shown to be the case elsewhere; sea lions along the California coast had perinatal periods averaging only 3–4 days during El Niño years, compared to 6–7 days in other years. The average perinatal period for sea lions at Chiswell Island was more than two days longer in 2002 (11.9 days) than in 2001 (9.8 days), suggesting that 2002 may have been a better year for obtaining sufficient prey prior to giving birth. However, the perinatal periods in both years were relatively high compared to those known for Steller sea lions throughout their range. Other studies in Alaska have estimated average perinatal durations between 8.0 and 10.1 days. This indicates that the Chiswell Island animals were probably well fed prior to giving birth, though interannual variations do occur.

There was a significant correlation between the duration of the perinatal period and the timing of births—females that gave birth later in the season generally left to forage sooner than females that gave birth earlier. Among seal and sea lion species, older females tend to give birth earlier in the season than younger ones. Also, older females are presumably more experienced at capturing prey, and rapid, skillful acquisition of large quantities of food prior to pupping would allow them to remain on the rookery for longer periods after giving birth.

After the perinatal period, lactating females begin a routine of feeding at sea followed by resting and nursing pups on shore. Feeding trips from Chiswell Island during the first few months after



Foraging trip duration from combined 2001 and 2002 data showing changes throughout the summer.

pupping averaged 15.6 hours in 2001 and 11.4 hours in 2002, which also indicates that food was more abundant during 2002. Time spent on shore was correspondingly longer in 2001, averaging 22.5 hours compared to 19.9 hours in 2002. Yet, on a percentage basis, females still spent relatively more of their time foraging at sea in 2001 (41%) than in 2002 (36%).

At Chiswell Island, foraging trip durations decreased slightly in the first month after birth from approximately 14 hours to 10 hours. The longer trips shortly after giving birth may indicate that females required more time feeding in order to replenish lost energy from the perinatal fast. However, after approximately a month, foraging trips increased steadily for at least another 25 days, reaching an average of greater than 30 hours. Some foraging trips lasted up to four days at two months after giving birth. By this time, most of the pups are increasingly active and swimming frequently, so their growth and energy demands are increasing. The mothers must spend more time foraging to meet these increasing demands, as lactation is costly in terms of energy expenditure. Foraging trip duration increased sharply at the end of July in both 2001 and 2002. This may also suggest that prey resources nearby the rookery had been consumed or had moved elsewhere.

Our research suggests that Steller sea lions on Chiswell Island may experience alternating "good" years and "not-so-good" years for pup production and postnatal care. If this cycle is actually related to prey abundance, we would expect to see a similar pattern there. The best-known fish species in Alaska that has a biannual cycle is the pink salmon. Pink salmon runs are currently stronger during even years than in odd years in the Resurrection Bay area and the northern Gulf of Alaska, which corresponds with years of healthy production at the Chiswell Island rookery. Salmon species are common in the diet of Steller sea lions in Alaskan waters, though they are not thought to be a predominant prey item for the western stock. Therefore, the biannual cycles in pink salmon may not, by themselves, explain the similar cycles in Steller sea lion productivity. Current investigations by ASLC and the University of Alaska Fairbanks of Steller sea lion diet and food availability in the Chiswell Island area may help us understand these cycles more completely.

We recorded and analyzed 336 half-hour behavior samples on randomly selected females between June 1 and August 10, 2001. Lactating females spent 9.6% of their time nursing during the afternoon, compared to 7.1% in the morning and 4.2% in the evening. The amount of time per day spent nursing varied widely. The amount of time spent nursing was the same during the perinatal period as after the perinatal period (6.1%). In other sea lion species, suckling time increases during the first few months of the pups' life and has been correlated with milk intake. Suckling times for Steller sea lion pups do not necessarily increase during this period, but rather their suckling efficiency improves, allowing them to ingest more milk as they grow. The overall percentage of time spent suckling is similar to that at other rookeries in Alaska.

Causes of Pup Mortality and Survival

The stillbirths observed at Chiswell Island were not collected nor were their mothers examined, so the true reasons for these failures to produce live pups are not known. Furthermore, an unknown number of females may abort their pups before arriving at the rookery. Alaska Department of Fish and Game research published in 1998 reported reproductive failures to be as high as 45% during the 1980s. Those females that did successfully reproduce were healthier, as determined by weight and blubber thickness, than those that did not reproduce. Other potential causes for reproductive failure may include high body burdens of contaminants, genetic incompatibility, disease, and naturally produced toxic algal blooms.

One female pup died eleven days after being born in 2002. A necropsy on this animal revealed massive amounts of bruising around the hips and right shoulder and a puncture wound near the right hip. Death was attributed to an infected

abscess near the vaginal cavity. Female Steller sea lions are often intolerant of offspring that are not their own, and it is not uncommon to observe them picking up and tossing other pups that get too close. These instances rarely result in a fatality for the pup, but we believe that this was likely the cause of death in this case. Breeding bulls on the rookery can weigh up to one ton and are often indifferent toward the pups. An inattentive bull may also inadvertently crush a pup during a territorial conflict with another bull, although we have not observed this on Chiswell Island.

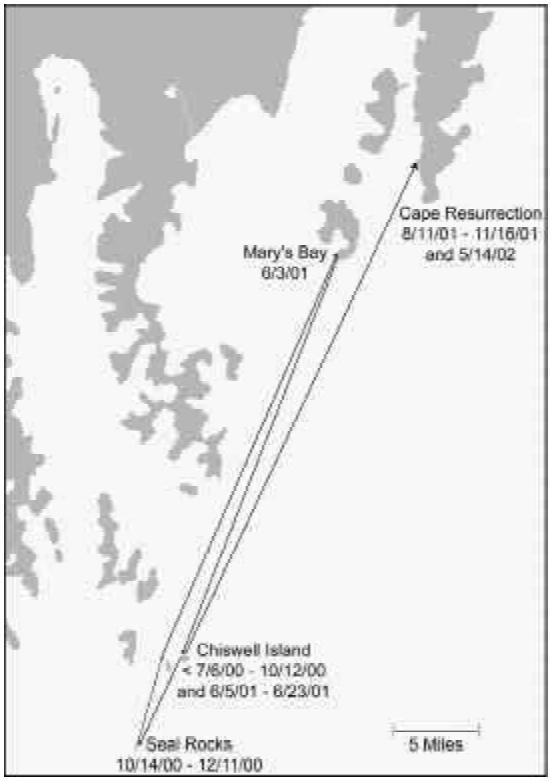
During 2002, two major storms with seas of 20 feet or more buffeted Chiswell Island during the month of June, washing pups from the rookery. Storms of this proportion are common in the Gulf of Alaska during winter but not in summer. Most of the pups were less than one week old and unable to swim effectively on their own when the first storm hit on June 8, 2002. At least eight pups were lost during that storm, and another three were lost during the second storm in late June, representing 17% of the pups born on Chiswell that year. Maternal care also includes removing pups from harm's way, and pups that did survive these storms were pulled by the nape of the neck high onto the rookery and, in some cases, out of the surf. Pups that were washed away were presumed dead from starvation or drowning. Storms of this proportion had not been observed during June in the preceding three years.

The extent of predation by killer whales on Steller sea lions is another issue that is currently being investigated by ASLC and the North Gulf Oceanic Society (NGOS). Other predators such as sharks are not currently thought to take sea lions to any significant extent in Alaskan waters. One or more transient killer whales have been seen near shore at Chiswell Island on 35 days in 2001, compared to 14 days in 2000 and only 4 days in 1999. Increased sightings during 2001 may be due, in part, to greater observer effort and greater awareness of these predators. A single killer whale, identified by NGOS in 2000 as AT109, a female more than 30 years old, was seen most often at Chiswell Island. This killer whale exhibits unusual behavior for a transient, such as tail-slapping and breaching immediately in front of the rookery. (Transient killer whales are normally stealthy predators of marine mammals, unlike residents, which primarily eat fish and do not need to remain quiet.)

There has only been one confirmed report of a kill by AT109 at Chiswell Island on July 31, 2001, from a local tour boat captain. This animal, with a sea lion in her mouth, swam directly under the vessel about 150 m from the island. The age or sex of the sea lion could not be determined, but it was assumed to be approximately six weeks of age. Once in 2000 and twice in 2001, we observed AT109 making charges into sea lion groups in the water. However, she disappeared below the surface after these attacks, so her success in capturing her prey was unknown. We assume that she is preying upon pups and other young individuals because we saw no flocking birds or prey pieces from the tearing apart of large sea lions that would indicate such activity; pups and other small individuals could probably be swallowed whole. As further evidence, AT109 visited for nine days in 2001; pup numbers dropped significantly from an average of 50.2 for four days prior to the visit to 38.2 for four days after the visit. During the same four-day periods in 2000 when no killer whales were present, there was not a significant change in pup numbers. At a minimum, AT109 causes a major disturbance to the rookery. Of 31 identifiable females known to have pups prior to the 2001 killer whale visit, only 27 of them still had pups after the visit. These data give us a range of pup losses from 13 to 24% at Chiswell Island due to predation during only one and a half weeks in 2001. As of September, AT109 had not been seen at Chiswell Island during 2002, though she has been sighted elsewhere in north gulf coast waters.

While not all Steller sea lion pups survive through their first year of life, we determined that at least 46% of the Chiswell Island pups born in 2000 survived to at least April 2001. The easiest way to estimate sea lion survival and movements is by marking these animals as pups. The National Marine Fisheries Service, the Alaska Department of Fish and Game, and ASLC have tagged and branded hundreds of pups throughout Alaska during the past few years. Thirty pups were tagged at Chiswell Island in 2000. The following is a case study of one individual that remained in the Chiswell Island/Resurrection Bay area over its first few years.

A female pup was tagged with the number 971 on July 6, 2000, weighing 29 kg at approximately one month of age. She remained on Chiswell Island through October 12, 2000, then moved five miles to the south, where she was seen on October 14, 2000, at Seal Rocks with her mother. The pair was subsequently observed several times at Seal Rocks until December 11, 2000. However, partly due to camera difficulties through much of the winter, they were not observed again until the



The travels of tagged pup number 971 through its first two years of life.

next summer. On June 3, 2001, 971 was identified by a local tour boat captain at the Mary's Bay haulout near the mouth of Resurrection Bay. Two days later, 971 returned to Chiswell Island with her mother and was still nursing. On June 6, 971's mother gave birth again, and 971 was immediately weaned. However, she was subsequently seen with the mother and new pup until late June.

We continued to follow 971's mother through most of the early breeding season, but her natural markings were not strong enough to confidently identify her when she was more active later in the season. Later, we observed 971 by herself at the Cape Resurrection haulout on August 11 and November 16, 2001, and then again on May 14, 2002. She appeared to be very healthy and retained both of her tags. We hope she returns to breed at Chiswell Island some day.

Summary

Interannual variations do occur in Steller sea lion pup production and maternal care at Chiswell Island. Maternal investment during both "good" and "not-so-good" years is comparable to or better than that seen in the eastern population of sea lions, which appears to have stabilized in recent years. The biannual cycle at Chiswell Island does suggest, however, that these animals may need more food or higher quality food than they are able to obtain in certain years. The animals of the western stock are somewhat distinct from the eastern stock and therefore may need more or different types of prey to successfully produce and raise a pup; this may be caused by differences in their genetic makeup, the environment (such as colder water), or the lipid, protein, or vitamin content of their predominant prey species.

Early pup mortality can be caused by killer whale predation or unusual storms that occur when pups are too young to swim effectively. Stillbirths and intraspecific aggression are not thought to be major factors of early pup mortality; the occurrence of abortions prior to the females arriving at Chiswell Island is not known. The amount of maternal care that Steller sea lion pups receive can affect their ability to survive storms, feeding killer whales, accidents, or other fates as changes occur in the health and attentiveness of their mothers and of themselves.

These and other results from the Alaska SeaLife Center's comprehensive Steller sea lion research program continues to provide the information needed by resource managers to better understand and develop the best possible management strategies for the species and its ecosystem.

The Chiswell Island group is part of the U.S. Fish and Wildlife Service's Alaska Maritime National Wildlife Refuge. The placement of equipment and research conducted on refuge land was done under a special use permit issued by the U.S. Fish and Wildlife Service and under NMFS permit No. 782-1532-00 issued under the authority of the Marine Mammal Protection Act and the Endangered Species Act.

Suggestions for Further Reading

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