

Killer Whales and Predation on Steller Sea Lions

Craig O. Matkin

North Gulf Oceanic Society, Homer, Alaska

Lance Barrett Lennard

University of British Columbia, Department of Zoology, Vancouver, British Columbia, Canada

Graeme Ellis

Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo, British Columbia, Canada

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The western stock of Steller sea lions has declined from over 140,000 individuals in the 1960s to possibly fewer than 40,000 individuals in 2000. The primary hypotheses put forth by the National Marine Fisheries Service (NMFS) explaining this decline centers around food limitation. One alternative hypothesis that has recently received attention is that the decline or lack of recovery is due to the effects of predation by killer whales or sharks. Reports of large numbers of killer whales surrounding longline and trawl fishing vessels in western Alaska suggest that there are many killer whales in the region.

In order to assess the impact of killer whale predation on this population decline, we need the following information:

1. Number of Steller sea lions.
2. Intrinsic growth rate of Steller sea lion population.
3. Number of killer whales that prey on Steller sea lions.
4. Percentage of the killer whale diet that consists of Steller sea lions and age class of sea lion that is consumed.

Table 1. Killer whale population estimates for Alaska, British Columbia, and Washington.

Region	Resident	Transient	Total	Reference
Southeast Alaska, B.C., Washington	405 (65%)	219 (35%)	624 ^a	Ford and Ellis 1999, Ford et al. 2000, Matkin et al. 1999
PWS/Kenai Fjords	352 (87%)	54 (13%)	406	Matkin et al. 1999
Western Alaska	238 (88%)	33 (12%)	271	Dahlheim 1994, NMFS NMML Database
Total	995 (76%)	306 (24%)	1,301 ^a	

^aDoes not include 200+ genetically unique "offshore whales."

There are good data from adult and pup counts on trend sites (haulouts and rookeries) to establish minimum numbers of Steller sea lions both in the eastern population (about 30,000) and in the western population (about 39,000) (Ferrero et al. 2001). A.W. Trites (University of British Columbia, Vancouver, pers. comm.) estimated an intrinsic rate of increase of 4% for Steller sea lions in both the eastern and western populations. However, in the 1980s the population was estimated to have declined at an annual rate of 15%, while in the 1990s the population was estimated to have declined at an annual rate of 5%.

In the eastern North Pacific, from Puget Sound to Kenai Fjords, two ecotypes of killer whales have been identified. These are residents (fish eaters) and transients (marine mammal eaters). They are genetically separable using mtDNA sequencing of the d loop region and nuclear DNA microsatellite techniques. They do not associate or interbreed. It appears that a similar division exists in western Alaska; however, separation of ecotypes in this region has been based only on visual inspection of photographs of individually identifiable animals.

Genetic separation using mtDNA has determined two haplotypes of resident whales, northern resident and southern resident. Although both haplotypes exist in the Prince William Sound/Kenai Fjords region as separate acoustic clans, there is male mediated gene flow between them. Several haplotypes of transient killer whales have been identified in Alaska, including the unique AT1 transient population, the Gulf of Alaska transients, and the West Coast transients. The AT1 transients appear limited to the Prince William Sound/Kenai Fjords region and have declined from 22 whales in 1988 to 10 whales in 2001. The Gulf of Alaska transients are of unknown population size but have been photographed from Prince William Sound west to the waters around Kodiak Island. We suspect their

Table 2. Marine mammals and predation by West Coast transient killer whales in British Columbia, 1973-1996.^a

Prey species	Kill	Harassment	Total	(% of total)
Harbor seal	72	8	80	(49)
Harbor porpoise	16	0	16	(10)
Steller sea lion	8	12	20	(12)
Dall's porpoise	7	11	18	(11)
California sea lion	4	4	8	(5)
White-sided dolphin	1	3	4	(2)
Gray whale	0	2	2	(1)
Minke whale	0	1	1	(1)
River otter	0	3	3	(1)
Unidentified mammal	14	0	14	(8)

Also observed were 27 attacks on seabirds.

^aFrom Ford et al. 1998.

range extends to the west beyond Kodiak. Accurate determination of the size of the transient population in the waters west of Kenai Fjords is necessary to assess the impact of killer whale predation on Steller sea lions.

There are more residents than transients, particularly in the range of the western Steller sea lion (Table 1). In British Columbia and southeastern Alaska, where harbor seal and Steller sea lion populations have been stable or increasing, the percentage of transients is much higher than in Prince William Sound/Kenai Fjords or from preliminary data from western Alaska.

Based on population numbers from Prince William Sound/Kenai Fjords and the preliminary data from western Alaska, we developed a point estimate of 125 marine mammal-eating transient killer whales occupying the range of the western Alaska population of Steller sea lions. The actual figure may range higher or lower than this.

Stomach contents from six Alaska killer whales contained harbor seals (in 5 stomachs), Dall's porpoise (in 2 stomachs), Steller sea lions (in 2 stomachs), and beluga (in 1 stomach). One stomach was empty. The percentage of the killer whale diet that consists of Steller sea lions has been examined during feeding habit studies of killer whales conducted in British Columbia and in Prince William Sound. (Tables 2 and 3) The percentage of the predation and harassment events that involved Steller sea lions were 12% in British Columbia and 19% in Prince William Sound. The actual percentages of predation were undoubtedly lower since a majority of the interactions in British Columbia and all of the interactions in Prince William Sound were harassments where no positive evidence of a kill was observed or collected. In addition, feeding habit studies in Prince William Sound

Table 3. Marine mammals and predation by AT1 and Gulf of Alaska transients in Prince William Sound, 1988-1996.^a

Prey species	Kill	Harassment	Total	(% of Total)
Harbor seal	10	12	22	(30)
Dall's porpoise	12	6	18	(23)
Steller sea lion	0	14	14	(19)
Harbor porpoise	2	0	2	(3)
Humpback whale	0	6	6	(8)
Sea otter	0	3	3	(4)
River otter	0	1	1	(1)
Unidentified mammal	7	0	7	(9)
Salmon	0	1	1	(1)

Also observed was 1 attack on seabirds.

^aFrom Saulitis et al. 2000.

Table 4. Killer whale predation estimates for western Alaska.

	High	Low	Best	Historical
Killer whale food needs (kg day ⁻¹)	72	59	59	59
Total number of killer whales	175	125	125	125
Avg. weight sea lion taken (kg)	160	300	160	160
% Sea lion in killer whale diet	0.20	0.05	0.125	0.125
No. sea lions eaten by killer whales	5,908	449	2,103	2,103
Total number of sea lions	38,000	38,000	38,000	100,000
Total sea lion deaths ^a	7,600	7,600	7,600	20,000
% Deaths due to killer whales	77	6	27	10

^aCrude death rate estimated at 0.20.

indicate that some transient populations or individuals specialize on particular prey items. The AT1 transient population preyed primarily on harbor seals and Dall's porpoises, while most Steller sea lion harassments in Prince William Sound were by specific individuals in the Gulf of Alaska killer whale transient population. Only stomachs from Gulf of Alaska transients contained Steller sea lion remains. We currently estimate a range of percent sea lion in the killer whale diet of 5-20 with a point estimate of 12.5.

The food requirements for a wild killer whale were determined using estimates of caloric requirements ($\text{cal kg}^{-1} \text{day}^{-1}$) from three sources (Baird 1994, Barrett-Lennard et al. 1995, Estes et al. 1998). Their estimates ranged from 50 to 62 $\text{cal kg}^{-1} \text{day}^{-1}$. For an average killer whale of 3,500 kg (from captive data) eating pinnipeds with an average caloric value of 3,000 cal gm^{-1} (Perez 1990), this suggests a requirement of 59-72 kg day^{-1} of prey. Estimates were made using several combinations of derived estimates for the predation parameters that simulated high, low, and best guess estimates as well as an estimate of historical predation (Table 4). A more complex model is under construction by author L. Barrett Lennard.

The results of these calculations demonstrate the need for more reliable data, particularly refinement of our estimates of killer whale population size and the percentage of sea lion in the killer whale diet. Also needed is better information on the size of sea lions typically consumed. Until these data are available, we cannot rule out the possibility that killer whale predation may be a factor in the continuing decline and lack of recovery of Steller sea lions. However, it is unlikely that they played a role in the initial decline of the western population of Steller sea lions.

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