

**Shallow Water Nearshore Fish Assemblages
Around Steller Sea Lion Haulouts Near Kodiak, Alaska**

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Abstract

Steller sea lions (SSL, *Eumetopias jubatus*) from the endangered western Alaska stock eat a variety of prey - some of commercial value others not. A common link among them is that these known prey species spawn, grow, or spend their entire lives in shallow and subtidal waters, including species whose commercial harvest is being restricted to reduce potential competition with SSL. These shallow nearshore waters, their algal cover, and fish/prey inhabitants may be of particular importance to SSL pups that use the area immediately adjacent to haulouts extensively in their first year while developing their diving and foraging abilities. Despite their potential importance to young sea lions, prey availability and other ecological attributes of nearshore SSL habitat have not been well described. One reason is that these areas are generally too shallow and rocky for standard large-vessel acoustic and trawl prey surveys.

In this study SCUBA-based surveys will be used to quantify juvenile and adult fish species present in nearshore waters adjacent to two sea lion haul-outs. Seasonal prey availability and biological and physical parameters recorded at these sites will be used to describe nearshore habitat used by young sea lions for shelter, prey, and training. These will be compared to results of similar surveys conducted at two nearby sites not used by Steller sea lions as haulouts as a means of assessing key components of traditionally used haulout habitat. SCUBA surveys will be coordinated and scheduled to coincide with and augment ongoing research on Steller sea lion diets, foraging patterns, and offshore prey availability.

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From the 1960's to 1990's the western stock of Steller sea lions (SSL, *Eumetopias jubatus*) declined by over 80% for still unknown reasons (Calkins and Goodwin 1988, Loughlin et al. 1992, Sease and Loughlin 1999, Hill and DeMaster 1999). In the 1990's, their annual rate of decline slowed to 5-10% but again, the factors affecting this change are unknown although it is believed survival between weaning and adulthood is somehow compromised (Merrick 1995, Sease and Merrick 1997). One hypothesis is that past Steller sea lion declines resulted from nutritional stress related to the quantity, quality, or availability of prey within their critical habitat (ASG 1993, Calkins et al. 1998, NMFS 1995, Sease and Merrick 1997, Merrick et al. 1997).

As with other species, critical habitat can be defined as those areas that provide prey and shelter for mothers and dependent pups (Moen 1973). Steller sea lion weaning is poorly documented but thought to be a variable and protracted process, lasting 6-23 months (Porter 1997). Through the animal's first winter the bulk of its nourishment is likely obtained from their mother who returns to suckle between multi-day foraging trips. As the pup matures it may start exploring and foraging immediately around its haulout and supplement its milk diet with shallow subtidal or intertidal demersal prey species. Pre-weaned pups' foraging depth appears to be limited to waters less than 50m (Merrick 1995) and close to haulouts despite their ability to swim long distances between haulouts (ADFG and NMML unpub.data). The waters immediately surrounding haulouts therefore may be particularly critical to inexperienced pups as they learn to forage and become entirely independent of their mothers.

Extensive use of nearshore waters around Kodiak haulouts by Steller sea lions has been documented visually and telemetrically. Data collected in 2000 and 2001 from sea lion pups captured on Long Island and equipped with satellite-linked depth recorders by NMML and ADFG show pups (born previous June) remain primarily on or near the Long Island or nearby Cape Chiniak haulout and make relatively shallow dives through early spring. In April these and other identifiable pups have been observed suckling (still nutritionally dependent on mother) on Long Island and swimming and playing within 100m of the haulout (Wynne unpub.data).

Seasonal prey use by Steller sea lions using the Long Island haulout has been documented by examining and identifying prey remains in fecal samples (scats) deposited on the haulout. As in other studies, the most frequently occurring prey varied seasonally but included flatfish (arrowtooth flounder and soles), gadids (walleye pollock and Pacific cod), cephalopods, cottids (Irish lords), and forage fish (sandlance, capelin, herring) species. Four of the most frequently occurring prey groups in sea lion scats from Long Island are considered to be shallow subtidal or intertidal species, including gunnels, sandlance, sandfish, and Irish lords (Eschmeyer and Herald 1983). Ronquils, snailfish, greenling, poachers, cockscombs, and other inter- or subtidal fish species were found less frequently in the scats. Many of the flatfish, gadid, and cottid fish species found in sea lion diets use nearshore waters and kelp beds for spawning, rearing and shelter (Eschmeyer and Herald 1983). Although it is not possible to ascertain the age of a scat's depositor, it is easy to imagine that these subtidal species would show up more frequently in scats of pups learning to forage and more restricted to shallow nearshore waters than older animals.

Objectives

Dive surveys were used to estimate prey abundance immediately adjacent to two Steller sea lion haulouts: Long Island and Cape Chiniak. Similar surveys were conducted around two

rocky headlands in the Chiniak Bay area that are not used as haulouts by Steller sea lions. The rationale for this project is:

- Subtidal species may be important to weaning Steller sea lions as they learn to forage around haulouts and supply at least some of their nourishment with limited diving capabilities,
- These species are not sampled in current prey availability studies,
- Prey abundance near haulouts may be a critical component of SSL habitat,
- This project will complement ongoing prey assessments in the deeper water around the two haulouts.

Specific Hypothesis:

We hypothesized that there is a difference in the nearshore fish species composition and abundance between haulout and non-haulout sites.

Methods

Study sites off Kodiak Island were chosen based on known patterns of use by Steller sea lions, similar physical characteristics, and accessibility. Long Island and Cape Chiniak are Steller sea lion haul outs, while Miller Point and Cliff Point are not and hence function as controls. Water depths sampled at each site included 9m, 15m, 21m, 27m and 33m.

Sites were sampled in July (2001), November (2001), March (2002), and May (2002) and July (2002). The July 2002 cruise was funded by the PCCRC. Visual transects were used to sample adult and juvenile fish and algal community structure (see following sections).

Diver Visual Transects:

The SCUBA diver visual transects consisted of both a benthic and a midwater portion. The direction of each transect was determined using a random compass bearing in a direction that maintained the transect in its requisite water depth. At each depth, three 30m transects were placed end to end, but separated by a randomly selected distance of at least 5 m.

For the benthic survey, all fishes were identified and counted within 1.0 m of the bottom in a 4 m wide swath, 2 m on either side of the transect line. The midwater survey was used to count fish on the return trip at half the water depth. All fishes were counted that were swimming within visual range of more than 1 m off the bottom (Bodkin 1986). The width of the midwater transects was calculated as twice the water clarity as measured at 2 meters off the bottom (Bodkin 1986).

Algal Surveys

To determine canopy forming and understory kelp composition and abundance, algal surveys were completed for each transect at each kelp bed during each survey. These surveys documented seasonal changes in the macroalgal assemblages at each site and depth so that this information could be correlated with seasonal changes in fish assemblages.

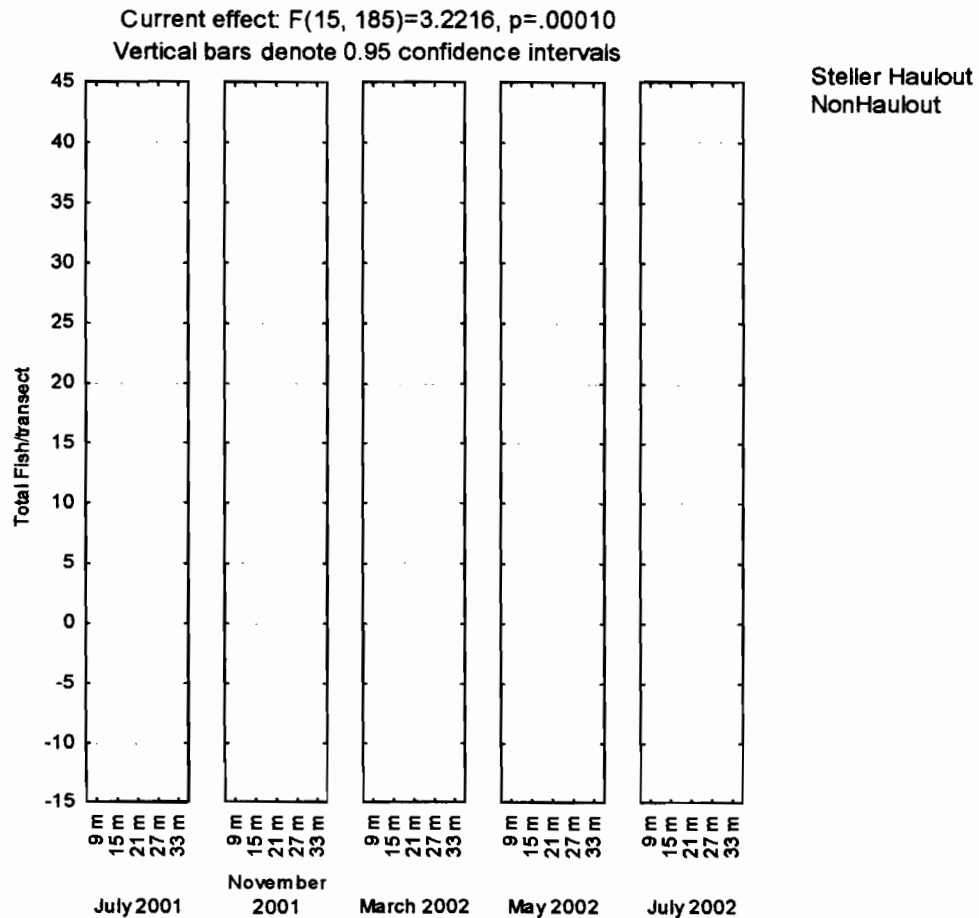
For these algal surveys, bottom substrate cover was quantified along the 30 m permanent fish transects using a 1m long point quadrat bar (similar to that described by Cowen et al. 1982). This allowed the quantification of smaller, understory macroalgae. Overstory kelp stipes (*Laminaria* sp., *Agarum cribrosum*, *Thalassiophyllum clathrus*, etc) were identified and counted within a 1m² three-sided quadrat placed adjacent to the point bar. Four point quadrat bars and four three-sided quadrats were placed randomly along each fish transect. The habitat data was correlated with the various adult and juvenile fish data to determine the relationship between particular algal (canopy-forming, overstory, or understory) and fish species and to determine habitat differences between areas.

Preliminary Results

Results for this project are currently being analyzed. Although heavy seas prevented sampling on some occasions, a total of 278 thirty meter transects were completed during the five sampling periods.

Abundance of fishes and algal composition were analyzed seasonally at the various depths at both SSL and non-SSL haulout sites using a General Linear Model, nesting site effects within the Steller/non Steller effect. From this analysis, it appears that there is a significant difference ($p=0.004$) in total fish abundance between the Steller and non Steller haulout sites, primarily at the 15, 21 and 27 m water depths and in July and November of 2001, and July 2002 (Figure 1). It also appears that the depth pattern shows an overall greater abundance of fishes at the 9, 15, and 21 m depths during July and November 2001 and July 2002 ($p>0.001$), with no significant difference between the depth strata during March and May 2002. This might be indicating a migration of fish into deeper waters during these periods. Finally, this analysis also suggests that there is a seasonal pattern that indicates a higher overall abundance of fishes during the summer months (Figure 1). Lower abundance and more even distribution patterns were found during the winter months.

FIGURE 1: Total Fish Abundance by Season and Depth, Steller and Non Steller sites



Diversity for fish was calculated as a count of the number of fish species present in a transect. Due to the large number of zero values in the data set, a diversity index such as the Shannon Weaver was inappropriate. Our diversity measure was analyzed using a similar General Linear Model as described for the fish abundance. Since no significant differences were found in fish diversity between Steller and non Steller sites ($p=0.1266$), further analysis between sampling

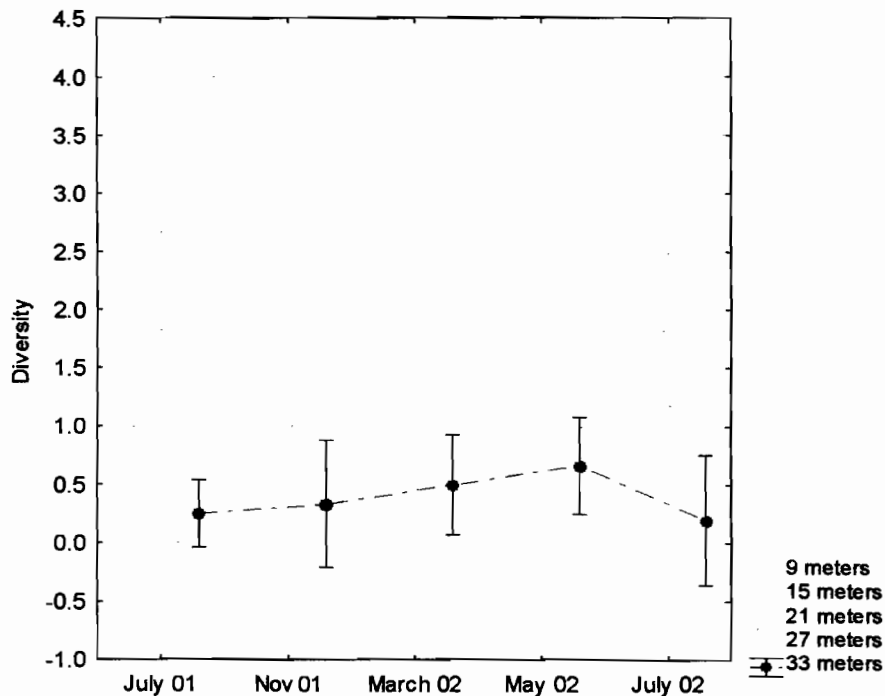
periods ($p < 0.0001$) and depth strata ($p = 0 < .0001$) combines the results for both Steller and non Steller sites.

Fish diversity was found to have both seasonal and depth strata trends (Figure 2). The seasonal trend shows an overall highest level of diversity during July 2001. The depth trend shows a steady decline in fish diversity in the shallow water depth strata of 9, 15 and 21 m. These trends persisted into the winter/spring sampling periods of November 2001 and March 2002. Diversity of fishes then increased again during May and July 2002 (Figure 2). The 9, 15, and 21 m isobaths are similar in their diversity measure and are responsible for all seasonal fluctuations. The deeper strata, 27 and 33 m show very stable diversity pattern with little or no seasonal variation (Figure 2).

FIGURE 2: Diversity Means by Depth*Sample Period

Current effect: $F(16, 185) = 3.4975, p = .00002$

Vertical bars denote 0.95 confidence intervals



A total of twelve fish species were considered common during this study (combining depths and sites; Table 1). Fishes that were less than 1% of total seen or in fewer than three total transects were considered rare species and will be analyzed later. Total counts for each common species ranged from 3 to 492. Frequency of occurrence is recorded as the number of transects in which each species was seen out of the 278 transects. These numbers ranged from one to 69 (Table 1). Some fish, such as the irish lords, were seen at Steller and non Steller sites equally while others, such as some of the greenlings, were found more at either Steller sites or non Steller sites.

TABLE 1:

Fishes Species
CompositionFrequency
of
Occurrence

Scientific Name	Common Name	Total Count	Steller	Non Steller
Hexagrammidae				
<i>Hexagrammus decagrammus</i>	Kelp Greenling	235	69	43
<i>Hexagrammus lagocephalus</i>	Rock Greenling	29	19	5
<i>Hexagrammus stelleri</i>	White Spotted Greenling	26	13	4
Scorpaenidae				
<i>Sebastes ciliatus</i>	Black Rockfish	492	11	38
<i>Sebastes</i> spp. Juvenile	Juvenile rockfish	14	1	4
Cottidae				
<i>Hemilepidotus hemilepidotus</i>	Red Irish Lord	34	12	11
<i>Hemilepidotus jordani</i>	Yellow Irish Lord	22	6	5
<i>Icelinus borealis</i>	Northern sculpin	9	4	3
Bathymasteridae				
	Unknown Ronquil	43	6	20
Gadidae				
<i>Gadus macrocephalus</i>	Juvenile gadids	5	1	0
Pleuronectidae				
<i>Lepidopsetta</i> spp	Rock Sole	23	5	7
Aulorhynchidae				
<i>Aulorhynchus flavidus</i>	Tubesnout	3	1	2

Cluster analyses are currently being performed to further explore patterns found in the fish data. Algal and benthic habitat composition are also currently being analyzed. From these analyses, correlations will be conducted between habitat and the patterns found in the fish fauna.

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