Population Status and Food Habits of Steller Sea Lions in Oregon

Robin F. Brown, Susan D. Riemer, and Bryan E. Wright

Oregon Department of Fish and Wildlife
Marine Mammal Research Program
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Corvallis, OR 97330

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INTRODUCTION AND BACKGROUND

The abundance of Steller sea lions (*Eumetopias jubatus*) has declined significantly throughout much of the species' range in the North Pacific since the mid-1970s (Braham et al. 1980, Merrick et al. 1987, National Marine Fisheries Service 1992, National Marine Fisheries Service 1995). From an original population of nearly 300,000 animals, abundance dropped 50-60% to an estimated 116,000 animals by 1989 (Loughlin et al. 1992). As a result of these observed declines, Steller sea lions were listed as "threatened" range-wide under the Endangered Species Act in 1990. Subsequent genetic analyses suggested that the population consists of two stocks (eastern and western) separated at 144^0 W longitude in the Gulf of Alaska (Bickham et al. 1996, Loughlin 1997). Steller sea lions in the western stock continued to decline in abundance at about 5% per year during the 1990s (Loughlin and York, *in press*). In 1997 the western stock was listed as "endangered", while the eastern stock remained classified as "threatened". In recent years, counts of Steller sea lions in the eastern stock (Southeast Alaska to Oregon) have increased at several percent per year (Strick et al. 1997, Sease et al. 1999, Sease and Loughlin 1999, P. Olesiuk, Dept. of Fisheries and Oceans, unpubl. Data, Riemer et al. 2001.)

Explanations for the initial decline of the western Steller sea lion stock that have been considered and determined to be unlikely ultimate causes include population redistribution, commercial and subsistence harvest, predation, effects of pollution and entanglement in marine debris (Merrick et al. 1987). It is possible that some of these factors may now be important at the current lower population levels. Sea lion mortalities incidental to commercial fisheries and shooting of animals may have contributed to the decline but are not thought to be significant at present. Currently the National Marine Fisheries Service (NMFS) and others are focusing attention on what may be declines in the quality and/or quantity of the prey base available to younger sea lions, possibly resulting in reduced nutritional condition and increased susceptibility to mortality from disease, parasitism and predation (J. Sease, National Marine Mammal Laboratory, NMFS, pers. comm.). For these reasons, the collection and analysis of data on the

distribution, abundance, population trends and food habits of Steller sea lions in parts of the range where declines have not occurred may be of important comparative value.

The two rookeries in southern Oregon and a single rookery just south of the border in northern California constitute the largest reproductive aggregation of Steller sea lions in U.S. waters south of Alaska. The Oregon Department of Fish and Wildlife (ODFW) has monitored Steller sea lion abundance and distribution at Orford Reef and Rogue Reef rookeries and at eight haul-out areas in Oregon annually by aerial photographic surveys since 1976. Surveys of sea lion abundance at the St. George Reef rookery have been conducted since 1987. Since the mid-1980s, ODFW has also collected sea lion scat (fecal) samples from rookeries in order to describe prey selection and food habits of Steller sea lions in this region. In July of 2000, ODFW entered into a contract with Oregon State University (OSU) to continue this research on Steller sea lion population status and food habits in Oregon. The following report summarizes: 1) field work conducted for aerial surveys and food habits sample collections (July 2000 - June 2001), and 2) laboratory analysis and summary of food habits information and statewide population trends (July - December 2001).

METHODS

Population Status

Aerial Photographic Surveys

The aerial photographic survey methods used to monitor the distribution, abundance, and trends of Steller sea lions in Oregon were similar to those used to count pinnipeds in other areas from California to Alaska (Braham et al. 1980, Johnson and Jeffries 1983, Beach et al. 1985, Bigg 1985, Brown 1988; Merrick et al. 1987, Pitcher 1989, Harvey et al. 1990, Huber et al. 1992, Loughlin et al. 1992, Hanan 1996, Sease et al. In Press). Most early surveys (1976-1983) were flown in a single-engine, high-wing aircraft (e.g. Cessna 172 or 182) at altitudes of between 600 and 1,000 feet. Many surveys in later years were conducted in twin-engine, high-wing aircraft (e.g. Partenavia Observer). Data collected during surveys included date, time, location,

general weather conditions, an estimate of the number of sea lions at each site, and the number of photographs taken.

One to two days were required to complete a single statewide survey from northern California to the mouth of the Columbia River at the border with the State of Washington. Surveys were conducted on consecutive days when weather permitted, although a complete survey of all rookeries and haul-out areas sometimes required a 3rd or 4th survey day. We attempted to conduct annual statewide photo surveys for Steller sea lion population trends late in the reproductive period (early July) when the maximum number of newborn pups was expected to be seen (Merrick 1982). However, due to the constraints of aircraft availability, weather conditions and other work requirements, these trend counts included surveys conducted between June 10 and July 10 of each year. Some of the earlier surveys conducted within this window included ODFW participation in range-wide surveys for Steller sea lions coordinated by the National Marine Mammal Laboratory (NMFS). Specific surveys dates within this time period were also chosen to maximize counts by selecting for lower tide levels, optimal weather conditions, and mid-morning to mid-afternoon survey windows, when the largest number of sea lions was expected to be hauled out on land.

Photographs of animals at each site were taken at a near vertical, oblique angle using a hand-held 35 mm SLR camera, a 70-210 mm zoom lens, and high speed (400 ASA) color slide film. These slide photographs were projected onto a white surface and the image of each animal was marked with a pen to prevent over- or under-counting. Counts of sea lions were divided into two major categories: 1) adult and juvenile animals, and 2) newborn pups. In some cases, counts of adult territorial males were made at specific rookery sites, but this was not done consistently. If the photo images were of poor quality or were missing, field estimates for the number of animals at those locations were used. Counts made in this manner constitute the abundance data reported here.

Analysis of Abundance Trends

In this report, counts of Steller sea lions at St. George Reef, CA are presented separately and were not included in the regional trend analyses. Statewide counts of adult and juvenile (non-pup) Steller sea lions were used to examine overall population trends in Oregon from 1976 to 2001. Only surveys conducted between June 10 and July 10 of each year were used in the analysis; exceptions occurred in 1978 (June 1), 1991 (June 4), and 2001 (July 11). The number of surveys per location varied within and between years. We therefore computed an average count per location within year prior to summing across locations to obtain the total count for that year. We modeled the data using an exponential growth model

$$N_t = N_0 e^{rt} \quad (1)$$

where N is the count at year t, e is the base of natural logarithms, and r is the growth rate. The growth rate r was estimated by first taking the logarithms of both sides of (1)

$$\log(N_t) = \log(N_0) + rt \quad (2)$$

and then fitting a simple linear regression model of $\log(N_t)$ on year t. Average statewide counts conducted early in the study period (1977-1981) were compared to counts in later years (1997-2001) to examine and describe changes in the use of specific areas occupied by Steller sea lions along the Oregon coast.

Food Habits

Scat Collection, Processing and Prey Identification

Collection and examination of pinniped fecal remains (scat) to identify species of prey consumed is a tool that has been used for many years in many areas (Pitcher 1980, Brown and Mate 1983, Antonelis and Perez 1984, Beach et al. 1985, Olesiuk et al. 1990, Riemer and Brown 1997, Lance et al. 2001). The Steller sea lion food habits information presented here was derived from the examination of scat samples collected at Steller sea lion rookeries and nearby haul-out areas on the southern Oregon coast. These areas were approached from sea in a small boat and researchers climbed out on the rocks, slowly

pushing sea lions out of the collection area. Scat samples were often collected during trips to rookeries as part of other research activities (e.g. pup capture, sampling, and marking projects), but they were also collected during dedicated food habits sample collection trips. Scat samples were placed in individual plastic bags and were kept separate by collection site for processing and identification purposes (though data from samples were later combined for reporting purposes). These samples were labeled with date and location and frozen for processing at a later time.

Scat samples were processed by thawing and then partially dissolving the sample in water. The sample was then rinsed with running water through a series of nested sieves (2mm, 1mm, .71mm). All prey hard parts recovered from the sieves were dried, placed in jars, and labeled for storage and identification. Pinniped prey species were determined using all identifiable prey hard parts recovered from each sample. Prey hard parts consisted of bones, otoliths, cartilaginous parts, lenses, teeth and cephalopod beaks. Dried hard parts were examined under a dissecting microscope and prey parts were separated for identification. These prey hard parts were identified by ODFW staff using a comparative collection of fish from the northeastern Pacific Ocean and Oregon estuaries. Samples which contained prey remains too eroded to identify were recorded as fish unidentified.

RESULTS

Population Status

Aerial Photographic Surveys

In recent years, Steller sea lions have been found at 11 different haul-out areas and rookeries in the study area (Figure 1). The usage of a small number of these sites has changed, but the two main rookeries on the southern Oregon coast (Rogue Reef and Orford Reef), and the one rookery on the northern California coast (St. George Reef, 13 km NW of Crescent City, CA) have remained the areas of largest concentrations of sea lions in this geographic area. Twenty-five years of annual aerial photographic population trend surveys for Steller sea lions in Oregon have been conducted in a reasonably

consistent manner since 1976. Surveys of sea lion abundance at the St. George Reef rookery have been conducted since 1987. The same ODFW staff members have conducted these surveys under a standard survey protocol since 1984. From 1977 to 1983, additional pinniped surveys funded by ODFW were conducted by Oregon State University staff (including one author of this report). Some of these early surveys may not have been conducted in the same rigorous manner (with respect to optimum survey conditions), however the general increasing trend in the sea lion counts also occurred during this period.

With support from this contract, ODFW conducted two additional statewide aerial photographic surveys for Steller sea lions in Oregon on July 6-7, 2000 and April 13, 2001 (Table 1). Counts of adult and juvenile (non-pup) Steller sea lions in Oregon during the breeding season have increased from about 1,500 animals in the mid-1970s to nearly 4,000 by the late 1990s (Figure 2; Table 2). These count data, fitted to an exponential model, suggest an estimated annual rate of increase of 3.7% (95% confidence interval = 2.9-4.4%).

A comparison of non-pup Steller sea lion counts at all sites in Oregon indicates that abundance has increased at nearly all locations over the entire survey period. In the mid-to-late 1980s, sea lions appeared to abandon the Ecola Point site, possibly in favor of the Columbia River South Jetty (approx. 35 km to the north), which became a more frequently used haul-out site since about that same time (Figure 3).

Making accurate counts of pups on rookeries from 35mm color slide survey film is sometimes difficult, such counts may not be comparable between years (given variation in survey conditions and photo quality), and generally they underestimate the total number of pups at a site. Although it may not be clearly documented by the existing set of pup count data (Table 3), pup production at the rookeries in Oregon has probably increased with increasing adult/juvenile abundance over the 25-year survey period. During the past decade approximately 200-300 and 500-600 pups have been born

annually at Orford Reef and Rogue Reef, respectively. An additional 100-250 pups have been born annually at St. George Reef during the same period.

Food Habits

With support from this contract, ODFW collected an additional 116 Steller sea lion scat samples from the Rogue Reef complex during four collection trips in April and June, 2001. To date, a total of 408 Steller sea lion scat samples collected from southern Oregon rookeries and haul-out areas during the period April-July, 1986-2001 have been processed and analyzed. Identification of prey hardparts removed from these samples indicates that North Pacific hake (*Merluccius productus*) was the most frequently occurring prey item utilized by Steller sea lions in this geographic area during the spring and early summer months (Figure 4). North Pacific hake constitutes the largest biomass of any single marine fish species in this region and has apparently been utilized consistently by Steller sea lions here. Due to several particularly strong year classes that occurred in the early 1980s, the regions hake stock reached an historical high abundance level of 5.7 million t in 1987 (Dorn et al. 1999). Other frequently occurring prey includes Pacific lamprey (*Lampreta tridentate*), salmonids (*Oncorhynchus* spp.), skates (Raja spp.), Pacific herring (*Clupea pallasii*), and rockfish (Sebastes spp.). No significant or obvious variations in prey species utilization was seen, by area or year, within the sets of Steller sea lion scat samples that have been collected on the southern Oregon coast.

DISCUSSION

Despite the significant population declines in other parts of the range, reproductive period trend counts of adult and juvenile Steller sea lions in this region have increased from several thousand animals in the mid-1970s to nearly 5,000 animals (adults, juveniles and pups) in 2001 at an average annual rate of 3.7%. In this report, counts of Steller sea lions at St. George Reef, CA were presented separately and were not included in the regional trend analyses. Future work with these data will include a trend analysis of animals

occupying the three main rookery areas during the reproductive period, and a separate analysis of sea lions found on all haul-out sites in the entire study area.

One possible reason for the growth and well being of the Steller sea lion population in this area may be the protection provided the species under the Marine Mammal Protection Act since 1972. Shooting of Steller sea lions, while once common according to local anecdote, is not thought to have been a serious threat here in recent years. The proximity of the Rogue Reef rookery to areas frequently used by the public may also provide a certain amount of protection for these animals. In other areas of Oregon, Steller sea lions rarely frequent nearshore areas where they might come in regular contact with human activities. Mortalities related to fishery interactions are thought to be minimal in this portion of the range. Most sea lions interacting with sport or commercial fisheries are reported to be California sea lions.

In 1996 a total of 1,263 Steller pups were counted on the three primary sea lion rookeries in the region (NMFS/ODFW unpubl. data, W. Perryman NMFS pers. comm.), making this the most significant reproductive sub-population of Steller sea lions in the region. While additional useable substrates (unoccupied rocks and islands) exist in this area, those rookeries currently in use appear to have relatively high densities of animals on them during the reproductive period. These densities may contribute to the apparently high mortality of newborn pups observed at these sites late in the reproductive period when compared to other portions of the range (T. Loughlin, NMFS, pers. comm.).

North Pacific hake appears to have been an important spring/summer prey species for Steller sea lions in this area from the mid- 1980s through the 1990s. While currently still the most abundant biomass of marine fish in the region at that time of the year, this hake stock has been steadily declining over the past decade, perhaps due in part to an increase in the exploitation rate from less than 10% in the late 1980s to nearly 20% by the late 1990s (Dorn et al. 1999). This harvest rate exceeds that for walleye pollock in the Gulf of Alaska and Bering Sea, a species heavily utilized by Steller sea lions in Alaska. Currently, NMFS and others are undertaking a new review and assessment of Pacific

whiting stock status and harvest rates. Any response by the Pacific Northwest Steller sea lion population to the recent decline in North Pacific hake abundance may not be detected for some time, if at all. However, continued collection of food habits samples over this period, may provide information on shifts between major sea lion prey items and/or an increase in the diversity of the more frequently occurring food items.

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Table 1. Counts of adult and juvenile Steller sea lions at 11 locations in Oregon and Northern California during two statewide aerial photo surveys (photos not adequate for pup count during July, 2000 survey).

Location	July 6-7, 2000	April 13, 2001
Columbia River So. Jetty	479	758
Ecola Point	0	0
Three Arch Rocks	81	0
Cascade Head	12	37
Sea Lion Caves	454	11
Cape Arago	48	5
Blanco Reef	82	0
Orford Reef	715	5
Rogue Reef	1,175	588
Crook Point	9	0
St. George Reef, CA	776	nc[a]

[a] = no count

Table 2. Annual reproductive-period trend counts of adult and juvenile (non-pup) Steller sea lions in Oregon, June 10 – July 10, 1976 – 2001. Available annual counts of non-pups at St. George Reef, CA are also presented.

Year	Oregon	St. George Reef, CA
1976	1486	nc[a]
1977	1461	nc
1978*	1805	140
1979	1542	nc
1980	1632	nc
1981	2105	nc
1982	2604	nc
1983	2106	nc
1984	1867	nc
1985	2210	nc
1986	2289	nc
1987	2709	275
1988	2825	nc
1989	2183	404
1990	2414	nc
1991*	3091	626
1992	3581	693
1993	2838	386
1994	3293	612*
1995	3837	719
1996	3205	765
1997	3897	937
1998	3971	847
1999	3275	774
2000	2927	776
2001*	3648	810

*Includes survey(s) from outside the June 10-July 10 survey window.

Table 3. Raw, unadjusted counts of Steller sea lion pups at Rogue Reef, Orford Reef, and St. George Reef Rookeries during June and July, 1984 to 2001 from aerial photos and from ground visits. Counts are maximum values from within the June 10 – July 10 survey window. Number of counts per year varies. For any year the relation of the count to the presumed maximum for that year varies and is unknown. Poor survey conditions and photo quality can result in erroneously low aerial survey counts.

	Rogue Reef		Orford Reef		St. George Reef	
Year	Aerial	Ground	Aerial	Ground	Aerial	Ground
1984	340	nc[a]	65	nc	nc	nc
1985	344	370	85	nc	nc	nc
1986	296	nc	nc	nc	nc	nc
1987	200	395	89	nc	14	nc
1988	349	552	159	nc	nc	nc
1989	407	nc	181	nc	11	nc
1990	463	492	111	298	nc	124
1991	341	nc	80	nc	50	nc
1992	423	nc	123	nc	109	nc
1993	398	nc	203	nc	110	nc
1994	407	nc	155	nc	117	nc
1995	364	nc	161	nc	92	nc
1996	510[b] / 685[c]	nc	198[b] / 335[c]	nc	73[b]/243[c]	nc
1997	485	nc	211	nc	186	nc
1998	251	nc	51	nc	62	nc
1999	397	nc	164	nc	102	nc
2000	54	nc	1	nc	142	nc
2001	399	600[d]	122	nc	90	nc

[a] = no count; [b] = ODFW small format camera count; [c] = NMFS large format camera count (W. Perryman, SWFSC, pers. comm.); [d] = ground estimate

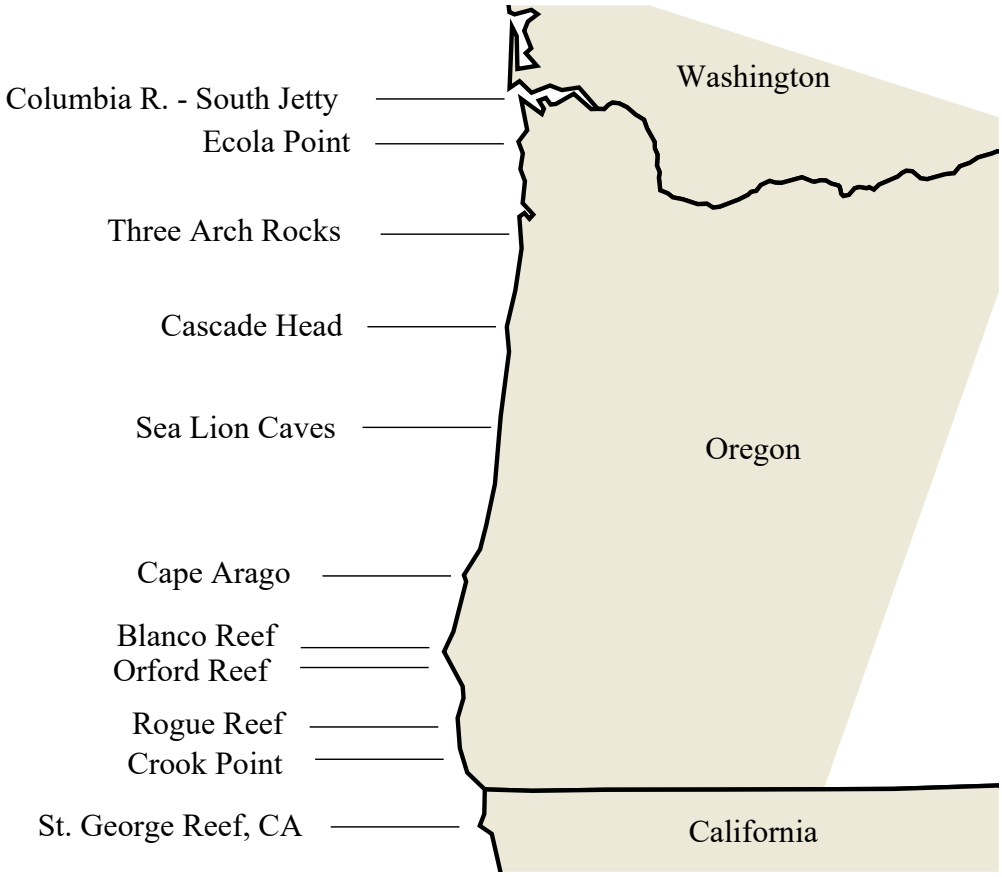

Figure 1. Steller sea lion haul-out sites and rookeries in the study area. A small number of pups (<8) have been born in some years at Three Arch Rocks, but the major rookeries are located at Orford Reef, Rogue Reef and St. George Reef.

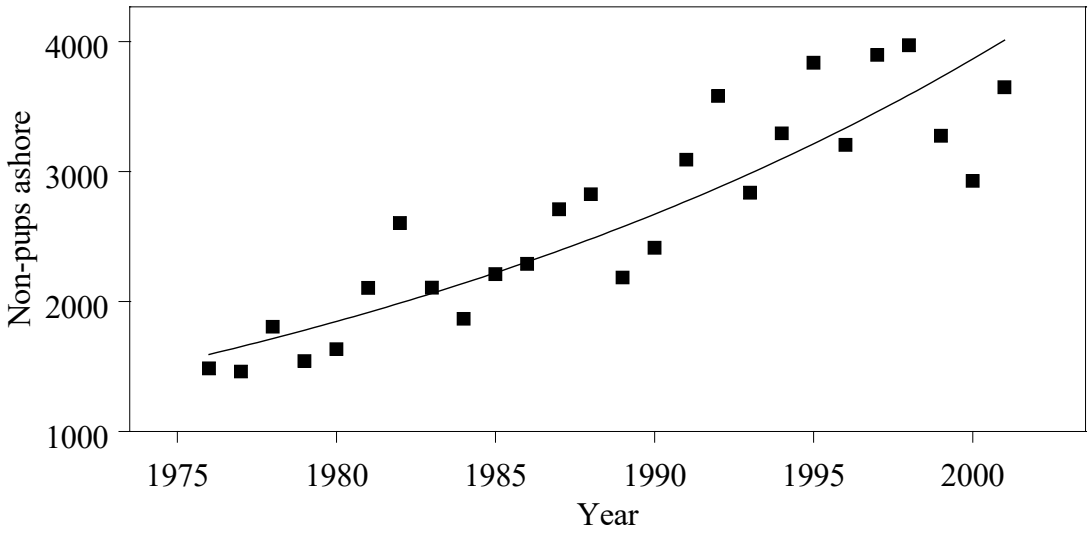

Figure 2. Counts of adult and juvenile (non-pup) Steller sea lions in Oregon, 1976-2001, fitted to an exponential model. Estimated annual rate of increase was 3.7% (95% confidence interval was 2.9-4.4%).

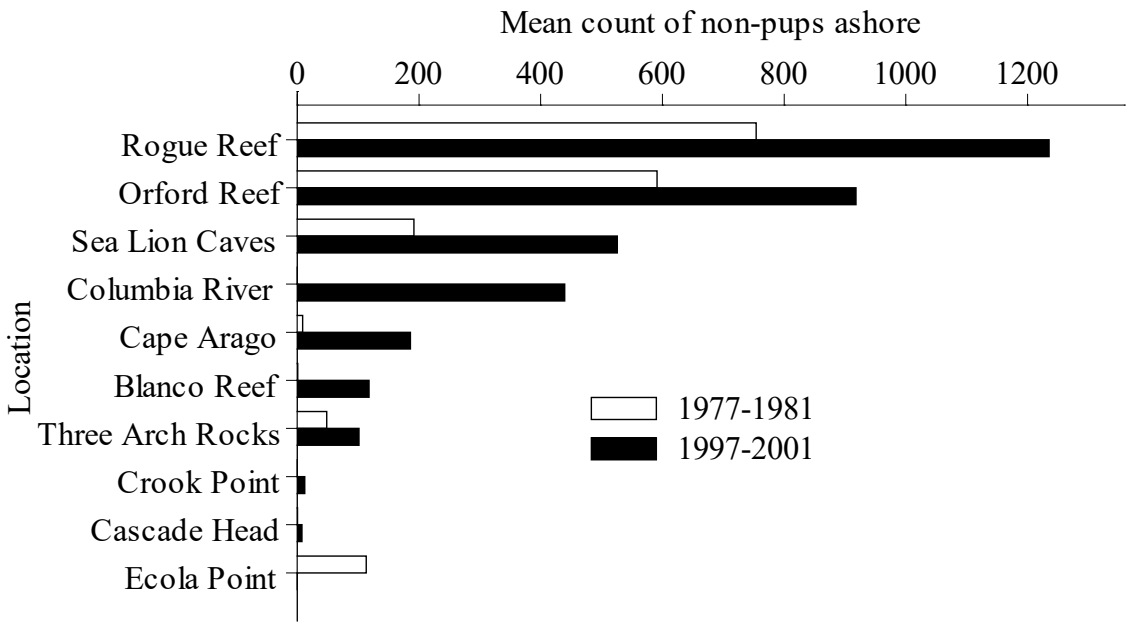

Figure 3. Comparison of average adult and juvenile (non-pup) Steller sea lion counts in Oregon, 1977-1981 vs. 1997-2001.

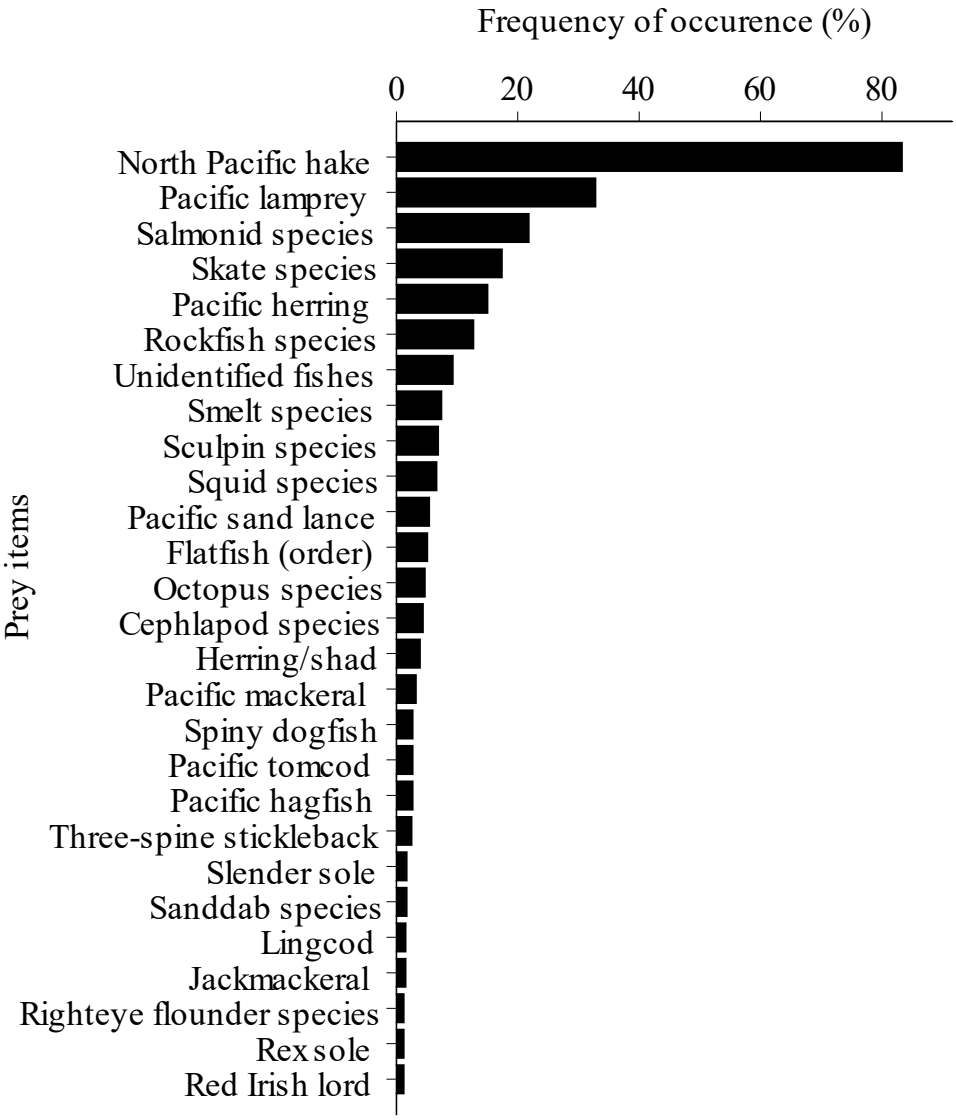

Figure 4. Prey items found in ≥1% of 408 Steller sea lion scat collected from sites in southern Oregon during April-July 1986-2001. An additional 24 prey species were found in less than 1% of the samples examined.