PINNIPED FOOD HABITS IN OREGON

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ABSTRACT

Under Section 120 of the recently amended (1995) Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) was directed to conduct a scientific investigation of pinniped-salmonid interactions in the Pacific Northwest. The purpose of this investigation was to determine if pinniped feeding patterns have significant negative impacts on depressed (threatened, endangered, or soon to be listed) salmonid stocks. In this report, the Oregon Department of Fish and Wildlife (ODFW) with funding provided by the Pacific States Marine Fisheries Commission (PSMFC) provides a summary of recent information on pinniped food habits in Oregon. The scat collections presented here were made at Cascade Head, Rogue Reef and Orford Reef, and in the Columbia, Rogue, Siletz, Umpqua, and Alsea rivers. These collections include scat collected from Pacific harbor seal (Phoca vitulina), California sea lion (Zalophus californianus) and Steller sea lion (Eumetopias jubatus). A re -examination of Columbia River area scat samples collected in the early 1980's, (Beach et al., 1985), are also presented. The purpose of this re-examination was to look for salmonid remains previously unidentified in the samples. A determination of salmonid size from recently collected gastrointestinal (GI) tract samples from the Columbia River (Brown, et al. 1995), is also included. A preliminary comparison was made of prey species identified from lavage, enema and scat samples collected during a cooperative effort by ODFW, Washington Department of Fish and Wildlife (WDFW) and NMFS in the Columbia River in April 1995. The food habits data reported here indicate that pinnipeds in these studies prey heavily on schooling fishes, such as Pacific whiting and Pacific mackeral for sea lions and smelt, herring and anchovy for harbor seals. Because they are opportunistic feeders, pinnipeds are successful in changing prey species depending on the availability of fish and will utilize fish such as salmon when they are abundant. The variability in the salmonid consumption reported here is likely due to salmonid life history, salmon are not present in estuaries at all times of the year but can be abundant during the peak of their runs.

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INTRODUCTION

Under Section 120 of the recently amended Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) was directed to conduct a scientific investigation of pinniped-salmonid interactions in the Pacific Northwest. The purpose of this investigation was to determine if pinniped feeding patterns have significant negative impacts on depressed (threatened, endangered, or soon to be listed) salmonid stocks. Knowledge about prey selection by pinnipeds is key to assessing their potential impact on salmonid stocks. The Oregon Department of Fish and Wildlife (ODFW) with funding provided by the Pacific States Marine Fisheries Commission (PSMFC) further describes pinniped food habits in Oregon in this report.

The four major work elements reported here are 1) the reanalysis of Columbia River area scat samples collected in the early 1980's, (Beach et al., 1985); 2) examination of California sea lion scat collected at Cascade Head; 3) determination of salmonid size from recently collected gastrointestinal (GI) tract samples from the Columbia River (Brown, et al. 1995); and 4) examination of previously collected pinniped scat samples from the southern Oregon coast. In addition pinniped prey items were identified from previous scat collections made in Siletz Bay, Alsea Bay, and the Umpqua River, along with a comparison of lavage, enema and scat samples collected in the Columbia River. Completion of these food habits analyses, in particular the re-examination of the early Columbia River collections using new prey identification techniques and the examination of all existing samples for identification of smolt vs. adult salmonid consumption were identified as important to the NMFS investigation and report to Congress.

STUDY AREA AND METHODS

Information on food habits of pinnipeds (seals and sea lions) in Oregon were obtained through examination of prey hardparts found in scat (fecal) samples and recently collected pinniped GI tracts. Scat collections were made at Cascade Head, Rogue Reef and Orford Reef, and in the Columbia, Rogue, Siletz, Umpqua, and Alsea rivers (Table 1). These collections include scat from Pacific harbor seal (Phoca vitulina), California sea lion (Zalophus californianus) and Steller sea lion (Eumetopias jubatus). Scat samples collected in the early 1980's from the Columbia River, Grays Harbor and Willapa Bay (Beach et al., 1985) were re-examined for salmonid remains, using new bone identification techniques. Prey species in lavage, enema and scat samples from a cooperative collection effort by ODFW, Washington Department of Fish and Wildlife (WDFW) and NMFS in the Columbia River in April 1995, were identified and compared. All existing Oregon scat samples, as well as GI tracts recently collected in the Columbia River, were re-examined for identification of smolt vs. adult salmonid consumption. All prey in this report are reported as percent frequency of occurrence in the sample.

Scat Collection and Processing

Pinniped scat samples were obtained primarily during low tides by landing a boat on a haul-out area and slowly moving the animals into the water. Scat samples were then collected and placed in individual plastic bags. These samples were labeled and frozen for processing at a later time. Scat samples were processed by dissolving them in water with a small amount of mild detergent and then rinsing with water through nested sieves (2mm, 1mm, .71mm). All prey hard parts recovered from the sieves were dried, placed in jars, and labeled for identification and storage.

Prey Identification

Prey species were determined using all identifiable prey hard parts recovered from each sample. Prey hard parts consist of bones, otoliths, cartilaginous parts, lenses, teeth and cephlapod beaks. Samples 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. Otoliths were identified, counted, and sided (left-right) to determine minimum numbers of fish present in each sample. Approximately 10% of these samples were sent to Pacific Identifications Inc., a biological consulting company, for verification. Salmonid remains were categorized either as adult or as smolt/small salmonid, by the size of hard parts recovered. Smolts and small salmonids were combined at this time due to the inability to separate salmonid smolts from cutthroat trout and other small salmonids. When an individual sample was reported as containing salmonids, it could have contained adult remains, smolt/small salmonids remains, or both. In any case, this represents the occurrence of salmonids in just one sample. Therefore, in some cases, the total of the number of samples containing adult salmon parts plus the number of samples containing smolt/small salmonid parts may be greater than the number reported as containing any salmonid remains.

The ability to identify prey items to the species level varies depending on the type of bone(s) recovered, the state of digestion, the amount of bone erosion, and the group of fish identified. For example, rockfish species (Sebastes) are difficult to identify to the species level using bones, so they are often reported only to genus. Since current techniques do not allow individual salmonid species (Onchorhynchus) to be identified using skeletal bones alone, they are identified in this report as Salmonid.

RESULTS

Forty-eight fish species and families were identified as pinniped prey from 11 scat collections made at 9 different locations in Oregon. A total of 646 scat samples from harbor seals (n=214), California sea lions (n=230) and Steller sea lions (n=202) were processed for prey species identification.

Steller Sea Lions

Rogue Reef and Orford Reef

Rogue Reef and Orford Reef are located on the southern Oregon coast near Gold Beach and Port Orford respectively. Both areas are important breeding sites for the threatened Steller sea lion. Scat collections were made at Pyramid Rock, Rogue Reef and Long Brown Rock, Orford Reef in conjunction with pup tagging trips during June and July of 1986, 1987, 1988, 1990, and 1993 (Table 1). When these collections were made approximately 2,000 animals were occupying these two rookery rocks. In the 202 scats collected, Pacific whiting was found to be the most frequently occurring prey species at 84.1% and salmonids were identified in 19.3% of the samples (Table 2). Adult salmonids were identified in 18.8% of the samples and smolt/small salmonids in 1.0%.

California Sea Lions

Columbia River, East Mooring Basin

The East Mooring Basin haulout at Astoria is used by approximately 100 California sea lions throughout the winter. There is a commercial fish processing plant in the basin and other processing plants are located along the Astoria waterfront within a few miles of the haulout. Scat samples were collected at this site by the Columbia River Gillnet Observer Program in March of 1992 and 1993 (Table 1). ODFW staff at Astoria suggested that fish carcasses and sometimes whole fish were occasionally discarded by fish plant staff during the period these scat collections were made. This information was substantiated by the initial identification of prey parts in scat samples, and a comparison with commercial fish landing data from the lower Columbia River. One species commonly identified in the scat was dover sole, which was the most frequently landed commercial species during the time of the collections. However, because salmon landings during the time of the scat collections were low, and because it was believed that salmon were not discarded by the plants, salmonid remains in the scat samples were identified and are included in this report. Remains from salmonids were recovered in 21 (19.1%) of the 110 samples examined. Nineteen samples (17.2%) contained adult salmonid remains, and four (3.6%) contained smolt/small salmonid remains. Some fish species that were not handled by fish plants were recovered from the scat and identified as sea lion prey including large scale sucker, lamprey and peamouth.

Cascade Head

Cascade Head located on the north Oregon Coast, near Lincoln City, is one of the largest haulout areas for California sea lions in Oregon. This rocky headland is used by 500 - 1500 sea lions in the fall and winter. Pacific mackeral was found to be an important prey species in both the February (52%) and October (74%) collections. Salmonids occurred in 29.3% of the scat samples collected in February and in 7.9% of those collected in October (Tables 3 and 4). In February adult salmonids occurred in 20 of the samples (24.3%) and 19 samples (23.2%) contained smolt/small salmonid remains. All three of the October samples with salmonid remains (7.9%) contained only adult fish parts.

Pacific Harbor Seals

Columbia River, Desdemona Sands

Desdemona Sands is one of the largest harbor seal haulout areas in the lower Columbia River. Between 1000 and 3000 animals use this area year-round, with peak numbers occurring during mid-winter. The two groups of scat presented in this report represent 5 collection trips between February 1992 and October 1994. These collections have been combined and presented here as winter/spring (February/March, 1992-93) and fall, (September/October, 1994). The most frequently occurring prey item identified in the spring collection was eulachon (84.3%), followed by Pacific lamprey (19.6%) and starry flounder (11.8%) (Table 5). Eulachon spawn in Columbia River tributaries in large numbers from January through March, which explains the high percentage of smelt in the harbor seal diet at this time of year. No salmonids were identified in these winter/spring scat samples. Northern anchovy (50%) was the main prey item in the fall scat collection, followed by Pacific herring (44.4%), salmonids (38.9%), smelt (25%), and Pacific staghorn sculpin (19.4%) (Table 6). Of the 14 samples which contained salmonids, 12 (33.3%) contained adult fish and 4 (11.1%) contained smolt/small salmonid remains. A scat, lavage and enema collection trip was also made to this site in April of 1995 and is discussed below.

Oregon Coastal Rivers and Estuaries

Alsea Bay

One scat collection trip was made to Alsea Bay in September 1986. Alsea Bay has a number of haulouts throughout the lower estuary and a harbor seal population of approximately 400 - 600 animals. Five prey species were identified in the 6 scat samples collected, rex sole (83.3%), Pacific whiting (33.3%), dover sole (33.3%), smelt (16.7%) and salmonids (16.7%). The salmonid remains identified were from an adult fish.

Umpqua River

Four scat collection trips were made to the Umpqua River between 1988 and 1993; half of the collections were made in the summer and the other half in the winter. The Umpqua River has the largest population of harbor seals on the southern Oregon coast at approximately 600 - 1000 animals. These collections were combined and the main prey item identified was Pacific lamprey (52%), followed by unidentified fish (44%) and surfperch (20%) (Table 7). No salmonids were identified in this collection.

Siletz Bay

The Siletz Bay haulout is located at the mouth of the river and is used by approximately 200 - 300 harbor seals. Six scat collection trips were made to the Siletz Bay haulout at various times of the year during all seasons from 1983 to 1985. All scat collections were combined for this summary. Dover sole (66.6%) was the main prey item identified in these collections, followed by rex sole (27.7%) (Table 8). Adult salmonids were identified in 2 (11.1%) of the samples.

Rogue River

ODFW began scat collections in the Rogue River in April 1995 and will continue, through 1996. The Rogue River harbor seal haulout is a sand spit connected to the south jetty across from the Port of Gold Beach boat launch. The haulout is accessible from the mainland by foot. In 1995, twenty-four scat collection trips were made to this site, with a total of 355 scat samples collected. Eleven scat samples from two collection trips were processed and prey species identified. The two main prey items were Pacific sanddab and salmonids occurring in 45.4% of the samples; followed by Pacific tomcod and Pacific lamprey in 27.2% (Table 9). The salmon parts recovered from the 5 samples containing salmonids were all from adult fish. The number of returning adult spring chinook in the Rogue River in 1995 (counted over Gold Ray dam) was one of the highest counts on record. During this spring chinook run, seals and sea lions were regularly observed preying on these fish in the mouth of the river. The scat samples presented here were all collected when large numbers of salmonids were present in the river and so probably accounts for the relatively high frequency of occurrence of salmonids in these samples.

Lavage, Enema and Scat Prey Identification

On April 18 and 19, 1995 a cooperative harbor seal tagging and food habit data collection field trip was undertaken by ODFW, WDFW and NMFS. The following is a comparison of prey remains identified using these three techniques. Sixteen animals were handled (10 females and 6 males), of which 15 were tagged and released, (one animal died). Eight animals were lavaged (stomachs pumped), seven of these were also given enemas. Four animals were given enemas without being drugged and were immediately released. Two of the eight lavage samples contained prey remains, while all contained round worms (an intestinal parasite). Ten of the eleven enema samples contained prey remains, and 6 of the 10 contained identifiable prey. In addition, 68 scat samples were collected on April 17, 18 and 19; with 67 containing prey remains. All enema, lavage, and scat samples were processed and prey remains were identified by ODFW staff.

The number of prey items identified varied with the technique used, which may have been due in part to the difference in sample size between the techniques. The lavage samples contained 4 prey species (Table 10), the enema samples contained 13 prey species (Table 11) and the scat samples contained 27 prey species (Table 12).

The percent frequency of occurrence of salmonids, both adult and smolt/small salmonid, was greatest in the scat (19.4%). No salmonid remains were recovered from the lavages. One of the 10 enema samples contained remains from an adult salmonid and a smolt/small salmonid. In the enema samples unidentifiable fish (fin rays and eroded bone) had the highest percent frequency of occurrence (50%), followed by Pacific herring (40%) and Pacific staghorn sculpin (30%). The main prey items identified in the scat samples were Pacific staghorn sculpin (49.3%), starry flounder (35.8%), Pacific herring (28.4%), and salmonids (19.4%). Of the 13 scat samples which contained salmonids, six (9%) had remains from adult fish and 8 (11.9%) had remains from smolt/small salmonids.

Re-examination of Beach et al. (1985) Scat Samples

ODFW staff re-examined Pacific harbor seal scat samples collected in 1980 - 1982 by Beach et al. (1985) from the Columbia River, Grays Harbor and Willapa Bay. The purpose of the re-examination was to look for salmonid remains previously unidentified in the samples. Beach et al. (1985) used only otoliths to identify prey species. Using new prey identification techniques, ODFW recovered teeth, gillrakers, vertebrae and other salmonid remains and classified them as either adult or smolt/small salmonid (Table 13). Re-examination of the scat collected by Beach et al. (1985), showed the largest increase in salmonids was found in scat collected in August and September in Willapa Bay (Table 13). For example, August 1980 had a sample size of 65 scats, using only otoliths Beach et al. (1985) reported salmonids as occurring in only nine (13.8%) of the samples; by using otoliths and bones ODFW staff identified salmonid remains in 33 (50.8%) of the samples. Twenty-one of the salmonids identified using all bone, were adults and 15 were smolt/small salmonids. As a second example, in September 1980 at Willapa Bay, no salmonids were identified using only otoliths in seventeen scat samples. By using otoliths and other bones, adult salmonids were recovered in nine (52.9%) of the samples.

When all areas of the Beach et al. (1985) study are combined, otolith identification results in 29 samples containing salmonids, while bone and otolith identification results in 132 samples containing salmonids. Out of a total of 1082 samples, salmonids were identified in 2.3% of the samples using otoliths only and 12.2% by combining the bone and otolith identification. In many cases, in samples where Beach et al. (1985) reported steelhead trout, (identified from otoliths), ODFW recovered smolt/small salmonid vertebrae. However, Beach et al. (1985) reported that no salmonid smolt otoliths were identified in the collection. Further study is necessary to accurately determine smolt/small salmonid size for the identification of steelhead smolts.

Salmonid Remains From GI Tracts, Columbia River

Determining the size of salmonids consumed by pinnipeds collected during the Columbia River Gillnet Observation study was identified as a priority for the NMFS investigation of pinniped-salmonid interactions. Of the 61 Pacific harbor seal GI tracts collected in the Columbia River eight (13.1%) contained salmonids. Of the 8 GI tracts with salmonids, half contained smolt/small salmonid remains and half contained adult salmonids. Eighteen California sea lion GI tracts were collected and 5 (27.8%) contained salmonids; four samples (22.2%) contained adult fish remains and one sample (5.6%) contained remains from a smolt/small salmonid. Salmonids were found in 2 (20%) of the 10 GI tracts collected from

harbor seals in Willapa Bay; both were adult fish. Salmonids were identified in 50% of the 10 harbor seal GI tracts collected in Grays Harbor; four (40%) contained adult remains and 1 (10%) contained smolt/small salmonid remains.

DISCUSSION

This report provides a summary of recent information on pinniped food habits in Oregon. Food habits information can provide a picture of where animals are feeding and can identify important prey species. However, feeding location, season, prey availability and species of predator involved in these collections all contribute to the observed variation in these food habit results. Because data on pinniped diets vary with location and season, prey selection information from one site can not be applied to a large geographic areas or over a long time periods. Increasing food habit study locations and expanding collection times would give a more accurate picture of pinniped diets in Oregon. The types of fishes that are important to pinnipeds vary due to seasonal availability, behavior, habitat requirements and the status of the fish stock. The food habits data reported here indicate that pinnipeds in these studies prey heavily on schooling fishes, such as Pacific whiting and Pacific mackeral for sea lions and smelt, herring and anchovy for harbor seals.

Salmonid Consumption by Pinnipeds

In some cases salmonids can be a frequently occurring prey item in a pinnipeds diet, but in other situations salmon are not identified as prey. Pacific harbor seal scat collected at Desdemona sands, in February/March did not contain salmonids, while salmonids occurred in 38.9% of the September/October scat collected from the same location. The life history of salmon is the most likely explanation for its variability in pinniped diets; salmon are not present in estuaries at all times of the year, but can be abundant during the peak of their runs. Man made structures such as fish ladders found at dams and hatcheries which channel fish through a narrow passage can create artificial feeding areas for pinnipeds and increase predation on these fishes. Pinnipeds can adapt to utilize this type of available food source, as has been observed in many areas, most notably at the Ballard Locks in Washington and more recently at Willamette Falls, Oregon. The removal of woody debris in estuaries and rivers is another factor that result in more effective predation, by removing the hiding places needed by fish to elude predators. There is no doubt that pinnipeds have been feeding on salmonids for as long as they have co-existed. Because they are opportunistic feeders, pinnipeds are successful in changing prey species depending on the availability of fish and will utilize fish such as salmon when they are abundant.

Pacific Whiting and Steller Sea Lions

Pinnipeds, being opportunistic feeders, effectively utilize locally abundant prey species. Some very abundant fishes found in Oregon coastal marine waters, such as Pacific whiting, are a common prey item for sea lions during the summer and fall. Pacific whiting appears to be very important prey species for breeding Steller sea lions in Oregon. Preliminary satellite tagging information indicates that

in June female Steller sea lions stay on the rookeries for several days caring for their pups and will leave for 12 - 14 hours to forage before returning to their pups again (ODFW unpub. data). The scat collected during this same time period contains a high frequency of occurrence of Pacific whiting. This information leads us to believe that females are concentrating their feeding on these large offshore schools of fish. Females need to find prey in large numbers to maximize their time spent feeding and minimize the time away from their pup. Feeding patterns of Steller sea lions in Oregon outside of the breeding season is relatively unknown and requires further study.

Pinnipeds and Schooling Fishes

The summaries in this report show schooling fishes such as smelts, Northern anchovy, Pacific whiting, Pacific mackeral and eulachon are all important prey species for Oregon pinnipeds (Table 14). The schooling behavior and large biomass of these schooling fishes may be the reason they are preferred prey for pinnipeds. Preying on these fishes may provide an overall energy savings for the animals by allowing them an opportunity to feed on large numbers of fish during a given feeding period. Eulachon occur in the Columbia River from January to April and in this summary were identified as a preferred prey item by Pacific harbor seals in February and March. This run of fish occurs just before pupping season and their frequent consumption of this oily fish may help these animals build up fat reserves prior to this event (Beach et al. 1985). Pacific mackeral another common schooling fish was identified as an important prey item for California sea lions at Cascade Head in October and February. The health of these stocks of fishes is an issue that may become more critical in the future as pinniped numbers and the importance of these species to commercial fisheries continue to increase. Steller sea lion numbers in Alaska have been declining over the last 30 years. This decline may have been related to an overharvest of pollock near the sea lion rookeries. As a result, certain commercial fisheries in Alaska have been restricted over the last 5 years.

Lavage, Enema and Scat Comparison

Reported here was a first comparison of these three methods of collecting information on pinniped food habits. Scat collection from this study yielded the highest number of identified prey species and the highest percent frequency of occurrence of salmonids. It is possible to collect large numbers of scat with relatively few people, along with a reduction in stress to individual animals. Also, larger sample sizes obtained via scat collection resulted in a greater diversity of prey species for pinniped food habit analysis.

Table 1. Oregon pinniped scat collections examined for this report including, date, species, sample size (n) and location.

Date	Species	n	Collection Location
Feb/March 1992-93	Pv	51	Columbia River, Desdemona Sands
Sept/Oct 1994	Pv	36	Columbia River, Desdemona Sands
April 1995	Pv	67	Columbia River, Desdemona Sands
1983-85 year-round	Pv	18	Siletz River
September 1986	Pv	6	Alsea River
1988-93 summer/winter	Pv	25	Umpqua River
April/July 1995	Pv	11	Rogue River
March 1992-93*	Zc	110	Columbia River, East Mooring Basin
February 1994	Zc	82	Cascade Head
October 1994	Zc	38	Cascade Head
June-July 1986-93	Ej	202	Rogue/Orford Reefs

Pv - Pacific harbor seal, Zc - California sea lion, Ej - Steller sea lion.

* Identified salmonid species only.

Table 2. Prey species identified from Steller sea lion scat (fecal) samples (n=202) collected in June and July, 1986 - 1993 at Rogue Reef and Orford Reef, Oregon.

Species	% Frequency of Occurrence
Pacific Whiting	84.1
Pacific Lamprey	38.6
Salmonid*	19.3
Pacific Herring	15.3
Squid/Octopus	13.4
Fish unid.	7.9
Skate	7.9
Rockfish	7.4
Sculpin	6.9
Three-spine Stickleback	5.9
Flatfish	5.4
Pacific Mackeral	5.0
Smelt	5.0
Pacific Hagfish	2.5
Red Irish Lord	2.5
Jackmackeral	2.0
Northern Clingfish	1.5
Prickleback	1.5
Spiny Dogfish	1.5
Cod	1.0
Northern Anchovy	1.0
Pacific Staghorn Sculpin	1.0
Pacific Tomcod	1.0
Greenling/Lingcod	1.0
Gunnel	0.5
Lingcod	0.5
Pacific Sandfish	0.5
Pacific Sardine	0.5
Perch	0.5
Rex Sole	0.5
Shark	0.5

*Of the 39 samples (19.3%) which contained salmonids, 38 (18.8%) contained adult salmonid remains and 2 (1.0%) contained smolt or small adult salmonid remains.

Table 3. Prey species identified from California sea lion scat (fecal) samples (n=82) collected on February 1, 1994 at Cascade Head, Oregon.

Species	% Frequency of Occurrence
Pacific Mackeral	52.4
Salmonid*	29.3
Pacific Sardine	29.3
Squid/Octopus	26.8
Pacific Herring	24.4
Smelt	24.4
Pacific Lamprey	22.0
Spiny Dogfish	22.0
Rockfish	20.7
Skate	15.9
Pacific Whiting	14.6
Pacific Sand Lance	13.4
Northern Anchovy	13.4
Whitebait Smelt	9.8
Flatfish	9.8
Pacific Staghorn Sculpin	8.5
Fish unid.	8.5
Sturgeon Poacher	3.6
Pacific Hagfish	3.6
Rex Sole	2.4
Pacific Tomcod	2.4
Lingcod	2.4
Jackmackeral	2.4
Pacific Cod	1.2
Peamouth	1.2
Starry Flounder	1.2
Poacher	1.2
Cod	1.2

*Of the 24 samples (29.3%) which contained salmonids, 20 (24.3%) contained adult salmonid remains and 19 (23.1%) contained smolt or small adult salmonid remains.

Table 4. Prey species identified from California sea lion scat (fecal) samples (n=38) collected on October 6, 1994 at Cascade Head, Oregon.

Species	% Frequency of Occurrence
Pacific Whiting	73.7
Pacific Mackeral	65.8
Jackmackeral	36.8
Pacific Herring	31.6
Squid/Octopus	10.5
Salmonid (adult)	7.9
Pacific Sand Lance	2.6
Petrale Sole	2.6
Pacific Staghorn Sculpin	2.6
Spiny Dogfish	2.6
Smelt	2.6
Flatfish	2.6

Table 5. Prey species identified from Pacific harbor seal scat (fecal) samples (n=51) collected in February and March 1992 - 1993 at the Columbia River, (Desdemona Sands) Oregon.

Prey Species	% Frequency of Occurrence
Eulachon	84.3
Pacific Lamprey	19.6
Starry Flounder	11.8
Pacific Staghorn Sculpin	7.8
Fish unid.	7.8
Pacific Herring	5.9
Smelt	5.9
Whitebait Smelt	3.9
Pacific Sand Lance	2.0
Pacific Whiting	2.0
Pacific Tomcod	2.0
Longfin Smelt	2.0

Table 6. Prey species identified from Pacific harbor seal scat (fecal) samples (n=36) collected in September and October 1994 at the Columbia River, (Desdemona Sands) Oregon.

Prey Species	% Frequency of Occurrence
Northern Anchovy	50.0
Pacific Herring	44.4
Salmonid*	38.9
Smelt	25.0
Pacific Staghorn Sculpin	19.4
Fish unid.	16.7
Flatfish	11.1
Pacific Whiting	8.3
Rex Sole	8.3
Whitebait Smelt	8.3
Dover Sole	5.6
Pacific Sand Lance	5.6
Perch	5.6
Starry Flounder	5.6
Pacific Lamprey	2.8
Pacific Mackeral	2.8
Pacific Tomcod	2.8
Peamouth	2.8
Shiner Surfperch	2.8

*Of the 14 samples (38.9%) which contained salmonids, 12 (33.3%) contained adult salmonid remains and 4 (11.1%) contained smolt/small salmonid remains.

Table 7. Prey species identified from Pacific harbor seal scat (fecal) samples (n=25) collected in winter and summer, 1988 - 1993 at the Umpqua River, Oregon.

Species	% Frequency of Occurrence
Pacific Lamprey	52.0
Fish unid.	44.0
Perch	20.0
Squid/Octopus	12.0
Pacific Staghorn Sculpin	12.0
Smelt	12.0
Pacific Tomcod	8.0
Rex Sole	8.0
Dover Sole	4.0
Flatfish	4.0
River Lamprey	4.0
Sculpin	4.0
Threadfin Sculpin	4.0

Table 8. Prey species identified from Pacific harbor seal scat (fecal) samples (n=18) collected year around from 1983 - 1985 at the Siletz River, Oregon.

Species	% Frequency of Occurrence
Dover Sole	66.7
Rex Sole	27.8
Pacific Whiting	11.1
Salmonid (adult)	11.1
Fish unid.	11.1
Rockfish	5.6
Pacific Staghorn Sculpin	5.6
Shiner Perch	5.6
Pacific Lamprey	5.6
Starry Flounder	5.6
Flatfish	5.6
Perch	5.6

Table 9. Prey species identified from Pacific harbor seal scat (fecal) samples (n=11) collected in May and July, 1995 at the Rogue River, Oregon.

Species	% Frequency of Occurrence
Pacific Sanddab	45.4
Salmonid (adult)	45.4
Pacific Lamprey	27.2
Pacific Tomcod	27.2
Squid/Octopus	18.1
Starry Flounder	18.1
Smelt	9.0
Flatfish	9.0
Fish unid.	9.0

Table 10. Prey species identified from Pacific harbor seal lavage (n=2), collected on April 18, 1995 at the Columbia River, (Desdemona Sands) Oregon.

Prey Species	% Frequency of Occurrence
Pacific Staghorn Sculpin	50.0
American Shad	50.0
Flatfish	50.0
Shrimp	50.0

Table 11. Prey species identified from Pacific harbor seal enemas (n=10) collected on April 18-19, 1995 at the Columbia River, (Desdemona Sands) Oregon.

Prey Species	% Frequency of Occurrence
Fish unid.	50.0
Pacific Herring	40.0
Pacific Staghorn Sculpin	30.0
Whitebait Smelt	10.0
Pacific Sand Lance	10.0
Shiner Surfperch	10.0
Pacific Lamprey	10.0
Pacific Tomcod	10.0
Salmonid*	10.0
Starry Flounder	10.0
Spiny Dogfish	10.0
Squid/Octopus	10.0
Sculpin	10.0
Flatfish	10.0

*The 1 sample (10.0%) which contained salmonids, had remains from an adult and a smolt/small salmonid.

Table 12. Prey species identified from Pacific harbor seal scat (fecal) samples (n=67) collected on April 17-19, 1995 at the Columbia River, (Desdemona Sands) Oregon.

Prey Species	% Frequency of Occurrence
Pacific Staghorn Sculpin	49.3
Starry Flounder	35.8
Pacific Herring	28.4
Salmonid*	19.4
Smelt	17.9
Pacific Lamprey	16.4
Prickleback	14.9
Fish unid.	9.0
Pacific Sand Lance	7.5
Shiner Surfperch	7.5
Flatfish	7.5
Pacific Tomcod	6.0
Northern Anchovy	4.5
River Lamprey	4.5
Whitebait Smelt	3.0
American Shad	3.0
Three-spine Stickleback	3.0
Peamouth	3.0
Rockfish	3.0
Perch	3.0
Pile Perch	1.5
Pacific Hagfish	1.5
Pacific Whiting	1.5
Pacific Sandfish	1.5
Herring/Shad	1.5
Sculpin	1.5
Snailfish	1.5
Shrimp	1.5

*Of the 13 samples (19.4%) which contained salmonids, 6 (9.0%) contained adult salmonid remains and 8 (11.9%) contained smolt or small adult salmonid remains.

Table 13. ODFW Re-examination of salmonid remains using bones and otoliths from Pacific harbor seal scat samples collected by Beach et al. (1985) in the Columbia River, Grays Harbor, Willapa and Tillamook Bays 1980 - 1982 (reported as percent frequency of occurrence).

Mo/yr	n	Location	Beach et al.	ODFW	Adult	Smolt/Small
Jan/82	5	Grays	0	0	0	0
Mar/81	27		0	0	0	0
Apr/82	111		0	0.9	0	0.9
May/81	6		0	0	0	0
June/81	15		6.7	6.7	0	6.7
July/80	80		2.5	11.2	5.0	6.3
July/81	14/15		14.3	26.6	20.0	6.7
Aug/80	62		0	12.9	8.1	4.8
Aug/81	75		9.3	20.0	4.0	16.0
Nov/80	8		0	25.0	25.0	0
Mar/81	11	Willapa	0	0	0	0
May/82	1		0	0	0	0
June/80	10		0	20.0	0	20.0
June/81	1		100.0	0	0	0
July/80	26		3.8	11.5	3.8	7.7
Aug/80	65		13.8	50.8	32.3	23.1
Aug/81	79/65		0	13.8	10.8	3.1
Sept/80	17		0	52.9	53.1	0
Nov/80	1		0	0	0	0
Jan/81	18	Columbia	0	0	0	0
Jan/82	12		0	0	0	0
Feb/82	15		0	0	0	0
Mar/81	6		0	0	0	0
Mar/82	3		0	0	0	0
Apr/81	28		3.6	10.7	3.6	7.1
Apr/82	5		20.0	20.0	0	0
May/81	19		0	5.3	5.3	0
June/80	12		0	8.3	0	8.3
June/81	10		0	0	0	0
July/80	24		0	0	0	0
July/81	91/90		0	0	0	0
Aug/80	37		0	2.7	2.7	0
Aug/81	32		3.1	18.8	18.8	0
Sept/81	72/73		0	19.2	19.2	0
Oct/80	12		0	8.3	8.3	0
Nov/80	16		0	0	0	0
Dec/80	24		0	0	0	0
Sept-Oct/81	38/37	Tillamook	7.9	18.9	10.8	8.1

Table 14. Food habits information from California sea lion scat (fecal) samples (n=120) and Pacific harbor seal scat samples (n=214) and Steller sea lion scat samples (n=202) collected from 1986-1995 at 8 different locations in Oregon, (percent frequency of occurrence in samples greater than or equal to 10%).

California sea lions

Species	% Frequency of Occurrence
Pacific Mackeral	56.7
Pacific Whiting	33.3
Pacific Herring	26.7
Jackmackeral	22.5
Salmonid	22.5
Squid/Octopus	21.7
Pacific Sardine	20.0
Smelt	17.5
Pacific Lamprey	15.0
Spiny Dogfish	15.8
Rockfish	14.2
Skate	10.8
Pacific Sand Lance	10.0

Pacific harbor seals

Species	% Frequency of Occurrence
Pacific Staghorn Sculpin	22.4
Eulachon	18.2
Pacific Lamprey	18.2
Pacific Herring	17.8
Starry Flounder	16.4
Salmonid	16.4
Fish unid.	14.0
Smelt	13.6

Steller sea lions

Species	% Frequency of Occurrence
Pacific Whiting	84.1
Pacific Lamprey	38.6
Salmonid	19.3
Pacific Herring	15.3
Squid/Octopus	13.4

Appendix A. Scientific and common names of prey identified in pinniped scat collected in Oregon.

Common Name	Scientific Name
American Shad	Alosa sapidissima
Cod	Gadidae
Dover Sole	Microstomus pacificus
Eulachon	Thaleichthys pacificus
Flatfish	Pleuronectiformes
Greenling/Lingcod	Hexagrammidae
Gunnel	Pholididae
Herring/Shad	Clupeidae
Jackmackeral	Trachurus symmetricus
Lingcod	Ophiodon elongatus
Longfin Smelt	Spirinchus thaleichthys
Northern Anchovy	Engraulis mordax
Northern Clingfish	Gobiesox maendricus
Pacific Cod	Gadus macrocephalus
Pacific Hagfish	Eptatretus stoutii
Pacific Herring	Clupea pallasii
Pacific Lamprey	Lampetra tridentata
Pacific Mackeral	Scomber japonicus
Pacific Sanddab	Citharichthys sordidus
Pacific Sandfish	Trichodon trichodon
Pacific Sand Lance	Ammodytes hexapterus
Pacific Sardine	Sardinops sagax
Pacific Staghorn Sculpin	Leptocottus armatus
Pacific Tomcod	Microgadus proximus
Pacific Whiting	Merluccius productus
Peamouth	Mylocheilus caurinus
Perch	Embiotocidae
Petrale Sole	Eopsetta jordani
Pile Perch	Damalichthys vacca
Poacher	Agonidae
Prickleback	Stichaeidae
Red Irish Lord	Hemilepidotus hemilepidotus
Rex Sole	Glyptocephalus zachirus
River Lamprey	Lampetra ayresii
Rockfish	Sebastes sp.
Salmonid	Oncorhynchus sp.
Sculpin	Cottidae
Shark	Hexanchiformes
Shiner Surfperch	Cymatogaster aggregata
Shrimp	Crustacean
Skate	Rajidae
Smelt	Osmeridae
Snailfish	Liparididae

Appendix A. cont.

Common Name	Scientific Name
Spiny Dogfish	Squalus acanthias
Squid/Octopus	Cephlapod
Starry Flounder	Platichthys stellatus
Sturgeon Poacher	Agonus acipenserinus
Threadfin Sculpin	Icelinus filamentosus
Three-spine Stickleback	Gasterosteus aculeatus
Whitebait Smelt	Allosmerus elongatus

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