that precise estimation of production can be done within 30 d by sampling for eggs; this goal seems attainable for the northern anchovy. Utilization of the method for other species seems feasible.

Literature Cited

COLLINS, R. A.
1969. Size and age composition of northern anchovies (*Engraulis mordax*) in the California anchovy reduction fishery for the 1965-66, 1966-67, and 1967-68 seasons. *In* the northern anchovy (*Engraulis mordax*) and its fishery 1965-1968, p. 56-74. Calif. Dep. Fish Game, Fish Bull. 147.

HUNTER, J. R., AND S. R. GOLDBERG.
1980. Spawning incidence and batch fecundity in northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 77: 641-652.

KLINGBEIL, R. A.
1978. Sex ratios of the northern anchovy, *Engraulis mordax*, off southern California. Calif. Fish Game 64:200-209.

MURPHY, G. I.
1966. Population biology of the Pacific sardine (*Sardinops caerulea*). Proc Calif. Acad. Sci., Ser. 4, 34:1-84.

SAVILLE, A.
1964. Estimation of the abundance of a fish stock from egg and larval surveys. *In* J. A. Gulland (editor), On the measurement of abundance of fish stocks, p. 164-170. Rapp. P.-V. Réun. Cons. Perm. Int. Explor. Mer 155.

SEBER, G. A. F.
1973. The estimation of animal abundance and related parameters. Hafner Press, N.Y., 506 p.

SMITH, P. E.
1972. The increase in spawning biomass of northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 70: 849-874.

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FOOD OF THE HARBOR SEAL, *PHOCA VITULINA RICHARDSI*, IN THE GULF OF ALASKA

The harbor seal, *Phoca vitulina richardsi* (Shaughnessy and Fay 1977), is the most abundant and widespread coastal pinniped in the Gulf of Alaska. Harbor seals occupy virtually all nearshore habitats, and individuals occasionally occur as far as 100 km offshore (Spalding 1964; Wahl 1977; Fiscus et al.[1]). Despite their abundance and ecological importance, little information is available on their diet in Alaskan waters. In the most extensive food study published to date, Imler and Sarber (1947) examined stomachs of 99 seals from southeastern Alaska and 67 from the Copper River Delta. Wilke (1957) presented information on the food of seven harbor seals collected from Amchitka Island in the western Aleutian Islands. Kenyon (1965) reported on the stomach contents of 11 harbor seals taken in the same location. Bishop (1967) commented on stomach contents of two seals from Aialik Bay and two from Tugidak Island. Virtually no information has been available on the food of harbor seals from the Gulf of Alaska.

The study area (Figure 1) included coastal Gulf of Alaska from Yakutat Bay to Sanak Island. The portion of Cook Inlet north of Kachemak and Kamishak Bays was not included. The study area was divided into seven subareas for data analysis: northeastern Gulf of Alaska, Copper River Delta, Prince William Sound, Kenai coast, Lower Cook Inlet, Kodiak, and Alaska Peninsula.

Selection of Valdez as terminus of the trans-Alaskan oil pipeline and planned outer continental shelf oil and gas lease sales were the principal motivating factors for conducting this research. Production and transport of crude oil appeared to have the potential for significant alteration of the marine biota (Evans and Rice 1974) thus influencing the abundance and composition of harbor seal prey species. Established commercial fisheries for salmon, *Oncorhynchus* spp.; Pacific herring, *Clupea h. harengus*; halibut, *Hippoglossus stenolepis*; king crab, *Paralithodes camtschatica*; snow crab, *Chionoecetes bairdi*; Dungeness crab, *Cancer magister*; and shrimp, *Pandalus* spp., occur over the area, and pinnipeds are sometimes considered to be significant competitors with these fisheries. Data are needed to establish the possible impact of harbor seals on these commercially exploited species. Plans for developing fisheries are required by Federal laws (Public Law 94-265, Fishery Conservation and Management Act of 1976, and Public Law 92-522, Marine Mammal Protection Act of 1972) to utilize an integrated ecosystem approach to management

[1]Fiscus, C. H., H. W. Braham, R. W. Mercer, R. D. Everitt, B. D. Krogman, P. D. McGuire, C. E. Peterson, R. M. Sonntag, and D. E. Withrow. 1976. Seasonal distribution and relative abundance of marine mammals in the Gulf of Alaska. *In* Environmental assessment of the Alaskan Continental Shelf. Vol. 1. Principal investigators reports for October-December 1976, p. 19-264. Environmental Research Laboratories, NOAA, Boulder, Colo.

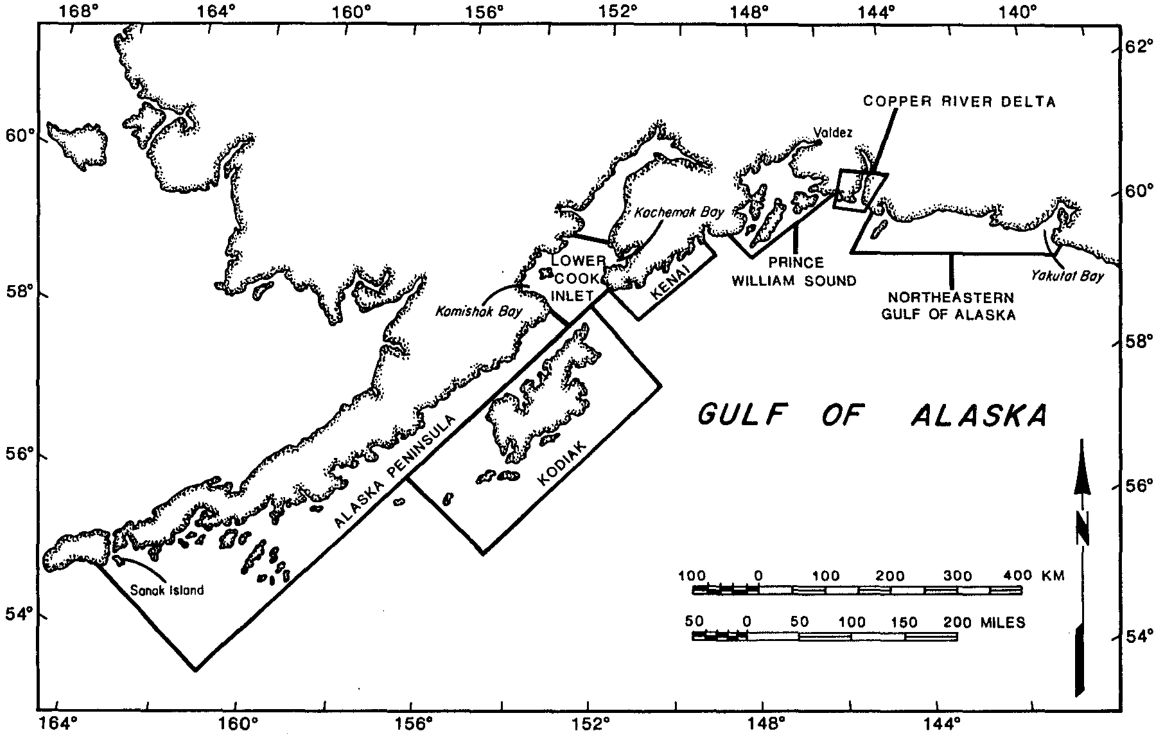

FIGURE 1.—Geographic subdivisions of Gulf of Alaska study area.

considering marine mammal populations as well as fishery resources.

Methods

A total of 548 harbor seals were collected by rifle throughout the Gulf of Alaska from 1973 through 1978 (Table 1). Reasonably complete seasonal coverage was obtained for Prince William Sound and the Kodiak area. Stomach contents were removed in the field, wrapped in muslin, and preserved in 10% Formalin.[2] In the laboratory the volumes and number of occurrences (number of stomachs in which a prey species was found) were determined for prey species. Because digestion was often advanced, skeletal materials, particularly fish otoliths and cephalopod mandibles (beaks), were the primary criteria for identification (Fitch and Brownell 1968; Pinkas et al. 1971).

Otoliths and other skeletal components from fish were tentatively identified to the lowest taxonomic level possible by comparison with reference materials. Otolith identifications were verified by John E. Fitch, California Department of Fish and Game, Long Beach. Cephalopod beaks were classified as either squid or octopus with the aid of Pinkas et al. (1971), and squid beaks were identified to family by Clifford H. Fiscus, National Marine Fisheries Service, NOAA, Seattle, Wash. Decapod crustaceans were identified by Kathryn J. Frost and Lloyd F. Lowry, Alaska Department of Fish and Game, Fairbanks.

In order to integrate data on both frequency of occurrence and prey volumes into a single ranking of prey utilization I used a modified form of the Index of Relative Importance (IRI)[3] devised by

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

TABLE 1.—Geographic and seasonal distribution of harbor seals collected in the Gulf of Alaska.

Area	Number of seals			
	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.
Northeastern Gulf of Alaska	—	22	—	9
Copper River Delta	—	18	27	—
Prince William Sound	62	24	26	39
Kenai coast	43	14	—	3
Lower Cook Inlet	—	37	—	—
Kodiak	4	106	38	53
Alaska Peninsula	—	20	3	—

[3]Original Index of Relative Importance as derived by Pinkas et al. (1971) was calculated by summing the numerical and volumetric percentage values and multiplying by the frequency of occurrence percentage value.

Pinkas et al. (1971). The numerical component of their formula was deleted because of the disparity in size of harbor seal prey items. The modified IRI was calculated as percentage of occurrences multiplied by percentage of volume.

Results

Food was present in 269 of the 548 stomachs. Fishes composed 74.5%, cephalopods 21.5%, and decapod crustaceans 4.0% of the occurrences (Table 2). A minimum of 27 species of fish were identified belonging to 13 families. Cephalopods included both octopus and squids of the family Gonatidae. Decapod crustaceans were primarily shrimps with one occurrence of a crab. The five top-ranked prey of harbor seals in the Gulf of Alaska were walleye pollock, octopus, capelin, eulachon, and Pacific herring (Table 3).

Regarding prey utilization by area of collection (Table 4), sample sizes were small and collections did not span all seasons (Table 1). Either walleye pollock or octopus was the top-ranked food in all marine areas and eulachon was dominant in the estuarian and freshwater habitats of the Copper River Delta. Walleye pollock was the top-ranked item in the eastern areas: northeastern Gulf of Alaska, Prince William Sound, and the Kenai coast. In the western areas: Lower Cook Inlet, Kodiak, and the Alaska Peninsula, octopus had the highest ranking. In Lower Cook Inlet, octopus and shrimps made up over 60% of both total

TABLE 2.—Stomach contents of 269 harbor seals collected in the Gulf of Alaska, all areas and seasons combined. [% under Occurrences = Percentage of occurrences and 95% confidence limits.]

Prey	Occurrences		Volume	
	No.	%	ml	%
Cephalopoda:	97	21.5±3.9	20,433	20.0
Octopus sp., octopus	77	17.1±3.5	18,753	18.3
Gonatidae, squids	20	4.4±2.0	1,680	1.6
Decapoda:	18	4.0±1.9	3,800	3.7
Shrimps	17	3.8±1.9	3,400	3.3
Crabs	1	0.2±0.5	400	0.4
Rajidae:				
Raja spp., skates	3	0.7±0.9	2,780	2.7
Clupeidae:				
Clupea h. harengus, Pacific herring	29	6.4±2.4	6,560	6.4
Salmonidae:				
Oncorhynchus spp., salmon	9	2.0±1.4	4,477	4.4
Osmeridae:	67	14.9±3.4	23,034	22.5
Mallotus villosus, capelin	40	8.8±2.7	10,687	10.4
Thaleichthys pacificus, eulachon	22	4.9±2.1	11,837	11.6
Hypomesus pretiosus, surf smelt	4	0.9±1.0	460	0.4
Unidentified Osmeridae, smelts	1	0.2±0.5	50	<0.1
Gadidae:	134	29.7±4.3	26,603	26.0
Eleginus gracilis, saffron cod	5	1.1±1.1	395	0.4
Gadus macrocephalus, Pacific cod	28	6.2±2.3	3,240	3.2
Microgradus proximus, Pacific tomcod	7	1.6±0.7	1,030	1.0
Theragra chalcogramma, walleye pollock	94	20.8±3.9	21,938	21.4
Zoarcidae:				
Lycodes spp., eelpouts	6	1.3±1.2	60	0.1
Scorpaenidae:				
Sebastes spp., rockfishes	4	0.9±1.0	810	0.8
Hexagrammidae:				
Hexagrammos spp., greenlings	2	0.4±0.7	400	0.4

TABLE 2.—*Continued.*

Prey	Occurrences		Volume	
	No.	%	ml	%
Cottidae:	10	2.2±1.5	1,912	1.9
Dasycottus setiger, spinyhead sculpin	2	0.4±0.7	—	—
Enophrys bison, buffalo sculpin	1	0.2±0.5	240	0.2
Myoxocephalus spp., sculpins	2	0.4±0.7	1,430	1.4
Unidentified Cottidae, sculpins	5	1.1±1.1	242	0.2
Trichodontidae:				
Trichodon trichodon, Pacific sandfish	10	2.2±1.5	3,025	3.0
Bathymasteridae:				
Bathymaster signatus, searcher	3	0.7±0.9	40	<0.1
Ammodytidae:				
Ammodytes hexapterus, Pacific sand lance	19	4.2±2.0	463	0.5
Pleuronectidae:	23	5.3±2.2	2,615	2.6
Atheresthes stomias, arrowtooth flounder	3	0.7±0.9	—	—
Eopsetta jordani, petrale sole	1	0.2±0.5	—	—
Glyptocephalus zachirus, Rex sole	1	0.2±0.5	150	0.1
Hippoglossoides elassodon, flathead sole	5	1.1±1.1	130	0.1
Lepidopsetta bilineata, rock sole	1	0.2±0.5	—	—
Limanda aspera, yellowfin sole	6	1.3±1.2	1,650	1.6
Lyopsetta exilis, slender sole	2	0.4±0.7	—	—
Parophrys vetulus, English sole	2	0.4±0.7	65	<0.1
Unidentified Pleuronectidae	2	0.4±0.7	620	0.6
Unidentified fish remains	17	3.8±1.9	5,320	5.2
Totals	451	100.0	102,332	100.1

TABLE 3.—Rankings by modified Index of Relative Importance (IRI, see text footnote 3) of major prey of harbor seals collected in the Gulf of Alaska. Only those prey with IRI ≥2 are included.

Rank	Prey	Modified IRI	Occurrences (%)	Volume (%)
1	Walleye pollock	445	20.8	21.4
2	Octopus	313	17.1	18.3
3	Capelin	92	8.8	10.4
4	Eulachon	57	4.9	11.6
5	Pacific herring	41	6.4	6.4
6	Pacific cod	20	6.2	3.2
7.5	Flatfishes	13	5.1	2.6
7.5	Shrimps	13	3.8	3.3
9	Salmon	9	2.0	4.4
10	Squids	7	4.4	1.6
11	Pacific sandfish	7	2.2	3.0
12	Sculpins	4	2.2	1.9
14	Skates	2	0.7	2.7
14	Pacific sand lance	2	4.2	0.5
14	Pacific tomcod	2	1.6	1.0

TABLE 4.—Major prey of harbor seals from seven geographic areas in the Gulf of Alaska. Prey ranked in order of modified Index of Relative Importance (IRI, see text footnote 3). Only prey with IRI ≥2 are included. [Occurrences = Percentage of occurrences ± 95% confidence limits.]

Area and prey	IRI	Occurrences	Volume (%)
Northeastern Gulf of Alaska (stomachs with contents 17; occurrences 39; volume 2,420 ml)			
Walleye pollock	640	28.2±15.4	22.7
Surf smelt	196	10.3±10.8	19.0
Capelin	143	23.1±14.5	6.2
Shrimps	131	2.6± 6.3	50.4
Copper River Delta (stomachs with contents 14; occurrences 15; volume 8,115 ml)			
Eulachon	8,826	93.3±17.4	94.6
Salmon	36	6.7±17.4	5.4
Prince William Sound (stomachs with contents 83; occurrences 122; volume 28,290 ml)			
Walleye pollock	1,375	29.5± 8.5	46.6
Pacific herring	166	14.8± 6.7	11.2
Squids	77	13.1± 6.4	5.9
Octopus	75	13.9± 6.6	5.4
Salmon	33	3.3± 3.6	10.0
Capelin	16	4.1± 3.9	3.8
Pacific tomcod	5	1.6± 2.7	3.3
Pacific cod	4	4.9± 4.2	0.9
Saffron cod	3	2.5± 3.2	1.3
Eulachon	3	1.6± 2.7	1.9
Kenai coast (stomachs with contents 30; occurrences 52; volume 7,225 ml)			
Walleye pollock	1,503	40.4±14.3	37.2
Pacific herring	247	11.5± 9.6	21.5
Pacific sandfish	44	7.7± 8.2	5.7
Capelin	19	5.8± 7.3	3.3
Pacific tomcod	4	3.8± 6.2	1.0
Lower Cook Inlet (stomachs with contents 17; occurrences 23; volume 5,412 ml)			
Octopus	1,697	39.1±23.4	43.4
Eulachon	532	17.4±18.6	30.6
Shrimps	501	21.7±20.0	23.1
Capelin	17	8.7±14.4	1.9
Kodiak Island (stomachs with contents 102; occurrences 192; volume 42,685 ml)			
Octopus	631	21.4± 6.1	29.5
Capelin	323	10.9± 4.7	21.3
Walleye pollock	70	12.0± 4.9	5.8
Flatfishes	63	10.9± 4.7	5.8
Pacific cod	55	8.3± 4.2	6.6
Pacific sand lance	9	8.3± 4.2	1.1
Pacific herring	9	2.1± 2.3	4.2
Shrimps	8	3.6± 2.9	2.2
Salmon	6	2.1± 2.3	2.9
Sculpins	3	4.2± 3.1	0.7
Eulachon	2	0.5± 1.3	4.6
Alaska Peninsula (stomachs with contents 6; occurrences 9; volumes 8,185 ml)			
Octopus	929	33.3±41.8	27.9
Walleye pollock	824	22.2±37.5	37.1
Pacific sandfish	342	11.1±29.7	30.8
Pacific cod	40	22.2±37.5	1.8
Sculpins	26	11.1±29.7	2.3

occurrences and volumes which was nearly twice the percentages in other areas.

Chi-square analyses of prey occurrences for Kodiak Island and Prince William Sound indicated that in Prince William Sound more walleye pollock ($P<0.01$) were eaten than in Kodiak (Table 5). In Kodiak there was higher utilization ($P<0.05$) of capelin than in Prince William Sound. Octopus and Pacific cod were not utilized at significantly different rates ($P>0.05$). While samples were inadequate for statistical testing, it appeared that more squids and Pacific herring and fewer Pacific sand lances, flatfishes, and sculpins were eaten in Prince William Sound than in Kodiak.

TABLE 5.—Comparison of occurrences of principal prey ($N \geq 4$) of harbor seals collected in Prince William Sound and the Kodiak Island area. Statistical comparisons were made by chi-square analysis. [% = Percentage ± 95% confidence limits; — = Inadequate sample for statistical testing.]

Prey	Kodiak		Prince William Sound		
	No.	%	No.	%	*P*
Octopus	41	21.4±6.1	17	13.9±6.5	>0.05
Squids	2	1.0±1.7	16	13.1±6.4	—
Shrimps	7	3.6±2.9	1	0.8±2.0	—
Pacific herring	4	2.1±2.3	18	14.8±6.7	—
Salmon	4	2.1±2.3	4	3.3±3.6	—
Capelin	21	10.9±4.7	5	4.1±3.9	<0.05
Pacific cod	16	8.3±4.2	6	4.9±4.2	>0.10
Walleye pollock	23	12.0±4.9	36	29.5±8.5	<0.01
Sculpins	8	4.2±3.1	0	0.0	—
Pacific sand lance	16	8.3±4.2	0	0.0	—
Flatfishes	21	10.9±4.7	1	0.8±2.0	—
Total occurrences	192		122		

Salmon were found in the diet of harbor seals from both Prince William Sound and the Kodiak Island area only during the summer (Table 6). In the Kodiak area, feeding on Pacific sand lance appeared to be greatest in the fall while use of capelin seemed to peak in the spring. Use of Pacific herring by harbor seals appeared greatest in the spring in Prince William Sound.

Prey items were found in the stomachs of 13 harbor seal pups 2.5-11 mo of age and included shrimps, capelin, Pacific tomcod, walleye pollock, and Pacific sand lance. All items were <15 cm total length.

Discussion

The high ranking of walleye pollock in the harbor seal diet may have been a direct function of its abundance. Pereyra and Ronholt[4] found that walleye pollock was the dominant fish species in the Gulf of Alaska, composing 45% by weight of total fish stocks. Octopus, the second-ranked prey, appears to be an important food of harbor seals throughout the eastern North Pacific as nearly all food studies have found them to be a major component of the diet (Scheffer and Sperry 1931; Imler and Sarber 1947; Fisher 1952; Wilke 1957; Spalding 1964; Kenyon 1965; Bishop 1967). Five of the six, top-ranked prey were off-bottom, schooling fishes. Use of this type of prey may minimize

[4]Pereyra, W. T., and L. L. Ronholt. 1976. Baseline studies of demersal resources of the northern Gulf of Alaska shelf and slope. U.S. Dep. Commer., NOAA Processed Rep. NMFS NWFC, 281 p.

TABLE 6.—Seasonal occurrences of principal prey ($N \geq 4$) of harbor seals from the Kodiak Island area and Prince William Sound. [No. = Occurrences of prey; % = Percentage and 95% confidence limits.]

Area and prey	Jan.-Mar. No.	Jan.-Mar. %	Apr.-June No.	Apr.-June %	July-Sept. No.	July-Sept. %	Oct.-Dec. No.	Oct.-Dec. %
Kodiak Island area:								
Octopus	0	0.0	24	25.8± 9.4	6	15.0±12.3	9	15.8±10.3
Salmon	0	0.0	0	0.0	4	10.0±10.5	0	0.0
Capelin	0	0.0	14	15.1± 7.8	3	7.5± 9.4	3	5.3± 6.7
Pacific cod	0	0.0	8	8.6± 6.2	3	7.5± 9.4	4	7.0± 7.5
Walleye pollock	0	0.0	15	16.1± 8.0	3	7.5± 9.4	6	10.5± 8.8
Pacific sand lance	0	0.0	0	0.0	3	7.5± 9.4	12	21.1±11.5
Total occurrences	2		93		40		57	
Prince William Sound:								
Octopus	9	15.8±10.3	2	15.4±21.6	2	14.3±20.1	5	13.2±12.1
Squids	8	14.0± 9.9	0	0.0	3	21.4±23.5	5	13.2±12.1
Herring	8	14.0± 9.9	5	38.5±29.2	2	14.3±20.1	2	5.3± 8.4
Salmon	0	0.0	0	0.0	4	28.6±25.9	0	0.0
Capelin	4	7.0± 7.5	0	0.0	1	7.1±14.7	0	0.0
Walleye pollock	15	26.3±12.3	4	30.8±27.7	1	7.1±14.7	15	39.5±16.9
Total occurrences	57		13		14		38	

foraging effort and conserve energy compared with selection of more solitary species (Smith and Gaskin 1974).

The major differences in prey utilization between Prince William Sound and Kodiak are not readily explainable. However, water depths and topography for the two areas are considerably different (U.S. Department of Commerce[5]). Kodiak waters have considerable shallow shelf area, particularly east and south of the Island, and Prince William Sound generally has a rocky, precipitous coast and deep waters reaching 740 m. These features may influence prey composition, abundance, and availability to harbor seals.

Differential utilization of certain prey by season appeared to be explained by availability in most instances. Salmon occurred in stomachs of seals from both Kodiak and Prince William Sound only during the summer. In both areas salmon are only available in quantity in nearshore waters during this period. The apparent increases during spring in utilization of herring in Prince William Sound and capelin in the Kodiak area probably reflected nearshore distribution associated with spawning in these species (Hart 1973; Jangaard 1974). In the Kodiak area, Pacific sand lance were utilized to a greater extent during fall. No reason is known for this.

Six of the 10, top-ranked prey; walleye pollock, Pacific herring, Pacific cod, flatfishes, shrimps, and salmon are either currently harvested commercially or may be harvested in the near future (North Pacific Fishery Management Council[6]). Of particular interest is the possibility of increased harvests of walleye pollock which was the top-ranked prey of harbor seals accounting for about 21% of both total occurrences and volumes of food items. Sergeant (1976) believed that fisheries could compete with natural predators and cause their populations to stabilize at levels well below those existing prior to the fishery.

Harbor seals are present on the Copper River Delta from May through September. The results of this study and those of Imler and Sarber (1947) indicated that eulachon was the dominant prey from late May to mid-July. Nothing is known about feeding during late summer and fall when eulachon are not present.

Although specialized feeding on shrimps by newly weaned harbor seal pups was reported by Havinga (1933), Fisher (1952), and Bigg (1973), small fishes were the primary food of young seals <1 yr old collected during this study.

During this study several sampling problems and prey identification biases became apparent. Distinct geographic and seasonal variations in prey utilization were found to occur and because of this it was difficult to determine if a completely representative sample was obtained. Also, our sampling was restricted to nearshore waters. If a significant amount of feeding took place offshore and availability and composition of potential prey was different there, the results of this study would not be totally representative. In addition, the probability of detecting and identifying various

[5]U.S. Department of Commerce, NOAA, Nautical Charts No. 8556 and 16700.

[6]North Pacific Fishery Management Council. 1978. Fishery management plan for the Gulf of Alaska groundfish fishery during 1978. Unpubl. manuscr., 220 p. North Pacific Fishery Management Council, P.O. Box 3136 DT, Anchorage, AK 99510.

prey in the stomachs was not equal. Cephalopod beaks are not always passed through the intestinal tract and may remain in the stomach for several days before they are regurgitated (Pitcher unpubl. data). This increases the probability of detection thereby exaggerating estimates of their utilization.

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Literature Cited

BIGG, M. A.
1973. Adaptations in the breeding of the harbour seal, (*Phoca vitulina*). J. Reprod. Fert., Suppl. 19:131-142.

BISHOP, R. H.
1967. Reproduction, age determination and behavior of the harbor seal, (*Phoca vitulina*) in the Gulf of Alaska. M.S. Thesis, Univ. Alaska, College, 121 p.

EVANS, D. R., AND S. D. RICE.
1974. Effects of oil on marine ecosystems: A review for administrators and policy makers. Fish. Bull., U.S. 72:625-638.

FISHER, H. D.
1952. The status of the harbour seal in British Columbia, with particular reference to the Skeena River. Fish. Res. Board Can., Bull. 93, 58 p.

FITCH, J. E., AND R. L. BROWNELL, JR.
1968. Fish otoliths in cetacean stomachs and their importance in interpreting feeding habits. J. Fish. Res. Board Can. 25:2561-2574.

HART, J. L.
1973. Pacific fishes of Canada. Fish. Res. Board Can., Bull. 180, 740 p.

HAVINGA, B.
1933. Der Seehund in den Hollandischen Gerwassern. Tijdschr. Ned. Dierkd. Ver. 3:79-111.

IMLER, R. H., AND H. R. SARBER.
1947. Harbor seals and sea lions in Alaska. U.S. Fish Wildl. Serv., Spec. Sci. Rep. 28, 23 p.

JANGAARD, P. M.
1974. The capelin (*Mallotus villosus*) biology, distribution, exploitation, utilization, and composition. Fish. Res. Board Can., Bull. 186, 70 p.

KENYON, K. W.
1965. Food of harbor seals at Amchitka Island, Alaska. J. Mammal. 46:103-104.

PINKAS, L., M. S. OLIPHANT, AND I. L. K. IVERSON.
1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dep. Fish Game, Fish Bull. 152, 105 p.

SCHEFFER, T. H., AND C. C. SPERRY.
1931. Food habits of the Pacific harbor seal, *Phoca richardii*. J. Mammal. 12:214-226.

SERGEANT, D. E.
1976. History and present status of populations of harp and hooded seals. Biol. Conserv. 10:95-118.

SHAUGHNESSY, P. D., AND F. H. FAY.
1977. A review of the taxonomy and nomenclature of north Pacific harbour seals. J. Zool. (Lond.) 182:385-419.

SMITH, G. J. D., AND D. E. GASKIN.
1974. The diet of harbor porpoises (*Phocoena phocoena* (L.)) in coastal waters of Eastern Canada, with special reference to the Bay of Fundy. Can. J. Zool. 52:777-782.

SNEDECOR, G. W., AND W. G. COCHRAN.
1967. Statistical methods. 6th ed. Iowa State Univ. Press, Ames, 593 p.

SPALDING, D. J.
1964. Comparative feeding habits of the fur seal, sea lion, and harbour seal on the British Columbia coast. Fish. Res. Board Can., Bull. 146, 52 p.

WAHL, T. R.
1977. Sight records of some marine mammals offshore from Westport, Washington. Murrelet 58:21-23.

WILKE, F.
1957. Food of sea otters and harbor seals at Amchitka Island. J. Wildl. Manage. 21:241-242.

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PRODUCTION AND GROWTH OF SUBYEARLING COHO SALMON, *ONCORHYNCHUS KISUTCH*, CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*, AND STEELHEAD, SALMO GAIRDNERI, IN ORWELL BROOK, TRIBUTARY OF SALMON RIVER, NEW YORK

Decline of lake trout, *Salvelinus namaycush*, and burbot, *Lota lota*, populations in the Great Lakes from 1930 to 1950 created a void of a large offshore piscivore in these waters. Smith (1968) attributed the decline to overexploitation by the commerical fishery and predation by the sea lamprey, *Petromyzon marinus*. The decline was followed by proliferation of the alewife, *Alosa pseudoharengus*, in Lakes Ontario, Huron, and Michigan