

Predation by Marine Mammals on Squids of the Eastern North Pacific Ocean and the Bering Sea

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Introduction

When marine mammals (with the exception of a few cetaceans) forage for food over the continental shelf, fish usually comprise most of their prey. Along the continental slope fish and cephalopods are equally important, and in the deeper waters of the North Pacific Ocean and the Bering Sea squids form a major part of their diet. In the eastern North Pacific Ocean the neritic squid *Loligo opalescens* is the most important species preyed on by marine mammals over the continental shelf. However, the data available on consumption of squid by marine mammals have not been systematically reviewed.

Parts of this paper were originally prepared for a workshop on squids held at the Seattle Laboratory of the NMFS Northwest and Alaska Fisheries Center on 19-20 March 1981. The purpose of the workshop was to gather information on the squid resources of the region, principally from central California to the Bering Sea, for potential development of squid fisheries. The various species of squids were listed and described and information was presented on their distribution, seasonal abundance, commercial utilization, and position they play

in the northeastern Pacific Ocean ecosystem.

This paper is an attempt to consolidate and make available information from several sources on the relationship between squids and their major marine mammal predators. Most of the small cetaceans, several of the large cetaceans, and most pinnipeds prey on squid and octopus when available.

Marine mammals inhabiting the eastern North Pacific Ocean and Bering Sea are listed in Table 1. Of the 45 marine mammals listed in Table 1, 26 are known to prey on squid or octopus in varying degrees, and it is quite likely that many of the remaining 20 may also prey to

some extent on these cephalopods. Major predators are discussed here.

Important sources of information on the predator-prey relation between marine mammals and squids of the epipelagic, mesopelagic, and the continental shelf waters in the eastern North Pacific Ocean are the annual reports of agencies of the United States (National Marine Fisheries Service, NOAA) and Canada (Department of the Environment) on pelagic fur seal research carried out during 1958-74. These reports provide information on species identified from stomachs of northern fur seals, and general locations where these seals were taken. In the past several years, data

Table 1.—Marine mammals of the eastern North Pacific Ocean, Bering, and Chukchi Seas. Those known to prey on cephalopods are marked with an asterisk (*). (Names are after Rice, 1977.)

Common name	Scientific name	Common name	Scientific name
Walrus	<i>Odobenus rosmarus</i>	Spotted dolphin	<i>Stenella attenuata*</i>
California sea lion	<i>Zalophus californianus*</i>	Striped dolphin	<i>Stenella coeruleoalba*</i>
Northern sea lion	<i>Eumetopias jubatus*</i>	Saddleback dolphin	<i>Delphinus delphis*</i>
Northern fur seal	<i>Callorhinus ursianus*</i>	Pacific whiteside dolphin	<i>Lagenorhynchus obliquidens*</i>
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	Northern right whale dolphin	<i>Lissodelphis borealis*</i>
Sea otter	<i>Enhydra lutris*</i>	Whitehead grampus	<i>Grampus griseus*</i>
Harbor seal	<i>Phoca vitulina richardsi*</i>	False killer whale	<i>Pseudorca crassidens*</i>
Spotted or larga seal	<i>Phoca largha*</i>	Shortfin pilot whale	<i>Globicephala macrorhynchus*</i>
Ringed seal	<i>Phoca hispida*</i>	Killer whale	<i>Orcinus orca</i>
Ribbon seal	<i>Phoca fasciata*</i>	Harbor porpoise	<i>Phocoena phocoena</i>
Bearded seal	<i>Erignathus barbatus</i>	Dall's porpoise	<i>Phocoenoides dalli*</i>
Northern elephant seal	<i>Mirounga angustirostris*</i>	Belukha	<i>Delphinapterus leucas*</i>
Gray whale	<i>Eschrichtius robustus</i>	Sperm whale	<i>Physeter macrocephalus*</i>
Minke whale	<i>Balaenoptera acutorostrata</i>	Pygmy sperm whale	<i>Kogia breviceps*</i>
Bryde whale	<i>Balaenoptera edeni</i>	Dwarf sperm whale	<i>Kogia simus*</i>
Sei whale	<i>Balaenoptera borealis</i>	North Pacific giant bottlenose whale	<i>Berardius bairdii</i>
Fin whale	<i>Balaenoptera physalus</i>	Goosebeak whale	<i>Ziphius cavirostris*</i>
Blue whale	<i>Balaenoptera musculus</i>	Ginkgo-tooth whale	<i>Mesoplodon ginkgodens</i>
Humpback whale	<i>Megaptera novaeangliae</i>	Archbeak whale	<i>Mesoplodon carlhubbsi</i>
Right whale	<i>Balaena glacialis</i>	Bering Sea beaked whale	<i>Mesoplodon stejnegeri</i>
Bowhead whale	<i>Balaena mysticetus</i>	Densebeak whale	<i>Mesoplodon densirostris</i>
Rough-toothed dolphin	<i>Steno bredanensis*</i>		
Bottlenose dolphin	<i>Tursiops truncatus*</i>		
Spinner dolphin	<i>Stenella longirostris*</i>		

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from this research have been combined and compiled in a series of reports (North Pacific Fur Seal Commission, 1962, 1969, 1971, 1975, 1980; Lander, 1980; Perez¹; and Perez and Bigg²).

Two abundant small cetaceans (Dall's porpoise and Pacific white-sided dolphin) and the northern fur seal inhabit the same subarctic waters and consume essentially the same species of squids (Kajimura et al., 1980). Antonelis and Fiscus (1980) briefly discussed the food and feeding habits of pinnipeds of the California Current. Some demersal species were found in the stomachs of collected specimens, evidencing that these pinnipeds, including the fur seal, and the two small cetaceans which feed primarily in surface and near surface waters on epipelagic and mesopelagic species, also feed over the continental shelf and descend to the bottom.

Several other small cetaceans are abundant in tropical and subtropical waters and two of them, the saddleback dolphin and the shortfin pilot whale, range northward into the southern fringe of the region discussed here. Reilly (1977) summarizes the available information on feeding habits of the pilot whale. He describes five population centers for this species; the northernmost (Californian) stretches from about San Francisco Bay, Calif., to northern Baja California, Mexico. This population may feed mostly on the squid *Loligo opalescens*. The saddleback dolphin is most abundant

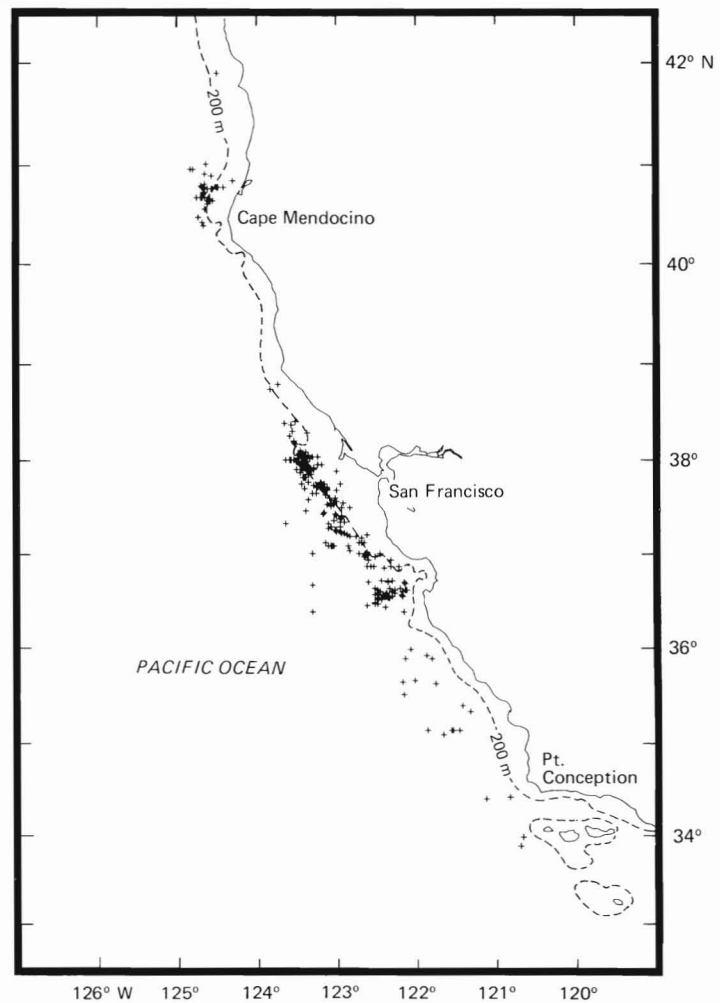


Figure 1.—Locations off California where northern fur seals were collected whose stomachs contained *Loligo opalescens*.

¹Perez, M. A. 1979. Preliminary analysis of feeding habits of the northern fur seal in the eastern North Pacific Ocean and Bering Sea, 1958-74. In H. Kajimura, R. H. Lander, M. A. Perez, A. E. York, and M. A. Bigg, Preliminary analysis of pelagic fur seal data collected by the United States and Canada during 1958-74. Natl. Mar. Mammal Lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way, N.E., Seattle, WA 98115. (Submitted to 22d Annual Meeting of the North Pacific Fur Seal Commission.) Unpubl. rep., p. 167-232.
²Perez, M. A., and M. A. Bigg. 1980. Interim Report on the feeding habits of the northern fur seal. In H. Kajimura, R. H. Lander, M. A. Perez, A. E. York, and M. A. Bigg, Further analysis of pelagic fur seal data collected by the United States and Canada during 1958-74, Part 2. Natl. Mar. Mammal Lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way, N.E., Seattle, WA 98115. (Submitted to 23d Annual Meeting of the North Pacific Fur Seal Commission.) Unpubl. rep., p. 4-172.

from the California Bight southward and also preys heavily on squids.

Most information on bathypelagic and benthic squids has been obtained by examining the stomach contents of several species of toothed whales, primarily the sperm whale taken by commercial whalers and from specimens stranded on beaches.

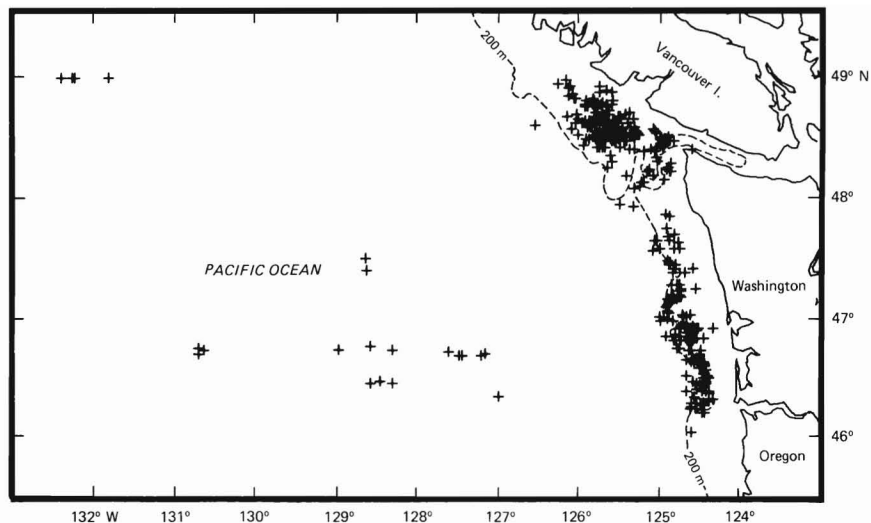
Methods

Collection of Specimens

Fur seals were taken at sea by the

United States and Canada during 1958-74. Collections were made in seven areas as follows: 1) California, December to June 1958-66; 2) Oregon, January to May 1958-65; 3) Washington, December to June 1958-74; 4) British Columbia, January to July 1958-72; 5) Gulf of Alaska, February to August 1958-68; 6) Western Alaska, May to October 1958-68; and 7) Bering Sea, May to November 1958-74. Because the cephalopod fauna of Oregon, British Columbia, and Western Alaska is similar to adjoining areas, only four of the areas

Figure 2.—Locations off Washington where northern fur seals were collected whose stomachs contained *Loligo opalescens*



are discussed. See the annual reports mentioned previously for methods of taking.

Dall's porpoise, Pacific white-sided dolphin, and several other small cetaceans (saddleback dolphin and killer whale) were also taken at sea during fur seal research cruises (see Kajimura et al., 1980, for description of taking).

Sperm whales taken commercially off central California by commercial whalers from 1956 to 1971 (Rice, 1974 and pers. commun.) were examined at the Richmond, Calif., stations and stomach contents retained for identification at the National Marine Mammal Laboratory (NMML) in Seattle, Wash.

Stomach contents of stranded specimens were collected as they became available and identified in the NMML. Squid remains in stomachs ranged from relatively intact and undigested whole specimens to undigestible hard parts such as the gladius, beaks, and statoliths. Unfortunately many identifications must be based on beaks alone. The head, base of arms and tentacles, and the buccal mass persist in a stomach longer than do other body parts, and this fragment can be useful in identifying a specimen at least to genus.

Squid beaks from the stomachs of marine mammals, fish, and birds usually can be identified to family. In some instances, however, species identifications can be made where no near relatives occur. For example, in the eastern North Pacific Ocean *L. opalescens* is the only representative of its family presently known to occur and *Onychoteuthis borealijaponicus* is the only representative of its genus. There are many species of gonatids and they cannot be identified with certainty from beaks alone; how-

ever, if the head and arms, and tentacles are relatively intact, identification usually can be made to genus. Within the past 20 years the numbers of species described in the family Gonatidae from the North Pacific Ocean and Bering Sea has more than doubled, and more species will likely be identified and described in the future.

The degree of digestion of prey items is important and should be considered when analyzing information on prey species from marine mammal stomachs. Whole or relatively undigested squids indicate consumption near the point of capture; however, beaks alone may represent accumulations of previous feedings and the animal could have traveled a considerable distance from where the prey was consumed. Prey identified from the stomachs of dead, stranded specimens usually provide little information on where prey was consumed. Squids, by family, are discussed below.

Squids Taken as Prey

Loliginidae

Loligo opalescens is the only species of this family identified from the north-eastern North Pacific Ocean. It is found

from the shore seaward over the continental shelf and slope within its range which extends from Mexico northward to British Columbia (Recksiek and Frey, 1978; Bernard, 1980). Young (1972) stated that *L. opalescens* probably is the most abundant cephalopod species off the California coast. Bernard (1980) mentions this squid as being present in large numbers in the shallow waters off British Columbia. It is locally abundant seasonally and is a major prey of fishes, seabirds, and most pinnipeds and small cetaceans throughout its range.

During all months in which fur seals were collected (January through June off California and December through June off Washington), *L. opalescens* was found in the stomachs of fur seals collected off California and Washington. Most fur seals that had consumed it were taken over the continental shelf and slope or a relatively short distance seaward of the slope. It was reported in the stomachs of six fur seals collected well offshore in the eastern part of the Gulf of Alaska; however, significant numbers have not been found in seals taken north of Hecate Strait, British Columbia. Locations where fur seals were collected whose stomachs contained *L. opalescens* are shown in Figures 1 (California) and 2

(Washington) (from Kajimura³ and unpublished records⁴). It was also found in the stomachs of Dall's porpoise and Pacific white-sided dolphins collected off California and Washington (Kajimura et al., 1980) and in saddleback dolphins collected off California (Fiscus and Niggol, 1965).

Onychoteuthidae

Onychoteuthis borealijaponicus is the only species of this genus identified from transitional and subarctic waters of the North Pacific Ocean⁵. It ranges over the continental slope and seaward, occurring rarely over the continental shelf from Baja California north to British Columbia in the eastern North Pacific Ocean (Young, 1972). The stomachs of three seals taken off Kodiak Island in the Gulf of Alaska in April and May 1960 contained *O. borealijaponicus*; it is taken in surface gillnets in subarctic waters of the North Pacific Ocean south of western Alaska and the Aleutian Islands (footnote 4). In the western North Pacific Ocean, this species ranges north to the Kuril Islands and waters south of the western Aleutian Islands at least seasonally (Naito et al., 1977). It is a major prey of pinnipeds and cetaceans that forage in offshore epipelagic and mesopelagic zones.

It was identified from the stomachs of fur seals collected off California during all months in which fur seals were collected (January-June), and off Washington from January to June. None were reported off Washington in December but only 78 seals were taken during that month. Occurrences of *O. borealijaponicus* increased off Washington in April and May; however, this increase could

have been the result of an increase in the number of cruises seaward of the continental slope during those months. Locations where fur seals were collected whose stomachs contained *O. borealijaponicus* are shown in Figures 3 (California) and 4 (Washington) (footnotes 3 and 4). This species is also taken by Dall's porpoise and Pacific white-sided dolphins (Kajimura et al., 1980).

Ommastrephidae

Most members of this family are found in tropical and subtropical waters south

of the subarctic water mass except for *Ommastrephes bartramii* which apparently ventures across the subarctic boundary on occasion (Clarke, 1966; Young, 1972). While we have not identified *O. bartramii* from the stomachs of marine mammals collected in the eastern North Pacific Ocean, the species occurs at least seasonally as reported by Bernard (1980), and we have identified several specimens taken in gillnets by Pacific Salmon Investigation (NMFS Northwest and Alaska Fisheries Center) vessels south of the Aleutian Islands.

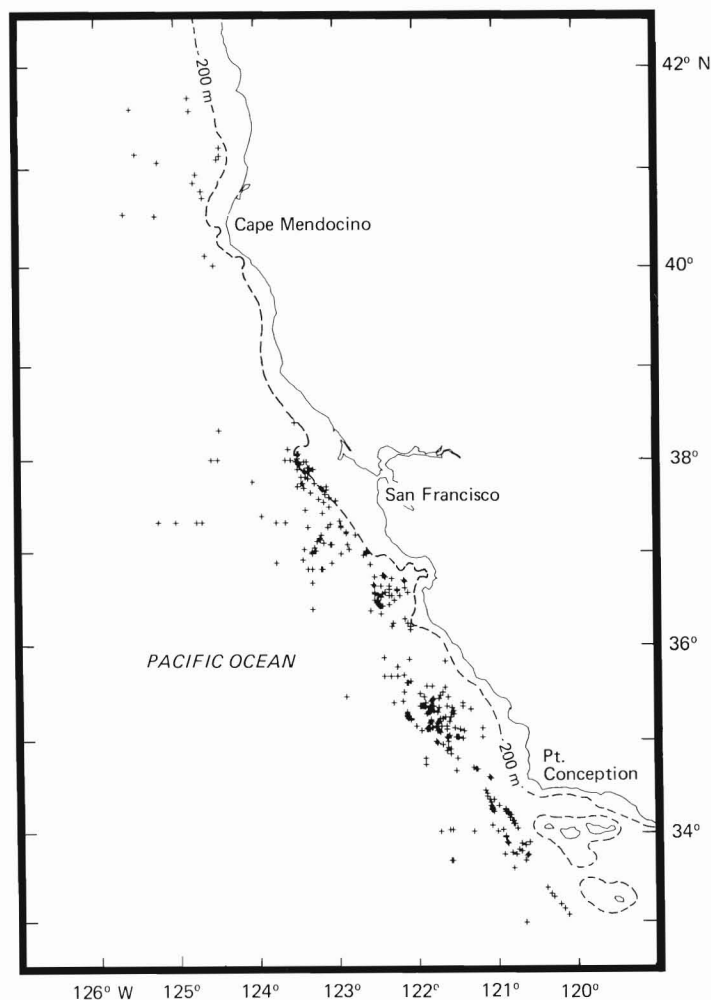


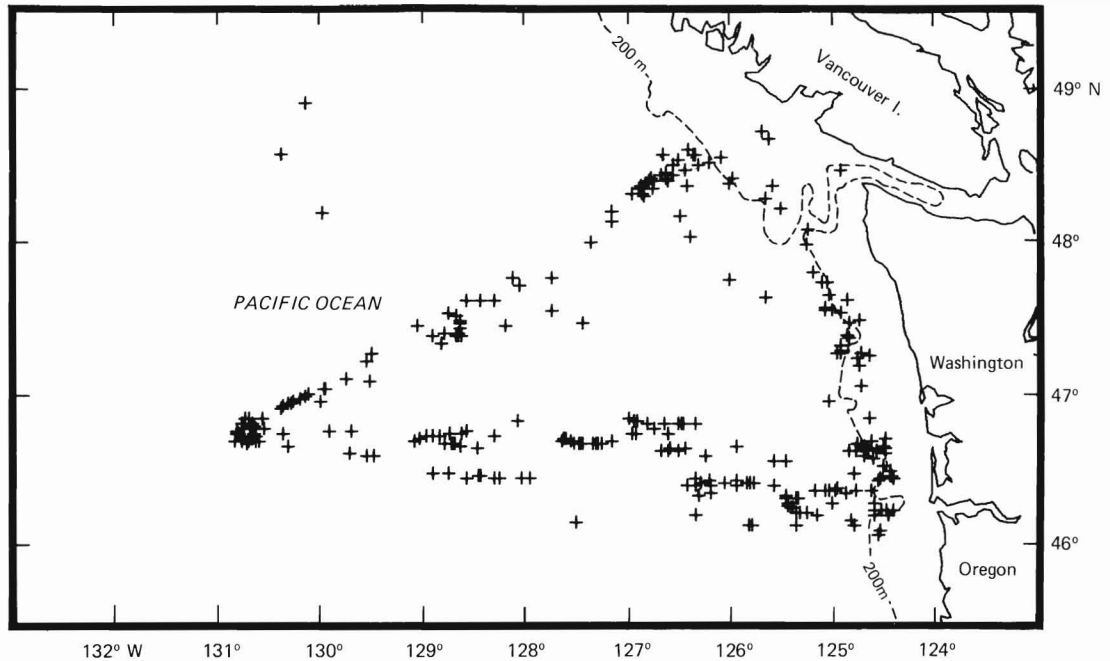
Figure 3.—Locations off California where northern fur seals were collected whose stomachs contained *Onychoteuthis borealijaponicus*.

³Kajimura, H. 1981. The opportunistic feeding of northern fur seals off California. Natl. Mar. Mammal Lab., Northwest and Alaska Fish. Cent., Natl. Mar. Fish Serv., NOAA, 7600 Sand Point Way, N.E., Seattle, WA 98115. Unpubl. rep., 46 p.

⁴Unpublished records of the National Marine Mammal Laboratory, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way, N.E., Seattle, WA 98115.

⁵The other recognized species in the genus, *O. banksii*, is apparently tropical or subtropical in the Pacific Ocean (Young, 1972).

Figure 4.—Locations off Washington where northern fur seals were collected whose stomachs contained *Onychoteuthis borealijaponicus*.



Gonatidae

Three genera, *Gonatus*, *Berryteuthis*, and *Gonatopsis*, comprising about 12 species, represent this family in subarctic waters of the North Pacific Ocean and Bering Sea (Young, 1972; Okutani, 1973; Naito et al., 1977; Anderson, 1978; Bublitz, 1981; and Jefferts, 1981). It is extremely difficult or impossible at present to identify these species from beaks alone; therefore, this discussion will be restricted to the family level.

Members of this family are found principally from the continental slope seaward and in some inshore deepwater localities such as Prince William Sound, Alaska, and southeastern Alaska-British Columbia. Some individuals may be found at all depths from near the bottom along the continental slope to surface waters at night (Roper and Young, 1975). Percy et al. (1977) reported vertical migrations of three species of gonatids off Oregon (*Gonatus pyros*, *G. onyx*, and *Gonatopus borealis*), and most cephalopods captured (mostly juvenile and larval forms) were caught in the

upper mesopelagic and epipelagic zones.

Gonatids were identified in the stomachs of fur seals collected off California and Washington during all months in which fur seals were collected (January-June off California, November-June off Washington). Off California, gonatids comprised a smaller portion of the fur seals' diet than did *L. opalescens* and *Onychoteuthis borealijaponicus*; however, they were well represented as prey of the Pacific white-sided dolphin and Dall's porpoise which may regularly feed at greater depths than do fur seals. Gonatids were well represented among squids identified from the stomachs of sperm whales taken by commercial whalers off central California in the 1960's (footnote 4). Sperm whales apparently were feeding near the bottom primarily along the continental slope and into deeper waters. Those taken by commercial whalers were collected within 60-100 n.mi. (110-185 km) of San Francisco Bay where the whaling stations were located.

Off Washington, gonatids were more

evident in the fur seal's diet than off California and probably were as important as *O. borealijaponicus* seaward of the continental shelf. Gonatids were well represented in the prey of the Pacific white-sided dolphin and Dall's porpoise off Washington (Kajimura et al. 1980). Pike (1950) and Clarke and MacLeod (1980) reported Gonatidae from the stomachs of sperm whales taken off British Columbia. Locations where fur seals were taken whose stomachs contained gonatids off California and Washington are shown in Figures 5 and 6 (footnote 4).

Gonatids are an important prey of fur seals and the smaller cetaceans in the Gulf of Alaska from March through June over the outer continental shelf, the continental slope, and seaward. Locations where seals whose stomachs contained gonatids were collected in the Gulf of Alaska are shown in Figure 7 (footnote 4). Gonatids have been identified from the stomachs of northern sea lions and harbor seals collected in the northern Gulf of Alaska and Prince

Figure 5.—Locations where northern fur seals were collected off California whose stomachs contained Gonatidae.

William Sound (Pitcher, 1977; Calkins⁶; Pitcher and Calkins⁷).

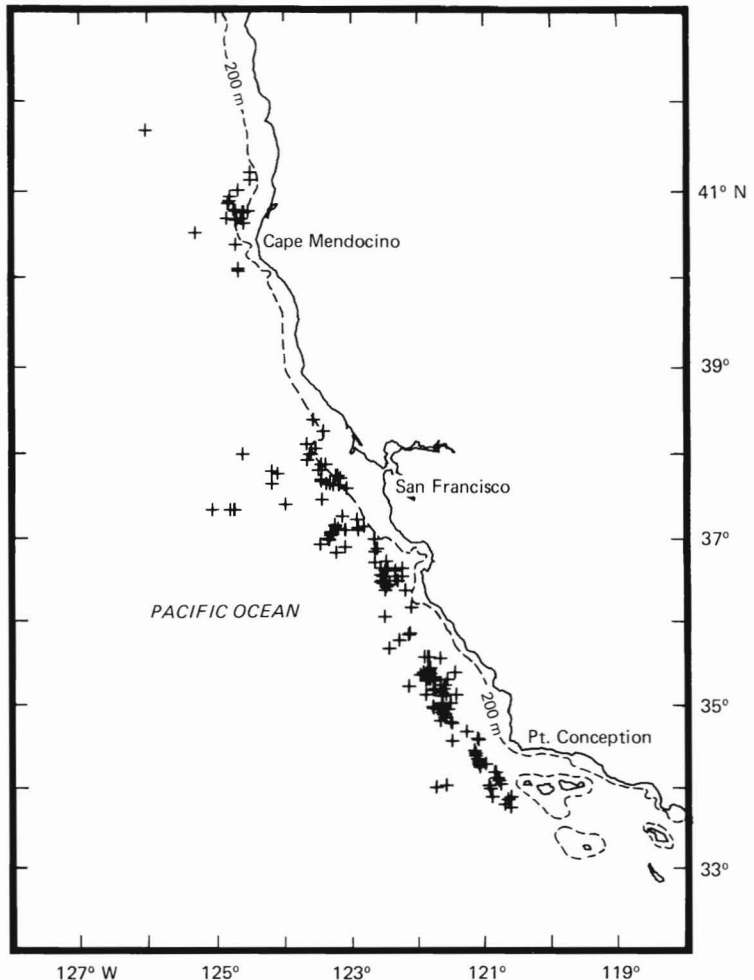
Gonatids, inhabitants of the continental slope and seaward from the slope, are the only cephalopods identified in the stomachs of fur seals collected in the eastern Bering Sea from June through September. Locations in the eastern Bering Sea where fur seals whose stomachs contained gonatids were collected are shown in Figure 8 (footnote 4). Gonatids also are prey of the Dall's porpoise in both the Gulf of Alaska and Bering Sea (Kajimura et al., 1980). The northern sea lion and ribbon seal probably prey on gonatids along the continental slope. Lowry et al. (1977) report squids as important food of ribbon seals. Lowry et al. (1979), summarizing available information on feeding by the ice seals, reported squids were consumed by ribbon and spotted seals. We have a few records of gonatids from the stomachs of ringed seals taken in the Chukchi Sea (footnote 4). Octopus were reported from the stomachs of bearded and spotted seals. Johnson et al. (1966) identified octopus in the stomachs of a few ringed and bearded seals taken at Point Hope, Alaska, in the Chukchi Sea. Gonatids also formed a significant part of the food of sperm whales taken by Japanese and Soviet whalers in the Gulf of Alaska and Bering Sea (Table 2).

Results and Discussion

Some marine mammals are relatively restricted in their diet, regularly feeding on only a few types of prey. However, many of the toothed whales and those

⁶D. G. Calkins, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99502. Pers. Commun.

⁷Pitcher, D. W., and D. G. Calkins. 1981. Biology of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Outer Continental Shelf Environmental Assessment Program Final Report. Juneau Project Office, P.O. Box 1808, Juneau, AK 99802.



pinnipeds that range over the offshore and oceanic waters (as opposed to coastal species [Repenning, 1976]) are opportunistic feeders, perhaps attracted to certain localities or regions by seasonally abundant fishes and squids. Over the continental shelf, fishes comprise most of their diet, but along the continental slope (sometimes characterized by nutrient-rich upwellings) fish and squids are equally important prey. In oceanic waters squids are usually the most important prey.

At least nine squids have been identified from the stomachs of fur seals collected in the eastern North Pacific Ocean and Bering Sea (Table 3) and a small

pelagic octopus, *Ocythoe tuberculata*, was identified in the stomachs of a few fur seals taken off southern California. Four of these squids, *Abraliopsis* spp., *Octopoteuthis* spp., *Moroteuthis robusta*, and *Chiroteuthis* spp., and the pelagic octopus *Ocythoe* were taken in relatively small numbers and did not contribute significantly to the fur seal's food in this region.

The northern fur seal, as well as many other marine mammals, is migratory. Thus, information gathered during pelagic fur seal studies, which was keyed to periods of seasonal abundance in certain localities, does not provide information on a year-round basis. For example, no

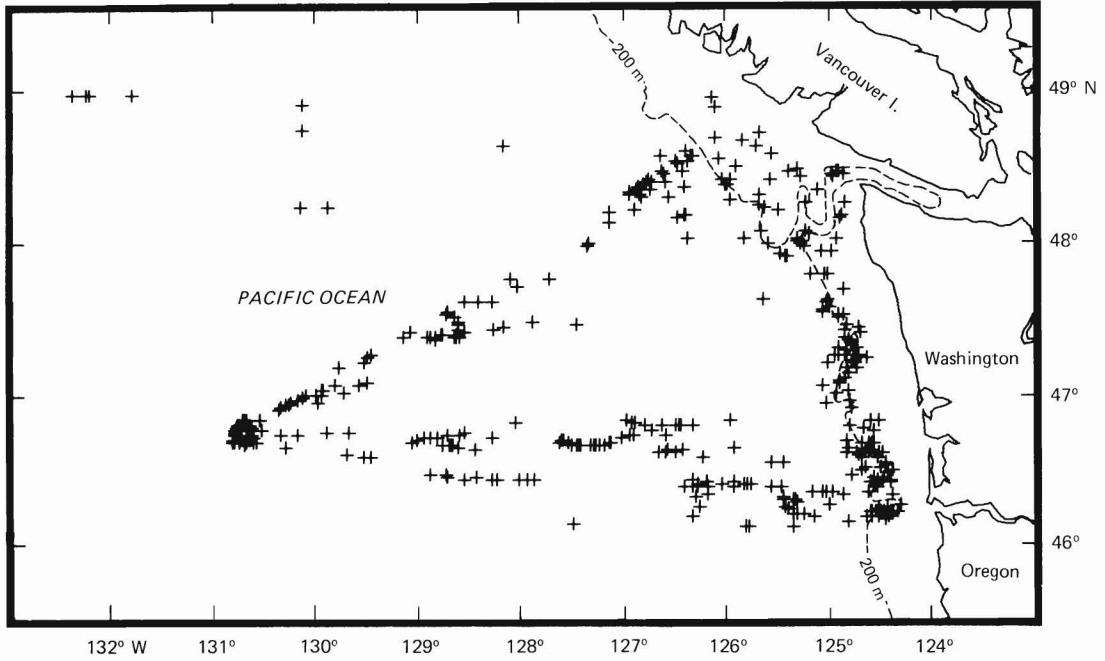


Figure 6.—Locations where northern fur seals were collected off Washington whose stomachs contained *Gonatidae*.

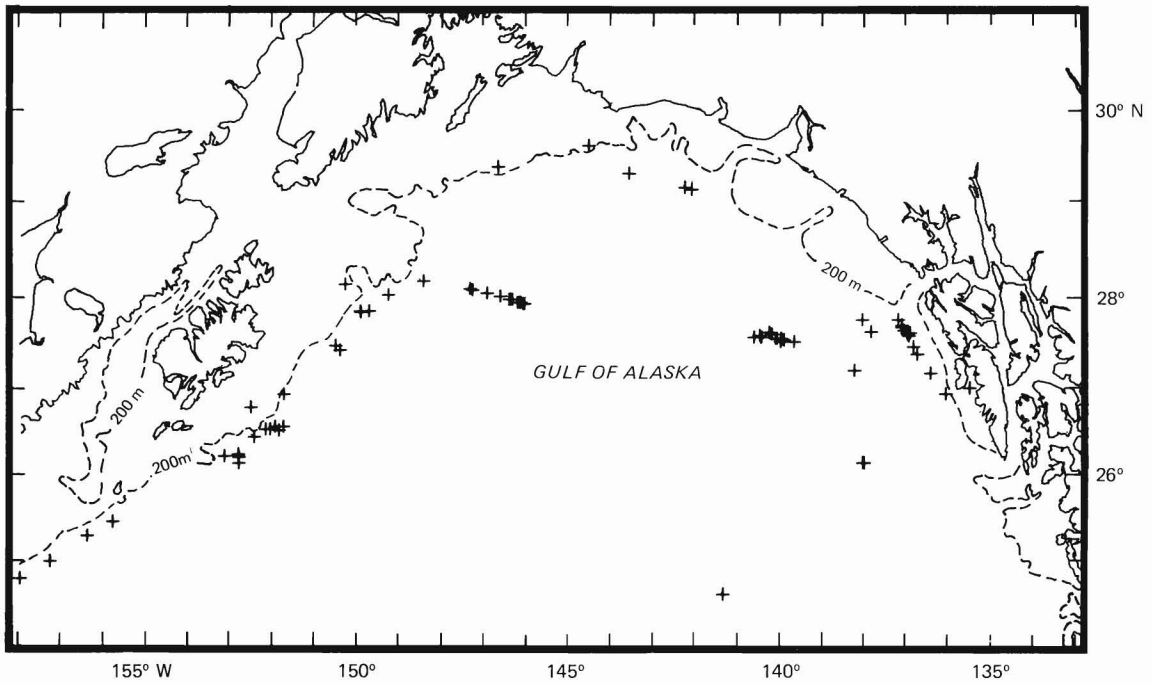


Figure 7.—Locations where northern fur seals were collected in the Gulf of Alaska whose stomachs contained *Gonatidae*.

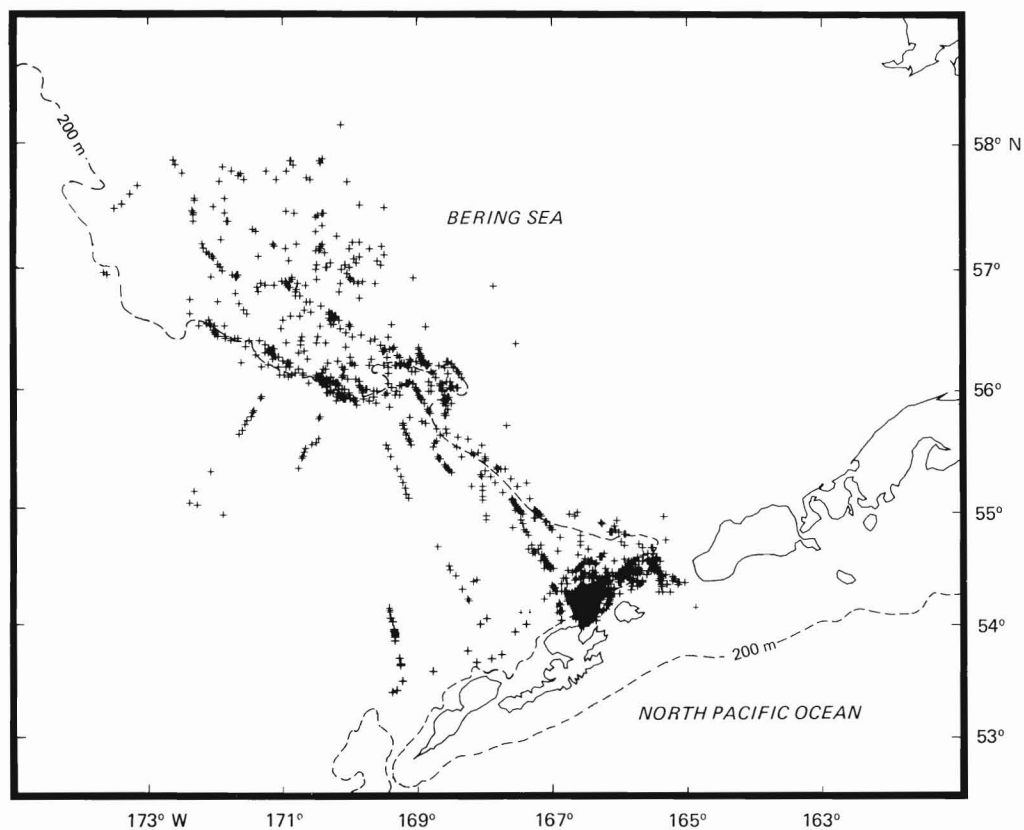


Figure 8.—Locations where northern fur seals were collected in the Bering Sea whose stomachs contained Gonatidae.

Table 2.—Squids identified from the stomachs of sperm whales from the Bering Sea and Gulf of Alaska^{1,2}.

Family and species name	Aleutian area and Bering Sea	Gulf of Alaska	Family and species name	Aleutian area and Bering Sea	Gulf of Alaska
Family Gonatidae			Family Chiroteuthidae		
<i>Gonatopsis borealis</i>	2	—	<i>Chiroteuthis veranyi</i>	2	—
<i>Berryteuthis (Gonatus) magister</i>	1,2	1	Family Mastigoteuthidae		
<i>Gonatus fabricii</i>	2	—	<i>Mastigoteuthis</i> sp.	1	—
<i>Gonatus fabricii</i> var <i>separata</i>	2	—	Family Cranchidae		
<i>Gonatopsis makko</i>	1	—	<i>Taonius pavo</i>	1,2	—
Family Octopoteuthidae			<i>Galiiteuthis armata</i>	1,2	—
<i>Octopoteuthis longipetra</i>	2	—	<i>Cralloteuthis behringiana</i>	2	—
Family Onychoteuthidae			Family Ommastrephidae		
<i>Moroteuthis robustus</i>	1,2	1	<i>Todarodes (sloaneipacificus) pacificus</i>	2	—
<i>Onychoteuthis (banksii) borealijaponicus</i>	2	—	<i>Ommastrephes bartramii</i>	2	—
Family Histoteuthidae			Order Octopoda		
<i>Stigmatoteuthis</i>	1	—	<i>Octopus</i> sp.	2	—
<i>Meleagroteuthis separata</i>	2	—			
Family Architeuthidae					
<i>Architeuthis japonica</i>	2	—			

¹1 = data from Okutani and Nemoto (1964).

²2 = data from Kodolov (1970).

Table 3. —Cephalopods identified in the stomach contents of northern fur seals, *Callorhinus ursinus*, collected during pelagic fur seal investigations, 1958-74.

Year	Location ¹	<i>Loligo opalescens</i>	<i>Abraliopsis</i> sp.	<i>Octopoteuthis</i> sp.	Other gonatids	<i>Gonatus</i> spp.	<i>Berryteuthis</i> spp.	<i>Gonatopsis borealis</i>	<i>Onychoteuthis borealijaponicus</i>	<i>Moroteuthis robusta</i>	<i>Chroteuthis</i> sp.	Unident. squid
1958	CA	x	—	—	—	x	—	—	x	—	—	x
	OR	x	—	—	—	—	—	—	x	—	—	x
	WA	—	—	—	—	—	—	—	—	—	—	—
	AK (SE, GA, WA, BS)	—	—	—	—	—	—	—	—	—	—	—
1959	CA	x	—	—	—	x	—	—	x	—	—	x
	OR	x	—	—	—	x	—	—	x	—	—	x
	WA	x	—	—	—	x	—	—	x	—	—	x
1960	AK	—	—	—	x	x	x	—	—	—	—	
1961	CA	x	x	—	x	—	—	x	x	—	—	x
	OR	x	—	—	x	—	—	—	—	—	—	x
	WA	x	—	—	x	—	—	x	x	—	—	x
	BC	x	—	—	x	—	x	—	—	—	—	x
1962	AK (WA, UP, BS)	—	—	—	x	x	x	—	—	—	—	x
1963	AK (BS)	—	—	—	x	x	x	—	—	—	—	
1964	CA	x	—	—	x	x	—	—	x	—	—	x
	OR	x	—	—	x	x	—	—	x	—	—	x
	WA	x	—	—	x	x	x	x	—	—	—	x
	AK (BS)	—	—	—	x	x	x	x	—	—	—	—
1965	CA	x	x	—	x	x	x	x	x	x	x	x
	WA	x	—	—	x	x	—	—	—	—	—	x
1966	CA	x	x	—	x	x	—	—	x	x	—	x
1967	WA	x	—	—	x	x	—	—	x	—	—	—
1968	WA	x	—	—	x	x	x	—	x	—	x	x
	AK (GA, BS, WA)	—	—	—	x	x	x	x	—	—	—	x
1969	WA	x	x	—	x	x	—	—	x	—	—	x
1970	WA	x	x	—	x	x	x	x	x	x	x	x
1971	WA	x	x	—	x	x	—	x	x	—	x	x
1972	WA	x	x	x	x	x	x	x	x	x	x	x
1973	AK (BS)	—	—	—	x	x	x	x	—	—	—	x
1974	AK (BS)	—	—	—	x	x	x	x	—	—	—	x

¹SE = southeastern Alaska, GA = Gulf of Alaska, WA = western Alaska, UP = Unimak Pass, BS = Bering Sea, CA = California, OR = Oregon, WA = Washington, AK = Alaska, BC = British Columbia.

collections were made off California from July to December, off Washington from July to November, in the Gulf of Alaska from August to February, or in the Bering Sea from November to April, times when few or no fur seals are present. Information is needed on the distribution and abundance of squids for given localities for the entire year to determine if potentially valuable squids are available in significant numbers to support commercial fisheries.

By combining data available on cephalopod occurrences in the stomachs of fur seals, other pinnipeds, small ceta-

ceans, and sperm whales with those obtained from traditional methods of direct collecting and sampling, we can compile a useful base of information for cephalopod stock assessment and fishery development.

Based on frequency of occurrence in the stomach contents of marine mammals, the following squids probably are sufficiently abundant in some parts of the North Pacific Ocean and Bering Sea to support commercial fisheries: *L. opalescens*, presently fished off central and southern California, could probably support fisheries from northern California

to British Columbia; *Onychoteuthis borealijaponicus* may also be sufficiently abundant in this area and seasonally into Alaskan waters. At least two (*Berryteuthis magister* and *Gonatopsis borealis*) of the 12 or more species of gonatid squids found in the area are large and probably abundant enough for commercial utilization from Washington north to the Bering Sea. Populations of several genera (*Symplectoteuthis*, *Dosidicus*, and *Ommastrephes*) within the family Ommastrephidae are probably abundant enough to support commercial fisheries from subtropical waters north

to southern California. One member of the genus *Ommastrephes*, *O. bartramii*, occurs north to the subtropical-subarctic boundary region and may be present further north seasonally in sufficient numbers to support a fishery.

Octopus spp. which are found on the continental shelf throughout the region form part of the catch in the bottom trawl fishery and are regularly taken by harbor seals, northern and California sea lions, several of the ice-inhabiting seals, and sperm whales.

Information that can be obtained from examinations of marine mammal stomach contents and used for developing commercial fisheries include: Identification of prey, date and general location where the marine mammals are captured, and the size, sex, and reproductive condition of prey. Clarke (1977) mentioned that marine mammals often are more efficient in capturing large squids than are nets; thus, information on size (maturity) of a species in a given location perhaps can best be obtained through the identification of stomach contents.

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