POTENTIAL RESOURCE COMPETITION IN THE SOUTHEASTERN BERING SEA: FISHERIES AND PHOCID SEALS

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ABSTRACT

Five kinds of phocid seals commonly occur in southeastern Bering Sea: ringed, bearded, ribbon, harbor, and spotted seals. Current investigations sponsored by the Alaska Outer Continental Shelf Environmental Assessment Program, in conjunction with other available data (published and unpublished) indicate that fishes and crustaceans of current or potential commercial importance are the major prey species of these seals. Competition between man and seals for these fisheries resources will continue to intensify.

Harbor seals in the southeastern Bering Sea eat a variety of fishes, shrimps and octopus. In general the same is true for spotted and ribbon seals. Capelin are a dominant prey item in the diet of spotted seals. Pollock are the major food of ribbon seals. The prey of ringed seals in this region is poorly known. However, fishes, shrimps and zooplankton are all eaten. Bearded seals are benthic feeders eating mostly tanner crabs, spider crabs, and shrimps. Fishes and crustaceans of present or potential commercial value which are also major food items of these seals in southeastern Bering Sea include pollock, capelin, smelt, herring, various flatfishes, tanner crabs, and pandalid shrimps.

Mutually conflicting interpretations (and regulations) resulting from the Marine Mammal Protection Act and the Fisheries Conservation and Management Act, if perpetuated, may preclude a balanced systems management approach for marine mammal and fishery resources of southeastern Bering Sea.

INTRODUCTION

The Bering Sea, a semi-isolated embayment of the North Pacific Ocean, is biologically one of the richest and most heavily exploited bodies of water in the world (Hood and Kelley 1974). Oceanographic, meteorologic and geographic features combine to create a very dynamic system with widely variable seasonal extremes. High temperature conditions prevail in much of the area in midsummer, while in winter and early spring arctic conditions prevail in the northern areas. The presence of seasonal sea ice in part of the area has a profound effect on weather (Konishi and Saito 1974), productivity (McRoy and Goering 1974) and marine mammals (Fay 1974).

Several species of invertebrates, fishes and mammals found in the Bering Sea have been or are now being harvested. The overexploitation and decline of yellowfin sole (*Limanda aspera*), Pacific ocean perch (*Sebastes alutus*), herring (*Clupea harengus*), halibut (*Hippoglossus stenolepis*) and shrimp (*Pandalus borealis*) in this area are well documented (Pruter 1973, 1976). Stocks of at least three species of pinnipeds in the Bering Sea, the Pacific walrus (*Odobenus rosmarus divergens*), the ribbon seal (*Phoca fasciata*) and the fur seal (*Callorhinus ursinus*), have also been significantly reduced by overharvesting in the past (Fay 1957, Chapman 1961, Shustov 1967).

Two recent pieces of federal legislation have had far-reaching impact on management of fishery and mammal resources in marine waters of the United States. The Marine Mammal Protection Act (Public Law 92-522) recognizes marine mammals as significant functional elements of marine ecosystems and encourages the maintenance of "optimum sustainable populations." The Fishery Conservation and Management Act (P.L. 94-265) recognizes the

need to "conserve and manage" fishery resources while developing the capability to harvest species that presently are under-utilized or not utilized at all by American fishermen. The necessity for management for marine resources is implicit in both of these pieces of legislation. In order to manage populations of a target species it is essential to know the amount of that species harvested by other oceanic consumers. To maintain optimum sustainable populations of marine mammals, one must know something about the capacity of the environment to sustain them. Although management of marine mammals is implied in the MMPA, effective programs have not been developed in Alaska, except for the Pacific walrus.

Approximately 25 species of marine mammals occur in the Bering Sea (Fay 1974, Nishiwaki 1974). In this paper we report recent data on the foods of five species of phocid seals in the Bering Sea south of 61°N latitude and east of 174°W longitude. The species reported on include the harbor seal (*Phoca vitulina richardsi*), spotted seal (*P.v. largha*), ringed seal (*P. hispida*), ribbon seal (*P. fasciata*) and bearded seal (*Erignathus barbatus*). Harbor seals are widely distributed in the coastal zone of the Aleutian Islands, the Alaska Peninsula and northern Bristol Bay. During ice-free months they occur as far north as Hooper Bay and perhaps to the Yukon River delta. When sea ice is present these seals utilize it as a platform and are occasionally found well into Bristol Bay. Spotted and ribbon seals are found mainly in the Bering Sea ice front during winter and spring. In summer spotted seals move to the north and to the coast while ribbon seals appear to become pelagic in the Bering Sea. In winter and spring bearded and ringed seals are found throughout the Bering Sea ice. Greatest concentrations of ringed seals occur in the shorefast ice zone while most bearded seals are found in moving ice north of the front. The majority of bearded and ringed seals move north into the Chukchi and Beaufort Seas in summer. The taxonomy of these species has been discussed by Burns and Fay (1970) and Shaughnessy and Fay (1977). Aspects of distribution, ecology and natural history have been described by Burns (1967, 1970) and Fay (1974).

METHODS AND MATERIALS

Feeding habits were determined from examinations of the contents of the digestive tract of seals obtained from two sources. Samples from seals killed in the nearshore zone around Nunivak Island were purchased from Eskimo subsistence hunters at Mekoryuk. All other samples were from seals killed for research purposes, usually from small boats or helicopters launched from a large research vessel. The species and sex of collected seals were recorded and a series of standard measurements was obtained from most specimens.

Contents of stomachs were gently washed on a 1.00 mm screen. The retained contents were either examined immediately or preserved by freezing or in a 10 percent formalin solution for subsequent examination. Otoliths and other hard parts of prey were obtained from intestines which had been split lengthwise, gently washed and the contents allowed to settle out in water. Contents of both stomachs and intestines were sorted and identified to the lowest possible taxonomic rank. The numbers of each prey species found were determined by counts of hard parts or whole individuals. The volume of each type of food in the stomach was determined by water displacement.

Data from all seals of a given species taken at a specified time and location were combined. In most cases the results obtained from examinations of stomach and intestinal contents have been combined as well. Prey species were ranked in importance on the basis of their frequency of occurrence and representation by volume and number.

RESULTS AND DISCUSSION

FOODS OF SEALS IN THE SOUTHEASTERN BERING SEA

There is very little information available on the foods of harbor seals in the Bering Sea. Such information as there is comes primarily from the Aleutian Islands (Table 1). The foods of seals

collected at three locations in the Aleutian Islands were not similar. Numerous pollock (*Theragra chalcogramma*) and cod (*Gadus macrocephalus*) otoliths were found in three seals collected at Unalaska. The only food remains in two seals collected at Atka Island were beaks of *Octopus* sp. Pandalid shrimps, mysids and cod were the major items found in six seals collected at Adak. Wilke (1957) and Kenyon (1965) report on the contents of 18 stomachs from harbor seals collected at Amchitka Island. Octopus, Atka mackerel (*Pleurogrammus monopterygius*) and greenling (*Hexagrammus* sp.) were the major food items found. A mixture of fishes, cephalopods and shrimps in the diet of harbor seals has been reported from the Commander (Marakov 1968) and Kuril Islands (Panina 1966).

A harbor seal taken in the drifting ice of southern Bristol Bay in March 1976 had fed entirely on capelin *(Mallotus villosus)*. Capelin are widespread in Bristol Bay in the spring (Lowry, Frost and Burns, unpublished) and it is probable that they are the major food of harbor seals in that area and season. No published data are available on the foods of harbor seals in Bristol Bay in summer and fall. The animals are common along the coast and are frequently found near river mouths and estuaries where anadromous and coastal spawning fishes are concentrated. It seems likely that fishes such as capelin, herring (*Clupea harengus*) and rainbow smelt (*Osmerus esperlanus*) are the major food items at that time. Fishes of the smelt and cod families and herring are known to be major foods of harbor seals in southcentral and southeast Alaska (Imler and Sarber 1947, Pitcher 1977) and Washington (Scheffer and Sperry 1931).

Our findings of the foods of spotted seals (Table 2) are consistent with those of other investigators. Spotted seals taken at Mekoryuk fed on a variety of nearshore fishes and shrimps (Table 2). Similar results have been reported for the Commander Islands (Barabash-Nikiforov 1936) and Robben Island (Nikolaev and Skalkin 1975). Spotted seals taken in spring on the pack ice of the Okhotsk Sea had eaten mainly pollock (Wilke 1954, Fedoseev and Bukhtiyarov 1972). This was also the case for a seal we obtained in the region northwest of the Pribilof Islands. A seal collected in May west of St. Matthew Island had remains of octopus, pollock and eelpout (*Lycodes* sp.) in the stomach. Gol'tsev (1971) reported that a number of different fishes and shrimps were utilized by spotted seals during the spring in Karaginski Bay and the Gulf of Anadyr. In Bristol Bay we found that during March and April capelin were the only food eaten by spotted seals. Two seals collected in late May west of Nunivak Island had eaten capelin and herring.

Along the Bering Sea coast the food habits of spotted and harbor seals are probably similar during the summer. In the summer-fall period spotted seals in the coastal zone of the Seward Peninsula feed on herring, saffron cod (*Eleginus gracilus*), smelt, sculpins (Cottidae) and occasionally shrimps (Lowry, Frost and Burns, unpublished).

Our stomach samples from ringed seals are limited, having been obtained from six animals taken at Mekoryuk between late April and mid-June 1975. About 60 percent of the stomach contents from those seals was fishes, two-thirds of which were saffron cod and one-third sculpins. The remainder of the food included amphipods, mysids and crangonid shrimps.

The lack of information about foods of Bering Sea ringed seals was noted by Fedoseev (1965) who reported on the foods of this seal in the Sea of Okhotsk. In that area and in the Bering Strait and eastern Chukchi Sea ringed seals feed on zooplankton, shrimps and small fishes such as saffron cod, arctic cod (*Boreogadus saida*), herring, smelt and sculpins (Kenyon 1962, Johnson *et al.* 1966).

Our samples of ribbon seals were obtained from the area northwest of the Pribilof Islands in March and April of 1976 and 1977. The stomachs of these seals contained little other than hard parts of prey such as otoliths, bones or beaks. The contents of the large and small intestines were also examined. Results are shown in Table 3.

Pollock was the most commonly represented prey in our samples. Similar results were reported for ribbon seals in the Sea of Okhotsk by Fedoseev and Bukhtiyarov (1972). Shustov (1965) examined 1,207 stomachs from the northern Bering Sea. In the 32 stomachs containing

food, crustaceans (shrimps, crabs and mysids) were more common than fishes. He found no pollock in his sample. These differences may be explained in part by the fact that his specimens were taken in a more northerly location than ours. Apparently only stomachs containing significant amounts of food remains were examined by Shustov. In our samples the stomachs were mostly empty and crustacean remains could have already been digested and excreted.

The stomach contents of bearded seals in our sample consisted mostly of tanner crabs (*Chionoecetes opilio*), crangonid shrimps (*Argis* ssp., *Crangon* spp. and *Sclerocrangon boreas*) and spider crabs (*Hyas* spp.). Our findings (Table 4) are similar to those of Kosygin (1971), who found crustaceans, mostly tanner crabs, to be the primary food of bearded seals in the Bering Sea. Kosygin also found snails, worms and demersal fishes in the specimens he examined. These types of food were also represented in our samples but in small amounts (8-30% of the total sample volume). A large number of food species have been reported from stomachs of bearded seals taken at other Alaskan localities (Kenyon 1962, Johnson *et al.* 1966, Burns 1967). This probably reflects the differences in benthic communities in which bearded seals forage throughout their range.

POTENTIAL RESOURCE CONFLICTS

As has been shown, a number of species of commercially important marine organisms are utilized as food by phocid seals in the southeastern Bering Sea. The impact of this predation and of the taking resulting from commercial fishing activities is of great academic and practical interest and concern. Information contained in this paper is only a partial contribution toward a description of food utilization patterns. Reported food consumption rates for pinnipeds in captivity range from 4 to 10 percent of body weight per day (Keyes 1968, Geraci 1975). Such a wide range of values could cause an error of up to 2½ times depending on the food consumption rate used. Available population estimates of seals rely on indices of of abundance and are of undetermined accuracy. At present there is not enough information available to make quantitative estimates of the consumption of commercially important finfishes and shellfishes by seals. However, some present and potential conflicts are obvious and will be briefly discussed by species.

Walleye pollock. in the southeastern Bering Sea pollock are one of the major foods of harbor, spotted and ribbon seals, particularly in the vicinity of the Pribilof Islands. They are occasionally eaten by bearded seals and probably ringed seals. Pollock also make up a large portion of the diet of fur seals, *Callorhinus ursinus* (Scheffer 1950), and sea lions, *Eumetopias jubatus* (Lowry, Frost and Burns, unpublished), in this region. Utilization of pollock by cetaceans and seabirds is not well documented but is known to be important.

Pollock have been intensively fished in the eastern Bering Sea since the 1930's. The peak catch of over 1.8 million metric tons was harvested in 1972 (Pereyra *et al.* 1976). As a result of several indications of overfishing, the total allowable catch (TAC) of pollock in the eastern Bering Sea was set at 950,000 metric tons (mt) for 1977 (NMFS 1977). It seems likely that the biomass of pollock consumed by birds and pinnipeds presently exceeds the catch by the fishery (McAlister and Perez 1976).

Pacific cod. Cod are much less abundant than pollock in the southeastern Bering Sea. They are seldom eaten by seals except for harbor seals in the eastern Aleutian Islands. Sea lions are occasionally reported to prey on this species (Wilke and Kenyon 1952). Catches of cod in the Bering Sea have ranged widely in recent years (Pereyra *et al.* 1976). The TAC is now set at 58,000 mt (NMFS 1977).

Herring. Although extensive published data are lacking for the southeastern Bering Sea, it is apparent that herring are a major component of the summer diet of harbor and spotted seals in that region. This is based on reports of the importance of herring in other regions (Spalding 1964; Lowry, Frost and Burns, unpublished) and observations of the associations between

spotted seals and schools of spawning herring (Burns, unpublished). The herring resource of the eastern Bering Sea has declined over the past decade (Pruter 1973). The TAC for 1977 was set at 18,670 mt, less than half of the catch in the peak fishing year of 1964-65 (NMFS 1977). The consumption of herring by spotted and harbor seals probably exceeds the TAC of the fishery.

Smelt. The rainbow (or boreal) smelt is a significant component of the diet of spotted seals near estuaries of the Seward Peninsula in summer and fall (Lowry, Frost and Burns, unpublished). Although we presently have no samples from the coastal zone of Bristol Bay in summer, it is probable that smelt are of similar importance to harbor and spotted seals in that area and season. There is presently no commercial fishery for rainbow smelt in the eastern Bering Sea. Rainbow smelt were considered by Barton (1977) to be the most important species in the sports/subsistence fishery of southeastern Bristol Bay.

Capelin. Although capelin are not commercially fished in the Bering Sea at present, they are harvested extensively in other parts of the world (Jangaard 1974). A recent assessment indicated that a commercially viable resource exists in this area (Barton 1977). Our findings have indicated a very great dependence on capelin by spotted and harbor seals in the Bristol Bay region, at least during spring. Capelin were the only food eaten, although other appropriate prey such as pollock and shrimps were also available. Although data from other times of the year are not available, it is very likely that capelin are equally important to these seals in summer. Capelin are also eaten by ribbon seals in the Bering Sea in spring and by fur seals (Fiscus *et al.* 1964) and sea lions (Fiscus and Baines 1966) in spring and summer.

Pandalid shrimps. Shrimps of the genus *Pandalus* are eaten by all phocid seals in the southeastern Bering Sea. However, in our limited samples they did not seem to be a major food item of any species. This may be due to the fact that the stocks of the primary species in the area, *P. borealis,* were overfished in the decade of the 1960's (Pruter 1973) and have not yet recovered (NMFS 1976). The TAC for southeastern Bering Sea shrimp stocks is presently zero.

Tanner crabs. Tanner crabs are the major food item of bearded seals in the southeastern Bering Sea. These seals are the largest phocids in northern Alaskan waters. In areas where tanner crabs are abundant they seem to feed on them exclusively. Only a small proportion of the bearded seal population ranges into the southeastern Bering Sea, thereby minimizing their impact on the crab resource in that area. Tanner and spider crabs are also an important prey species of bearded seals in more northerly areas (Johnson *et al.* 1966, Burns 1967).

The stocks of tanner crabs in the Bering Sea are presently large (Pereyra *et al.* 1976). Two species, *Chionocetes opilio* and *C. bairdi,* are taken in the fishery, with the larger *C. bairdi* the preferred species. The catch of *C. opilio* is presently well below the maximum sustained yield level although it is expected to increase in the near future (NPFMC 1977).

CONCLUSION

Sergeant (1976) pointed out the serious threat that commercial fishing for small pelagic fish species in the North Atlantic posed for seals of that region. Intensive fisheries such as are presently occurring in the southern Bering Sea for pollock and herring as well as the probable development and/or expansion of fisheries for other species such as crabs, shrimps, cod, capelin and smelt may well result in a readjustment of marine mammal populations to levels significantly below those which occur at present.

As aptly pointed out by Sergeant (1976):

> Whether to continue to regard the sea mammals as resources to be harvested wisely, or as pests of fisheries to be controlled (which amounts to [results in] the same thing), or as cultural resources to be conserved for their aesthetic value, is a socio-economic decision which will depend largely on how we wish to exploit our fishery resources.

In the United States some very basic decisions on these matters have been made. Unfortunately, they are almost mutually exclusive and biologically impossible to achieve. We

cannot maintain maximum populations of marine mammals and also develop significant commercial fisheries, or vice versa. However, interest groups on both sides of this issue, largely uninformed about the potential impacts of their efforts, are attempting through legislation and regulation to do just that. The probable result appears obvious.

It is necessary to depart from current rhetoric and develop effective management programs which truly revolve around a systems management approach.

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TABLE 1. Major food items of harbor seals from the Aleutian Islands and western Bristol Bay.

Area of Collection	Dates	Sample Size	Ranking of Importance				
			1	2	3	4	5
Unalaska Island (Beaver Inlet)	10-13 Apr 72	3	Pollock	Pacific cod	–	–	–
Adak Island (Bay of Islands)	25 July-1 Aug 73	6	Pandalid shrimps	Mysids	Pacific cod	Sculpins	Crangonid shrimps
Atka Island (Kurorov Bay)	2-3 Aug 73	2	Octopus	–	–	–	–
SW Bristol Bay 156°00'N, 164°29'W	27 Mar 76	1	Capelin	–	–	–	–

TABLE 2. Major food items of spotted seals from the southeastern Bering Sea.

Area of Collection	Dates	Sample Size	Ranking of Importance				
			1	2	3	4	5
Mekoryuk	17-30 May 75	8	Greenling	Crangonid shrimps	Herring	Sculpins	–
NW Pribilof Is.	2 Mar. 77	1	Pollock	–	–	–	–
W St. Matthews Is.	26 May 77	1	Octopus	Eelpout	Pollock	–	–
SW Bristol Bay	25-27 Mar 76	7	Capelin	–	–	–	–
W Bristol Bay	20 Apr 77	4	Capelin	Pollock	–	–	–
W Nunivak Is.	30 May 77	2	Capelin	Herring	–	–	–

TABLE 3. Major food items of ribbon seals from the southeastern Bering Sea.

Area of Collection	Dates	Sample Size	Ranking of Importance 1	2	3	4	5
NW Pribilof Islands	19-20 Apr 76	5	Pollock	Eelpout	Octopus	Capelin	–
NW Pribilof Islands	21-22 Mar 77	4	Pollock	Capelin	Eelpout	Octopus	Flatfish

TABLE 4. Major food items of bearded seals from the southeastern Bering Sea.

Area of Collection	Dates	Sample Size	Ranking of Importance 1	2	3	4	5
N Pribilof Islands	22 Mar-23 Apr 77	3	Tanner crabs	Worms	Snails	Eelpouts	Flatfishes
NW Bristol Bay	29 Mar 77	1	Crangonid shrimps	Spider crabs	Hermit crabs	–	–
Mekoryuk	6-30 May 75	12	Crangonid shrimps	Spider crabs	Sculpins	Isopods	Pollock

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200 YEARS AND
200 MILES OF CHANGE

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