Marine Mammals Species Accounts

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Introduction

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Marine mammals have always been a significant component of the marine fauna of Alaska, and they have been a cornerstone for support of coastal peoples as far back as archaeological evidence allows us to delve. Marine mammals continue to be a major source of food and income for coastal residents of Alaska.

The earliest European incursions into what is now Alaska were based on a quest for furs, particularly of sea otters and fur seals. These two marine mammals were the basis for establishment and support of Russian America, a colonial empire which eventually dissolved when the populations of these animals dropped too low to support profitable commerce and maintenance of the colony.

The United States purchased Alaska from Russia in 1867. For many years, the marine mammal resources of the new territory were largely ignored except by entrepreneurs. During the early American period, the partly recovered population of fur seals was again almost decimated, bowhead whales were greatly reduced, and Pacific walruses were reduced to numbers low enough that widespread famine occurred in several Eskimo settlements. In 1911, the Federal Government passed the Fur Seal Act, according statutory protection to fur seals and sea otters, although the Act allowed for a continuing harvest of the former. In subsequent years, sporadic interest was directed toward other marine mammal species, but no meaningful regulations or management programs for their protection were promulgated until 1936. In that year, bowhead and grey whales were protected from commercial exploitation, though subsistence hunting continued. The Walrus Act was passed in 1941 to restrict hunting of these animals by non-Natives and to curb traffic in walrus ivory.

With the exception of biological studies of fur seals, none of these protective measures involved significant attempts to obtain scientific information about the marine mammal fauna of Alaska, nor to develop management regimes based upon scientific information. This situation prevailed through World War II and until the early 1950's when the level of scientific inquiry into the natural history of Alaska's fauna began to increase significantly. Natural history studies of walrus, belukha whales, sea lions, sea otters, harbor seals, and polar bears were underway by 1955. Sponsors of these early studies included the Alaska Territorial Game Commission, the U.S. Fish and Wildlife Service, the University of Alaska, and the University of British Columbia.

In 1959, Alaska became a state and assumed jurisdictional responsibility for most of the fish and wildlife resources of direct importance to people living in the state. The new state of Alaska did not assume jurisdictional responsibility for those marine mammals species that either were regulated by international convention (great whales and fur seals) or those not significantly affected by residents of the state (small cetaceans with the exception of belukha).

The marine mammal species most significantly affected by activities of coastal residents in Alaska and for which the state assumed jurisdictional responsibility included:

1) Sea otter, *Enhydra lutris* Linnaeus
2) Sea lion, *Eumetopias jubata* (Schreber)
3) Harbor seal, *Phoca vitulina richardsi* (Gray)
4) Belukha whale, *Delphinapterus leucas* (Pallas)
5) Polar bear, *Ursus maritimus* Phipps
6) Pacific walrus, *Odobenus rosmarus divergens* (Linnaeus)
7) Ringed seal, *Phoca hispida* Schreber
8) Bearded seal, *Erignathus barbatus* (Erxleben)
9) Ribbon seal, *Phoca fasciata* Zimmerman
10) Spotted seal, *Phoca largha* Pallas

Within one year of Statehood, intensive research and management programs were directed at the first six listed species. By 1962, the remaining four species (the ice-associated seals) were the subject of state management and research efforts.

State programs conducted from 1959 to 1972 were varied and complex. Some of the major accomplishments included development of conservation programs for each of the ten species, acceptable resolution of existing conflicts between marine mammals and fisheries, successful reintroduction and subsequent expansion of sea otters in areas of their former distribution, elimination of control programs involving the wasteful killing of seals and sea lions, elimination of the bounty on seals, harvest monitoring and broad-based research efforts, development of recreational and commercial uses, and initiation of public education and information programs throughout the state, particularly in coastal areas. State-funded research efforts were augmented by studies undertaken by the University of Alaska.

In 1972, the U.S. Congress passed the Marine Mammals Protection Act (MMPA). This act terminated all marine mammal management programs of Alaska and other coastal states, though it did provide a mechanism for a state to resume management.

Under terms of the Marine Mammal Protection Act, extensive scientific information is required to determine the population status and trends for species or stocks a coastal state wishes to manage. Acquisition of such biological information required an ongoing research program. From 1973 to 1975, Alaska continued to fund research on most species for which it hoped to regain management authority. Funding became increasingly problematic. Because Alaska did not have authority or responsibility to manage marine mammals, there was reduced incentive to invest limited research dollars required for conservation programs involving other wildlife species managed by the state. To the extent possible, basic research continued, though on a reduced scale. Management functions, including harvest monitoring, were discontinued except on a case-by-case basis.

Starting in 1973, the nucleus of a state marine mammal research staff was maintained largely by research contracts from industry and Federal agencies. International events centering around petroleum had a great impact on marine research in the United States, particularly in Alaska. Rapidly rising oil prices and an embargo that demonstrated the tenuous nature of dependable oil supplies from middle-eastern nations encouraged a U.S. policy of energy independence. The largest, undiscovered reserves of oil and gas are believed to lie beneath the extensive continental shelves of the Atlantic and Pacific oceans and the seas adjacent to Alaska.

The federally funded Outer Continental Shelf Environmental Assessment Program (OCSEAP) was undertaken in 1975 to provide baseline environmental information in regions proposed for lease, to determine environmentally sensitive areas and/or biological processes, and, to the extent possible, predict and mitigate or prevent adverse biological impacts. Marine mammals are high-profile components of the fauna in all Alaskan outer continental shelf areas. They have been the subject of OCSEAP studies since 1975. Many of those studies were undertaken by scientists of the Alaska Department of Fish and Game. The OCSEAP-funded studies have been the main marine mammal research involvement of the state since 1976. On the management side, efforts have been continued to maintain the option of state management. These efforts have included amendments to the Marine Mammal Protection Act that were passed in Autumn, 1981.

The 1981 amendments and corresponding federal regulations specify the requirements that a state must meet in order to exercise management authority. In general terms, the requirements include submission of a request to the appropriate federal agencies (in the case of Alaska, requests would go both to the Department of the Interior and to the Department of Commerce), determination, based on an adequate record, of the current population size and range of the optimum sustainable population levels for each species, and federal approval of detailed management programs developed by a state.

The issues involved include both science and policy. The State of Alaska is currently (autumn, 1984) involved in a broad-based effort to inform the public of the issues, to provide information about the ten species of greatest management interest to Alaska, and to determine public attitudes with respect to the option of state management. On the scientific side of the question, the state is still involved in basic research and is also accumulating information from all sources about the biology of each of the ten species.

The following species accounts were prepared in order to provide the interested public with a concise summary of biological information and basic management considerations for each of the species which may be subject to a state management regime. In order to benefit the widest audience, these accounts have been written in a semi-popular style. References to the scientific literature have not been included in the text, though selected references have been indicated at the end of each account.

The authors of the accounts are very familiar with their subjects. Each has been or is currently working in marine mammal research, and some also have extensive management experience. The species accounts are a synthesis of accumulated information and, to varying degrees, the results of the authors' investigations.

It is hoped that these accounts will stimulate renewed interest in the unique array of marine mammals found in waters adjacent to Alaska. More detailed information about species included in the accounts can be obtained by reviewing the selected references and by contacting the Alaska Department of Fish and Game.

The Belukha Whale *(Delphinapterus leucas)*

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Belukha Whale

Delphinapterus leucas

A. Introduction

Only two closely related species of toothed whales reside primarily in arctic and subarctic waters, belukhas (*Delphinapterus leucas*) and narwhals (*Monodon monocerus*). Of the two, the belukha is more widespread and well known to northern coastal residents. These two whales, although very different in some ways, also share many characteristics including aspects of morphology, natural history, and importance in the economics of northern villages.

Like the commonly used English name, white whale, belukha, derived from the Russian word for white, is descriptive of the coloration of adult animals. The term beluga, commonly applied to this species, is a Russian name for the white sturgeon. In order to prevent confusion between the fish and the whale, many researchers prefer the common names, belukha and white whale, for *Delphinapterus*.

Belukhas appear well suited to life in arctic and subarctic waters where cold temperatures and seasonal sea ice are the rule. The white body color obviously blends well with their surroundings. This is true not only during months when sea ice is present, but also during open water periods when herds of belukhas are often described as resembling white caps on the ocean. Newborn calves and immature animals are gray shaded with blue or brown and often blend well with the color of the surrounding water. The survival value, if any, of this apparent camouflage is not clear. Unlike most other odontocetes except the narwhal, the belukha has no dorsal fin, although a low ridge occurs on the back. This is an apparent adaptation to moving in and around ice. The robust body shape is due to a comparatively thick blubber layer which reduces the loss of body heat into the water. The rounded head has a short snout topped by a large, bulging melon. The melon is filled with fine oil and may function as an acoustic organ for communicating, navigating, and locating food.

Belukhas are comparatively small whales. In Alaska, near-term fetuses range from 130 to 180 cm in length and weigh about 40-60 kg. Adult males are somewhat larger than females, ranging from 3.2-4.4 m in length and an estimated 520-1200 kg in weight. Females are about 3.1-3.6 m long and weigh 480-700 kg. Size attained at adulthood varies geographically. Individuals more than 6 m in length have been recorded in some areas of the Arctic. Much of the weight is comprised of blubber which can be as much as 12 cm thick on large individuals.

B. Distribution and Migration

Belukhas are widely, though not uniformly, distributed throughout seasonally ice-covered waters of the northern hemisphere. Based on a knowledge of seasonal patterns of movement and concentration areas and the presence of major, though not complete, geographical barriers, it is likely that the population can be divided into a number of somewhat discrete stocks. Differences in size of adult animals among areas are considered by some as evidence of stock separation.

Belukhas in Alaska are considered to comprise two populations. One ranges throughout the northern Gulf of Alaska from at least Kodiak Island to Yakutat Bay. The center of abundance of this population is clearly in Cook Inlet where they are numerous throughout the year. Seasonal movements in this area are poorly known, but spring concentrations of belukhas occur annually near mouths of rivers flowing into northwestern Cook Inlet.

A second much larger group of belukhas ranges seasonally throughout the Bering, Chukchi, Beaufort and East Siberian seas. This group is called the western Arctic population. During winter these whales occur in the ice fringe and front from the Alaska coast to Siberia, as well as in regions of the Bering and Chukchi Sea pack ice where open water regularly occurs. As the ice recedes in spring, a large segment of the population moves north, some of them passing Point Hope and Point Barrow during May. Those belukhas are thought to migrate eastward through offshore leads in the Beaufort Sea, then south along the west coast of Banks Island to the Mackenzie River estuary where they appear in late June. Other belukhas migrate less extensively and are seen in coastal waters of the Bering and Chukchi seas shortly after ice breakup. In summer months, they occur in the Bering, Chukchi, Beaufort, and East Siberian seas, primarily in the coastal zone and along the pack ice edge. Major concentrations in North American waters occur in the Mackenzie River estuary, Kasegaluk Lagoon (central Chukchi Sea), Kotzebue Sound, Norton Sound and Bristol Bay. They have been recorded in major river systems such as the Yukon River several hundred kilometers from the sea. Belukhas leave the coastal zone in late summer to late autumn. Animals in the northern part of their range move southward ahead of and with the advancing ice pack, most of them passing through Bering Strait and into the Bering Sea.

Factors which may limit the overall distribution of belukhas are poorly known. The coincidence of their range with that of sea ice suggests a strong affinity for arctic and subarctic waters. Although they are known to wander at least as far south as Tacoma, Washington on the Pacific coast and New Jersey in the Atlantic, there is no evidence to suggest that belukhas were ever abundant south of their present range. Predation by killer whales and sharks and competition with other marine consumers for food may be factors important in determining their southern limit.

Normal distribution of belukhas appears most affected by ice conditions and distribution of prey. During winter, ice characteristics are probably the most important single factor. Although they can break through thin ice, in areas where geographic, oceanographic, and meteorologic factors do not cause ice motion and the formation of leads, belukhas cannot survive. Well-documented accounts relate the entrapment and subsequent death of hundreds of belukhas in such circumstances.

During summer and autumn, belukhas concentrate in areas where prey are abundant. It has been suggested that warm water temperatures in estuary systems confer an energetic advantage to newborn young which have not yet attained a thick blubber layer. The interplay of these two factors, abundant prey and warm water, in determining belukha distribution during the open water season is of major interest. Animals of all sex and age classes are found in summer concentration areas, and, although some of the animals examined have been actively feeding, many have empty stomachs. By the same token, although some calves are born in estuaries, many are known to be born outside of estuarine concentration areas.

C. Habitat Requirements

Four factors are of considerable importance in determining suitability of habitat for belukha whales. They are:

1. Predictable and regular access to air.
2. Water of appropriate quality and characteristics.
3. Access to food of appropriate type and quantity.
4. Freedom from excessive predation and other disturbance factors.

The need for air to breathe excludes belukhas from vast areas of the Bering and Chukchi seas during winter and spring months. They cannot survive in these coastal zone areas because of extensive shorefast ice. In addition, areas of stable, heavy ice cover such as occur north of Bering Strait and around major Bering Sea islands present unfavorable conditions. Belukhas are often common in areas where winds, currents, and land forms combine to create frequent ice motion and leads. Since they can easily break through several centimeters of ice, belukhas seldom suffer from short-term episodes of calm weather or freezing when new ice covers leads in such areas.

Belukhas appear able to tolerate waters with a wide range of temperature, salinity, and depth characteristics. During winter they commonly swim in water below 0°C, while in summer some animals frequent areas such as lagoons where surface temperatures may reach 12°C. The possible importance of warm water areas for newborn animals has already been noted. Belukhas have been recorded in completely fresh waters of rivers as well as in brackish and fully marine areas. Although they are sometimes sighted in deep water north of the shelf break of the western Beaufort Sea, most belukha sightings are from coastal and continental shelf areas. The maximum diving depth of belukhas is not known, but the duration of dives is short, frequently 3-5 minutes, so belukhas are thought to feed at comparatively shallow depths.

Food habits of belukhas will be discussed in Section F. At this time, it is sufficient to note that the areas and times in which belukhas appear in large numbers are in many instances closely correlated with the appearance of concentrations of fishes such as salmon, herring, smelt, and arctic cod. Each belukha must, on an annual basis, consume sufficient food to provide energy for growth, maintenance, and, if appropriate, reproduction. If adequate nutrition is not attained, growth and productivity will be lessened, and mortality may be increased. In addition to providing insulation, the thick blubber layer of belukhas serves as an energy reserve, making them somewhat independent of short-term fluctuations in food supply. As a result of the large proportion of blubber, belukhas have a comparatively small amount of body musculature. This probably results in a slow swimming speed which may put them at a disadvantage in competing with the fast swimming porpoises of more southern waters.

Possible predators of belukhas include killer whales, sharks, polar bears, and humans. Other than those harvested by humans, it is probable that relatively few belukhas die from predation. Present harvests in Alaska do not appear to limit belukha numbers or range (see Section I). The incidence of mortality due to disease and parasitism is not known. Physical factors known to cause mortality include entrapment in ice and occasionally in fishing gear, especially large mesh gillnets and fish weirs.

Responses of belukhas to the array of possible disturbances caused by humans are poorly documented. Available evidence is scant and sometimes contradictory suggesting that the response to a particular factor will depend on its context and the specific animal or animals involved. For example, it appears that boat traffic and other activities in the Yukon River and Kotzebue Sound have altered the distribution of belukhas in those areas. In contrast, in Cook Inlet and Bristol Bay, where human activities are much more intense, belukhas have apparently adjusted to such activities. Most significant disturbances involve introduction of sounds, physical structures, or chemicals into belukha habitat. Available observations suggest that belukhas are quite adaptable and can accommodate reasonable amounts of acoustic and physical intrusions. They become less tolerant of noise disturbances in those areas where they are periodically hunted. Introduction of chemicals such as petroleum compounds into the marine environment would likely have complex direct and indirect effects on belukhas, generally in proportion to the intensity of contamination.

D. Abundance and Trends

Although records of sightings of belukhas in Alaskan and Soviet waters are numerous, no comprehensive surveys have been undertaken in order to estimate total abundance.

The Cook Inlet population is probably greater than 400 individuals. Recent visual counts of single large groups suggest that this number is conservative and the stock may number in excess of 500. Sightings of belukhas in Yakutat Bay suggest that some members of this stock may move relatively long distances.

Estimation of the size of the western Arctic population of belukhas is complicated by their large and seasonally variable range. Assuming limited interchange among animals in summer concentration areas, a minimum estimate can be derived from available counts and observations. Estimates from aerial surveys conducted from 1972-1977 suggested that at least 7,000 belukhas, not including dark-colored juveniles, occurred annually in July in the Mackenzie estuary. Surveys conducted over a broader area in 1981 resulted in a minimum estimate of 11,500 whales in the eastern Beaufort Sea and Amundsen Gulf. In addition, 2,500-3,000 animals occur along the Chukchi Sea coast, 1,000-1,500 occur in Bristol Bay, and 1,000-2,000 occur in the vicinity of Norton Sound and the Yukon River delta. These estimates indicate a minimum total of 13,500-18,000 belukhas summering in coastal waters of Alaska and western Canada. This estimate is conservative since the 1981 eastern Beaufort Sea surveys did not include the entire area, and no corrections were made for areas not surveyed or for uncounted submerged animals. Considering these factors and the unknown number of whales summering along the northern Chukchi Sea ice edge and in waters of the USSR, the actual abundance of belukhas in the western Arctic population may exceed 25,000. Available data indicate that this stock has been and continues to be stable in size.

E. Vital Parameters

Age structure of the population and rate of reproduction are critical parameters for estimation of productivity of belukha whales. Methodological problems and controversies have made it difficult to derive these values. Major problems have involved interpretation of growth rings in teeth and of structures present in ovaries. Recent thorough studies have largely resolved these questions, allowing valid interpretation of data. It is now generally agreed that belukhas, like some other odontocetes, deposit two dentine layers (each comprised of a light and dark band) in the teeth each year. This is unlike pinnipeds such as ringed seals in which one dentinal layer is deposited annually. Tooth wear resulting in loss of rings causes underestimation of age in older animals. This, however, is of comparatively little importance provided that reliable ages can be determined up to the age of sexual maturity. In many belukhas, more than one ovulation can occur during the breeding period which results in the presence of accessory corpora lutea in the ovary. These were previously erroneously interpreted by Soviet researchers as evidence for annual breeding.

The reproductive cycle of belukhas is now quite well understood. Female whales first ovulate and are capable of breeding just prior to their fourth or fifth birthday. Reproductive activity commences in males at about age eight. Most breeding activity occurs in April and May. Since the gestation period is about 14.5 months, females first give birth the following July or August at age five or six. A single calf is usually born and nursed for a two-year-period. It appears females do not breed again until the year after calving, making the breeding cycle basically triennial. In a group of sexually mature female belukhas examined during summer, one should find that about one-third of the animals have just calved or are carrying a term fetus, one-third have recently bred, and one-third are accompanied by year-old calves which they are nursing. This of course assumes that all animals capable of ovulating do so, and that they are successfully impregnated and bear a calf. Although available data are sparse and subject to biases, it is likely that success in ovulation, pregnancy, and birth is somewhat less than 100%.

Biases associated with hunting and collecting of belukhas complicate estimation of sex ratio and age structure of the population. For example, only six of 68 female belukhas taken in western Alaska in 1977-1979 were less than six years of age. Available data suggest the sex ratio does not significantly deviate from unity. The predominance of males in the harvest in many regions, however, may have resulted in more adult females than adult males in the present population, the effect of which would be an increase in population productivity.

Assuming that one-third of adult females are capable of breeding each year and 90% of those actually breed and give birth, 30% of adult females would produce young each year. If the sex ratio is one to one and 60% of all females are sexually mature, gross annual production of calves would be 9%. This rate is low compared to animals such as seals in which annual breeding is the rule. Some studies have suggested annual calf production rates of 12-13% based on occasional biennial breeding and a population comprised of 56% females.

Mortality rates of belukhas in Alaska cannot be calculated from the biased age samples that are available. Known causes of mortality other than hunting by humans include predation by killer whales and polar bears and occasional entrapment by sea ice and fishing gear. The possible role of disease and parasites in mortality of belukhas is not well known. Maximum ages recorded are 30-34 years old but these are probably underestimates due to tooth wear. The relatively low rate of production and large proportion of

older animals in harvests suggests that natural mortality rates are low for both young and adult belukhas.

Sustainable yield of belukha populations is believed to be 5-10% per year.

F. Food Habits

Studies of food habits of belukha whales throughout their range have identified more than 100 different species in the diet. In all areas, most of the available data are from animals taken during spring and summer. In coastal waters of Alaska, belukhas feed on a series of sequentially abundant and highly available prey, particularly anadromous and coastal spawning fishes. These include primarily salmon, smelt, capelin, eulachon, herring, and saffron cod. Other organisms such as shrimps, octopus, and sculpins are also commonly eaten. Arctic cod and pollock may be particularly important foods in offshore waters during winter and spring. Although food other than milk is found in stomachs of some yearlings, belukhas are not nutritionally independent until age two. Small fishes and crustaceans may be more important in the diet of young whales.

Although some feeding has been observed in river systems and lagoons, in some concentration areas such as the Mackenzie Delta, food is rarely found in stomachs of harvested animals. In such areas, feeding may occur in nearby marine waters. The influence of prey distribution on location of belukhas throughout the year merits further study.

Seasonal changes in feeding intensity have not been documented, but are likely to occur in relation to patterns of prey abundance and availability. Differences in growth rates and adult size of belukhas in various parts of their range may be related to nutritional factors.

G. Ecological Significance

Belukha whales are widely distributed and generally abundant in ice-covered regions where the marine mammal fauna is often dominated by pinnipeds. Their range generally overlaps little with that of other toothed whales. The closely related narwhal occurs with belukhas in the eastern Canadian Arctic. Harbor porpoise range overlaps that of the belukha in Cook Inlet, the Bering Sea, and the northwest Atlantic. These three species share characteristics such as generally small size, slow swimming speed, and ability to locate and utilize schools of shoaling fishes. The belukha is obviously more ice-adapted than the harbor porpoise. Competitive relationships among belukhas and narwhals are unclear, but based on a comparison of their present ranges it appears that the belukha is the more broadly adaptable species.

The food resource base of belukhas in Alaska is shared

began in the late 1950's and have recently expanded in the central Inlet. To date these activities have had no discernible effect on belukhas. Areas particularly important for calving have not been identified, perhaps due to the comparatively warm conditions in the Inlet. Observed concentrations of belukhas probably are caused by local availability of prey such as salmon and herring. Although belukhas at times damage fishing gear and may become entangled and drown, this type of interaction does not appear acute at present.

Concerns with regard to the western Arctic population vary greatly among areas. The winter range of much of the population coincides with productive regions of the Bering Sea shelf. Stocks of fishes on which belukhas prey are intensively harvested. Present fishery management plans are designed to stabilize or enhance most of these stocks and should provide for maintenance of that segment of the belukha food resource base. High seas fisheries cause little or no direct mortality to belukhas since they seldom operate in ice-covered areas frequented by the whales. Proposed Federal oil and gas leases in the North Aleutian Shelf and Navarin and St. George basins are a major concern for both belukhas and fisheries in those biologically rich areas.

Conflicts between fishermen and belukhas are most acute in some areas of the Bering Sea where both exploit dense summer concentrations of fishes in coastal areas. Historically the greatest conflict has been associated with salmon runs in inner Bristol Bay. After documenting the magnitude of the conflict, the Alaska Department of Fish and Game developed and implemented a program to displace belukhas from selected areas without causing them any apparent harm. Recorded killer whale sounds broadcast underwater successfully kept belukhas away from the mouths of major rivers during the peak of salmon smolt out-migration. A few belukhas are taken incidentally each year by salmon fishermen. It is thought that belukhas avoid all but large mesh nets such as those used to catch salmon, seldom becoming entangled in and damaging gear. Although intense, the boat and aircraft traffic associated with catching, processing, and transporting salmon and herring in Bristol Bay has apparently not altered use of the Bay by belukhas.

North of the Yukon-Kuskokwim delta, the areas where belukhas feed during summer are presently fished mostly for subsistence purposes. Some of these stocks may be fished on wintering grounds, or as they pass through more southerly waters. Commercial fishing for herring has occurred intermittently in Norton Sound since about 1909, while salmon have been taken commercially there since 1961 and in Kotzebue Sound since 1965. Present fishery management plans provide for maintenance of those stocks. Future fisheries development in northern waters such as Norton and Kotzebue sounds must be designed so that the sum of fishery-related activities does not detrimentally affect belukhas or their habitat.

with many species of marine mammals and seabirds. Arctic cod and pollock, which are probable major foods in offshore waters, are of similar significance in the diet of fur seals, sea lions, harbor, spotted, ribbon, and ringed seals and fin, minke, and humpback whales. In the coastal zone, herring, smelt, capelin, saffron cod, and salmon are eaten by belukhas, as well as sea lions, harbor, spotted, and ringed seals, and harbor porpoise. Overall, the greatest trophic overlap probably occurs between belukhas and spotted seals which share major prey and much of their range throughout the year. In and near some concentration areas, belukhas undoubtedly are the major fish-eating consumers. Stocks of several major prey species are at present fully exploited by subsistence and/or commercial fisheries. Others have potential for future harvests. Size, distribution, and productivity of stocks of these fishes are affected by patterns of human harvest and predation by major consumers including belukhas.

Well-documented instances of predation by killer whales and polar bears confirm the occasional importance of belukhas in the diet of those predators. Other possible natural enemies such as walrus and large sharks probably eat few belukhas. Carcasses of animals which die from predation and other causes provide nutrients and food for a host of marine and terrestrial scavengers and decomposers.

Because belukhas migrate along routes where they are accessible to humans and live in the coastal zone during summer, coastal residents have developed a strong nutritional dependence on these whales in many areas of the Arctic. Whales harvested from the Bering-Chukchi stock have in the past provided and continue to provide a substantial portion of the annual food procured by coastal residents of western and northern Alaska and northwestern Canada. The importance of the annual belukha hunt is obvious from the effort expended in procuring, preparing, and storing the meat, oil, and muktuk obtained. Hunters and families commonly travel many miles from their winter homes to areas where they traditionally hunt belukhas.

H. Conflict Situations

The wide general distribution of belukhas and the variety of habitats in which they are found may indicate an ability to adapt to an array of ecological conditions. A limited number of areas, however, are used annually by large numbers of animals. Although the reasons for such use are somewhat unclear, it is likely that conditions found in these areas are critical to the health of populations.

Belukhas in Cook Inlet occur within view of the growing city of Anchorage. Although bordered on the northwest by vast areas of wilderness, the Inlet, particularly in the northern and eastern portions, is the site of considerable activity. Commercial fishing, recreational boating, and transport of people and materials have occurred for many years. Activities associated with oil and gas development

Belukhas annually occur in large numbers in summer in Kotzebue Sound, Kasegaluk Lagoon, and the Mackenzie River delta. While in these summer concentration areas, belukhas appear to be very sensitive to disturbance. Barge traffic in the Mackenzie delta has been observed to cause temporary changes in belukha movements, behavior, and distribution. Local people have observed fewer belukhas in northeastern Kotzebue Sound since the development of the commercial salmon fishery. It appears that relative freedom from disturbance as well as a complex of biological and physical factors make these concentration areas suitable. Probable future developments affecting areas of important coastal habitat are many as are their possible effects on belukhas. Management plans must be developed to protect the biological and physical integrity of these areas as well as to minimize activities directly detrimental to belukhas. Since we presently know little of the functional significance of concentration areas and the responses which belukhas will show to the array of possible disturbance factors, a cautious approach to coastal development is warranted.

Much of the western Arctic belukha population moves twice annually through Bering Strait. Development near this narrow passage and possible accompanying contamination could have a severe impact on belukhas. Exploration and development of petroleum reserves as well as transportation of materials and products are of major concern.

Harvests of belukha whales by humans will be discussed in the next section. Harvests in recent years have been well within sustainable limits and have had no discernible effect on population size or distribution. Coastal residents utilize a variety of natural food sources in varying quantities depending on customary patterns of use, current need, and annual availability of the various species. Stocks of terrestrial species are maintained under regulations and provisions of the State of Alaska. Of the marine resource species, fishes are regulated by both State and Federal agencies while marine mammals, with the exception of fur seals and depleted bowhead whales, are protected by the Marine Mammal Protection Act (MMPA). Possible conflicts arise when, for example, it is suggested that the harvest of a species such as belukhas be increased as a substitute for a depleted species such as bowheads. Sustainable yields of all resource species must be considered in light of human needs and demands if multi-species management and ecosystem stability are desired.

I. Harvest Levels

In Cook Inlet, belukha whales are currently subject to insignificant harvest by humans. Only a few animals are taken annually. In the 1930's, an attempt was made to commercially harvest Cook Inlet belukhas. About 100 were netted in the Beluga River and processed for meat and oil. The venture was abandoned after the initial catch. During the 1960's, a few belukhas were taken in Cook Inlet.

The western Arctic belukhas provide an important food resource to residents of coastal Alaska, Canada, and Siberia. In American waters, belukhas are available to subsistence hunters at several sites in spring as they move north through lead systems of the Bering and Chukchi seas, and during months of open water when they occur in the nearshore coastal zone from Bristol Bay to the Beaufort Sea. They provide relatively large amounts of meat, muktuk, oil, and by-products for local use and barter. At favorable hunting locations, the return per unit of effort is quite high.

Archaeological evidence indicates that belukhas were taken by prehistoric subsistence hunters along the western and northern mainland of Alaska as well as at Nunivak, St. Lawrence, King, and the Diomede islands. Due to changes in settlement patterns and resource dependencies, they no longer are hunted in a regular and organized manner in Bristol Bay, Kuskokwim Bay, or the Yukon River estuary, but organized annual summer hunts still occur in southern Kotzebue Sound, in Kasegaluk Lagoon near Point Lay, and in the Mackenzie delta. In most of these locations, coordinated groups of hunters in outboard powered boats drive the belukhas into shallow water where large numbers can be killed with few lost due to sinking. During April to June, belukhas also are taken by bowhead whaling crews camped along the nearshore lead of the Chukchi Sea close to the villages of Wales, Kivalina, Point Hope, Wainwright, and Barrow. The number of whales taken in this fashion depends greatly on ice and weather conditions and the success of the bowhead hunt. Opportunistic hunting during the open water season may occur on an irregular basis at many locations, particularly in Hooper, Tooksook, and Norton bays and near Kaktovik, Wainwright, and Tuntutuliak.

The magnitude of recent harvests in Alaska and Canada has been well-documented. The annual retrieved harvest in the Mackenzie estuary from 1972-1977 ranged from 122 to 177 with an average of 141 whales taken. Since it was estimated that one belukha was killed but lost for every two to three retrieved, the total kill in this area in recent years has averaged about 200 animals annually. Based on available records, this is considerably fewer whales than were taken in this area in earlier years. Whales harvested are predominately males.

Between 1968 and 1973, the total harvest of belukhas in Alaska at all locations from Bristol Bay to Barter Island averaged 183 animals annually. Harvest levels in 1977, 1978, and 1979 were 247, 177, and 138, respectively. In 1981 the statewide take was 154-191. The geographical distribution of the harvest varies somewhat from year to year. For example, hunters at Elephant Point (inner Kotzebue Sound) take about 80 whales each year, but harvested only five in 1979, which resulted in the low total harvest for Alaska. Harvests of more than a few animals are usually taken annually at Hooper Bay, Stebbins, Koyuk, Elephant Point, Point Hope, Point Lay, and Wainwright. Of 195 animals harvested in 1977 to 1979 for which sex was known, 106 (54%) were males. From 1980 to 1982, 109 of 281 (39%) were males.

The loss rate associated with harvests in Alaska varies with the circumstances under which the hunt is conducted. It is estimated that one-fourth to one-third are taken in deep water with losses of 60%, and the remainder are taken in shallow water with losses of 20%. Based on a harvest of 185 animals per year, the average annual total kill would be 241-247 belukhas. This level of exploitation is less than that sustained in former times, for example in the late 1950's, when the annual harvest in Alaska was 400 to 500 whales.

The number of belukhas from the western Arctic population harvested annually in Soviet waters is less well known. One source indicates that, along the Chukchi Peninsula, "the yearly catch sometimes reaches 100-200 animals." Total annual removals from the population in recent years have, therefore, been about 600-700 animals.

J. State Management Objectives

The primary objective which the State would pursue with regard to belukha whales is the maintenance of healthy and productive populations. In order to achieve this objective, a broad program of research and management would be needed to determine the optimum size of belukha populations in relation to other ecosystem elements and to regulate harvests so that the population remains at optimum size. Under a State management regime, belukhas would be incorporated into an ecosystem-based, multispecies resource management plan. In addition, protection of belukha habitat would be provided in the formulation of State policies and regulations.

The second major objective of State management would be to provide for beneficial use of the belukha resource by all people. As provided for in State statutes, preference in harvest would be given to residents with a customary and traditional dependence on belukhas. Regulations could be designed to ensure reasonable distribution of the allowable harvest, to minimize loss associated with taking, and to allow full utilization for harvested animals. Nonconsumptive uses such as viewing and photography of belukhas in the wild would be encouraged to the degree possible.

K. Problems

Since 1972 belukhas have been protected under terms of the MMPA. Unlimited harvests by Natives have been allowed.

Since it was assumed that responsible Federal agencies would monitor harvests and conduct biological research on belukhas, such involvements by the State were greatly reduced starting in 1973. Programs were not developed by Federal agencies, however, and needed information on

belukha biology and Native harvests was not gathered. A small-scale State program was conducted in 1977-1979 with limited funds gathered from several sources; however, this project did not have adequate support and was limited in scope. In 1981 the project was expanded somewhat to include studies of distribution and movements in Alaskan waters. That project terminated in 1983. The interruption of belukha research and management programs caused by the MMPA is the primary reason that major data gaps which presently exist have not been filled. It is difficult to preserve belukha habitat when critical habitats are poorly defined or to prevent disturbance when the nature of and responses to disturbances are not known. This lack of information could have a major impact on present and future programs which may affect belukhas and their habitat.

L. Biological Impacts of Current and Proposed Management Plans

Belukhas are currently protected under terms of the MMPA. They may be taken only by Eskimos, Indians, and Aleuts for subsistence or handicraft purposes. Harvest statistics and biological specimens have been collected in recent years by the Alaska Department of Fish and Game (ADF&G). The responsible Federal agency has not made any discernible attempt to monitor harvests, collect biological data, or provide for protection of belukha habitat.

If management authority for belukhas were returned to the State, the Department of Fish and Game would continue and expand its ongoing program of monitoring harvest levels in Alaska and collecting biological data. The belukha is recognized as a species of particular interest due to its importance in the local economy of many Alaskans and Canadians and because of the increasing rate of development within belukha habitat. Materials will be collected from belukhas taken throughout the State in order to better understand their basic biology and to monitor parameters indicative of population health and productivity. Regulations would be designed to maintain the belukha harvest within the sustainable range. Additional regulations may be needed to reduce loss rate or manipulate sex and age composition of the harvest in order to affect stock sizes. Research would be undertaken to improve available data on belukha distribution, particularly in the coastal zone, and to determine the factors which affect observed distribution. Information on belukhas and areas of particular importance to them would be incorporated into State and local planning such as preparation of Coastal Zone Management Plans. In addition ADF&G biologists would provide input in the development of relevant Federal policies and Fishery Management Plans.

M. Projections

If Alaska resumed management authority for belukhas, the State would implement a broad-scale research and management plan. Harvest monitoring would be expanded to include greater geographical coverage, particularly in the southern Bering Sea. Greater effort would be devoted to determining sex, age, and biological parameters of harvested animals. It is anticipated that any harvest of belukhas will be by subsistence hunters in the Bering-Chukchi region. The average total annual kill would be limited so that the population remains within the optimum sustainable range. A general consideration of present and future distribution and needs of subsistence users indicates that bag limits or quotas would not be needed in order to limit subsistence take. Total harvest levels are expected to be similar to recent years. Non-Native subsistence hunters would benefit since they would be allowed to legally harvest belukhas.

In addition to analysis of biological parameters, State research programs would focus initially on aspects of distribution in and use of the coastal zone by belukhas. A major improvement in available data is expected within the first two years of such a program. Such data are essential for evaluating importance of various areas. Development is occurring within the habitat of belukhas and informed decisions must be made with respect to potential conflicts and compatible uses. Critical habitat areas within State waters would be protected by statute or regulations. Protection of habitat is the most immediate concern with respect to belukha whales and is probably of greatest overall significance for the future health of belukha populations. Protection of belukha habitat would be actively pursued.

The belukha would be managed as one of a group of interacting marine resource species. Stock sizes of the various species might be manipulated through regulation of harvests in order to offset environmental factors, balance biological interactions, or alleviate conflicts. It is expected that multi-species management would be of great benefit to the future health and stability of belukha stocks and the marine ecosystems of which they are a part.

No adverse impacts are expected from resumption of State management of belukhas.

N. Economic Analysis

Although commercial harvesting of belukhas has occurred commonly throughout the Arctic, the present primary use of belukhas in Alaska is for subsistence. The value of the belukha hunt to subsistence hunters is difficult to quantify. In addition to the value of the products, principally food, the hunt is of great traditional and cultural value and is often a major annual event for entire families and villages.

Belukhas are comparatively large animals and, where hunted, they are often taken in considerable numbers. Whales are primarily processed into meat, muktuk, and oil. Some organs are eaten, containers are sometimes made from the stomachs or esophagus, and teeth are used in

handicrafts. In 1960 it was estimated that 83,000 kg of belukha meat and oil were used by Eskimos living in villages along the Bering Sea coast, representing a yield of about 227 kg from each of the 300-400 animals harvested. An average whale taken in the Mackenzie estuary has been estimated to yield 48 kg of dried meat, 20 gallons of oil, and 30 gallons of muktuk.

The cash value of belukha products can be figured in two ways, either as what the actual products could be sold for in Native villages or elsewhere, or as the cost of purchasing substitutes. Neither method is entirely adequate. The sale of belukha products is limited, although substantial amounts may be bartered at times. The domestic value of belukha products in the Mackenzie region in 1977 approximated $1.10 per kilogram for dried meat, $1.50 per gallon for oil, and $5.00 per gallon for muktuk. An average whale was worth approximately $233. Costs for equivalent foods in Alaskan villages are three to four times greater. Substitutes for meat and oil are generally available, but there is no adequate substitute for muktuk. Costs of imported foods in remote areas have always been high and have increased markedly in recent years due to inflation and rising transportation costs. The comparatively low income of many rural residents coupled with the relatively poor quality of substitute foods make them a poor alternative in most instances. The belukha harvest in Alaska is undoubtedly worth tens of thousands of dollars annually to coastal residents.

Commercial uses of belukhas are numerous. Hides can be processed as leather, and oil is suitable for industrial use or human consumption. Meat is suitable food for humans or animals, while bones and viscera could be processed as animal food. Buttons have been made from belukha teeth.

Although difficult to quantify, nonconsumptive uses of belukhas undoubtedly are of great value. With the exception of Cook Inlet, much of the habitat of belukhas in Alaska is comparatively remote, therefore viewing and photography in the wild may never become popular as they have in some localities in Canada. Belukhas adapt well to captivity and are successful and popular attractions at several oceanaria.

O. Management Effectiveness

After Statehood in 1958 and prior to the MMPA in 1972, belukhas were managed by the State of Alaska. Since harvest levels were comparatively low and generally reduced from previous years, no limit was imposed on the take, although harvests were monitored by biologists working in coastal areas. Nonlethal techniques were developed to displace belukhas from areas in Bristol Bay where they severely conflicted with major salmon fisheries. This action effectively moderated the conflict without harm to the belukhas.

After 1972 only Eskimos, Indians, and Aleuts were allowed to harvest belukhas. This had no overall effect on total harvest since most of the take has always been by Eskimos. Sale of belukha products to non-Natives was prohibited. From 1974-1976 the magnitude of the harvest was not monitored. Due to an urgent need for harvest data and the lack of any Federal program to obtain the information, State biologists resumed monitoring of harvests in 1977. Since then they have collected all available information on magnitude and sex and age composition of the harvest and biological specimens from harvested animals.

P. Selected References

Brodie, P. F. 1971. A reconsideration of aspects of growth, reproduction, and behavior of the white whale (*Delphinapterus leucas*), with reference to the Cumberland Sound, Baffin Island population. J. Fish. Res. Board Can. 28:1309-1318.

Davis, R. A. and C. R. Evans. 1982. Offshore distribution and numbers of white whales in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. Rep. by LGL Ltd., Toronto, Ontario for SOHIO Alaska Petroleum Co., Anch. AK. and Dome Petroleum Ltd., Calgary, Alberta. 78pp.

Fay, F. H. 1978. Belukha whale. Pages 132-137 in D. Haley, ed. Marine mammals of eastern North Pacific waters. Pacific Search Press, Seattle, WA.

Fish, J. F. and J. S. Vania. 1971. Killer whale, *Orcinus orca*, sounds repel white whales, *Delphinapterus leucas*. Fish. Bull. 69:531-535.

Fraker, M. A. 1977. The 1977 whale monitoring program, Mackenzie estuary, NWT. F. F. Slaney and Co. Ltd. Vancouver, Canada. 53pp.

Harrison, C. S. and J. D. Hall. 1978. Alaskan distribution of the beluga whale, *Delphinapterus leucas*. Can. Field-Nat. 92(3):235-241.

Kleinenberg, S. E., A. V. Yablokov, B. M. Belkovich, and M. N. Tarasevich. 1964. Beluga (*Delphinapterus leucas*): Investigation of the species. Transl. from Russian by Israel Program for Scientific Translations (IPST Cat. No. 1923). 376pp.

Klinkhart, E. G. 1966. The beluga whale in Alaska. Alaska Dept. Fish and Game report. 11pp.

Lensink, C. J. 1961. Status report: beluga studies. Unpubl. Rep. Alaska Dept. Fish and Game. 38pp.

Seaman, G.A. and J. J. Burns. Preliminary results of recent studies of belukhas in Alaskan waters. Rep. Int. Whaling Comm. 31, SC/32/SM13:567-574.

Sergeant, D. E. 1973. Biology of white whales (*Delphinapterus leucas*) in western Hudson Bay. J. Fish. Res. Board Can. 30:1065-1090.

_____ and P. F. Brodie. 1975. Identity, abundance, and present status of populations of white whales, *Delphinapterus leucas*, in North America. J. Fish. Res. Board Can. 32:1047-1054.

The Pacific Walrus *(Odobenus rosmarus divergens)*

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Pacific Walrus

Odobenus rosmarus divergens

A. Introduction

In subarctic and arctic waters the walrus, *Odobenus rosmarus*, is without doubt one of the most unique species. Its wide distribution, large size, and habit of hauling out on ice and land has made it evident and characteristic of the cold region fauna of the northern hemisphere. Those same characteristics have made walruses very important to the development and survival of indigenous people and to the exploration of the Arctic and exploitation of its resources. Fortunately many observers, from early explorers to modern scientists, have found walruses interesting and worthy of study. Several significant summaries of walrus biology and population status have been published in recent years.

The walrus is the only surviving species of the family Odobenidae. While ancestral forms apparently flourished one to ten million years ago, all except *Odobenus* were extinct by recent times. The walrus, like other members of the Order Pinnipedia, is adapted for feeding and traveling in the water while maintaining an association with ice or land as a substrate on which to rest, socialize, give birth to, and care for young.

Walruses generally are similar to other pinnipeds. In outward appearance, they most closely resemble sea lions. Both fore and hind limbs are modified for swimming. Unlike seals and like sea lions, their hind limbs can be brought beneath the body and the chest raised up by the front flippers, allowing a sort of quadrapedal locomotion on land or ice. Their chests are massive in comparison to the hindquarters, their necks are thick, and their heads square. Their skin is covered with short, sparse hairs and overlies a thick layer of blubber. Color generally is brownish. The most distinctive feature of walruses, and the one from which their generic name is derived (*Odobenus* meaning tooth-walker), is the development of massive canine teeth, or tusks, in the upper jaw. These tusks, possessed by nearly all adults of both sexes, begin to be visible at about age two. The broad snout, covered with stiff short bristles below the nasal region, is also unique among pinnipeds.

Newborn walrus calves are approximately 100-120 cm in standard length (straight line distance from nose to tail) and weigh 45-60 kg. Subsequent growth is quite rapid with the weight of one-year-olds about triple that of newborns. Adult walruses are among the largest of pinnipeds. Average adult males are approximately 320 cm long and weigh 1,200 kg , while adult females are about 15% shorter and 30% lighter. Females and males are similar in appearance, although they can be distinguished by characteristics of tusks, head shape, and chest.

B. Distribution and Migration

As a species, walruses are nearly circumpolar in distribution, but the subspecies with which we are concerned, the Pacific walrus (*O. r. divergens)*, is restricted primarily to the Bering, Chukchi, East Siberian, and western Beaufort seas. In Alaskan waters, two of the major factors influencing walrus distribution are water depth and characteristics of sea ice. Since they are primarily benthic feeders, they do not remain in water too deep for efficient feeding. Walruses, therefore, are seldom seen in water more than 100 m deep. During much of the year, walruses are found in and around sea ice. Although they can break through thin ice, they generally are not found in areas where thick ice covers more than 80% of the sea surface.

During winter and early spring, virtually all members of the walrus population are associated with the sea ice of the Bering Sea. Based on observations in the 1960's and early 1970's, two areas of concentration were identified, one south and west of St. Lawrence Island, and the other in northern Bristol Bay and outer Kuskokwim Bay. As sea ice cover diminishes in late spring and summer, some animals, mostly mature bulls, occupy hauling areas on land in Bristol Bay and Bering Strait. Most of the population, including adult females and calves and subadults of both sexes, moves north with the receding ice into the Chukchi Sea. Those animals summer along the southern edge of pack ice from just east of Barrow to Wrangel Island. Land haulouts sometimes occur at Cape Lisburne and more commonly on Wrangel Island. As ice formation begins in the fall, walrus move southward, some swimming well ahead of the advancing ice and passing through Bering Strait mostly from October to December. Large numbers congregate near Bering Strait haulouts and sometimes on St. Lawrence and Punuk islands during those months. Herds of males that have summered in the Bering Sea desert those hauling areas to join the rest of the population on the Bering Sea winter ice.

C. Habitat Requirements

Physical characteristics of walrus habitat are difficult to quantify. Limitations imposed by water depth and ice cover have already been briefly mentioned. The range in water depths at which walrus feed is thought to be primarily between 10 and 80 m. It is unknown whether the observed range is a function of the diving capacity of walruses or the depth distribution of their prey. Because walruses require regular access to both water and air, some sea ice conditions are not suitable. During cold months when ice is continuously forming, walruses are restricted to areas where winds, currents, and land formations cause regular openings to occur in the ice cover. Such conditions occur in the Bering Sea ice front, south of St. Lawrence Island, and

in several areas near the Alaskan and Siberian coasts. During warmer months when new ice is not forming, food availability appears to influence walrus distribution most strongly. Walruses are much more common in relatively dispersed ice at the edge of the main pack than farther to the north in heavy, consolidated ice.

The coastal locations used as hauling areas by walruses represent a variety of physical types including rocky islands with steep cliffs and boulder beaches, low-lying sand and gravel spits extending from islands or the mainland, tundra-covered islands with gently sloping sand/gravel beaches, and mainland coast with sand/gravel beaches backed by steep bluffs. Although diverse in their physical characteristics, these areas undoubtedly have some common properties which make them more suitable than other similar appearing areas. The location of hauling areas in relation to normal distribution and migration patterns is certainly of significance. For example, the Punuk Islands are in an ideal location for walruses to rest during their fall southward migration while they await the formation of ice in the Bering Sea. Hauling areas, particularly those used in summer months, may be located in close proximity to feeding grounds. Perhaps of greatest significance is the fact that all areas used regularly by large numbers of walruses are located where the animals are not subjected to frequent and regular disturbances.

Details of walrus food habits are discussed in Section F. Briefly, most of the food of walruses, in all areas and seasons for which data are available, consists of several species of bivalve molluscs. The sensory and feeding apparatuses of walruses are highly specialized to allow efficient location, manipulation, and ingestion of clams. An average sized adult walrus will consume about 60 kg of food per day. Since only certain parts of the clams are eaten, the actual biomass destroyed per day probably is three to four times that amount. Obviously, clams must be reasonably dense for a walrus to find and eat an adequate amount in a day. Few data are available on distribution and abundance of the clams eaten by walruses. Available data indicate that clams are not uniformly distributed, so in at least some parts of the walrus range high density areas may not be very common or extensive.

The only known walrus predators are polar bears, killer whales, and humans. Polar bears apparently kill mainly calves, while killer whales take animals of all ages. Although available data are inadequate to estimate rates of mortality due to predation, the impact is probably slight in comparison to other causes of death. Human predation is discussed in Section I. Although numerous disease conditions and parasites have been found in walruses, few deaths can be attributed to those factors. Trauma caused by rock slides and crushing by other walruses have been identified as mortality factors on hauling grounds.

D. Abundance and Trends

Estimating the actual abundance of walruses is complicated by many factors. The best method presently available is extrapolating numbers counted from aircraft flown along transects over the walrus range. Problems encountered include inaccurate counts by observers, the vast size of the area to be covered, the unknown number of animals below the surface, and the tendency of walruses to be clumped rather than randomly or uniformly distributed. The problems can, in part, be overcome by taking aerial photographs of large groups, organizing surveys properly in relation to known walrus behavior and distribution, and using statistical techniques for survey design and analysis. Although the exact number of Pacific walruses will probably never be known, aerial surveys can and have provided reasonable estimates of abundance and clear indications of trends in numbers.

Based on available information, the walrus population in the first half of the 19th Century probably numbered about 200,000. The population was rapidly reduced by commercial hunting for hides, ivory, and oil primarily from 1860-1880. The population reached a very low level, perhaps 50,000 individuals, by the turn of the century. Government regulation of harvest allowed the population to increase somewhat in the early 1900's, but intensified Soviet commercial harvests in the 1930's to 1950's brought about a second major decline. It appears that the population has been increasing since about 1960.

Reasonably reliable estimates of walrus numbers based on aerial surveys are available for 1960-1975. In 1960, the population was estimated at 70,000-100,000. In 1970 and 1972, estimates of numbers were 101,000 and 136,000, respectively. Combining results of Soviet and American surveys in 1975 gave a mean estimate of 209,000 with a range of 168,000- 250,000. A coordinated U.S.-Soviet survey of walruses was conducted in September, 1980. Preliminary data from that survey indicate that the population then numbered 270,000-290,000 walruses.

E. Vital Parameters

The biology of walruses has been studied for at least the past 30 years. Due to the availability of specimens from the American subsistence and Soviet commercial/research harvests, most of the basic vital parameters of walruses are quite well known. Due to possible biases in such collections and sometimes inadequate sample sizes, not all parameters exhibit the desired degree of accuracy.

Female walruses become sexually mature (capable of breeding) between four and ten years of age. Few four-year-old animals breed successfully, but most are mature by age six. Breeding occurs during winter; calves are born in spring of the following year. Most male walruses become capable of breeding at eight or nine years of age,

but they do not attain physical maturity, and probably are seldom successful in competing for females, until about 15 years of age. The breeding system is probably polygynous, that is, one male will breed with several females. The maximum life span appears to be about 40 years.

The sex ratio of walrus calves at birth is one to one. The sex ratio of breeding adults is less well known. Researchers agree that adult (meaning sexually and physically mature) females outnumber adult males, perhaps by a factor of two or three to one. The skewed sex ratio is probably caused by several factors including intraspecific breeding competition among males and the preponderance of males in harvests by humans.

The gross productivity of the walrus population, like nearly all animal populations, basically depends on the proportion of mature females in the population and the frequency with which they produce young. The proportion of mature females obviously depends on age at sexual maturity and sex ratio of adults. As just discussed, the first of these parameters is well known while the second is less certain. The most recent and complete study of the composition of the walrus population concluded that it was (in 1972) comprised of about 46% adult females. Since the breeding season of walruses occurs prior to the time of calving, the normal interval between production of calves is two years. For various reasons, all females are not regular, therefore the average interval between calf production is about 2.3-2.5 years. Observations of the composition of walrus herds in late spring indicate that overall 35-40% of the adult females have recently given birth and are accompanied by calves and 40-45% have recently become pregnant. This would result in a gross rate of production of 16-18%. In other words, a population of 100,000 walruses would produce 16-18,000 calves each year.

Although most causes of death in walruses probably are known, mortality rates are difficult to estimate. Mortality from "natural" causes most likely is greatest in young animals and mature males. Walruses provide their young with considerable care and protection for a period of up to two years, so calf mortality may be lower than expected based on comparisons with other species. Animals which can be diagnosed as having died from disease or parasitism are very rarely encountered. Natural predators, polar bears and killer whales, are uncommon in comparison to walruses and overlap with major concentrations of walruses only seasonally in portions of their range. Probably the most significant natural causes of death are intraspecific competition among males and crushing and trampling by other walrus on hauling areas. It has been estimated that about 50% of the animals born survive to sexual maturity. This would result in a net recruitment rate of approximately 8-9%.

The major known source of mortality is hunting by humans. The average annual total number of animals killed in Soviet and American harvests from 1958-1977 has been estimated as approximately 5,500. The kill has been strongly biased toward males. Details of the harvest will be considered in Section I.

The rate of increase of the walrus population is a function of recruitment and mortality. In other words, the rate of increase is equal to the net rate of recruitment less mortality, which can be partitioned into natural and hunting-induced mortality. As discussed previously, natural mortality rates are not well known, but are probably at least 2% per year, while the average number killed by hunting in recent years has been approximately 3-4% of the average estimated population. For an increase in walrus numbers from 100,000 in 1970 to 209,000 in 1975, there would have to be an annual rate of increase of 15%. Obviously such a rate of increase could not occur with a net recruitment of 8-9% and a total mortality of 5-6%.

It is apparent that one or more of the recent estimates of walrus abundance is in error. It has been estimated, based on the age composition of harvested animals, that the population in the early 1960's numbered at least 90,000. In order for the population to double in ten years (i.e. to increase from 100,000 in 1965 to 200,000 in 1975) would require an annual rate of increase of about 7%. Such a rate is possible, but would require very high productivity and very low mortality. Both productivity and mortality are usually density dependent. At low population levels, high productivity and low mortality usually occur. As the population size approaches or exceeds the carrying capacity of the environment, productivity usually declines while mortality increases, resulting in a decreased or even negative rate of increase. It is reasonable to assume that productivity, mortality, and population increase rates have changed with expansion of the walrus population. More data are needed on vital parameters of walruses, especially the response of those parameters to changing population size.

F. Food Habits

Walrus calves feed almost entirely on their mothers' milk for the first year of life. During their second year, they begin to eat invertebrates, but many continue to suckle. They are usually fully weaned at two years of age, but a few may continue to nurse for another year.

After weaning, walruses feed almost entirely on benthic organisms. Animals belonging to 60 genera representing ten phyla have been identified in walrus stomachs. In the Bering and Chukchi seas, however, the only groups eaten in quantity are clams, snails, crabs, shrimp, worms, and sea cucumbers. Seals are eaten occasionally. Of those groups, clams usually make up 85-95% of the stomach contents examined at a given locality. Most of the clams eaten belong to six genera: *Mya, Serripes, Spisula, Hiatella, Clinocardium, and Tellina.* The principal species eaten varies markedly in different localities, indicating regional differences in species abundance. Only the soft parts of clams are found in the stomachs. Shells are separated and discarded prior to ingestion.

Most of the walrus stomachs examined in recent years have been collected from the spring Eskimo hunt in the Bering Strait region. The available data, therefore, are inadequate to describe broad-scale seasonal and geographical feeding patterns.

In general, similar prey species are eaten by both males and females. In the northern Bering Sea, females tend to eat smaller species of clams and smaller individuals of the large species. Males feed primarily on large individuals of large species. Although age-related food differences have not been rigorously examined, it appears that young animals feed on smaller items than do adults.

The species of clams eaten by walruses are generally long-lived and slow-growing. Limited sampling of benthic fauna seems to indicate that clams are not abundant enough to withstand the foraging of the present walrus population. Based on the stomach contents of bearded seals which also feed on clams, the abundance of at least one prey species (*Serripes groenlandicus*) appears to have declined over recent years in Bering Strait.

It is not unusual to find remains of seals (including hide, blubber, meat, organs, and bones) in stomachs of walruses. Apparently most seal-eaters are males with slight behavioral and physical distinctions from other male walruses. Remains of a young bearded seal were found in the stomach of one of 107 walruses collected in the Bering Strait region from April-June 1974-1976. In 54 walrus stomachs collected there in spring of 1979, four contained seal remains probably representing three spotted seals, one ringed seal, and one bearded seal. It is unclear whether walruses kill the seals they eat, obtain them as carrion, or both. In May, 1979, a walrus was seen feeding on the carcass of a recently dead spotted seal pup which showed no obvious signs of disease or starvation. Remains of another spotted seal pup were found nearby.

G. Ecological Significance

For thousands of years, walruses have been part of the biological community of the Bering-Chukchi platform. They are large and numerous and range widely on an annual basis. Their activities, particularly while foraging on the sea floor, undoubtedly have affected the development and character of other organisms, and the walruses in turn have been affected themselves.

Although small and juvenile clams are eaten by several species of benthic invertebrates and fishes, the walrus is the only species with a specialized diet of large clams. Most of the species eaten by walruses sometimes are eaten by bearded seals, but bearded seals derive a large portion of their food from other types of benthic organisms. By their foraging, walruses may directly limit or reduce clam populations. The foraging of walruses involves disruption and sometimes ingestion of considerable quantities of sediment, altering to some degree the physical qualities of the benthic habitat. The excretion of metabolic wastes and indigestable food remains by walruses provides for the release and transport of material and nutrients from the benthos into the water column. It seems very likely that, through a combination of these feeding-related factors, walruses influence the species composition and productivity of benthic communities especially in areas where large numbers of walruses regularly feed. This, in turn, would affect other species such as bearded seals and gray whales which feed to a large degree on benthos.

The impact of walrus predation on seal populations is impossible to evaluate at this time. Walrus stomachs collected in Bering Strait in spring, 1979, showed a much higher incidence of seal remains than expected. The possible predator-prey relationship between walruses and seals merits further investigation.

Walruses themselves provide food for a variety of other animals. Carcasses sinking to the sea floor are consumed by a variety of benthic scavengers. Animals that die on ice or wash up on shore may be fed upon by birds, foxes, and bears. As mentioned previously, walrus are killed and eaten by killer whales, polar bears, and humans. As a food resource, walruses are of little importance to killer whales, perhaps of moderate importance to polar bears, and of great importance to humans living on the Bering and Chukchi sea coasts.

H. Conflict Situations

Increased human presence and activity in the Bering-Chukchi region present a very real potential problem for the walrus population. The type and magnitude of the responses of walruses to most forms of human activity, unfortunately, generally become known only after the disturbance has occurred. Responses frequently may be of such small magnitude that they cannot be separated from "normal" variations in behavior, distribution, etc. Knowledge of walrus biology and insights gained from observations of past disturbances do allow us to anticipate some probable areas of concern.

Low flying aircraft, vessel noises, reports from firearms, and other loud noises regularly and predictably cause hauled-out walruses to move into the water, disrupting the animals' normal behavioral routine and constituting an additional and unnecessary expenditure of energy. When large numbers of walruses are hauled out, especially on land, "stampedes" may cause death or injury of numerous animals due to crushing. In addition, regular and frequent disturbances on coastal hauling grounds can cause abandonment of those areas, making it necessary to regulate access and types of activities in and near walrus hauling areas, particularly terrestrial sites. The effects of waterborne sounds on walruses are not known, but it seems likely that sounds of certain frequencies and intensities would cause walruses to avoid their source. The significance of such displacement would vary with locality and time of

year but could be great, for example, in traditional migration routes or feeding areas.

Many activities associated with coastal and offshore development have the potential to introduce deleterious substances into the marine environment. Examples are human wastes, chemicals and heavy metals from industrial and agricultural activities, thermal and radioactive pollution from electrical generating facilities, and a variety of petroleum products. Although it is unlikely that such substances would enter the marine system in quantities adequate to cause direct mortality to walruses, their presence could affect resistance to disease, successful production of young, and the abundance and suitability of food.

As discussed in Section F, walruses depend primarily on several long-lived, slow-growing species of clams for food. Any factor which causes a change in the relationship between food requirements of walruses and abundance and productivity of their prey can be expected to influence walrus numbers and productivity. Activities of other species feeding on benthic animals undoubtedly affect clam populations and, therefore, walruses. Human activities such as commercial fishing for clams (and perhaps other species) and dredging for gravel or gold probably would cause reductions in clam numbers. Perhaps of greatest significance is the recent increase in numbers of walruses themselves. While the walrus population has doubled in recent years, it is likely that the abundance of clams has declined due to increased predation. The net productivity of the walrus population should decline as it becomes more difficult to find adequate food and should reach zero when the population reaches "carrying capacity." It is possible that the walrus population may exceed (or already may have exceeded) the long-term carrying capacity of the Bering-Chukchi region, causing negative net productivity and a decline in population size. An effective management program would prevent overpopulation and overgrazing ultimately detrimental to walruses, their marine environment, and the coastal peoples dependent on them.

I. Harvest Levels

People have used walruses and their products for many centuries. The Eskimo people in the Bering Strait region have been closely tied to the availability of walrus. Early inhabitants of Beringia may have relied on naturally dead animals washed ashore. Later, primitive boats and weapons allowed hunters to pursue and kill limited numbers of walruses. During these two phases, a surplus of animals probably was rarely, if ever, harvested, and virtually all parts of the animals were used: meat, blubber, and some organs for food; oil for food, preservatives, heat, and light; skins for rope and coverings of dwellings and boats; intestines for windows and rain gear; and bone and ivory for tools and hunting implements.

Commercial harvesting of walruses also has a comparatively long history. Commercial harvests began in the late 1700's, intensified and peaked in the mid-1800's, and continue today. Ivory and oil were the primary products obtained in early years. In modern commercial harvesting by the Soviet Union, meat and organs are processed for human and animal food, hides for leather, ivory for carvings, and oil for a number of uses including soaps and cosmetics.

Recreational use of walruses has been a comparatively recent development. Photography and viewing of walruses in the wild and in captivity fall into this category, as does recreational hunting.

Walruses are harvested by citizens of both the U.S. (Alaska Natives only) and the USSR. Although a portion of the Soviet harvest is procured by coastal residents of Siberia, most of it has been taken by a commercial high seas fishery from large multi-purpose vessels. Total Soviet harvest declined from an average of about 5,000 per year in the 1940's and 1950's to 900 per year from 1965-1971. In the 1970's, harvest increased to 1,200-1,500 annually and in 1982 was approximately 4,000 animals.

In Alaska, harvest of walruses has been controlled by a variety of regulations and legislation. From 1958-1972, all people were allowed to hunt walruses under regulations passed by the State of Alaska, but preference was given to hunters taking walruses for food. Such subsistence hunters were allowed to harvest unlimited bull walruses and a limited number of cows. Recreational hunters were allowed only one bull walrus annually. The average annual Alaskan harvest during this period was approximately 1,600 animals. Passage of the Marine Mammal Protection Act (MMPA) in 1972 prohibited the harvest of walruses by non-Natives regardless of the nature of their past dependence on them. While Natives (primarily Eskimos) were allowed to harvest walruses with no regulation, they were prohibited from selling to non-Natives unless raw walrus materials were made into items of handicraft. The average annual harvest rose to 2,162 animals from 1973-1977. From April, 1976 until August, 1979, walrus again were managed by the State of Alaska under provisions of a waiver of the MMPA specifying that the total take of walruses (including subsistence and recreational hunting, collections for scientific research and public display) must remain below 3,000 annually. Due to a variety of problems involving terms of the waiver and judicial interpretation of the MMPA, Alaska relinquished management authority in August, 1979.

Not all walruses killed during hunting are retrieved. Although the number of animals killed and lost varies with the circumstances and is difficult to estimate, it is likely that the retrieved harvest represents about 60% of the total kill. The estimated total number of animals killed annually (including both Soviet and American harvests) between 1958 and 1977 has ranged from 3,078 to 9,230 with a mean

of 5,577. Since the population size more than doubled during that period, it is obvious that the kill was well below the possible sustained yield.

Regulations and legislation have markedly affected the opportunity of people to use the walrus resource. The Alaska law creating the Walrus Islands Game Sanctuary has fostered the development of the only major walrus hauling area in the United States and has provided a unique opportunity for scientific research and public enjoyment of walruses.

J. State Management Objectives

The primary walrus management objective the State of Alaska would pursue is the maintenance of a healthy and productive walrus population. While many factors affecting walruses cannot be controlled by the State, protecting habitat in a broad sense and regulating harvest of walruses and other marine resource species would help maintain an optimal sustainable population. Intrusions into walrus habitat could be prevented, mitigated, or regulated to minimize long-term detrimental impacts to the population or to the sustaining capacity of the habitat.

Second, the State would provide for beneficial uses of the walrus resource by all people. As provided for in State statutes, harvest preference would be given to residents with a customary and traditional subsistence dependence on walruses. If a harvestable surplus then remains, walruses could be harvested by recreational hunters or commercial interests. Other beneficial uses such as viewing and photography would be encouraged. All uses would be regulated to maintain the health of the walrus population while minimizing conflicts with other resources and obtaining the greatest overall benefit for all people.

K. Problems

Current regulations on harvest of walruses are based on provisions of the MMPA. These regulations present several problems. The MMPA provides for harvest of walruses by Alaska Natives, but prevents any regulation of that harvest unless the species is declared depleted or management is returned to the State. This, in effect, prohibits regulation of the most significant harvesters of walruses and precludes many management options. Although Natives are allowed to harvest walruses without limit, they can sell to non-Natives only those parts of the walrus that have been processed into handicrafts. This may not allow for full utilization of the harvested animals.

Future development in the coastal zone and marine waters off Alaska presents a number of potential problems for the walrus population. Included among the major threats are exploration, development, and transport of fossil fuels, extraction of minerals, harvest of renewable marine resources, and increased population and activity in the coastal zone. Provisions of the MMPA were not designed with these problems in mind so cannot be readily adapted to address them responsively. The regulatory powers of the State of Alaska, including coastal zone management and regulation of nearshore fisheries, however, provide a flexible framework to develop and implement plans and regulations minimizing effects of development on walruses.

One of the greatest problems facing the walrus population may be the recent rapid increase in walrus numbers. Walrus carrying capacity in the Bering-Chukchi region is not known with any degree of accuracy. Walruses are large and feed on slow-growing prey which are also food for other marine animals. Indirect indicators suggest the population already may have reached or exceeded the present carrying capacity. Overgrazing of a food resource by any animal results in decreased productivity and a decline in numbers. This commonly results in cycles of predator and prey abundance. Since walruses and clams are both long- lived and slow to mature, cycles, if they occur, would probably be of long duration. It is presently impossible to estimate the magnitude of future changes in walrus numbers. Management techniques to prevent or moderate such fluctuations in numbers are available, but are not provided for through application of the MMPA as presently written.

L. Biological Impacts of Current and Proposed Management Plans

Presently, under provisions of the MMPA, the options for actual management of the walrus population are very few. Walruses can be harvested only by Natives, and their harvests are subject to virtually no regulation. No provisions of the MMPA or other Federal law allow for protection of developing or extant hauling grounds of walruses. It is likely that few, if any, of these areas will develop unless they can be protected by the State as is the case with the Walrus Islands State Game Sanctuary. Harvest of walruses by Natives is expected to be similar to previous years or to increase slightly, and since raw products cannot be sold, in some locations, the harvest will be primarily for ivory. If harvests by the Soviet Union are similar to previous years, the population size will continue to increase until the carrying capacity of the environment is reached or exceeded. The productivity of the walrus population will then decline, mortality probably will increase, and the number of walruses in the population will decline. The magnitude and rate of population decline cannot be predicted at present and will depend on the degree to which the walrus food supply has been overutilized. If the population decreases to the point that it is declared depleted under terms of the MMPA, regulations restricting harvests may then be instituted. Other organisms dependent on the benthic ecosystem of the Bering-Chukchi system (bearded seals, gray whales, king crab, flatfishes, among others) also may be affected.

Walrus management by the State of Alaska would provide many more options for people using them as a resource.

State regulations could allow development of hauling areas where nonconsumptive uses would be encouraged to the degree possible. Considering factors such as ability to utilize retrieved animals, variable weather and ice conditions, and number of hunters, it seems unlikely that the number of walruses taken by subsistence and recreational hunters in Alaska would greatly exceed the take in recent years. The intentions of the Soviet Union regarding future walrus harvests are not known. Regulations would ensure that the total number of animals killed does not exceed the net annual increment to the population. Once the relationship between the size of the walrus population and the carrying capacity of their range is understood, it may be desirable to allow increase or decrease the population size. This could be accomplished by manipulating the various components of the walrus harvest through State regulation, in concert with programs implemented by the Soviet Union.

M. Projections

If walrus management is resumed by the State, a number of regulatory actions would be taken. Through the established procedure of public input and regulations enacted by the Board of Game, a framework for hunting would be established. In order to minimize hunting loss, regulations may also stipulate the kinds of equipment to be used in the taking of walruses. It should be emphasized that all potential users (both consumptive and nonconsumptive) have input into the regulatory process through submission of regulatory proposals and participation at public hearings.

To the extent possible, the State would encourage development of coastal hauling grounds by regulating human use of the most important areas. Consideration would be given to walrus habitat protection in the development of coastal zone and other management plans.

The State would encourage and participate in research to determine the relationship of walruses to their food resource as well as the range of optimal sustainable population size. The State would also undertake efforts to determine the relationship between walrus numbers and other components of the Bering-Chukchi marine ecosystem.

The State would determine, in consultation with other interested institutions, agencies and individuals, the presently desirable size of the walrus population and regulate the harvest of walrus to reach and maintain a desirable population size.

The primary benefit anticipated from State management would be stabilization of the walrus population before it greatly exceeds carrying capacity. If allowed to exceed carrying capacity, it could cause long-term, although perhaps not irreversible, damage to the Bering-Chukchi marine ecosystem. If the walrus food supply is overutilized, recovery of prey populations will be very slow due to slow growth rates and delayed maturation of major prey species. Stabilization of the walrus population is very important to coastal residents who will be significantly affected by a substantial decline in the number of walruses. The major secondary benefit of State management would be more equitable distribution of the walrus resource among all potential users and more efficient and complete use of harvested animals. State management policies would encourage broadening of the economic base of residents of rural villages while still providing for traditional dependencies on the walrus resource.

No direct adverse impacts are anticipated from State management. It must be emphasized, however, that the future health and stability of the walrus population largely depends on past management or lack thereof. It is possible, for example, that the present number of walrus already exceeds carrying capacity. If that is the case, a decline in population size will result regardless of future State management. In such circumstances, a decline in population is not only inevitable but also desirable. Flexible State management options will allow for regulations ensuring that harvests (by U.S. citizens) do not exacerbate the decline and that the population is stabilized at the most appropriate size.

N. Economic Analysis

The traditional importance of walruses in the economies of Alaskan coastal villages has been well documented. In the past, the economic value of walruses was measured primarily in terms of food and raw materials. Although walruses retain much of their former material resource value, present-day circumstances necessitate increased participation in a cash economy. It is very understandable that valuable products made from parts of walrus have become a main source of cash in many of these communities. It must be remembered that the value of a walrus and its parts for food, cash, or other purposes varies among locations and among individuals. Some people in some locations depend on walrus for much of their food and all of their income. To others, walrus hunting is a comparatively minor supplement to other sources of income.

For a number of reasons, it is quite difficult to estimate the present and potential value of the harvest of walruses in Alaska. The value of some parts of the animal, for example, the ivory and oosik (os penis), differ greatly depending on whether or not they are processed into objects of art. It is difficult to estimate the amount and value of walrus parts presently used locally as food. Furthermore, the potential uses of some walrus products have not been tested in recent years, and their value will depend on a large number of proximate economic factors.

Most parts of walruses can be used in ways analogous to other mammals. Walrus meat is nutritious and edible and can be used as food for humans or animals. While value of

meat will vary with market demand, location, etc., a range of from $0.77 per kilogram for animal feed to about $4.36 per kg for human consumption is reasonable. Walrus blubber can be used as food or rendered into oil with comparable value to other animal oil (present value of tallow in Fairbanks is $1.20 per kg). In addition to traditional uses, walrus hide is suitable for leather and other such uses of animal fiber. Prior to the MMPA, bull walrus skins were worth $280 apiece and were used as buffing material. The oosik of a male walrus is worth at least $50 as a curio, and if carved its value may exceed $100. Ivory from walrus tusks is of considerable value. In the raw state, it is worth at least $11 per kg or about $100 each for female tusks and $150 each for males. Carvings made from a single tusk can be worth over $1,000 to the carver.

Using the above figures, some gross approximations of the actual and potential economic value of walruses can be made. Based on data from recent years, it is reasonable to assume a harvest of 3,000 animals (not including calves), two-thirds of which are bulls. Under present provisions of the MMPA preventing sale of hides, meat, and blubber to non-Natives, virtually none of the hides and only about 10% of the meat is used. Under such circumstances, the value of 3,000 walruses would range between $1.5 and $6.0 million depending on the degree of art work done with oosiks and ivory. If hides, meat, and blubber were fully utilized, the value of the harvest would be on the order of $3.5-$13.0 million, or about double. In addition, considerable income would be available to rural communities from the guiding of sport hunters, if such were allowed. In the past, guided hunts have usually provided about $2,500 to the captain and crew of the boat. Fifty to 100 such guided hunts per year could provide an additional $125-250,000 in annual income.

O. Management Effectiveness

After Alaska attained Statehood in 1959, walruses were immediately singled out by the State as a species whose management was of particular concern. At that time, the walrus population was known to be reduced in size, and management measures were implemented to encourage an increase in the population. These measures included:

1. Monitoring the number of animals harvested including the number of animals wounded but lost.
2. Limiting the number of females and subadults that could be taken annually by each resident hunter.
3. A limit (one) on the number of walruses which could be taken annually by each nonresident hunter.
4. Protection of developing hauling areas (e.g. Round Island) from disturbance.

A primary objective of these regulations was to reduce the mortality experienced by the walrus herd, especially with respect to adult females. As part of the management program, hunters were encouraged to improve hunting techniques, thereby reducing the number of animals wounded and lost, and to utilize animals harvested to the greatest degree possible.

A second objective was protecting walrus habitat by severely limiting development and disturbance in critical areas. These areas have become focal points for nonconsumptive use of walruses.

The effectiveness of the State management strategy is attested to by the increase in walrus numbers, development of coastal hauling areas, and the amount of data collected on harvest of animals in Alaska.

Enactment of the MMPA negated all State regulations on taking of walruses. Since the MMPA allowed unregulated taking by Alaska Natives, however, the harvest of walruses continued. Although State regulations were no longer in effect, State biologists continued to obtain harvest data and biological samples from harvested animals. The annual number of animals killed and retrieved by Native hunters in 1973, 1974, and 1975 averaged slightly more (1,740) than the average annual Alaskan harvest during the previous ten-year period (1,555).

Management responsibility for walruses was returned to the State in April, 1976, following lengthy judicial and administrative proceedings. State management plans and regulations were subject to Federal review and approval. The terms of the waiver of the MMPA required that the total annual harvest (including subsistence and recreational hunting as well as taking for public display and scientific studies) be limited to no more than 3,000, a figure based on the 1972 population estimate of 140,000. Due primarily to conditions favorable to subsistence hunters, total harvests in 1976 and 1977 were comparatively large (2,989 and 2,450, respectively). In order to provide all residents an opportunity to harvest walruses while ensuring that the total harvest quota was not exceeded, it was necessary to allocate the quota among the various areas. In several instances, walrus hunting was stopped by emergency regulation when the quota was reached. State regulations also required that appropriate equipment be used to hunt walruses (in order to minimize wounding loss) and closed certain areas to hunting in order to protect hauling sites.

Although State regulations were effective in protecting walrus habitat, minimizing hunting loss, and limiting the total harvest, several major management problems arose. Surveys conducted in 1975 indicated that the walrus population was considerably larger than 140,000, and, in fact, had increased rapidly to over 200,000. This increase was evident not only to biologists but also to Native hunters who noted that the physical condition of the walruses they retrieved appeared to be declining. Under such circumstances, the quota of 3,000 was considered unnecessary and perhaps detrimental. If indeed the population was approaching carrying capacity, prudent management dictated that the rate of increase should be slowed or

halted, especially since the ability of the population to increase rapidly had been amply demonstrated. Attempts to obtain an increase in the quota were ineffective. Further, a suit filed against the Department of Interior by the people of Togiak and Bristol Bay challenged the legality of the waiver and the State regulations governing subsistence hunting. These factors, among others, convinced State officials that they would not be allowed to truly manage the walrus population. In effect, the State was only allowed to enforce Federal quotas, while possibly not being permitted to regulate the largest group of users. The State then took actions which were designed to cause walrus management to be resumed by the Federal Government (U.S. Fish and Wildlife Service). Federal management was resumed in August 1979, under stipulations of the MMPA.

P. Selected References

Brooks, J. W. 1953. The Pacific walrus and its importance conomy. Trans. 18th North American Wildlife Conference, pp. 503-510.

Brooks, J. W. 1954. A contribution to the life history and ecology of the Pacific walrus. Alaska Coop. Wildl. Res. Unit, Univ of Alaska, Fairbanks. Spec. Rep. No. 1, 103pp.

Burns, J. J. 1965. The walrus in Alaska, its ecology and management. Alaska Dept. Fish and Game, Juneau. 48pp.

Estes, J. A. and V. N. Gol'tsev. 1984. Abundance and distribution of the Pacific walrus: results of the first Soviet-American joint aerial survey, autumn, 1975. In F. H. Fay and G. A. Fedoseev (eds.), Soviet-American Cooperative Studies on Marine Mammals, Vol. 1 Pinnipeds. NMFS Circular Series (in press).

Fay, F. H. 1957. History and present status of the Pacific walrus population. Pages 431-455 in Trans. 22nd N. Am. Wildl. Conf., Wildl. Manage. Inst., Washington, D. C.

Fay, F. H. 1981. The walrus-*Odobenus rosmarus*. Pages 1-24. In S. H. Ridgway and R. J. Harrison, eds. Handbook of marine mammals, Vol. 1. Academic Press, London and New York.

Fay, F. H. 1982. Ecology and biology of the Pacific walrus, *Odobenus romarus divergens* Illiger. U. S. Fish Wildl. Serv. N. Am. Fauna No. 74. 279pp.

Fay, F. H. and B. P. Kelly. 1980. Mass natural mortality of walruses (*Odobenus rosmarus*) at St. Lawrence Island, Bering Sea, Autumn 1978. Arctic 33:226-245.

Fay, F. H., H. M. Feder, and S. W. Stoker. 1977. An estimation of the impact of the Pacific walrus population on its food resources in the Bering Sea. Final Rep. MMC, Contracts MM4AC-006 and MMSAC-024, U. S. Marine Mammal Comm., Washington, D. C. NTIS Publ. PB-273505. 38pp.

Fedoseev, G. A. 1962. (On the status of the stocks and the distribution of the Pacific walrus). Zool. Zh. 41:1083-1089. In Russian. (Transl. by F. H. Fay, Univ. Alaska, Fairbanks, October 1962, 12pp.)

Gol'tsev, V. N. 1976. (Aerial surveys of Pacific walrus in the Soviet sector during fall, 1975). Processed rep., Magadan Branch, TINRO, In Russian. (Transl. by J. J. Burns, Alaska Dept. Fish and Game, Fairbanks, Alaska. 26pp).

Krogman, B. D., H. W. Braham, R. M. Sonntag, and R. G. Punsly. 1979. Early spring distribution, density and abundance of the Pacific walrus (*Odobenus rosmarus*) in 1976. Unpubl. final rep., subcontract R 7120804, Res. Unit 14, Environmental Assessment of the Alaskan Continental Shelf, Outer Continental Shelf Environmental Assessment Program, Boulder, Colo. 47 pp.

Lowry, L. F., K. J. Frost, and J. J. Burns. 1980. Feeding of bearded seals in the Bering and Chukchi Seas and trophic interaction with Pacific walruses. Arctic 33:330-342.

The Polar Bear *(Ursus maritimus)*

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Polar Bear

Ursus maritimus

A. Introduction

Polar bears (*Ursus maritimus*) are top trophic level carnivores of the arctic sea ice environment. They are a "high-profile" species, and people throughout the world have a special interest in their welfare and management. Five nations share jurisdiction of most of their habitat, with international bear conservation programs and scientific information exchange. National programs are being developed to provide habitat protection as northern development increases. Each of the five nations has a different management approach with regard to hunting. In the United States, a management program could be developed to provide for different needs and uses depending upon the allowable harvest levels. These could include subsistence and recreational taking, contingent on maintaining healthy and productive populations.

Polar bears evolved from the same ancestor as brown bears (*Ursus arctos*), and both species are still closely related as demonstrated by matings between the two and production of fertile offspring in zoos. Size and weight of polar bears are similar to those of large brown bears. Newborn cubs weigh 600 to 700 grams, adult males weigh 350 to 650 kilograms, and adult females weigh 150 to 300 kilograms. Adaptations of the polar bear to a sea ice environment include a white coat with water repellent guard hairs and dense underfur, short furred snout, short ears, specialized teeth for a carnivorous rather than an omnivorous diet, and hair almost completely covering the bottom of the feet.

B. Distribution and Migration

Polar bears occur only in the northern hemisphere and most commonly in association with sea ice. Mark-recapture and morphological studies indicate several subpopulations of bears. In general, bears are most abundant around the perimeter of the polar basin for 200-300 kilometers offshore from land masses. They do occur throughout the polar basin, however, and have been recorded as far north as 88°N latitude. In some areas where there is marked seasonal advance and retreat of pack ice, bears make extensive north-south migrations. They have been recorded as far south as St. Matthew Island and the Pribilof Islands in the Bering Sea, James Bay and Newfoundland in Canada, and Iceland in the North Atlantic Ocean. In summer, depending on the region, polar bears concentrate along the southern portion of the drifting pack ice, or in bays which retain ice. In other areas, they spend the summer on land after sea ice melts or drifts far offshore. In winter, bears move south with the drifting ice and concentrate along certain favorable coastlines for denning and feeding. Climatic changes, especially heating and cooling trends, affect polar bear habitat and thereby impact distribution.

C. Habitat Requirements

During winter, polar bears (other than pregnant females) are almost always associated with sea ice in areas where seals are available for food. Pregnant females give birth in winter snow dens located along the coast, in the shorefast ice zone, and to a limited extent on drifting pack ice. Several factors are necessary for continued successful denning in an area. These include ice movements enabling bears to reach the area in the fall, availability of seals as a food source and ice conditions which facilitate their capture during pre-denning and post-denning periods, and suitable weather conditions (snowfall, wind, and ambient temperatures) which combine with topography to produce snowdrifts that do not thaw during the denning period (December to early April).

Summer habitat requirements are met in various ways. Bears in the Alaskan sector and in many other locations stay on the drifting sea ice and feed on seals as summer ice consolidates into a smaller area offshore. In other areas, bears remain associated with landfast ice and the marine mammals, mainly seals, it supports. On islands and areas adjacent to large bays where summer pack ice does not persist or is a considerable distance from shore, bears spend the summer on land. When on land, bears may form resting depressions in the cool soil and excavate earthen dens and snow dens for resting, for their cooling effect, and for protection from insects.

D. Abundance and Trends

Various workers have estimated polar bear population size and abundance both by regions and throughout their entire range. These estimates have been based on limited data and broad assumptions, so they vary widely. A review of the different estimates, however, suggests a minimum world population of 20,000.

Polar bears in and near Alaska have been extensively studied in order to determine their abundance, movements, and population parameters. The best estimates of the number of bears in this area range from 5,700 to 9,500.

While the five countries with jurisdiction over bears all share a concern about the potential impact of industrial development, it has not been identified as a cause of any population decline to date.

Hunting is the other activity with the potential to cause population declines. In the U.S.S.R., polar bear hunting has not been allowed since 1956, and Soviet scientists believe populations are now stable and increasing in some areas. Norway has not permitted hunting in the Spitsbergen Island group since 1971, and polar bears are

increasing. In Greenland, there is no evidence that the long-term annual harvest of 125-150 bears is adversely affecting populations. In Canada, the number of permits for taking bears has increased in recent years, and the annual kill is now approaching 700. Canadian officials believe that a maximum sustainable harvest has probably been reached in some areas. In Alaska, the number of bears frequenting the coast has increased since the elimination of aircraft hunting by the State of Alaska and implementation of the Marine Mammal Protection Act of 1972 (MMPA). This may indicate an increasing population, a change in distribution because airplanes are no longer legally used as an aid in hunting, distributional changes related to annual ice conditions, or a combination of these factors. Analysis of mark-recapture data through 1977 for bears adjacent to Alaska indicates a stable to slightly increasing population.

E. Vital Parameters

While most female polar bears breed at five years of age, the age of first breeding ranges from three to seven years. Although maximum breeding age of females has not been precisely determined, reproducing females as old as 21 years have been reported. Presence of mature sperm in testes and epididymides indicates that minimum and maximum ages at which males may be able to breed are 3 and 19 years. Although presence of sperm indicates breeding capability, it does not necessarily mean that bears as young as three and as old as 19 are successful breeders. The maximum age for polar bears is 25-30 years.

Breeding occurs in April, May, and June; delayed implantation, as demonstrated for other bear species, probably occurs. Young are born in December and commonly remain with the mother for approximately 28 months. The female may breed again at about the time the young separate from her, or may not breed for another year. The average length of breeding interval (time between successive parturitions) is 3.6 years in the Alaskan portion of the Beaufort Sea. Number of young per litter varies from one to three. Average litter size estimates vary between 1.58 and 1.87 in different geographic areas.

Studies performed during the 1970's show that adult males (age six and older) comprise 12% of the Alaskan population, 18% of the western Canadian arctic population, and 17% of the Hudson Bay population. Adult females comprise 26%, 19%, and 17%, respectively, of these three populations. Litter members (cubs, yearlings, and two-year-olds) comprise 32% and 26%, respectively, of the Alaskan and western Canadian populations.

The mean number of young produced per adult female per year is calculated by dividing mean litter size by breeding interval. Alaskan studies suggest that sexually mature females produce 0.46 young per year; Canadian studies suggest 0.54 young per year per breeding age female.

F. Food Habits

Polar bears feed primarily on ringed seals and secondarily on bearded seals. Bears also eat harp and hooded seals and walrus calves, and scavenge on carcasses of walrus, narwhals, and belukha and bowhead whales. Bears have reportedly attacked belukha whales. Bears that spend the summer on land eat small mammals, birds, eggs, and vegetation.

Bears catch seals in several ways. In April and May, they break into ringed seal pupping dens formed in snow on top of the ice. In years of high seal productivity, pups may constitute at least 50% of the seals killed by bears. During the rest of the year, bears most commonly take seals by waiting at a breathing hole or at the edge of open water. Bears also obtain seals by stalking them when they are hauled out on the ice in late spring and summer. Stalking is a less frequently used hunting technique than waiting at holes or the edge of open water.

G. Ecological Significance

The polar bear is a top trophic level carnivore that feeds primarily on ringed seals but also on other marine mammals. Studies have not yet been done indicating the degree to which bear predation may limit seal populations. The only competition, if any, between bears and other predators on ringed seals would be from coastal residents hunting mainly in the vicinity of villages, and from arctic foxes which prey on ringed seal pups. Commercial harvest of bearded seals by the Soviets and harp seals by the Norwegians and Canadians might also constitute limited competition.

Polar bears and arctic foxes mainly have a commensalistic relationship. Part of the fox population spends the winter on land while another segment spends the winter on sea ice, feeding on remains of seals killed by polar bears. The latter may be a more stable food source than the lemmings and carrion on which terrestrial foxes feed. Most foxes that winter on the ice go ashore in spring, but some may spend the summer on the ice.

As a top trophic level consumer, the polar bear can serve as an indicator of the occurrence and degree of concentration of environmental pollutants and contaminants in the far North. Polar bear tissue samples collected from 1967 through 1972 were examined for organochlorinated hydrocarbons, polychlorinated biphenyl (PCB), and mercury. Fat samples from nearly all bears examined contained PCB and organochlorinated hydrocarbons, including the DDT group, hexachlorobenzene, dieldrin, and endrin. Organochlorinated hydrocarbons found were at such low levels as to most likely affect bears minimally. The mean PCB level was relatively low compared to levels, apparently nonlethal, reported in some other mammals. All liver samples examined for mercury contained low levels, with bears taken north of Alaska having significantly higher

levels than bears taken to the west. At the time tissue samples were collected, relatively little human activity that would directly introduce pollutants and contaminants had occurred in the Arctic. Thus, introduction was probably from other areas by way of the atmosphere and oceans.

The only parasite found in a significant number of bears is a strain of *Trichinella* similar to the pork tapeworm causing trichinosis in humans. Alaskan Eskimos are aware in a general way of trichinosis and thoroughly cook polar bear meat before eating it.

H. Conflict Situations

Conflicts between bears and humans will increase as petrochemical exploration and development and other human activities increase in the far North. Direct confrontations will occur as bears come into seismic and oil camps and settlements. This will be less of a problem in Alaska where bears do not spend much time on land during the summer than it is in some other areas, particularly Canada.

Polar bear denning may also be affected as humans increase their activities in the Arctic. Human activity along the coast might cause females coming to shore to den in October and November to move back on sea ice and den there instead. Drifting ice may provide a less stable platform than land or shorefast ice, reducing denning success. Drifting ice may also transport bears to areas where they cannot find adequate food when they emerge from dens. Human activity may also interfere with bears that have selected denning sites or that are in dens. Soviet investigators have reported several instances on Wrangell Island where their presence caused bears to desert dens shortly after forming them in October and November. Soviets also report that females are readily frightened from dens before parturition. Disturbances could also affect bears later in the denning period. Bears in zoos produce cubs successfully only if shielded from noise and visual disturbances during denning and for several months thereafter. There is some evidence that bears in the wild, when disturbed in dens, neglect cubs or lead them out of dens before they are developed enough to withstand the severe mid- to late-winter environment. In contrast, however, there is also evidence that some denning females tolerate a certain degree of human activity in the general vicinity of the den. Bears may also be affected by human activity after leaving dens. For example, a pipeline that was a physical barrier to small cubs might unduly delay reaching sea ice and a readily available food supply.

The probability of an oil spill in arctic waters is high due to ice damage to platforms, pipelines, and oil transport ships. Ice would greatly reduce effectiveness of oil spill control and cleanup measures. Oil could affect polar bears by reducing insulating value of fur and, thus, a soiled bear's ability to maintain body temperature. Oil, if ingested directly or by licking from fur, is known to cause adverse physiological effects.

Conflict situations will be aggravated in areas where hunting is not permitted. These conflicts result from habituation of bears to humans and attraction of bears to human refuse.

I. Harvest Levels

Polar bear harvest figures since 1925 are summarized in Table 1. Polar bears north and west of Alaska may normally form somewhat discrete subgroups with only a limited amount of interchange, and harvest data are presented accordingly. A line extending offshore from the Alaska coast between Wainwright and Point Lay has been chosen to best separate the west and north subgroups.

Harvests through the 1940's were primarily by Natives hunting with dog teams for subsistence and the sale of hides. Estimated annual harvests based on fur export records for 1925-53 averaged 117 bears.

Guided hunting by aircraft started in the late 1940's and continued until stopped by the State of Alaska in 1972. The estimated annual harvest for 1954-60 was 160. With Statehood in 1959, Alaska received game management authority, and in 1961 made it mandatory that hunters present polar bear skins for sealing and examination. This enabled more precise measure of the harvest and provided other information about the bears taken. The average annual kill for 1960-72 was 260, with about 13% (average of 34 per year) taken by Alaskan Natives.

The State of Alaska stopped the use of aircraft to hunt polar bears in July, 1972. An alternate program of managed hunting from the ground was not implemented because the MMPA transferred management authority from the State to the Federal Government in late 1972.

Under the MMPA, only Alaskan Natives are allowed to take polar bears. The only restriction is that taking cannot be in a wasteful manner. Prior State regulations provided a preference for subsistence hunters and protected cubs and females with cubs.

Most Native hunters did not become familiar with details of the MMPA for some time after it was implemented, and many still followed previous State regulations on bag limits and protection of females with young. Harvest by Natives increased as they learned these restrictions no longer existed. Cessation of hunting with use of aircraft may also have caused more bears to be available in the vicinity of villages and thereby contributed to occasional high kills by Natives. Heavy ice in some years brought more bears to the coast, contributing to high kills in 1975 and 1976.

The State could not require Natives to seal hides and skulls after passage of the MMPA. Nevertheless, the State continued sealing on a voluntary basis whenever possible, in order to provide some continuity of data. The number of bears sealed plus estimates by State biologists of bears killed and not sealed give estimates of total annual kills. The average annual kill for 1973-79 was 86.

Table 1. Alaska polar bear harvest, 1925-79.

Year	West Area Total	West Area Females	North Area Total	North Area Females	W & N Areas Total	W & N Areas Females
1925-53					117(Avg)	
1954					100	
1955					128	
1956					135	
1957					206	
1958					128	
1959					250	
1960					162	
1961	111	29	37	11	148	40
1962	142	38	57	22	199	60
1963	137	21	50	17	187	38
1964	189	34	66	25	255	59
1965	202	40	96	28	298	68
1966	257	50	148	50	405	100
1967	131	16	92	30	223	46
1968	209	33	115	46	324	79
1969	201	40	87	34	288	74
1970	240	45	95	43	335	88
1971	146	31	68	29	214	60
1972	174	26	65	17	239	43
1973	13	6	23	11	36	17
1974	29	10	19	7	48	17
1975	108	50	38	16	146	66
1976	140	61	27	12	167	73
1977	80	39	34	17	114	56
1978	32	17	27	5	59	22
1979	15	6	14	5	29	11

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J. State Management Objectives

The principal management objective the State of Alaska would pursue for polar bears would be protection of adequate habitat and maintenance of healthy and productive populations. Research would be directed toward assessing the potential impacts of industrial development on polar bears and their habitat and reducing such impacts. A concerted effort would be made to have adequate stipulations for protection of bears and their habitat included in all land use permits.

A hunting program would include the following points: reducing impacts of the present unregulated hunting of pregnant females, cubs, and females with cubs; providing for customary and traditional needs of coastal residents; and providing for ground-based recreational hunting. Specific elements of a State management program cannot be anticipated since they will depend on regulations formulated through public input. Some basic elements can be anticipated. They are mandated by international agreements or are needed based on experience in managing similar species such as brown bears. Hunting would probably be allowed only from December 1 through May 31. The closed period during the fall would protect pregnant females coming ashore to den. Restriction of hunting to the winter period would also assure that hides are taken when prime. Taking of bears in dens would be prohibited as well as the use of aircraft as an aid to hunting. Hunters would be required to submit hides and skulls to a State representative for examination within 30 days after taking and to allow a tooth to be obtained for age determination.

The upper limit on the number of bears taken would be based on population abundance and status as determined by the Board of Game. It probably will be desirable to average harvest limits over periods of several years because availability of polar bears to ground-based hunters varies greatly from year to year. Even in years when bears are abundant in the coastal zone, it is unlikely that excessive numbers would be taken because females with young would be protected and hunting would not be allowed during autumn. Preference in taking would be given to residents with a customary and traditional dependence on polar bears.

Recreational hunting, if permitted, probably would be controlled and monitored by a permit system with drawings if applications exceeded available permits. Polar bears are considered a national and international resource, and recreational hunting permits most likely would favor neither State residents nor nonresidents. Hunters not residing in Alaska would have to employ licensed guides as they do for brown bears. The Alaska Legislature, working with the State Guide Board, probably would establish a special class of coastal resident guides in order to involve local people in the guiding industry.

K. Problems

The MMPA, as presently written and interpreted, precludes management of polar bear populations and regulation of the only user group allowed to hunt bears. There are no restrictions on taking of bears coming ashore to den, bears in dens, or family groups of females and young. Bears have a relatively low reproductive rate, and these segments of the population should be protected. Because denning bears and family groups currently are not protected under the MMPA, there have been suggestions that they arbitrarily be declared a depleted species, a designation which, under provision of the MMPA, would allow implementation of a management program. Declaring bears a depleted species when clearly they are not is undesirable since it could weaken support for declaring other species depleted if necessary. Once a species is classified in a protective status, it is often difficult—even with good biological justification—to reclassify to a status which can provide a balanced management program.

The comprehensive long-term State research program stopped in 1972 for lack of State or Federal funds. Since 1972, programs undertaken by other research organizations have lacked continuity, resulting in a decrease in new and current information. One exception is the research program now being conducted by the U.S. Fish and Wildlife Service.

It has become increasingly difficult to monitor the polar bear harvest since implementation of the MMPA. Before the MMPA, the State required hunters to present hides and skulls for examination and sealing and a tooth for age determination. The State continued to monitor the harvest after 1972, but the percentage of bears sealed dropped each year as more hunters realized sealing was no longer required. Beginning in 1980, the U.S. Fish and Wildlife Service started to monitor the harvest fairly intensively, but estimates of total kill and composition of bears in the harvest are much less precise than with a mandatory sealing program.

Wasteful taking and illegal sale of skins are other problems. Native hunters can make only limited use of polar bears and cannot legally transfer raw products of polar bears to non-Natives under the MMPA. Some skins have spoiled as a result; others have been sold illegally. While the Act states that bears may be taken provided waste does not occur, waste is not defined.

The United States is a party to the 1974 Oslo Agreement on Conservation of the Polar Bear, but cannot comply completely with the Agreement because of the MMPA. A resolution appended to that agreement requests governments of the five nations with polar bears to completely protect females with cubs, and cubs, as well as to prohibit hunting of polar bears in denning areas, when they are moving into denning areas, or are in dens. The MMPA does not allow these segments of the population to be protected along the Alaska coast. The Polar Bear Agreement also states that signatory nations will not allow the use of aircraft or large motorized vessels as an aid to the hunting of polar bears. The United States has neither adopted this regulation nor addressed conflicts between the Agreement and the MMPA, the former calling for hunting restrictions and the latter exempting one user group.

Interactions between bears and humans will increase as human activity grows in the Arctic. A biologically sound management program enabling hunters to take bears before they become problem animals can avert potential conflicts. This type of action is limited at present because only Natives can take bears.

L. Biological Impacts of Current and Proposed Management Plans

The present U.S. management policy for polar bears may have minimal biological impact on the bear population. Limiting hunting to a narrow strip along the coast has caused a significantly lower total recent harvest than the long-term sustained yield prior to the MMPA. Despite the lower total harvest, available data suggest that as many females are being taken now as were taken before the Act. Females can also be taken when accompanied by young, an act not allowed during the period of State management. Increased human activity disrupts polar bear habitat, raising the potential for taking females and young and, concurrently, requiring better monitoring of the kill and more research on population status.

A State management program would protect the following: females and their young, bears coming ashore to den, and bears in dens. Research findings, surveys, and impacts of development would determine numbers taken from other segments of the population. The State regulatory scheme would be both detailed and flexible, and management practices and regulations could be changed as necessary to prevent adverse biological impacts.

M. Projections

With return of management, the State would once again initiate research and management programs. Because of the national, international, and high seas aspects, it is intended that research would be on a cooperative basis with the Federal Government.

The State management program would determine acceptable polar bear harvest levels based on current population status and then allocate number of bears to be taken by user groups. As discussed in Section J, regulations would be imposed to protect females and young and to control methods of take. Resumption of State management would provide a legal basis for conducting a mandatory hide and skull sealing program through which biologists can obtain detailed harvest information as well as other data about the population as a whole.

A concerted effort would be made to inform the public and obtain compliance with regulations. The State regulatory process would provide for involvement of interested persons and groups in the formulation of regulations. Research would be directed at determining allowable harvest levels, identifying impacts of human development, and recommending protective measures for bears as that development proceeds.

N. Economic Analysis

Under present circumstances, the economic value of polar bears to U.S. citizens is relatively limited. Approximately 85 bears are taken each year; the meat of most is eaten. Some skins are made into mittens, boots, parka ruffs, and other salable items. Skins of other polar bears are used in villages as robes and clothing. Some unprocessed skins eventually spoil. The number of skins sold illegally to non-Natives is unknown, but it appears to be relatively low. There is little information available to quantify economic value, and the following figures are given as very rough current estimates to compare with estimates of economic value under a management program providing for more varied and complete use. Meat from 85 bears (136 kg per animal at $3.30 per kg) has a worth of about $38,000. A very rough estimate of the value of garments sold and of skins for personal use would be about $10,000. These estimates give a total annual current value for 85 bears of about $48,000.

The potential economic value of polar bears to residents of coastal settlements is much greater. Under State management, income could be derived from selling bear hides taken by subsistence hunters. If non-subsistence hunting is permitted, economic opportunity to coastal rural residents would accrue through guiding recreational hunters and providing goods and services in the villages. The following figures represent an assumed maximum annual harvest of 170 bears, 100 by subsistence hunters, and 70 by guided recreational hunters. The value of meat would be $61,000, assuming utilization of all the meat taken by subsistence hunters and half the meat taken by recreational hunters. Hides from bears taken by subsistence hunters and sold at $1,000 each would have a value of $100,000. Guiding fees for 70 recreational hunts at $4,000 each would be $280,000. The total direct economic value with this type of management and harvest regime would be $441,000. It is quite possible that a few State resident recreational hunters would not employ a guide, and that recreational hunters would not fully subscribe to the 70 recreational permits. Under these conditions, economic value as presented above could be somewhat lower. Any estimated resource value would be augmented by the value of goods and services provided to hunters while they were in a village.

O. Management Effectiveness

After Alaska Statehood and before passage of the MMPA, the State of Alaska had a well-funded and effective management and associated research program for polar bears. With passage of the MMPA and loss of management responsibility, the State discontinued all of its management activities other than harvest monitoring. Harvest estimates have become less precise in recent years because of legal interpretations that the MMPA precludes the State from requiring that Natives report the number of bears killed. Polar bears have not been declared a depleted species, and the U.S. Fish and Wildlife Service, the Federal agency now responsible for management has not, therefore, initiated a management program.

P. Selected References

Blix, A. S., and J. W. Lentfer. 1979. Modes of thermal protection in polar bear cubs - at birth and on emergence from the den. Am. J. Physiol. 236:R67-R74.

Harington, C. R. 1964. Polar bears and their present status. Canadian Audubon 26:4-11.

_____. 1968. Denning habits of the polar bear (*Ursus maritimus* Phipps). Can. Wildl. Serv. Rep. Ser. 5. 33pp.

Hensel, R. J., and F. E. Sorensen. 1980. Age determination of live polar bears. Pages 93-100 In C. J. Martinka and K. L. McArthur (eds.), Bears - their biology and management. Government Printing Office. Washington, D.C.

Jonkel, C. J., G. B. Kolenosky, R. J. Robertson, and R. H. Russell. 1972. Further notes on polar bear denning habits. Pages 142-185 In S. Herrero (ed.), Bears - their biology and management. IUCN Publ. New Ser. 23.

Lentfer, J. W. 1974. Discreteness of Alaskan polar bear populations. Proc. Int. Cong. Game Biol. 11:32-329.

_____. 1975. Polar bear denning on drifting sea ice. J. Mammal. 56:716-718.

_____. 1976. Environmental contaminants and parasites in polar bears. Alaska Fed. Aid in Wildl. Rest. Proj. W-17-4 and W-17-5. 22pp.

_____, and R. J. Hensel. 1980. Alaskan polar bear denning. Pages 101-108 In C. J. Martinka and K. L. McArthur (eds.), Bears - their biology and management. Government Printing Office. Washington, D.C.

_____, _____, J. R. Gilbert, and F. E. Sorensen. 1980. Population characteristics of Alaskan polar bears. Pages 109-115 In C. J. Martinka and K. L. McArthur (eds.), Bears - their biology and management. Government Printing Office. Washington, D.C.

Lono, O. 1970. The polar bear (*Ursus maritimus* Phipps) in the Svalband area. Norsk Polarinstitutt Skrifter 149. 103pp.

Manning, T. H. 1971. Geographical variation in the polar bear *Ursus maritimus* Phipps. Can. Wildl. Rep. Ser. 13. 27pp.

Stirling, I. 1974. Midsummer observation on the behavior of wild polar bears. Can. J. Zool. 52:1191-1198.

_____, D. Andriashek, P. Latour, and W. Calvert. 1975. Distribution and abundance of polar bears in the eastern Beaufort Sea. A Final Report to the Beaufort Sea Prog. Fisheries and Marine Service. Dept. of Environment. Victoria, B.C. 59pp.

_____, and W. R. Archibald. 1977. Aspects of predation of seals by polar bears. J. Fish. Res. Bd. Can. 34:1126-1129.

Uspenski, S. M., and A. A. Kistchinski. 1972. New data on the winter ecology of the polar bear (*Ursus maritimus* Phipps) on Wrangell Island. Pages 181-197 In S. Herrero (ed.), Bears - their biology and management. IUCN Publ. New Ser. 23.

The Sea Otter *(Enhydra lutris)*

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Sea Otter

Enhydra lutris

A. Introduction

The sea otter (*Enhydra lutris*) is the only truly marine representative of the mustelid family in North America. The sea otters' history in the Pacific includes intensive exploitation to the point of near extinction, total protection in the U.S. starting in 1911 under the Fur Seal Treaty, and a long, slow, recovery process. When protective status was conveyed to sea otters in 1911, only small isolated groups existed in the Kuril Islands, Aleutian Islands, along the Alaska Peninsula and the Kodiak Archipelago, in Prince William Sound, and in California. Those nucleus groups slowly expanded and have reached carrying capacity in some parts of their range. Numbers are large enough in Prince William Sound to create conflicts with commercial fishermen and to allow for translocation of animals to other areas of their former range. The population in California, although apparently slower to recover, has also created conflicts with commercial fishermen and has grown large enough to prompt consideration of translocating some animals.

The sea otter is most closely related to and appears to have evolved from common ancestors of modern skunks and weasels and is, therefore, classified as a mustelid. The sea otter possesses some exceptional adaptations allowing it to survive and cope well in the marine environment. It is the largest member of the mustelid family.

Sea otters have large, flipper-like, hind feet, no anal glands, retractile claws on their front feet, a loose flap of skin in which they hold food under each foreleg, flattened and rounded molariform teeth, a horizontally flattened tail, and external ears resembling the ears of otariids (eared seals) rather than their closest relative, the river otter.

The sea otter is the only member of the genus *Enhydra*. At one time, two races were recognized by U.S. scientists: the northern race which supposedly ranged from Vancouver Island to the Aleutian Chain and was designated *E. lutris lutris*, and the southern race which supposedly ranged from the Strait of Juan de Fuca southward into Baja California, Mexico. The southern race was designated *E. l. nereis*. Soviet scientists recognized a third race, *E. l. gracilis*, the Kuril-Kamchatka sea otter. More recent evidence suggests the division between *E. l. lutris* and *E. l. nereis* is rather arbitrary and probably not realistic. No compelling evidence exists to support subclassification of sea otters beyond a single species.

Most other marine mammals depend on a layer of blubber for insulation in the marine environment, but sea otters have no thick insulating layer of blubber; instead they have a dense rich coat of fur. Surface tension of water causes the tips of the guard hairs and fur to adhere to each other, trapping a layer of air next to the skin and preventing water penetration. In this manner, the sea otter maintains its body temperature, and the skin remains dry even while the otter dives to depths of 50 m or more. For this reason, sea otters spend much of their time grooming and cleaning their fur, and the pelage is kept extremely clean.

Pups have a yellowish coloration at birth because they are covered with a dense brownish fur and long, silky, yellowish-tipped, guard hairs. The sea otter's head is usually light-colored at birth. Karl Kenyon in his excellent monograph on sea otters says, "the late juvenile pelage is similar to that of the adult, which is typically dark bodied and buffy to light gray headed. The head tends to become whiter with age, and grizzling may appear on the other parts of the body. Body color varies from light buff (rare) through shades of brown to nearly black. The sparse guard hair may be dark or silver white."

B. Distribution and Migration

The historical range of the sea otter included most of the nearshore waters of the North Pacific rim from Morro Hermoso in Baja California, northward around the Gulf of Alaska, along the Alaska Peninsula and throughout the Aleutians, the Pribilof and the Commander islands, along the Kamchatka coast, and through the Kuril Islands to southern Sakhalin and northern Hokkaido. When sea otters were finally protected in 1911 after more than a century of overexploitation, all that remained in Alaska were a number of small groups scattered between the Rat Islands in the western Aleutians and Cape St. Elias. Other groups survived in the Kuril and Commander islands of the USSR and near Point Sur in California. At that time, the world population of sea otters probably numbered less than 2,000.

Once protected, these surviving nuclei grew and expanded until today they have repopulated most of their former range. In many areas of Alaska, sea otters have reached carrying capacity. In other parts of their range, areas of low density have been recently occupied.

Sea otters are well established throughout most of their former range in the USSR, which includes the Kuril Islands, southern Kamchatka Peninsula and Commander Islands. In Alaska sea otters now occupy virtually all former habitat between the Near Islands at the western end of the Aleutian Chain and Prince William Sound. Within this area, densities are at or approaching carrying capacity throughout most of the Rat, Delarof, and Andreanof islands of the Aleutians; the north side of Unimak Island and parts of both sides of the Alaska Peninsula and adjacent islands; Afognak Island; the Kenai Peninsula; and Prince William Sound. Areas of lower density remain in the Near Islands, the Islands of Four Mountains, Fox Islands, portions of the south side of the Alaska Peninsula,

and Kodiak Island. Some of these areas probably support lower densities because the carrying capacity of the habitat is lower, while others have low densities in areas of potentially higher carrying capacity. Since otters are established immediately adjacent to all of these areas of low density, and no barriers to movement are evident, densities can be expected to increase within the limits of local carrying capacities. The future of sea otters in the Pribilof Islands is less clear. Translocation attempts and probable limited natural immigration have failed to produce a significant resident group, although scattered individuals are occasionally sighted.

Repopulation has been less complete between Cape St. Elias and Baja, Mexico. Only one group of sea otters naturally survived in this area. That was near Pt. Sur in California. This group has increased and expanded its range, but more slowly than some Alaskan groups. Between 1965 and 1972, the Alaska Department of Fish and Game, in cooperation with other State, Federal, and Provincial agencies, translocated sea otters to several locations in an attempt to reestablish them in areas of former presence and to accelerate repopulation of the void between Alaska and California. Ten sea otters were released in Yakutat Bay, 402 in several locations in southeast Alaska, 89 at Vancouver Island, British Columbia, 59 in Washington, and 93 in Oregon.

Along the northern Gulf Coast of Alaska, sea otters now occur in scattered groups between Cape St. Elias and Cape Fairweather with a concentration of at least 50 in Yakutat Bay. Natural immigration probably contributed significantly to this increase. In southeast Alaska, the transplants have resulted in establishment of six group nuclei, at least four of which are well established and rapidly growing. Similarly a concentration which has become established near the Vancouver Island release site appears to have a good chance of survival. The status of the Washington and Oregon transplants is more tenuous. Small numbers persist in both areas, particularly Washington, but the numbers sighted in Oregon have dropped sharply in recent years. The Washington group is presently larger, but may remain too small for perpetuation to be assured.

Sea otter distribution will continue to expand as the repopulation process continues, and densities adjust to the capacity of the habitat. Within Alaska these changes should be fairly predictable and all in the direction of complete recovery unless human activities interfere.

C. Habitat Requirements

Sea otter habitat in the North Pacific can be considered as almost anywhere near shore within the 75 m depth curve. Although sea otters can be found in bays, estuaries, and lagoons, they most commonly inhabit waters of the open coast. Karl Kenyon in his monograph on sea otters says, "In general, sea otters favor waters adjacent to rocky coasts near points of land or large bays where kelp beds occur. Coasts adjacent to extensive areas of underwater reefs are particularly attractive. In such areas, especially where large rocks or islets are located near shore, some feeding and resting areas are sheltered from wind and storm waves regardless of their direction." Within such areas, sea otters tend to segregate by sex. In many areas, males occupy more exposed, rugged locations, while females and pups are generally found in more protected locations, indicating that different animals may have slightly different habitat requirements. Sea otters haul out on land, frequently in some areas and rarely in others, and they often favor kelp beds. There are, however, places such as north of the Alaska Peninsula where sea otters inhabit areas far from shore with few rocks, islets, or kelp beds. The habitat characteristics listed above, therefore, may be highly desirable and support the highest densities of otters, but may not be absolute requirements. Abundant food at accessible depths is the clearest habitat requirement. Prey not only must be abundant, but their populations must be capable of sustaining heavy predation if sea otter densities are to remain high for long periods.

While there are records of sea otters diving to depths in excess of 90 m, and large adults are often seen feeding in waters up to 80 m deep, all known self-sustaining groups have access to and heavily use waters less than 40 m deep.

D. Abundance and Trends

Sea otters are increasing in number and expanding their range in nearly all areas where they have not reached carrying capacity. Table 1 shows the most recent estimates of sea otter numbers.

Table 1. Estimates of sea otter numbers throughout their range based on data collected through 1976. All subpopulations in Alaska are stable or increasing.

Location	Estimate
California	1,800
Washington	20
Oregon	?
British Columbia	100
Southeast Alaska	600-800
Yakutat to Cape St. Elias	100
Prince William Sound	4,000-6,000
Kenai Peninsula and Cook Inlet	2,500-3,500
Kodiak (including Barren Island)	4,000-6,000
South side Alaska Peninsula	22,000-30,000
Aleutian Islands	55,100-73,700
North side Alaska Peninsula	11,700-17,200
Soviet Union	9-11,000

Total worldwide estimate = 110,860-150,160
Total Alaska estimate = 99,945-137,245

E. Vital Parameters

Studies of sea otters in the Aleutian Islands, where they exist at the level of carrying capacity, indicate that female sea otters usually become sexually mature when three years old and bear their first pup at four years. Although some breeding occurs year-round, in Prince William Sound and the Aleutians there is a peak in September and October with most births during May. While twin fetuses occur in 2% of the pregnancies there are no records of a female sucessfully rearing more than one pup at a time. Approximately half of the sexually mature females become pregnant each year. This suggests a breeding interval of two years although females appear physiologically capable of annual breeding. Recent U.S. Fish and Wildlife Service (USFWS) studies conducted in Prince William Sound indicate that annual breeding may be commmon in areas where sea otters have not been at carrying capacity for long periods. High pup/adult ratios observed in areas where numbers are rapidly increasing also suggest a shorter mean breeding interval.

Survival of pups is usually excellent until weaning, even where otters exist near carrying capacity, but mortality of recently weaned sea otters can be high where food availability is limited. This juvenile mortality seems to be a major population regulating mechanism when numbers are near carrying capacity.

Female sea otters commonly live to age 15 and some individuals live beyond age 20. The life span of males may be five years shorter. This shorter live span combined with differential sex ratio at birth (57 females to 43 males) and differential juvenile mortality rates often leads to an unbalanced sex ratio. Even in expanding groups where survival is high, an unbalanced sex ration may result from the greater tendency of males to disperse to vacant habitat. In some Aleutian Island subpopulations, the proportion of females may exceed 60%.

F. Food Habits

The sea otter's diet is highly variable and depends largely on what is available. Throughout their range, sea otters are opportunistic feeders. They generally feed on a wide variety of bottom dwelling invertebrates, but can turn to fish if the invertebrate supply is depleted. There has been no evidence of seasonality in the diet of sea otters.

In California the major food species are red abalone, gaper clams, purple hinged scallops, California mussels, rock crabs, and sea urchins, In Prince William Sound, sea otters eat several different species of clams, mussels, and lesser quanities of crabs and sea stars. In the Aleutian Islands, sea otters are known to eat chitons, snails, mussels, octopus, rock oysters, crabs, sea urchins, globe fish, and red Irish lords. Along the northside of the Alaska Peninsula, they probably feed heavily on clams and crabs. In the Commander Islands, sea otters eat clams, mussels, crabs and sea urchins.

Sea otters sometimes concentrate on a single prey species, utilizing it until it is drastically reduced and its availability very limited. For instance, in California sea otters have fed on red abalone until the stocks have been severely depleted in some areas of the otters' range. In some areas of Alaska, particularly Prince William Sound, sea otters have severely depleted some clam beds, and are thought to be responsible for reducing crab populations.

G. Ecological Significance

The sea otter has been termed a keystone species because of the role it plays in determining the ultimate stable state of the nearshore communities it inhabits. At one end of the spectrum, a stable state may exist between macroinvertebrate herbivorous grazers (such as sea urchins) and a dense algal forest. The macroinvertebrates graze on the algae, keeping its growth in check. When sea otters are introduced into this situation, they prey on the macroinvertebrates, reducing their densities, and thereby allowing the algal forest to flourish. Once the vegetational community has flourished, other important changes take place. The dense kelp forest significantly reduces wave action which results in increased siltation, a reduction in sessile invertebrates, and a reduction in the size of predators. Abundant algal drift, debris, and detritus allow higher densities of herbivorous crustaceans such as amphipods, isopods, and mysids, which in turn allow higher densities of predacious fishes.

The sea otter's impact on nearshore communities is not always this extreme and may in fact follow quite different patterns. The sea otter's ability to influence the structure of the community it inhabits is highly variable and depends upon the community itself. In much of the potential sea otter habitat, proper conditions do not exist which would allow a dense kelp forest to flourish in the absence of herbivorous macroinvertebrate grazers. In fact much of the sea otter range in the North Pacific does not have concentrated populations of invertebrate grazers in the absence of sea otters, nor do many of the areas have the apparent converse community, e.g., dense standing stocks of vegetation.

Sea otters are preyed upon by eagles, killer whales, and possibly sharks. On Amchitka Island in the 1960's, 50% of the eagle pairs on the island were regularly taking sea otter pups and feeding them to their young.

H. Conflict Situations

Of marine mammals, it is generally agreed that sea otters are the most vulnerable to pollution of the marine environment. In order for the pelage to maintain its insulative quality, it must remain clean. Any amount of soiling can reduce the insulating properties by preventing entrapment of air in the fur. It is not known how much soiling will cause stress in sea otters. Oil is perhaps the most dangerous possible

contaminant to sea otters, with releases posing a serious threat to their well-being.

In California a major conflict exists between sea otters and commercial and sport interests in the abalone and clam fisheries. Sea otters drastically reduce the numbers of abalone in their range, and, in some cases where otters are dense enough, appear to reduce the number of legally harvestable abalone below commercially significant levels. This problem does not now exist in Alaska, but the potential is certainly present. Recently in Cordova, residents have complained of increasing pressure on favored clam beds and crabs by sea otters. A fledgling industry of abalone harvesting is developing in southeast Alaska in close proximity to an expanding group of sea otters. In many areas such as Resurrection Bay at Seward, Kachemak Bay near Homer, and near the town of Kodiak, sea otters appear to be increasing and could present brisk competition for limited invertebrate resources.

I. Harvest Levels

Between 1742 and 1911, sea otters were reduced to a few small remnant groups by hunting. In 1911 sea otters were included in the Fur Seal Treaty, and all hunting, except by Alaska Natives using aboriginal means, was made illegal. Very few sea otters were harvested over the next 40 years, and, in many areas, they began to recover. Between 1951 and 1959, fewer than 200 were killed by the USFWS in the course of scientific studies and attempted translocations. The majority of these came from Amchitka Island. The USFWS studies indicated that certain groups in the Rat and Andreanof islands had recovered to prehunting levels, and hundreds of otters were starving each year. Biologists recommended that an experimental harvest program be started.

In 1960 management authority for resident species of wildlife, including the sea otter, passed to the State of Alaska. In 1962 and 1963, a total of 491 sea otters were harvested by the State at Amchitka Island in an attempt to determine the feasibility of harvests and collect information on reproduction, sex and age composition, and distribution of sexes. None were harvested between 1964 and 1966, while State efforts were directed at developing a translocation program. In 1967 sea otter studies were accelerated, and the harvest program resumed. State harvests were conducted only on islands where sea otters were at or near the carrying capacity of the habitat and were no longer contributing to the repopulation of other areas. All harvesting was done by State employees under the supervision of biologists. The harvest program was suspended after 1970 because of a lack of funds.

The removal of animals from a group for translocations to other areas or for scientific and display purposes has the same effect on a local group as a harvest. A summary of all otters removed from various Alaskan subpopulations since the State of Alaska assumed management authority is presented in Table 2.

Some of the animals removed were translocated to other parts of Alaska and did not cause a reduction in the overall number of otters in Alaska. Others were translocated to areas outside of the State.

Even after the harvest program had ceased, an effort was made to continue annual removal of approximately 300 sea otters from the area around Amchitka Island through transplant captures and scientific collections in order to study the effects of a sustained removal of that magnitude. This program was temporarily interrupted in November, 1971, when a nuclear test killed an estimated 1,000 to 1,350 sea otters.

Amchitka Island has sustained the heaviest "harvest" of any sea otter group. Between 1967 and November 1971, a total of 1,435 sea otters were removed from this group, an average of 287 per year. Of these, 1,200 were taken from the southeastern half of the island. The only apparent effect on the group was a slight reduction in an area where translocation captures were concentrated and an increase in the number of subadult animals in that area. All evidence suggests that harvesting increased productivity and that the subpopulation could sustain a harvest of two to three times that level if the removals were evenly distributed around the island.

J. State Management Objectives

The primary objective of any State management program for sea otters would be to continue natural repopulation of former sea otter habitat. The protection and maintenance of sea otter habitat is also a high priority, and to this end the State would advocate comprehensive resource planning and the institution of controls on the use and development of the coastal and marine environments.

In most areas, sea otter numbers would be allowed to approach carrying capacity and be regulated by natural factors. In some areas where numbers have reached carrying capacity and are not contributing to natural repopulation of adjacent areas, some otters might be harvested for commercial purposes or captured for translocation to areas of vacant habitat. If a harvest program were initiated, it would be closely regulated. If a harvest program has demonstrated that a systematic harvest can be conducted with no harm to either the local subpopulation or the stock as a whole. in restricted geographical areas where there are intensive conflicts between local fisheries and otters, more intensive harvests might be conducted which could reduce otters to a level below carrying capacity. This would increase survival of juveniles and change the age structure of the subpopulation downward.

The State recognizes recreation as one of the important uses of sea otters. Recreational uses include: viewing and photography, both incidental to other activities are as

Table 2. Numbers of sea otters removed from Alaskan waters between 1961 and 1972*

	1962	1963	1965	1966	1967	1968	1969	1970	1971	1972	Total
Amchitka Island											
ADF&G Harvest	180	311			205			205	93		994
Transplant mortality						114	120	27	22		283
Transplanted						356	116	59	64		595
Other			2		5	24	14	1	11		57
Total	180	311	2		210	494	250	292	189**		1,928
Tanaga Island											
ADF&G Harvest								606			606
Kanaga Island											
ADF&G Harvest						318					318
Adak Island											
ADF&G Harvest					300	194					494
Delarof Island											
Ogliuga and Skagul											
ADF&G Harvest								125			125
Ulak											
ADF&G Harvest								19			19
Montague Island & Green Island											
Transplant mortality				9				32		9	50
Transplanted				30				14		46	90
Other					1						1
Total				39	1			46		58	144
Hinchinbrook Island											
Transplant mortality			18								18
Transplanted			23								23
Other						1					1
Total			41			1					42

* Includes all animals that were harvested, died during studies by various agencies or during transplant capture or were transplanted to other areas or to zoos. Does not include natural mortality, illegal or accidental kills.

**Does not include an estimated 1,000 to 1,350 sea otters killed by the nuclear test "Cannikin."

primary objectives, and wilderness experience which includes the aesthetic rewards of being aware of, or observing, animals in natural interactions with their environment.

The State will encourage recreational observation through public information and education and will provide for such activities. Properly conducted harvesting does not unduly disturb the remaining animals and is generally considered compatable with recreational observation. Certain areas exceptionally suited to viewing sea otters may be zoned in space or time to exclude harvesting in favor of observation of sea otters in their natural environment.

The state has demonstrated that translocating sea otters to former ranges or vacant habit is a useful management tool. Future sea otter translocations may be approved if substantial public benefit can be shown. Proposed translocations would be reviewed by the State and must meet the following minimum requirements to be approved: 1) the proposed translocation site must provide sufficient and suitable habitat to support a viable group of translocated sea otters, as determined by comprehensive study; 2) prior study must establish that the introduction of sea otters will not adversely affect the numbers, health, or utilization of other resident species.

The State recognizes that sea otter pelts are commercially valuable. The State supports the concept of a well-regulated harvest in certain areas provided that: 1) the area is producing a harvestable surplus; 2) the surplus is not contributing to the repopulation of an adjacent area; and 3) the harvest does not significantly interfere with opportunity of the public to view otters.

A few areas may be reserved for scientific studies where sea otters and/or habitat can be manipulated.

The domestication of sea otters for commercial purposes is

normally not considered a wise use of the resource and usually would be discouraged by the State.

K. Problems

Passage of the Marine Mammal Protection Act of 1972 (MMPA) has created serious difficulties for sea otter management. The Act and the policies implementing the Act have curtailed scientific research and effectively stopped translocations. While known take has thus far been small, several organizations have expressed interest in initiating a sea otter harvesting industry. These groups want to take sea otters in large numbers within southcentral Alaska.

Under the MMPA, there is no mechanism to deal with conflicts between sea otters and fishermen. Prior to the Act, otters in an area where conflict occurred or was anticipated could be reduced in number by either translocation or harvest. Since 1972 neither option has been available. As sea otters continue to increase in number and expand their range, such conflicts are more likely to occur.

L. Biological Impacts of Current and Proposed Management Plans

Current U.S. management policy for sea otters has slowed the repopulation of vacant habitat by effectively stopping requirements. Although few sea otters are presently taken, the potential exists under the MMPA for large-scale unregulated harvest.

The proposed State management plan would encourage translocation of sea otters to areas not yet fully repopulated. In areas where conflicts with fisheries occurred, or where otters were approaching carrying capacity, the State would allow a closely regulated harvest which would reduce local abundance but have minumum biological impact on the population as a whole.

M. Projections

If State management of sea otters is reinstituted, translocation would be encouraged and limited harvest could be allowed. Sale of skins could be allowed under strict controls. Harvest would be monitored and directed closely to minimize impact on the overall sea otter population. Biological specimens would be collected whenever possible from harvested animals.

The Alaska Department of Fish and Game would resume a research program on sea otters to obtain population data important as imput for management decisions. Information on the importance of particular habitats, geographical centers of abundance, food habits, and energy requirements would be synthesized to provide input to coastal zone management plans, oil and gas development scenarios, and regulation of nearshore fisheries.

N. Economic Analysis

Economic impacts of the sea otter trade between 1742 and 1911 have been discussed by a number of authors. Many of the patterns or European occupation in Alaska were tied to the distribution of sea otters. Several major towns including Kodiak and Sitka were established to support the sea otter trade. Major changes in the distribution and size of the rural population of Alaskans occurred through manipulation by Russian fur traders and are still evident today.

The significance of sea otters diminished as their numbers were reduced. By 1911 only a few individuals derived any income from sea otters. While Natives were allowed to harvest sea otters using aboriginal methods and means between 1911 and 1959, few were taken and a complete ban on hunting at the time of Alaska Statehood passed unnoticed. Small numbers of individuals derived some income by working on Federal and State research, translocation, and harvest programs, but this probably never exceeded 40 man months of work per year. Passage of the MMPA in 1972 created the opportunity for Natives to again derive income from the harvest of sea otters, but no significant taking has been reported. It appears certain that some use will become established in the next few years, probably with significant effects on the otters.

An increasing number of individuals are deriving income from guiding, outfitting, and transporting people interested in viewing and photographing wildlife. As sea otters have become more numerous in easily accessible areas, they have attracted more interest and attention from viewers and photographers. It is difficult to assess the economic impact of this interest, but it promises to be a most significant use of sea otters, both in terms of numbers of participants and income generated. Viewing and photographic opportunities and their economic potential could be greatly reduced if unregulated hunting occurred. It is reasonable to expect that such hunting would be concentrated in areas of good access which also provide the best viewing opportunities.

In summary the economic importance of sea otters has been slight throughout this century. As accessible groups of otters have increased, their importance has grown. The State of Alaska's management plans would enhance both sea otter expansion and various uses of this unique resource.

O. Management Effectiveness

After Alaska Statehood and before passage of the MMPA, the State of Alaska had an effective management and associated research plan for sea otters. The harvest of sea otters by the public was prohibited, otters were translocated to repopulate former habitat, and closely regulated harvests were conducted by the State to provide information on the biological responses of otters to

harvesting. With passage of the MMPA and loss of management authority, the State was forced to discontinue these activities. Otters are no longer being relocated to former habitat. Conflict situations have begun to develop between sea otters and fisheries, and the State has no means of mitigating these conflicts.

P. Selected References

Calkins, D. G. 1978. Feeding behavior and major prey species of the sea otter, *Enhydra lutris*, in Montague Strait, Prince William Sound, Alaska. Fish. Bull. 76(1):125-131.

Eyerdam, W. J. 1933. Sea otters in the Aleutian Islands. J. Mammal. 14(1):70-71.

Harris, C. J. 1968. Otters, a study of the recent Lutrinae. Weidenfeld and Nicholson, London. 397pp.

Jameson, R. J., K. W. Kenyon, A. M. Johnson, and H. M. Wight. 1982. History and status of translocated sea otter populations in North America. Wildl. Soc. Bull. 10(2):100-107.

Jones, R. D. 1951. Present status of the sea otter in Alaska. Trans. N. Am. Wildl. Conf. 16:376-383.

Kenyon, K. W. 1969. The sea otter in the eastern Pacific Ocean. U.S. Fish Wildl. Serv. N. Am. Fauna 68. 352pp.

Lensink, C. J. 1960. Status and distribution of sea otters in Alaska. J. Mammal. 41(2):172-182.

Murie, O. J. 1940. Notes on the sea otter. J. Mammal. 21(2):119-131.

_____. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. U.S. Fish Wildl. Serv. N. Am. Fauna 61. 364pp.

Palmisano, J. F., and J. A. Estes. 1977. Ecological interactions involving sea otters. pp.527-567. In: M. L. Merritt and R. G. Fuller (eds.) The environment of Amchitka Island, Alaska. ERDA, Oak Ridge. (NTIS No. TID-26712).

Rausch, R. L. 1953. Studies of the helminth fauna of Alaska XIII: Disease in the sea otter with special reference to helminth parasites. Ecology 34(3):584-604.

The Steller Sea Lion *(Eumetopias jubatus)*

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Steller Sea Lion

Eumetopias jubatus

A. Introduction

Steller sea lions (*Eumetopias jubatus*) are large, conspicuous pinnipeds which inhabit the North Pacific. They are gregarious, polygynous mammals which gather on terrestrial haulouts to rest and on traditional rookeries to breed and bear young. Their center of abundance in Alaska is the northwestern Gulf of Alaska. In the North Pacific region, the vast majority of Steller sea lions occur within Alaskan waters.

Steller (or northern) sea lions belong to the family Otariidae or "eared seals." There are several genera in this group, two of which occur in Alaskan waters: the northern fur seal, *Callorhinus ursinus*, and the Steller sea lion. Steller sea lions, particularly large adult males, have short manes and extremely large necks and front shoulders which give the appearance of the maned terrestrial lion. The common name "Steller" is after the German naturalist G. W. Steller who first described this species in 1751.

At birth sea lion pups have a chocolate brown coat with a frosty appearance since the tips of the hairs are colorless. There appears to be a gradual lightning in coloration as the animals get older. Most adults show a yellowish cream coloration on the back, although some may remain darker. Nearly all males remain darker on the front of the neck and chest. Some animals may even have a red coloration.

Steller sea lions are the largest representatives of the family Otariidae and show pronounced sexual dimorphism. Weight at birth is about 23 kg, and curvilinear length at birth is about 120 cm. In females growth is rapid during the first four years but slows by the fifth year with little growth after age six. Males continue to grow until the eleventh year. Although there is great variability between year classes, all females probably reach adult size and maximum skeletal growth by their sixth year and males reach adult size as indicated by maximum skeletal growth in their eleventh year. The average weight of adult males is 566 kg with an average length of 282 cm. Adult females average 263 kg in weight and 228 cm in length. Although adult males are only about 20% longer than females, they weigh more than twice as much.

B. Distribution and Migration

Steller sea lions are distributed around the North Pacific rim from 34° N latitude to 66° N latitude. In North America, the breeding range includes the Pribilof and Aleutian islands and extends southward around the Gulf of Alaska, and continuously along the coast to California. The southern breeding limit is San Miguel Island, one of the Channel Islands in southern California. In the Bering Sea, there appears to be a summer movement of males toward the Bering Strait, although no pupping takes place north of the Pribilofs. In the Soviet Union, sea lions are found in the Kuril Islands, the Okhotsk Sea, the Commander Islands, and the western Bering Sea. They have also been recorded from Hokkaido and northern Honshu islands of Japan where 1,000-3,000 are found seasonally in coastal waters, and from the northern coast of the Korean Peninsula. Breeding occurs in the Commander Islands, Kamchatka and Japan.

Historically, shifts in distribution and movements of Steller sea lions have been noted throughout their range. Some areas are used to haul out and rest and are referred to as haulouts. Others are used for pupping and breeding and are termed rookeries. There was early recognition of marked seasonal movements in California, particularly those involving males moving northward after the breeding season. Long distance movements were also indicated by the recovery of spear points from sea lions in California which probably were implanted by Natives of southeastern Alaska. Movements of males along the west coast from the California Channel Islands to British Columbia and southern Alaska were recorded. An absence of adult males in the winter in California and the presence of either young males or females all year suggested seasonal migratory movements correlated with age and sex. Movements of sea lions onto Oregon rookeries also have been documented. Seasonal shifts in distribution of sea lions in Prince William Sound have been recorded as have movements of males between the Commander Islands and Kamchatka in the southwestern Bering Sea.

There has been extensive documentation of movements of Steller sea lions in the Gulf of Alaska. Juvenile sea lions often move away from the rookeries of their birth, dispersing widely. Most eventually return to those same rookeries, but generally not until after the third year. Long distance movements of up to 1,500 km have been documented. These include movements from northern British Columbia to Prince William Sound and from the northern Kodiak Island region to the vicinity of Baranof Island in southeastern Alaska. In 1977 there apparently was a major shift eastward of juveniles across the northern Gulf of Alaska, away from the major pupping rookeries in the Kodiak and Kenai Peninsula area. Such movements appear to be dispersal of subadults not correlated with any particular season, rather than definitive migration. There have been no detectable seasonal movements by subadults less than four years of age.

The evidence available at this time indicates that many adult females return to the large rookeries where they were born to bear their young and breed. In the northern Gulf of Alaska, a total of 15 identifiable branded cows bore pups at two rookeries where branding took place. Only one of these cows gave birth at a rookery other than where she was born.

C. Habitat Requirements

Steller sea lions range all along the coast and seaward as far as the continental shelf break. They utilize specific well-defined locations on shore to haul out and rest, bear their young, and breed. During the period when pupping and breeding do not occur (August through April), most rookeries are used by sea lions as haulouts. During the breeding and pupping season from May through July, most of the sea lions present on a rookery are adult females, adult males, and newborn pups. Generally, few subadults of either sex are present within the rookery, particularly during the peak of pupping from June 10 through June 20. Nearly all adult females present on a rookery during the breeding season will give birth to a pup. Most of the adult males present on the rookery during the breeding season defend territories from other males and breed cows as they come into estrus within their territories. Occasionally, where large rookeries are located, nonbreeding males can be found congregated at the fringes of the rookery proper.

In general most of the sea lions born are produced at a very few large rookeries. For instance in 1979 in the Gulf of Alaska, 29,728 pups were counted at ten rookeries. This probably accounts for more than 99% of the total number of pups produced in the Gulf of Alaska that year.

D. Abundance and Trends

The number of Steller sea lions in California, Oregon, and Washington has been estimated to be about 5,500 animals. Very few census data are available from British Columbia for the last two decades; the most recent published estimate of 4,000 was made in 1959. The only estimate of sea lion numbers in southeastern Alaska was 8,500 in 1973. In the Gulf of Alaska, there are presently estimated to be 135,000 sea lions, including pups, a level which has been relatively high and stable over at least the last 20 years. Sea lion numbers in the western Aleutian Islands appear to be about the same as they were in 1960. Fiscus surveyed the central and western Aleutians in 1979 and indicated a population size of 68,625. In 1977 the estimated total eastern Aleutian population was 25,000 sea lions, representing a decline of as much as 50% from 1957 census figures. No specific causes for this decline are known although it has been suggested that it may correspond to a concurrent increase in commercial groundfish fisheries in that area. Fiscus estimated that in 1980 the total Aleutian population of sea lions, including the eastern Aleutians, the Pribilof Islands, and Bristol Bay amounted to 96,000 animals. There are an estimated 2,500 sea lions in the Pribilof Islands and Bristol Bay.

Soviet scientists estimate that there are 30,300 sea lions in the waters of the USSR including the Commander Islands, Kamchatka Peninsula, Okhotsk Sea, Sakhalin Island, and the Kuril Islands. They also estimated 35,000 to 40,000 in the Bering Sea in 1980. It is not clear if these animals are from the large rookeries in the Aleutian Islands.

The total worldwide population of Steller sea lions is estimated at 281,800. The Alaska population is estimated at 242,000, including pups.

E. Vital Parameters

Most of the information on vital parameters of sea lions comes from a recently completed study of population assessment, ecology, and trophic relationships of these animals in the Gulf of Alaska. This study was undertaken by the Alaska Department of Fish and Game and was funded through the Federal Outer Continental Shelf Environmental Assessment Program. The information collected so far has not been adequate to estimate all vital parameters, however some of the more important ones are now known. The sex ratio at birth appears to slightly favor males. In a sample of over 7,000 pups, 51% were males and 49% females.

At three years of age, approximately 26% of the females ovulate for the first time. By six years of age and older, virtually all females ovulate annually. Pregnancy rates are approximately 20% at three years of age, and increase to 84% for females seven years and older. Although sample size is small, it appears that pregnancy rates decrease considerably after age 20. Males are physiologically capable of breeding at between three and six years of age, but they probably do not participate in breeding at the rookeries until after eight to ten years of age because of strong competition among the largest adult males for territories. Females breed annually and produce a single pup. Twins are known to occur, but are a rarity. Breeding occurs shortly after parturition, mostly from late May to mid-July. Implantation is delayed until about October. Most pups are born in June, although females give birth to viable young from mid-May to mid-July.

For female sea lions in the Gulf of Alaska, combined mortality from birth to three years is estimated to be 53%, while for age classes three through 11, the average annual mortality is 11%. Approximately 30% of the females born survive to reproductive maturity. In males, mortality from birth to three years is 73%, and the average annual mortality for ages three through five years was 13%. Data are not available for accurately estimating mortality in males beyond age five. However, based mainly on the age distribution of harem bulls, the mortality rate apparently increases substantially after age eight. By age ten, it is probably about 25% and by age 14 about 50%. Maximum reported ages for animals collected in the Gulf of Alaska between 1975 and 1979 were 18 years for a male and 30 years for a female.

Based on available data, overall productivity is very difficult to estimate, but a crude estimate can be made. Approximately 30,000 pups are born annually in the Gulf of

Alaska, where the population (excluding pups) is estimated at 100,028. This gives a gross annual production of 30%. Seventy percent of the females die before reaching reproductive maturity, therefore the average survival to the age of reproductive maturity for females of this population would be about 9%.

F. Food Habits

Steller sea lions eat a wide variety of invertebrates and fishes. Studies in the 1940's showed that in southeastern Alaska they ate pollock and skates while in the Gulf of Alaska they ate pollock, starry flounder, arrowtooth flounder, halibut, octopus, and salmon. In the 1960's, sea lions from the Shumigan Islands area were found to eat lamprey, salmon, smelt, sand lance, rockfish, greenling, and sculpins. They also fed on herring, crabs, bivalves, squid, and octopus. In the Bering Sea during the same time period, they fed on capelin, flatfishes, and salmon.

In early studies in the Gulf of Alaska, (1945-1960) invertebrates, (primarily clams, mussels, and snails), greenling and Pacific sand lance were the more dominant species in the diet of sea lions. In most recent studies (1975-1978), herring and walleye pollock were the most important species. The seven most important prey found in recent studies in the Gulf of Alaska in order of their importance were: walleye pollock, herring, squids, capelin, salmon, Pacific cod, and sculpins. Although salmon and herring were among the top seven, they are seasonally abundant fishes and are only available to most sea lions at limited times and in specific locations. Most of the top ranked prey of sea lions are off-bottom schooling species. Use of this prey type may be important in minimizing foraging effort and conserving energy; energy expenditure may be higher in procuring more solitary species.

G. Ecological Significance

Steller sea lions are top level consumers and feed from the intertidal zone to the edge of the continental shelf. In nearshore waters throughout most of their range, Steller sea lions utilize some of the same major prey species as harbor seals. In the Bering Sea, the major prey species of sea lions, including pollock, cephalopods, cod, capelin, and herring are also major prey of harbor seals, spotted seals, fur seals, and ribbon seals. In addition several of those species are extensively exploited in commercial fisheries. Since size, distribution, and productivity of fish stocks are affected by commercial fisheries as well as by other consumers such as sea lions and seals, competition may occur between fisheries and pinnipeds, or among pinnipeds for those resources.

The total consumption of fish and invertebrates by sea lions is substantial. In the Gulf of Alaska, there are an estimated 105,000 sea lions older than pups. Based on the sex and age distribution of that population and the mean weight of males and females, the total biomass of sea lions, excluding pups, is about 25,000 mt. If sea lions consume approximately 6% of their body weight in food daily, then they consume about 1,500 mt per day or 548,000 mt per year in the Gulf of Alaska alone. The commercial groundfish harvest in the Gulf of Alaska in 1981 was approximately 260,000 mt. The total annual consumption by sea lions in all Alaskan waters is probably almost a million metric tons.

Sea lions are known to prey on other marine mammals. On St. George Island in the Pribilofs, juvenile male sea lions have been observed preying on fur seal pups. In 1975 it was estimated that 3.4-6.8% of the fur seal pups born on St. George Island were killed by sea lions. Similar predation has not been observed on St. Paul Island, and was not noticed on St. George prior to 1974. In the Gulf of Alaska, sea lions occasionally kill and eat harbor seals and in the Bering Sea they have taken bearded seal pups and spotted seals.

Sea lions have few predators in Alaskan waters. They are eaten by killer whales and probably occasionally by large sharks. There has been little intentional take of sea lions by humans since enactment of the Marine Mammal Protection Act (MMPA). A few are harvested for subsistence purposes in the Aleutian and Pribilof islands and on St. Lawrence Island. Some accidental take occurs in conjunction with commercial fisheries.

H. Conflict Situations

The major conflicts between humans and sea lions in Alaska are fisheries conflicts. Sea lions have not, as yet, suffered greatly from coastal development or habitat appropriations, but potential conflicts with outer continental shelf oil development and production may exist. Large scale development could have serious direct effects on sea lions through contact with oil, contamination of rookeries and hauling areas, or disturbance. Sea lions could indirectly be affected by reductions of available prey.

Sea lions have long been considered a nuisance species by commercial fishermen. There have been conflicts reported between sea lions and commercial salmon trollers, gill netters, and seiners. Longline halibut fishermen have complained of problems with sea lions also. Sea lions often come into conflict with offshore fishing fleets, primarily trawl fisheries and king crab fishermen.

Conflicts between sea lions and salmon fishermen involve sea lions taking fish or parts of fish from nets and lines. In addition to the loss of fish, this often results in damage to gear. Sea lions occasionally end up with troll gear hooked in them or polypropylene net fragments attached to them. Conflicts offshore generally involve sea lions stealing fish from long lines or trawls and occasionally being hauled aboard a trawler with the nets. King crab fishermen regularly report that sea lions cause the loss of crabpots by biting and sinking the inflated plastic buoys which mark the pots.

I. Harvest Levels and Utilization

Very little harvesting of sea lions is presently taking place. On rare occasions, a single adult may be taken for crab or shrimp bait. Residents of the Aleutian Islands, the Pribilof Islands, and islands of the northern Bering Sea take sea lions for food.

Historically sea lions were used by coastal residents for subsistence purposes. The flesh was eaten, the intestines were used to make water resistant clothing, and the hides were used to make boots and boat coverings. Early European and Asian hunters harvested sea lions in Alaska for oil and hides. No modern demand exists for adult sea lion skins since extensive scars usually render them valueless to the leather and fur industries.

More recent use of sea lions has been of pups for their fur. An average of 4,164 sea lion pups were harvested annually on the major pupping rookeries between 1959 and 1972. These animals were taken shortly after birth, and the fur was utilized in the garment industry. This harvest of pups apparently had little effect on the population when it was otherwise healthy. However, pup harvesting was eliminated in 1972 with implementation of the MMPA.

Commercial fishermen are allowed to kill sea lions involved in fisheries conflicts under terms of permits issued by the National Marine Fisheries Service by authority of the Marine Mammal Protection Act (PL92-522). Each year approximately 1,000 sea lions are killed in the nearshore salmon fishery, and 800 to 1,600 are killed in the high seas fishery.

J. State Management Objectives

Under a State management regime, the intent would be to maintain healthy and productive sea lion populations. Within this framework, the State could provide for an array of beneficial uses in different areas. Responsible sea lion management would be based on sound scientific principles and knowledge. Sea lions are important for viewing, for subsistence and commercial products, for scientific study, and because of their interactions with other components of their ecosystem. The State would provide for preference among beneficial uses. The State would encourage recreational observation of sea lions and provide for such activities. Consumptive uses are generally considered compatible with casual recreational observations of sea lions. Certain areas exceptionally suited to viewing sea lions could be zoned in space or time to restrict non-subsistence consumptive utilization in favor of observation of sea lions in their most natural state.

The State recognizes that sea lion pelts are commercially valuable and that other parts may be used in the future. The State supports the concept of regulated harvests in some areas. Those harvests would be conducted within the framework of maintaining healthy and productive populations and would be managed for optimum yield.

Recreational hunting for sea lions has never been common, and hunting with no subsequent utilization of the animal is not considered a wise use. Such hunting would be opposed. Some areas may be reserved for scientific studies where sea lion populations and/or habitats may be manipulated.

The State recognizes that situations may arise requiring the removal or the reduction in numbers of sea lions in response to a specific problem. When sea lions are involved in depredations on fish already caught by fishermen, the State's policy is that it is the owner's responsibility to protect his property from damage. This may include destruction of the sea lion. Such control would be directed only at those animals specifically involved in depredations on fish or destruction of gear. Bounties are not considered a desirable means of effecting control.

The State could reduce a sea lion population in a specific area only after investigations have clearly demonstrated that sea lions are significantly detrimental to a fish population, are competing excessively with human utilization of that fishery resource, or are causing unacceptable damage to fishing gear, in effect, when and if the sea lion population threatens the health and stability of the ecosystem. In such cases the commercial and recreational values of sea lions would be weighed against similar values of that fishery resource. Control, when implemented, would consist of reducing only that portion of the sea lion population necessary to achieve the desired results.

K. Problems

The major problems in sea lion management today include expansion of commercial fisheries; exploration, development and transportation of fossil fuels, and intensified human activity in the coastal zone. Prerequisite to addressing these problems is a jurisdictional framework for coastal zone management, habitat protection, regulation of commercial fisheries, and multi-species management. Through such a framework environmental quality can be safeguarded, rookeries and haulouts protected, and fisheries regulated to provide for adequate distribution of resources among fisheries and other consumers. The MMPA does not provide such a framework. The Act was designed to protect depleted or declining species from direct human harvest. It does not address healthy and stable or increasing populations nor does it acknowledge that some harvest may be acceptable and/or desirable for consumptive use or to alleviate conflicts with other human activities such as commercial fishing.

With implementation of the MMPA, the State lost management authority for marine mammals, and with it the justification to fund research on these species. Since 1972 sea lion research has been intermittently funded by various federal research programs, often without much

continuity. For example, a marking program designed to study dispersal of juveniles, fidelity to rookeries, and age at first breeding, among other things, was prematurely terminated due to the vagaries of Federal funding. Valuable information of use in the future management of sea lions was lost.

L. Biological Impacts of Current and Proposed Management Plans

If the present situation of no harvest is maintained, sea lion populations can be expected to fluctuate subject to natural controls. It is likely that numbers in some areas will remain relatively high or continue to increase until a change in the carrying capacity of the habitat takes place, such as a reduction in food supply or a reduction in available breeding space. With changes in carrying capacity, corresponding changes in sea lion numbers, perhaps of considerable magnitude, can be expected. Presently the sea lion population in Alaska is limited only by the carrying capacity of the habitat.

If the State assumes management, sea lions may be harvested in some parts of their range. The population would be maintained at a high level, but should be less susceptible to broad natural fluctuations once it is below carrying capacity. The Alaska Department of Fish and Game would monitor harvest levels and collect biological data in order to monitor parameters indicative of population health and productivity. Regulations would be designed and implemented to insure that the harvest of sea lions remains within the sustainable range. Information on the location and importance of rookeries and haulouts, and on the food habits and food requirements of sea lions would be incorporated into State and local planning such as Coastal Zone Management Plans and creation of State wildlife sanctuaries, and into Federal policies and plans such as Fishery Management Plans and environmental stipulations for proposed oil and gas development.

M. Projections

Upon return of management of marine mammals to the State of Alaska, seasons and bag limits could be set, and in some areas a harvest could be permitted under strict control of the Department of Fish and Game. Pups could be harvested from the major pupping rookeries for their fur. A few adults might be harvested for human consumption. Primary areas of harvest would probably be in regions of current sea lion/fisheries conflicts. By allowing a harvest on sea lions, not only could direct economic benefits be derived from sale of the fur, but also conflicts between sea lions and fishermen could be mitigated and sea lion populations maintained at levels commensurate with carrying capacity as influenced by managed commercial fisheries.

The State would encourage and participate in research to determine the relationship of sea lions to their food resource as well as the possible effects of expanding commercial fisheries on the availability of food to sea lions. It has been suggested that a decline in the number of sea lions in the eastern Aleutians may correspond to an increase in groundfish fisheries in that region. A more complete understanding of the food requirements of sea lions will enable biologists to better evaluate such situations and provide input into fishery management plans, which may prevent similar problems in the future.

N. Economic Analysis

Sea lions have significant economic and aesthetic values. They are an important functioning component of the marine ecosystem and provide viewing and photographing opportunities to a wide variety of users.

Economic value of sea lions is primarily for the hides of pups, which are used by the European fur industry. Since no sea lion skins have been available to that market since 1972, it is difficult to predict present possible value. Pup pelts sold for approximately $10 each prior to 1972. If we assume a similar market value for a projected annual harvest of 4,000 sea lion pups, then the dollar value of this harvest would be $40,000. Adult and juvenile hides have had no value in the past.

If adults were harvested for crab bait or animal food, it could be assumed that the meat would be worth about $0.77/kg. If each animal yields approximately 50% of total body weight as meat, then adult cows would be worth about $100 each and an average adult male would be worth approximately $218. As human food, sea lion meat is worth an estimated $2.00 per kg. Subsistence harvests will continue, with or without a management program.

O. Management Effectiveness

Prior to the MMPA, the State allowed a regulated hunt of sea lion pups on selected rookeries. The harvest was maintained well within the sustainable range, and did not substantially reduce the number of sea lions. It did, however, give sea lions some commercial value and make fishermen somewhat more tolerant of the depredations to catch and gear caused by sea lions. With enactment of the MMPA, pup harvests were discontinued. The number of sea lions in the Gulf of Alaska has not increased detectably in the ensuing ten years. In the eyes of fishermen, however, sea lions have reverted to the category of pests with no commercial value. It is difficult to estimate how much sea lion mortality results from fisherman-sea lion interactions since fishermen know that it is illegal under the Act to kill marine mammals and most do not understand the mechanisms for obtaining incidental take permits; they are extremely reluctant to discuss accidental take, or intentional take for purposes of protecting their gear and/or catch.

Prior to 1972, the Alaska Department of Fish and Game funded an ongoing program to monitor the population

status of sea lions in the Gulf of Alaska. When management authority was rescinded in 1972, the State continued to address management concerns such as the impacts of coastal development and the interactions with fisheries, under-funding from a variety of sources, as available. However the programs have been of relatively short duration, lacked continuity, and in some instances have been prematurely terminated due to lack of funding. The responsible Federal agency (National Marine Fisheries Service) has not developed a significant research program on sea lions.

P. Selected References

Alaska Department of Fish and Game. 1973. Alaska's wildlife and habitat. Anchorage, Alaska. 143 pages and 563 maps.

Barabash-Nikiforov, I. I. 1936. (Pinnipeds of the Commander Islands). In S. V. Dorofeev and S. J. Freiman, eds. (The Marine Mammals of the USSR Far East). Vol. 3. Tr. VNIRO, Moscow. In Russian. (Translated and summarized by Dr. G. Mares, Pacific Biological Station, Nanaimo, B. C., Canada.)

Braham, H. D., R. D. Everitt, and D. J. Rugh. 1980. Northern sea lion population decline in the eastern Aleutian Islands. J. Wildl. Manage. 44:25-33.

Calkins, D. G. 1979. Marine Mammals of Lower Cook Inlet and the potential for impact from outer continental shelf oil and gas exploration, development and transportation. Processed report for NOAA, Outer Continental Shelf Environmental Assessment Program, Box 1808, Juneau, Alaska.

_____, and K. W. Pitcher. 1982. Population assessment, ecology and trophic relationships of Steller sea lions in the Gulf of Alaska. Final Report to Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.

Fiscus, C. H., and G. A. Baines. 1966. Food and feeding behavior of Steller sea lions. J. Mammal. 47:195-200.

Gentry, R. L. 1970. Social behavior of the Steller sea lion. Ph.D. dissertation, Univ. Calif., Santa Cruz. 113p.

_____, and J. H. Johnson. 1981. Predation by sea lions on northern fur seal neonates. Mammalia 45:423-430.

Imler, R. H., and H. R. Sarber. 1947. Harbor seals and sea lions in Alaska. U.S.Fish Wildl. Serv. Spec. Sci. Rep. 28. 22pp.

Kenyon, K. W., and D. W. Rice. 1961. Abundance and distribution of Steller sea lions. J. Mammal. 42:223-234.

Mate, B. R. 1973. Population kinetics and related ecology of the northern sea lion, *Eumetopias jubatus*, and the California sea lion, *Zalophus californianus*, along the Oregon coast. Ph.D. dissertation, Univ. Ore. 93pp.

Mathisen, O. A., R. T. Baade, and R. J. Lopp. 1962. Breeding habits, growth and stomach contents of the Steller sea lion in Alaska. J. Mammal. 43:469-477.

National Marine Fisheries Service. 1980. A report based on the workshop on stock assessment and incidental take of marine mammals involved in commercial fishing operations. National Marine Mammal Lab., Seattle, WA. Unproc. Rep. 102pp.

Pike, G. C., and B. E. Maxwell. 1958. The abundance and distribution of the northern sea lion (*Eumetopias jubatus*) on the coast of British Columbia. J. Fish. Res. Bd. Can. 15:5-17.

Pitcher, K. W. 1973. Distribution and abundance of sea otters, sea lions and harbor seals in Prince William Sound Alaska. Alaska Dept. of Fish and Game, Unproc. Rep. 16 pages and 79 maps.

Schusterman, R. J. 1981. The Steller sea lion *Eumetopias jubatus*. Pages 119-142 in S. H. Ridgway and R. J. Harrison, eds. Handbook of marine mammals, Vol. 1. Academic Press, London and New York.

Spalding, D. J. 1964. Age and growth of female sea lions in British Columbia. J. Fish. Res. Bd. Can. 21:415-417.

Thorsteinson, F. V., and C. J. Lensink. 1962. Biological observations of Steller sea lions taken during an experimental harvest. J. Wildl. Manage. 26:353-359.

The Bearded Seal *(Erignathus barbatus)*

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Bearded Seal

Erignathus barbatus

A. Introduction

The bearded seal, *Erignathus barbatus*, has probably been important to people as long as they have occupied arctic and subarctic regions. Coastal inhabitants have developed an understanding of this seal based on observations made throughout generations of hunting, examination of killed animals, and first-hand exposure to the environment in which the seals live and interact. Some of this knowledge has found its way into the scientific literature through investigators who have recorded opinions and facts reported to them by Native peoples; unfortunately, however, a large body of the information has not been recorded and may soon be lost.

Early northern explorers often made reference to the importance of bearded seals to local peoples. Many of these early accounts are in Russian. In recent years, bearded seal studies have been conducted by investigators from the USSR, Canada, and the U.S. Additional information about these phocids has been obtained from scientists working on other species of marine mammals.

Two subspecies of bearded seals are presently recognized in the circumpolar boreoarctic, *E. barbatus barbatus* occurring from the Laptev Sea westward to the Hudson Bay region, and *E. b. nauticus* occurring in the remaining region from the mid-Canadian Arctic westward to the Laptev Sea. There is some question as to the validity of the subspecies differentiation, but in lieu of definitive evidence we will use the traditional concept of two subspecies. This report will deal primarily with *E. b. nauticus* as it is the subspecies which is primarily found in the northern waters adjacent to Alaska.

The scientific name, *Erignathus barbatus*, is descriptive of two very characteristic features of the bearded seal. The generic name *Erignathus* is Greek and refers to the deep jaw. The specific name, *barbatus*, is of Latin origin and refers to the relatively long and numerous moustachial vibrissae. Some common names given the species are bearded seal (English), square flipper (Norwegian sealers term), morski zaits (a Russian term meaning sea hare used in the western portion of the USSR), laktak (a Russian term used in the Far East), mukluk (Siberian Upik Eskimo term), and oogruk (Inupiat Eskimo term).

Bearded seals are the largest of the northern phocids. Maximum recorded lengths and weights from the Bering-Chukchi region are 243 cm and 360.5 kg for females and 233 cm and 318 kg for males. Although large, bearded seals have disproportionately small heads. This characteristic was noted by Allen in the late 1800's when he wrote, "I find that the lower jaw of a very old male *P. vitulina* just fits an adult skull of *E. barbatus*, except that the latter is slightly longer." Although small, the skull is wider and more massive than those of other ice-associated phocids of the northern Pacific region.

Bearded seals are covered with relatively short, straight hair. They have none of the distinct and diagnostic color patterns, such as spots, rings, or bands found on other species of seals. Most adults are basically light to dark gray, being slightly darker down the middle of the back. Coloration is sometimes tawny-brown to dark brown. Term fetuses and newborn pups have dark (usually brown), dense, slightly wavy hair with light coloration on the facial regions and one to four broad, transverse light bands on the crown and back. At weaning, the pelage resembles that of older seals.

B. Distribution and Migration

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice. Because of this, these seals move great distances each year. During the winter months, most bearded seals are found in the Bering Sea where a combination of suitable ice conditions and waters shallow enough to permit feeding on the sea floor occurs over much of the area. Multiple aerial surveys undertaken in spring have confirmed that bearded seals are the most widely distributed pinniped occurring in the drifting seasonal ice. They are most abundant near St. Lawrence Island, in the ice 60-100 km north of the ice front zone, west of St. Matthew Island, and in the southern Gulf of Anadyr. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently bearded seals are less abundant there during winter.

In spring, between mid-April and June, as the ice begins to melt and recede, those seals overwintering in the Bering Sea (most of the population) migrate northward through the Bering Strait. During the summer months, most are found near the wide fragmented margin of multi-year ice covering the continental shelf of the Chukchi and western Beaufort seas. Some animals, particularly juveniles, may occur in open water during the summer months and have also been known to enter bays and ascend rivers, especially in the fall. Immature bearded seals have occasionally been taken with the aid of nets by Natives of the Imuruk Basin area (Seward Peninsula) during fall freezeup.

Bearded seals off the coast of Alaska do not utilize coastal hauling out areas as do bearded seals from some other parts of their range. This can probably be attributed to the fact that they are able to maintain a year-round association with ice in areas suitable for benthic feeding.

Little is known of the southward movements of bearded seals. Movement through the Bering Strait is thought to occur prior to or during freezeup in late fall and early winter. The southward migration is more diffuse than the spring migration.

C. Habitat Requirements

The Bering-Chukchi platform probably comprises one of the largest areas of continuous habitat for bearded seals in the world. This platform is a shallow intercontinental shelf which underlies approximately one-half of the Bering Sea and is contiguous through the Bering Strait with the shelf underlying all of the Chukchi Sea. Sea ice usually covers this region during late winter and spring. The Bering Sea and southern Chukchi Sea are relatively ice-free throughout late summer and fall; the margin of the multi-year pack ice usually occurs in the northern Chukchi Sea.

Most bearded seals are associated with sea ice year-round. The ice provides a platform on which to bear and nurse young and haul out to rest and complete the annual cycle. Bearded seals require regular access through the ice cover to air and water. Although they can make breathing holes in relatively thin ice, they avoid regions of thick shorefast ice and are not common in regions of unbroken, heavy drifting ice. They normally utilize areas where the pack ice is in constant motion producing leads, polynyas, and other openings.

Favorable winter habitat is found throughout most of the central and northern Bering Sea where vast areas of fractured moving ice occur over shallow water suitable for feeding. In the Chukchi and Beaufort seas, winter habitat is relatively limited due to extensive unbroken heavy drifting ice. During summer, when the Bering Sea is ice-free, the most favorable bearded seal habitat is found in the central or northern Chukchi Sea along the margin of the pack ice. Suitable habitat is extremely limited in the Beaufort Sea where the continental shelf is narrow, and the ice edge frequently occurs off the shelf over water too deep for feeding.

Bearded seals feed mainly on benthic organisms. Consequently they are usually restricted to relatively shallow water areas where they can dive to the bottom. Maximum reported diving depth is 200 m, although they usually feed in water depths of less than 130 m. They feed primarily on crabs, shrimps, and clams. Clams are particularly patchy in their distribution and are the major prey of walruses. There is some evidence that bearded seals are being forced to switch to other prey in areas like Bering Strait where walrus numbers have increased greatly in recent years. However, unlike the relatively stenophagous walruses, bearded seals are able to utilize a wide variety of prey and can probably find enough suitable food in the Bering-Chukchi region even in areas where clams are depleted.

The major predators of bearded seals in the Bering-Chukchi region polar bears and humans. Human predation is discussed in Section I. The magnitude of polar bear predation is unknown; however, in one study undertaken in Alaskan waters, five of 71 pinnipeds (7%) killed by bears were bearded seals.

D. Abundance and Trends

Numerous aerial and ship surveys for marine mammals have been conducted in the past; none of those has been specifically designed to assess bearded seal numbers and most have been conducted in the Bering Sea during the spring months of April and May. Although surveys of this nature cannot be used as a basis for estimating the total number of bearded seals, they do provide valuable information regarding relative abundance.

The number of bearded seals utilizing the waters off the coast of Alaska is presently thought to be in excess of 300,000 animals. An overall estimate of 450,000 bearded seals has been given for all regions of the North Pacific, including the Sea of Okhotsk population. Although there are no rigorous data on population trends of the Bering-Chukchi population, all available indicators suggest the population is stable and healthy.

E. Vital Parameters

The sex ratio of bearded seals appears to change with age. Studies conducted within the Bering-Chukchi area indicate that at birth males predominate, although the ratio is very close to one to one. In collections of animals older than pups, females composed 53-55%. This suggests a higher mortality rate in males although other factors such as sex-related differences in behavior, distribution, or sinking rate may influence the sex ratio of harvested animals.

Maximum life expectancy of bearded seals is about 30 years. The oldest animal recorded from the Bering and Chukchi seas was 26 years of age. Based on data obtained from animals killed by coastal Eskimo hunters, about 75% of the population was ten years of age or younger, and over 95% was 20 years or younger. At some locations, samples appeared to be significantly biased toward younger aged seals, lending credence to the hypothesis that younger animals occur in larger numbers close to shore.

Most male bearded seals become sexually mature, as indicated by testes and baculum size and by the onset of spermatogenetic activity, at ages six to seven. Some females first ovulate at the age of three years but most do not become pregnant until the age of six years. Observed ovulation rates are: 17% at age four; 50% at age five; 80% at age six; and 100% at the age eight.

Breeding coincides with the end of lactation and occurs from April to early June with a peak in May. Implantation of the fetus occurs mainly from mid-July to early August after a delay of approximately two months. Most bearded seal pups are born on ice floes in the Bering Sea between mid-March and the first week of May after a total gestation period (including delayed implantation) of about 11 months. The period of pupping is somewhat protracted and slightly earlier in the southern portion of the Bering Sea than near Bering Strait. The peak of pupping in the

Bering Strait region takes place during the last third of April. A single pup per female is usual; twinning is extremely rare.

In the Bering-Chukchi region breeding is annual. The observed pregnancy rate from 1962 through 1978 remained approximately constant at 83-85% of sexually mature females, or 77% of all females four years and older. Based on harvest data, female bearded seals seven years or older comprise approximately 29% of all seals older than pups. This would result in an annual gross productivity of about 24% . Since some four to six year old females produce young, gross productivity may be somewhat higher.

Based on life tables derived from harvest data, it is estimated that bearded seals three years or younger (including pups) comprise 40-45% of the population. Mortality of pups may be as high as 60%, decreasing to 19% by age one. Mortality for age classes six to 20 was about 8% per year, after which it increased gradually. Approximately 20% of the animals born survive to sexual maturity. This should result in a net annual recruitment of about 5%.

Causes of mortality in bearded seals, other than hunting, are not well known. Bearded seals are killed and eaten by polar bears, walruses, and perhaps occasionally killer whales. Rates of mortality caused by disease and physical factors cannot be estimated at present although they are probably very low.

F. Food Habits

Bearded seals are primarily benthic feeders utilizing mostly epibenthos (organisms occurring on, rather than in, the bottom), although organisms of the infauna and some demersal fishes are also consumed. Although the total array of food items consumed by bearded seals is large, relatively few types of organisms comprise the bulk of their diet. These include brachyuran crabs, shrimps, clams, sculpins, and sometimes arctic or saffron cod. Geographical variation in diet is largely a reflection of local faunal differences. Major prey types remain the same among areas, however the species eaten may change.

Throughout the Bering and Chukchi seas, spider and tanner crabs, shrimps, and clams make up the bulk of the bearded seal diet (usually more than 70% of the volume and no less than 55%), while fishes are generally of minor importance. The fishes most commonly eaten are sculpins and saffron cod. In some areas of the southern Bering Sea, tanner crabs are the major prey of bearded seals. Other significant prey from this area include spider crabs, shrimps, snails, and octopus. In the northern Bering Sea, spider crabs appear to be the most important food source, followed by tanner crabs, clams (Greenland cockles), and shrimps. Major food items utilized by these seals in the Chukchi Sea are similar to those of the northern Bering Sea except that tanner crabs are of minor importance. In the Beaufort Sea, spider crabs, shrimps, and arctic cod are most commonly eaten.

The nursing period in bearded seals is comparatively short, lasting 12-18 days. During this time the weight of the pup increases approximately 150%, mostly in the form of an accumulated blubber layer. Weaning occurs when the female abruptly deserts the pup. Some independent feeding occurs during the latter part of the nursing period; newly weaned pups are active feeders. They apparently eat more isopods, hippolytid shrimps, and saffron cod than adults do, and fewer brachyuran crabs, pandalid and crangonid shrimps, sculpins, and flatfishes.

There are marked seasonal changes in the proportions of various prey items in the diet of bearded seals. In the Bering and Chukchi seas, fewer clams and fishes and more shrimps and brachyuran crabs are eaten in autumn-winter. The marked seasonality in the utilization of clams may be because the clams are less active at low water temperatures and thus not available to the seals during colder periods of the year. In the Beaufort Sea, more arctic cod are apparently eaten in winter.

In recent years, changes in prey utilization have been noted at several locations in the northern Bering Sea. Near Diomede clams were the primary food found in seal stomachs in 1958 and 1967. Since 1979, clams have been a minor (less than 10%) component of the food. It has been suggested that this is due to a reduction in clam populations caused by increased numbers of walruses foraging in the area.

G. Ecological Significance

Unlike most of the other ice-associated pinnipeds which feed in the water column, bearded seals are primarily benthic feeders. Thus there is little trophic interaction between ringed, spotted, or ribbon seals and bearded seals except in particular instances when an abundant resource such as crangoned shrimps or saffron cod is shared by all. Bearded seals do, however, interact trophically with walruses which are also benthic feeders. Although walruses eat primarily infauna and bearded seals mainly epifauna, both species utilize clams. In the Bering Strait region in recent years, the proportion of clams has decreased substantially in the diet of bearded seals. This may be due to the increased number of walruses foraging in the same area on those same species of clams. The walrus population has increased dramatically during the past ten years and may presently number 270,000-290,000 animals. Unlike walruses, which pit and furrow the bottom while extracting infaunal clams, there is no evidence that bearded seals disrupt the bottom substantially while obtaining food. Thus their major influence on bottom communities is probably that of direct removal rather than of structuring the community by habitat alteration. In addition they may contribute considerably to

scavenger and detrital food webs since they often eat only parts of such prey as crabs and clams.

Bearded seals are of significant nutritional importance to coastal subsistence hunters. They are a preferred species among available subsistence resources along the Bering and Chukchi coasts. As mentioned in Section C, in a study in Alaskan waters pup and juvenile bearded seals comprised 7% of the pinnipeds killed by polar bears. Since bearded seals, even pups, are considerably larger than ringed seals, each individual eaten will make a much larger energetic contribution to the diet of bears.

H. Conflict Situations

Development of natural resources has spurred an interest in Alaska ever since the first Russian ships explored the area. Resource development is often viewed as the beginning of the end for wildlife. This may not be the case, but such development can present potential problems to wildlife, their habitat, and resource management since it often involves rapid and substantial changes which may persist for long periods of time. Although seldom mentioned because it is most difficult to quantify socially and economically, the degradation of aesthetic quality is a problem common to all forms of development. It is the change most immediately obvious when development occurs.

The effects of petrochemical development on bearded seals can be categorized as direct and indirect. Included in direct effects are disturbances which might result in a displacement of seals, a direct exposure to oil spills, and the occasional death of seals struck by vessels.

Offshore drilling rigs are serviced by vessels and aircraft. Seals may be occasionally struck and killed or injured by large vessels with a higher probability of such accidents occurring during the months of April through June. Low flying aircraft, particularly helicopters, are known to frighten bearded seals resting on the ice. Although there are no data available which indicate the effect of underwater noises on bearded seals, disturbances transmitted through the water must be considered. Support vessels as well as drill rigs produce constant background noise which may cause significant dislocation of seals.

It is not known whether bearded seals will avoid fuel and crude oil spills. Seals swimming in slicks can be expected to suffer from eye irritation. Seals hauling out on the ice through water containing fuel or crude oil will more than likely be completely covered. Contact and ingestion of oil are likely to result in damage to respiratory and alimentary systems as well as other physiological problems especially damage to the kidneys and liver. Newborn pups will certainly be affected because of their thin blubber layer and the probability of ingesting oil while nursing.

Of much greater concern than the direct effects of petroleum development are the indirect effects, which have the potential of adversely affecting the entire marine ecosystem. Such indirect effects will result mainly from the introduction of toxic compounds into the system. Long-term releases of toxic compounds may influence abundance of prey and populations of competing species. Available data do not allow an assessment of the probable magnitude and effect of such changes.

The effects of coastal development on bearded seals are presently unknown. The fact that these seals do inhabit waters near existing coastal settlements indicates that low levels of noise and disturbance may not cause significant dislocation.

As previously indicated, tanner crabs are a primary food source for bearded seals inhabiting the Bering Sea. It is possible that the commercial harvest of tanner crabs will affect their availability to bearded seals or that consumption by bearded seals could affect the commercial harvest of crabs. Bearded seals seem to prey differentially on gravid females; often only the abdomens of a hundred or more gravid female crabs may occur in the stomach. Bearded seals rarely utilize other commercial species of crabs.

I. Harvest Levels

Bearded seals have been hunted in the Bering, Chukchi, and Beaufort seas since the earliest occupation of these regions by humans. The principal harvesters are subsistence hunters residing along the coasts of Alaska and Siberia. The harvest of bearded seals in Alaska occurs in virtually all coastal villages from Bristol Bay to the Canadian border. Hunters normally use small, outboard powered boats and hunt in open leads among scattered ice floes close to shore. Although most of these seals are taken in late spring-early summer as they migrate north, a small portion of the harvest occurs during the winter and early spring. Because bearded seals are large and provide greater yield per hunting effort than other ice associated pinnipeds, they are a preferred subsistence species. Although methods of hunting them and some of the traditional uses of byproducts have changed, the importance of meat and to some degree hides remains the same. Soviet commercial sealers also take bearded seals, although they are not the primary species hunted.

The Alaska subsistence harvest remained largely constant at under 1,800 bearded seals annually from 1966 through 1979, with an occasional year of higher harvest. Since 1969 when commercial hunting was curtailed, the Soviet harvest has usually been between 1,000 and 2,000. In no year did the total harvest exceed 3% of the estimated population, and in only two years was it above 2%. Harvest data for bearded seals in the Bering and Chukchi seas for the years 1966 through 1979 are indicated in Table 1.

Table 1. Harvest of bearded seals in the Bering and Chukchi Seas, 1966-1979.

Table 1. Harvest of bearded seals in the Bering and Chukchi Seas, 1966-1979.

Year	American Harvest	Soviet Harvest	Total Annual Harvest
1966	1,242	6,230	7,472
1967	1,300	7,009	8,309
1968	1,050	4,577	5,627
1969	1,772	1,986	3,758
1970	1,759	2,533	4,292
1971	1,754	1,490	3,244
1972	1,353	1,428	2,781
1973	1,500	1,293	2,793
1974	1,600	1,256	2,856
1975	1,200	1,220	2,420
1976	2,125	1,644	3,769
1977	4,750	1,204	5,954
1978	1,598	2,053	3,651
1979	1,117	1,483	2,600

J. State Management Objectives

The primary management goal of the State of Alaska with respect to bearded seals would be the maintenance of a healthy and productive population. Where consistent with this primary goal, the State would provide for the beneficial use of the bearded seal resource.

A major objective of State management would be to provide for an optimum harvest of bearded seals by coastal rural residents, emphasizing yield of these seals for human use through domestic consumption. This and other uses would be accommodated based upon the biological productivity and population status of the species. Harvest strategies which may be necessary for sound multi-species management programs would be implemented. Other uses such as viewing and photography would be accommodated and encouraged.

In the interest of maintaining suitable habitat for bearded seals, the State would advocate comprehensive resource planning, and where required, the institution of controls on the use and development of marine environments and resources which are important to bearded seals and other species.

K. Problems

The MMPA provides that Alaska Natives only may harvest marine mammals. Fortunately the bearded seal population is healthy and stable, and there has been no need to regulate harvest. While bearded seals are an available and valuable subsistence resource, their full utilization is prevented through prohibition of sale of raw parts or products to non-Natives.

When the MMPA was implemented in 1972, it was assumed that the responsible Federal agency (National Marine Fisheries Service) would implement at least a minimal program to monitor harvest levels and conduct necessary research on this species. When it did not do so, the State, largely under contract funding, continued to collect harvest data as possible and engaged in studies on the natural history and ecology of bearded seals. In 1979 when that contract ended, so did harvest monitoring and research activities.

No major problems are anticipated under State management. The State would again monitor harvest levels and collect biological data pertinent to monitoring the status of the population. Sale of marine mammal parts and products to non-Natives could be allowed, thus providing economic impetus to fully utilize all animals taken. The preference for subsistence utilization would be maintained.

L. Biological Impacts of Current and Proposed Management Plans

The present U.S. management regime for bearded seals probably has had little, if any, biological impact on the species. The harvest remained relatively stable from 1966 through 1979, a period which covered seven years before and seven years after implementation of the MMPA. No marked change in harvest levels is anticipated if management is returned to the State. There has never been a large commercial market for hides, nor is it anticipated that one will develop.

M. Projections

Proposed State management would allow the taking of bearded seals for subsistence use without bag limit or seasonal restrictions. The hunting of the species is effectively controlled by regional climatic conditions and the seasonal availability of seals. It is anticipated that there will be little or no change in annual harvest levels.

Sale of raw parts could be allowed, enabling complete utilization of all harvested animals. Coastal residents would benefit since their ability to utilize bearded seals as a source of food and cash income would be enhanced.

Resumption of State management would once again provide a legal basis for ADF&G to conduct a program to monitor the harvest and institute other required components of a management program, including continued biological research and enforcement efforts. Biological data would be collected in order that the status of the population can be assessed at regular intervals and the adequacy of the existing management program assessed. Management schemes would be modified as necessary to

ensure the continued health and stability of the population.

Research on the interaction of bearded seals and walruses and the probable competition between the two species for a common food resource, clams, would be continued and if adequate funding is procured, expanded. The findings from such research will provide valuable input into multi-species management decisions.

Consideration would be given to bearded seals in the formulation of State conservation and management plans, and in State input to relevant Federal plans and actions.

N. Economic Analysis

In Alaska the bearded seal is harvested almost entirely for human food, oil, and hides, and under most circumstances in rural villages all of the animal is utilized or consumed. Because of this, it is very difficult to place a monetary value on the harvest. In 1979 the estimated yield of meat, oil, and hides for the reported harvest during an 18-month period between 1 January 1977 and 30 June 1978 was determined. Since most hunting occurs in spring, the figures were basically for two hunting years. Assigned dollar values were based on the following prices for bearded seal products: meat $3.30/kg, oil $0.22/kg, and hides $20.00 each. The average weight for all seals in that harvest was calculated to be 156.9 kg, and the average monetary value of each seal was calculated to be $285.62. The total monetary contribution to the villages for the 18-month period was $1,801,682.00 for a harvest of 6,308 seals.

The following prices for bearded seal products were acquired in October 1980 from a Native foods store in Nome, Alaska: meat $4.36/kg, oil $10.23/ kg, and hides $100.00 each. At those prices, the average monetary value of a seal was calculated to be $812.36, and the total monetary contribution to the villages for the 1979 harvest of 1,117 bearded seals would have been $907,410. If the prices given in the former estimate are used, that value would be $318,725. In either case, bearded seals must be considered a very important resource to many Native residents living along the Bering, Chukchi, and Beaufort seas.

In addition to the direct economic benefits from the harvest of seals, there are indirect benefits associated with management of the population. Under State management, biologists, field technicians, and some village assistants were, and would be again, employed by the Alaska Department of Fish and Game to monitor the bearded seal harvest and obtain and process biological specimens. These jobs provided economic opportunity in areas where employment prospects are extremely limited.

Potential nonconsumptive uses of bearded seals include viewing and photography of animals in the wild. In the spring when bearded seals haul out on ice in nearshore areas where they are accessible to coastal villages, it would be possible to develop a tourist industry which would provide guided viewing tours out into the sea ice to observe marine mammals and seabirds. Such an industry could provide economic opportunity not only to boat operators and "tour guides" but to entire communities which would be called upon to provide food, lodging, and other services.

O. Management Effectiveness

After Alaska statehood and prior to the MMPA, bearded seals were included in the regulatory framework formulated by the Alaska Department of Fish and Game. Regulations and bag limits or quotas were not deemed necessary due to a small annual take relative to estimated population size, and to environmental conditions and aspects of seasonal distribution that naturally limited the take. However, the State did monitor harvest levels and collect biological specimens from harvested animals to determine basic population parameters.

With enactment of the MMPA, bearded seals could no longer be managed by the State. Although this made little or no effective difference in the actual harvest levels, it meant that the State could no longer require harvest information or specimens from harvested animals, and, therefore, had no legal basis to monitor the status of the population. Further the responsible Federal agency, National Marine Fisheries Service, did not implement any sort of management plan; it did not monitor harvests nor develop a significant research program for bearded seals. Through outside contract funding, the State was able to maintain an ongoing research program which included monitoring harvest levels through 1979. At that time funding expired. The harvest has not been monitored since then, nor has significant research been conducted.

P. Selected References

Benjaminsen, T. 1973. Age determination and the growth and age distribution from cementum layers of bearded seals at Svalbard. Fisk Dir. Skr. Ser. Hav Unders. 16:159-170.

Burns, J.J. 1981. Bearded seal-*Erignathus barbatus*. Unpubl. final rep., Contract No. 02-5-022-53, Res. Unit 230, Environmental Assessment of the Alaskan Continental Shelf. Outer Continental Shelf Environmental Assessment Program, Boulder, CO. 77pp.

_____ Eley, T.J. 1978. An analysis of polar bear predation on Alaskan ice-inhabiting pinneped populations. AK. Dept. of Fish and Game unpubl. ms., 12pp.

Keyon, K.W. 1962. Notes on the phocid seals at Little Diomede Island, Alaska. J. Wildl. Manage. 26(4):380-387.

Kosygin, G.M. 1966a. (Some data on the feeding of the bearded seals in the Bering Sea during the spring-summer months.) Izv. TINRO 58.153-157. In Russian. (Transl. by U.S. Fish Wildl. Serv. Bur. Commer. Fish., Seattle, 1966.)

_____. 1966b. (Distribution and some biological features of Bering Sea pinnipedia (spring and summer period 1963).) Izv. TINRO 58:117-124. In Russian.

_____. 1966c. (Distribution of bearded seals in the Bering Sea in the spring period 1962-1964.) Izv. TINRO 58:125-128. In Russian.

_____. 1971. (Feeding of the bearded seal *Erignathus barbatus nauticus* (Pallas) in the Bering Sea during the spring-summer period.) Izv. TINRO 75:144-151. In Russian. (Transl. by Transl. Bur., Dep. Sec. State, Ottawa, Ont., Canada, Fish. Mar. Serv. Transl. Ser. No. 3747, 16pp.)

_____ and V. A. Potelov. 1971. (Age, sex and population variability of the craniological characters of bearded seals.) Izv. TINRO 80:266-288. In Russian. (Transl. by Transl. Bur., Dep. Sec. State, Ottawa, Ont. Canada, Fish. Mar. Serv. Transl. Ser. No. 2651, 29pp.

Lowry, L. F., K. J. Frost, and J. J. Burns. 1980. Feeding of bearded seals in the Bering and Chukchi Seas and trophic interaction with Pacific walruses. Arctic 33:330-342.

The Harbor Seal *(Phoca vitulina richardsi)*

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Harbor Seal

Phoca vitulina richardsi

A. Introduction

Harbor seals (*Phoca vitulina*), also known as common seals, are a ubiquitous, coastal species found throughout the temperate and sub-Arctic regions of the Northern Hemisphere. They are among the most widely distributed of the Pinnipedia, occurring over nearly 40 degrees of latitude in both the North Pacific and North Atlantic oceans.

Current subspecific classifications include *P. v. vitulina* in the eastern North Atlantic, *P. v. concolor* in the western North Atlantic, and *P. v. mellonae* in lakes on the Ungava Peninsula. Two subspecies are recognized in the North Pacific by some authorities: *P. v. richardsi* of coastal North America (including Alaska) and *P. v. stejnegeri* of eastern Asia. More recent studies suggest a single pan-Pacific form, *P. v. richardsi*, which exhibits significant clinal variation. Although previously considered a subspecies of *P. vitulina,* the ice-inhabiting form, or spotted seal, is now considered a distinct species, *P. largha.*

Harbor seals are medium-sized "earless" seals (Phocidae). Size at birth averages about 80 cm in length and 11 kg in weight. Pups gain weight rapidly during the month-long suckling period, perhaps doubling their weight. Growth is completed by seven to ten years when males average about 155 cm in length and weigh about 85 kg, and females weigh about 76 kg and are 145 cm long. Considerable individual variation exists in body size. There is also significant variation in both size at birth and adult size among various geographic populations. Seasonal variation occurs in thickness of fat (blubber) reserves. Seals are fat throughout winter and spring, and considerably thinner in summer (associated with lactation, breeding, and molt).

Harbor seals are covered with short, stiff bristle-like hair. Coloration varies considerably, but two basic patterns occur: a dark phase where the background is dark with light rings, and a light phase where the sides and belly are light colored with dark blotches or spots. The back is sometimes darker with blotches and light rings. Harbor seals molt annually; the timing varies with geographic area (and to some extent by individual), but occurs between June and October in Alaska.

B. Distribution and Movements

In Alaska harbor seals are distributed continuously along the coast from the British Columbia border north to Kuskokwim Bay, and west throughout the Aleutians. Harbor seals are generally considered sedentary animals, making local movements associated with such factors as tides, food availability, reproduction, and season. Tagging studies have shown juveniles to occur up to 250 km from their birth places. A radio-tagged adult was discovered 194 km from the tagging site. Some large scale seasonal movements are apparent in areas such as the Copper River Delta and northern Bristol Bay where high numbers are present in summer, but few are found in winter when the areas are usually covered by ice. While most harbor seals appear to be closely associated with coastal waters, occasional observations have been made of animals up to 80 km offshore. One radio-tagged animal crossed 75 km of open ocean between two islands in the Gulf of Alaska. Harbor seals are sometimes found in rivers and lakes, usually on a seasonal basis (present in summer, absent in winter) but several lakes have seals present year-around, and they may be resident. These lakes include Iliamna Lake and lakes on the Ungava Peninsula.

C. Habitat Requirements

Like other pinnipeds, harbor seals haul out of the water occasionally to rest, give birth, and nurse their young. There are indications that hauling out may be particularly important during the molt. Reefs, sand and gravel beaches, sand and mud bars, and glacial and sea ice are commonly used hauling substrata. Ready access to water, isolation from disturbance, protection from wind and wave action, and access to food sources have all been mentioned as prerequisites for haulout site selection. Births of young harbor seals do not appear to be restricted to a few major rookeries as is the case for many species of pinnipeds. Pups are born at nearly all hauling sites. Obviously areas with adequate supplies of suitable prey are necessary to support seal populations. Large expanses of productive, shallow water are probably important in supporting large numbers of harbor seals. As demonstrated by their wide distribution and occupation of a variety of physical habitats, harbor seals are quite adaptable.

D. Abundance and Trends

Harbor seals are a difficult species to census since the only time when they can be accurately counted is when they are hauled out. They haul out in thousands of locations in Alaska, and, even if seals at all sites could be counted, the proportion of the total population hauled out at any given time is unknown.

The best estimates of numbers for Alaska were generated from harvest data, the apparent effect of harvest levels on population density, observed densities of animals, and amount of available habitat. These estimates (made in 1973), which are not precise but do illustrate the general magnitude of the Alaskan population, are as follows: Dixon Entrance to Cape Fairweather - 30,000; Cape Fairweather to Kenai Peninsula, including Prince William Sound - 70,000; Cook Inlet, Kodiak Archipelago, Shelikof

Strait, and south side of Alaska Peninsula - 55,000; Aleutian Islands - 85,000; and north side of the Alaska Peninsula, Bristol Bay and the Pribilof Islands - 30,000. Data collected since 1973 suggest that estimates for areas three and five are low. Since the 1972 moratorium, harvests in all areas except the Cape Fairweather to Kenai Peninsula unit have been insignificant, and groups which may have been depressed by hunting could have grown.

Estimates of numbers in other areas of North America include: British Columbia—35,000; Washington, Oregon, California, and Mexico—12,000+; eastern Canada—12,700, and northeastern United States—10,500+.

E. Vital Parameters

The sex ratio of harbor seals at birth is approximately one to one and remains so until about five years of age. Thereafter mortality rates for males are higher, and females become relatively more abundant. By 20 years of age, females are three times as abundant as males. Maximum ages estimated from dental annuli are 32 years for a female and 26 years for a male. In the Gulf of Alaska, estimated natural mortality rates for harbor seals from birth to four years were 0.79 for males and 0.74 for females. The mean annual mortality rate for males between four and 17 years was 12.7% and for females between four and 19 years, 11.4%. Killer whales, Steller sea lions, and sharks have been implicated as predators of harbor seals.

Male harbor seals become sexually mature between three and seven years of age. Females first ovulate between the ages of three and seven years; however, most become pregnant for the first time between four and nine years of age. There are indications that females from heavily hunted groups may mature at younger ages than females from lightly hunted areas. Estimates of adult pregnancy rates have been similar for all harvested groups studied and range from 92% to 100% for females eight years and older. In younger seals from the Gulf of Alaska, the proportion of females that were pregnant increased from 17% at four years and 63% at five years to 88% and 89% at six and seven years. Overall pregnancy rate in the Gulf from 1975-1978 was about 92% for females eight years and older, or 81% for females four years and older. Reproductive failures were noted in 10.6% of the reproductively mature females collected between implantation and birth of pups. Pregnancy rates of adult females in the Aleutian Islands, where these seals are virtually unhunted, has been estimated at 75%.

Most breeding occurs between mid-June and mid- to late July. Implantation of the fetus occurs primarily during early October after a delay of approximately 11 weeks. Most pups are born between June 5 and 25, for a total gestation period (including delayed implantation) of about 11 months. Twinning is exceptionally rare as with other species of pinnipeds.

F. Food Habits

Harbor seals feed primarily on fishes and cephalopods (octopus and squids), although some decapod crustaceans, particularly shrimp, are eaten. They appear to favor off-bottom, schooling fishes. In Alaska, commonly eaten prey include walleye pollock, Pacific cod, capelin, eulachon, Pacific herring, salmon, octopus, and squids. Both seasonal and geographic variations in diets occur, usually involving prey such as herring, capelin, salmon, and squid.

In harbor seals collected in the Gulf of Alaska, fishes comprise 74% of the volume of stomach contents and cephalopods (mostly octopus) made up 22%. The three top ranking prey are pollock, octopus, and capelin. Along the north side of the Alaska Peninsula, a variety of fishes are eaten, including pollock, cod, sand lance, and sculpins. In the Aleutians, pollock, Pacific cod, and octopus are among the major prey, although other fishes and shrimps are also eaten. A small sample of seals from Otter Island in the Pribilofs had eaten 64% fishes and 29% octopus. Fishes eaten were mostly pollock and Pacific cod.

Daily feeding rates in harbor seals have been estimated at 13% of body weight during the first year of life, decreasing to a mean of 3% by age nine years.

G. Ecological Significance

Although they are widespread and relatively abundant, harbor seals do not appear to be the type of predator which regulates populations of prey, but rather seem to be quite adaptable, utilizing those suitable prey which are most abundant. They provide limited food for several predators, but are more important for their contribution to scavenger and decomposer food chains. They use the same prey as other species such as Steller sea lions, certain cetaceans, marine birds, and humans, but it is not clear if direct competition occurs.

H. Conflict Situations

The well-documented propensity of harbor seals to mutilate or remove salmon from fishermen's gillnets is probably the major conflict between humans and harbor seals in Alaska. This causes a direct economic loss to fishermen and often fosters an antagonistic attitude by some fishermen towards seals. The Copper River Delta, the mouths of the Stikine and Taku rivers, and portions of Bristol Bay are areas with notable harbor seal-fishery conflicts. Sometimes seals are caught and killed or injured in fishing gear, primarily gillnets, and occasionally in crab pots.

Human disturbance of hauled out harbor seals may increase neonatal mortality and stress older animals. Observations in Washington State and San Francisco Bay indicated that harbor seals may adapt the timing of haulout to avoid human disturbance in some situations. Hauled

out harbor seals in Alaska vary greatly in their reaction to disturbance. In some areas, seals will tolerate intense disturbance without entering the water while in other areas the seals will dash into the ocean in response to low intensity disturbance.

Habitat appropriation by coastal development has remained at low levels in Alaska, occurring primarily around coastal communities. In southeastern and southcentral Alaska, activities associated with logging, primarily storage of log rafts in protected bays, may make some areas less suitable for harbor seals. Shore-based facilities associated with development of offshore oil and gas reserves may usurp limited amounts of habitat, but probably will be insignificant if carefully selected.

I. Harvest Levels

Before the 1960's, the harvest of harbor seals was small. A few coastal residents used harbor seals for food and clothing while others hunted for bounty payment. In 1962-63 Alaskan harbor seal skins entered the European fur market. The annual harvest climbed from 6,000-10,000 seals prior to 1963, to more than 50,000 in 1965. The harvest in 1966 dropped to 25,000-30,000 and continued to decline each year. When the moratorium took effect in December, 1972, the annual harvest was estimated at 8,000-12,000. Since 1972 the annual harvest has probably ranged between 1,000 and 2,500. Most of the current harvest is taken by Alaskan Natives under the Native exemption clause of the Marine Mammal Protection Act.

The potential sustainable yield of harbor seals in Alaska probably exceeds 10,000 animals annually, particularly if a high proportion of pups is included in the harvest.

J. State Management Objectives

Harbor seals are a common faunal component of coastal southern Alaska, and the frequent sightings by both residents and visitors provide considerable enjoyment. Hides, meat, and blubber from harbor seals are traditional subsistence items for some coastal residents. Recreational hunting of harbor seals was a popular activity during the 1960's and early 1970's. Harbor seal skins were valued as trophies. Commercial hunting for the fur market was the major consumptive use of harbor seals in the decade preceding passage of the Marine Mammal Protection Act. All of these uses can best be met by protection of harbor seal habitat and maintenance of a high and productive population. State management of harbor seals would accommodate both nonconsumptive and consumptive uses. Recreational observation of seals could be encouraged through public information and education. Certain areas exceptionally suited to viewing seals might be zoned to restrict hunting in favor of observation of seals. Certain key habitats such as pupping rookeries and molting haulout areas could be recognized, designated, and protected from disturbance during critical times of the year. Although harbor seals are not a primary subsistence species like the ice-inhabiting seals to the north, this use would be given the highest priority where the need exists. Both recreational hunting and commercial hunting of harbor seals are recognized as legitimate uses of this species. Under a State management regime, recreational hunting would be given priority where conflicts develop between the two.

K. Problems

Actual management of harbor seals is precluded under the Marine Mammal Protection Act. Harvest is allowed under the Native exemption clause and cannot be restricted unless the species is declared depleted. Utilization of marine mammal parts by Native hunters is limited because of the prohibition of sale of raw products to non-Natives. If management authority of harbor seals were returned to the State of Alaska, sources of funding to implement an effective management program could be a problem. Programs would have to be established to monitor harvests, monitor population levels, and collect specimens for estimation of vital parameters. These efforts would require considerable commitments of money and manpower. Federal funding sources which were supposed to be made available under the Marine Mammal Protection Act have not been readily available.

From a biological viewpoint, allowable harvests are considerably greater if a large proportion of pups are included. Pup skins are a valuable commodity on the fur market. Considerable opposition to the harvest of seal pups has occurred nationally, primarily as a reaction to harp seal pup harvests and the publicity generated by protectionist groups. If pup harvests are conducted in a State program, some public opposition can be anticipated.

L. Biological Impacts of Current and Proposed Management Plans

Any proposed harvest levels would likely have only minor impacts on the population size. Stable subpopulations at carrying capacity would be somewhat reduced while those which were increasing would probably continue to grow, but at a slower rate. Directed harvests in locations with serious harbor seal-fishery conflicts could significantly reduce numbers in local areas.

M. Projections

Should the State regain management authority, it is anticipated that the annual harvest would range up to 10,000 seals. Raw skins of seals currently taken under the Native exemption cannot be commercially marketed. A state program would allow more flexibility in harvest guidelines.

The State would reinstitute management programs concerned primarily with monitoring harvests and monitoring and evaluating population status.

N. Economic Analysis

Economic impacts of a waiver of the moratorium can be only generally addressed since many of the associated variables such as fur prices and demand are not currently known. Limited economic stimulation would result from the sale of skins. Secondary economic benefit would occur from the use of boats and aircraft in support of hunting, transportation and tanning of skins, and the manufacture and sale of garments and handicraft items.

O. Management Effectiveness

Prior to December 1972, a regulated harvest of harbor seals occurred under State management. Seasons were closed during periods when skins were in poor condition, and quotas were imposed in areas with high harvests. Harvest levels were estimated throughout the State, and onsite monitoring occurred in key harvest areas. Research was conducted on various aspects of the life history and vital parameters of the harbor seal.

After implementation of the moratorium, State regulations on marine mammal harvests were invalidated. Research on harbor seals continued through 1978 under a variety of programs, primarily contracts with Federal agencies. All management associated activities ceased in 1972.

P. References

Bigg, M. A. 1969. The harbor seal in British Columbia. J. Fish. Res. Board Can. Bull. 172. 33pp.

_____. 1973. Adaptations in the breeding of the harbor seal (*Phoca vitulina*). J. Reprod. Fert., Suppl. 19:131-142.

Boulva, J., and I. A. McLaren. 1979. Biology of the harbor seal, (*Phoca vitulina*), in eastern Canada. J. Fish. Res. Board Can. Bull. 200. 24pp.

Calambokidis, J. et al. 1978. Chlorinated hydrocarbon concentrations and the ecology and behavior of harbor seals in Washington State waters. The Evergreen State College. Processed Report. 121pp.

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

Imler, R. H., and H. R. Sarber. 1947. Harbor seals and sea lions in Alaska. USDI. Fish and Wildl. Ser. Spec. Scientific Report No. 28. 23pp.

Kelly, B. P. 1979. Population and ecological genetics of pelage polymorphism in Pacific harbor seals. Unpubl. M. S. Thesis, Univ. of Alaska, Fairbanks. 121pp.

Klinkhart, E. G. 1969. The harbor seal in Alaska. Alaska Dept. of Fish and Game Wildlife Notebook Series. 2pp.

Pitcher, K. W. 1977. Population productivity and food habits of harbor seals in the Prince William Sound-Copper River Delta area, Alaska. Final Report to U.S. Marine Mammal Commission No. MMC-75103. USDC NTIS. PB-226 935. 36pp.

_____. 1980. Food of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. Fish. Bull. 78:544-549.

_____. 1979. Biology of the harbor seal, *Phoca vitulina richardsi*, in the Gulf of Alaska. OCSEAP Final Report USDC Boulder 72pp.

_____, and J. W. Slipp. 1944. The harbor seal in Washington State. Amer. Midland Naturalist. 32:373-416.

Shaugnessy, P. D., and F. H. Fay. 1977. A review of the taxonomy and nomenclature on North Pacific harbour seals. J. Zool., Lond. 182:385-419.

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. 52pp.

Vania, J., E. Klinkhart, and K. Schneider. 1969. Marine mammal investigations. Fed. Aid Fish Wildl. Rest. Rep. Alaska Dept. Fish and Game, processed report. 17pp.

The Ribbon Seal *(Phoca fasciata)*

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Ribbon Seal
Phoca fasciata

A. Introduction

The ribbon seal (*Phoca fasciata*) is probably the least studied seal inhabiting Alaskan waters. Although distinctive and striking in appearance, ribbon seals offer few sighting opportunities for most shore-based observers. Until the past few decades when Soviet and U.S. scientists began devoting increased attention to the Bering Sea during icy winter and spring months, little was known about ribbon seals other than their external appearance and general areas of occurrence.

Although once considered a member of a separate genus, *Histriophoca*, recent studies have shown that the ribbon seal is a member of the genus *Phoca*. This indicates the close relationship between ribbon seals and other members of the genus *Phoca* including ringed, spotted, harbor, and harp seals.

The common name of this species is obviously descriptive of the coloration of adult animals. The color pattern is one of light gray to silver bands on a background of dark gray-brown to black. There are basically four bands: one encircling the head or neck, one encircling the posterior portion of the body, and one on each side, broadly encircling the foreflippers. The pattern is similar on both sexes, but less distinct on females due to lighter background coloration.

At birth pups are covered by a dense coat of long white hair (lanugo) which is shed at weaning, three to six weeks later. After molting the white lanugo, young seals are silver gray on the sides and belly and blue-black on the back. The banded pattern of older seals appears gradually and is usually fully developed when seals reach the age of sexual maturity (about three years).

The coloration of ribbon seals is markedly different from all other species though it most closely resembles that of the harp seal, in which adults also show a banded pattern. Harp seals are thought to be the closest relatives of ribbon seals. Other than their coloration, one of the most distinctive features of ribbon seals is the shape and appearance of the head. The eyes are large, appear black, and are set in a broad, noticeably short-nosed skull. Ribbon seals have comparatively long and flexible necks and a slender body shape which gives them a long, lean appearance.

At birth, ribbon seal pups weigh approximately 10.5 kg and are about 86 cm long. By weaning in late May and early June, they have increased in length only a few centimeters, but have more than doubled in weight. Growth is comparatively rapid until about age seven, after which an average seal is about 150 cm long and weighs approximately 70 kg. There is great variation in length and weight in all age classes. Males and females are of similar sizes. As is the case with many other pinnipeds, weight fluctuates on an annual basis in relation to seasonal feeding cycles.

B. Distribution and Migration

The normal range of ribbon seals includes the Bering, Okhotsk, and Chukchi seas. Due to the partial geographical barrier formed by the Kuril Islands and Kamchatka Peninsula, ribbon seals in the Okhotsk Sea and in the Bering-Chukchi region have been considered separate groups. Because of the absence of complete physical barriers and the continuity of suitable habitat, however, some interchange probably occurs. Many major species of the North Pacific fauna are common in both these regions. Comparative studies of morphology, anatomy, and craniometrics have found no significant differences between ribbon seals from the two areas. The following discussion deals mainly with the Bering-Chukchi stock.

The distribution of ribbon seals is most precisely known for spring months when the seals are frequently hauled out on sea ice. It is then when pups are born and nurtured, and breeding and molting occur. The geographical location of ribbon seals during March and April is determined by the location and characteristics of the Bering Sea ice cover. Generally, these seals are found throughout the ice front, a broad swath of relatively dispersed and moving floes which extends from the Alaskan coast to Siberia. The position of the front and the ribbon seals associated with it varies daily and annually in response to short- and long-term weather conditions. In many years, the maximum extent of ice corresponds closely with the edge of the continental shelf. Although the occurrence of ribbon seals throughout the front is continuous, they mainly occur in local concentrations, probably in response to ice type and availability of food. In March and April, they are often numerous in the regions near and west of the Pribilof and St. Matthew islands.

As sea ice cover diminishes in May and June, ribbon seals become concentrated in the remaining ice remnants where pups achieve independence and older animals complete the annual molt. Ice remnants usually occur in the eastern Gulf of Anadyr, south and west of St. Lawrence Island, and occasionally south of Bering Strait near King Island.

When the last of the sea ice is gone from the Bering Sea, ribbon seals, unlike all other species of ice-associated pinnipeds, show no strong tendency to follow the receding ice north nor to move into the coastal zone. Although they have occasionally been recorded from the Chukchi Sea, it appears that most animals remain in the ice-free waters south of Bering Strait. Most sightings of ribbon seals during summer months are from the vicinity of the Pribilof Islands. This suggests that they spend summer months

feeding in the productive regions of the Bering Sea shelf and slope.

C. Habitat Requirements

Although they spend many months in ice-free waters, sea ice is vital to the life cycle of ribbon seals. For pupping, ribbon seals select areas of moderately thick large floes commonly 10-60 km north of the ice fringe and open sea. Newborn pups can probably survive wetting, though they swim poorly and generally avoid the water until after they are weaned. Pup survival and subsequent vigor may depend in part on the stability and persistence of the ice selected by its mother. Distribution of food probably also affects the location of pupping areas as adult females feed actively up to the time of pupping and molting. Also, newly independent pups require food after their fat reserves are depleted.

Since warmth is necessary for rapid growth and replacement of the epidermal tissue of the skin, seals haul out of the water often during the molt. Because ribbon seals do not haul out on land, sea ice is a particularly important substrate for that purpose. Therefore, ribbon seal distribution during late spring is strongly dependent on ice remnants; since feeding is greatly reduced, prey availability at this time of year appears to be of little consequence.

Subsequent to pupping, breeding, and molting, characteristics of physical habitat appear to be of little direct importance to ribbon seals. They are well adapted to a pelagic existence and apparently range widely within the Bering Sea. It is probable that they seek areas where the available prey are of the proper type and abundance. Energetic considerations and the need to return to ice in late winter and spring limit their wanderings mainly to productive waters of the Bering and Okhotsk seas.

In addition to seasonal requirements for food and physical habitat, many other factors undoubtedly act to define ribbon seal habitat. For example, when they are hauled out, ribbon seals are the least wary of ice-associated seals, and it is probably more than coincidence that their range seldom overlaps with that of the polar bear. Predation by killer whales and sharks may be of some importance in limiting distribution during warmer months. Although the possible effects of disturbance and environmental contamination on ribbon seals are poorly known, both, at some level, would undoubtedly affect the quality of ribbon seal habitat.

D. Abundance and Trends

As is the case with most species of marine mammals, estimates of ribbon seal abundance are not precise. Enumeration of this species is complicated by the short period during which they are easily observed, the extensive and remote nature of their habitat at that time, and the unknown proportion of animals that are hauled out and visible at a given moment.

Several estimates of ribbon seal numbers have been made, based primarily on shipboard and aerial surveys conducted in conjunction with Soviet commercial harvesting and U.S. and Soviet scientific studies. In the early 1960's, ribbon seals in the Bering Sea were estimated to number 80-90,000. Large and apparently excessive Soviet harvests, averaging 10,000 animals annually, were taken from 1961 through 1967. In response to an obvious decline in abundance, the harvest was reduced to 3,000 in 1969 and remained at that level through 1978. In 1970 ribbon seals were estimated to number 60-80,000 in the Bering Sea and 140,000 in the Sea of Okhotsk. Soviet researchers reported an increase in population size in the early 1970's. Recent estimates indicate a current Bering Sea population of approximately 100-110,000 ribbon seals.

E. Vital Parameters

Most of the information available on vital parameters of ribbon seals has been derived from examination of specimens collected during Soviet commercial sealing operations in the early 1960's, augmented by U.S. sampling efforts in 1967, and to a lesser extent in 1976-1979. Interpretation of some of these data is complicated by at least two factors. First, there is disagreement, even among Soviet scientists, over whether the samples collected were actually representative of the population or were biased by the nature of hunting operations. This problem is of particular importance when trying to determine the age structure of the population. Secondly, the specimens were collected during years when ribbon seal populations were being heavily exploited. Many vital parameters, particularly productivity and mortality, are density dependent, and their values may, therefore, have changed during the depletion and subsequent recovery of ribbon seal stocks.

All available data indicate that the sex ratio at birth and at maturity is one to one, as in most other ice-inhabiting seals. Sexual maturity, defined as the age of first conception, occurs as early as age two in some females. Virtually all females ovulate and are capable of producing young by age four. A few ribbon seals, therefore, first give birth at age three, while most produce young by age five. Females give birth to a single pup annually. In Soviet samples, 76-83% of females more than five years old had been pregnant in the year they were taken. Male ribbon seals become sexually potent between three and five years of age.

As is true of most mammals, mortality is high during the first year of life and much lower thereafter. Based on samples from the Sea of Okhotsk, mortality of pups in their first year has been estimated as high as 45%. Mortality declines rapidly to 8-10% annually in adult animals. About 25% of the animals born survive to productive maturity at age five. Causes of mortality include human hunting, disease, and physical trauma, as well as predation by killer whales, sharks, and perhaps polar bears and walrus. Maximum lifespan of ribbon seals is probably about 30 years.

In order to estimate productivity of ribbon seals, it is necessary to know the age structure of the population. Based on available data, sexually mature animals comprise about 57% of the population of animals older than pups. Given a one to one sex ratio and a low pregnancy rate of 80%, the gross annual production of young would be about 24%. This value agrees closely with most field observations. If 75% of animals born die before producing young, the net productivity of the population would be about 6%.

F. Food Habits

The foods of ribbon seals are known only for the months of February to June. Most samples are from April to June, a time of reduced feeding, but the types of foods in ribbon seal stomachs during spring undoubtedly shed some light on foods eaten at other times of year.

In general, ribbon seals eat a variety of fishes, cephalopods (octopus and squid), and crustaceans (primarily shrimp and mysids). Soviet researchers have suggested that crustaceans are the main food of young seals. Based on food remains in stomachs of animals taken in spring, fishes and cephalopods comprise the bulk of the adult diet. Recent studies in the Bering Sea showed major regional differences in kinds and estimated quantities of fishes eaten. Pollock and eelpout were major prey in both the southcentral and central Bering Sea. Arctic cod were the main prey in the northern Bering Sea. Estimated quantities of food consumed were much larger in the southcentral Bering Sea than in either of the other two areas. Although selectivity was influenced by apparent abundance of prey species, in general, gadids (pollock, saffron cod, and arctic cod), eelpout, and Greenland halibut were selected, while sculpins and capelin, although abundant based on results of sampling by investigators, were seldom utilized. Depending on the species of fish being consumed, ribbon seals may select for certain size classes.

During the ice-free period and in winter when ribbon seals must feed intensively, there are no data on their food habits. Based on the distribution of seals and their potential prey, it is likely that pollock, eelpout, other fishes, and cephalopods are major foods during those months also.

G. Ecological Significance

Although a certain degree of partitioning of food resources does occur, the main known foods of ribbon seals are eaten by many other species of marine mammals, seabirds, and fishes. Sea lions, harbor and spotted seals, and fin, minke, and humpback whales share the pelagic and demersal fish resource with ribbon seals in the Bering Sea. Seabirds, especially near large rookeries such as the Pribilof Islands, depend significantly on pollock, an important prey of ribbon seals. It is not known if utilization of pollock is intensive enough to approach the point of inter-specific competition. Consumption of prey by the various major consumers, as well as a variety of other biological and physical factors, can undoubtedly influence the food resource base shared by all.

Several of the major prey items of ribbon seals are subject to harvest in commercial fisheries. To the degree that such fisheries influence distribution and abundance of major prey, they can be expected to affect the ribbon seal population. Foraging activities of ribbon seals in turn may affect size, productivity, and the competitive relationships among stocks of their prey and associated species.

H. Conflict Situations

Since ribbon seals are usually found far from shore, they may be less affected by many traditional forms of development than other marine mammal species. From March through June, association with the ice front and remnants is vital to ribbon seals. Since they appear tolerant to disturbance during that period, minimal precautions should prevent direct conflicts with activities such as normal oil and gas exploration and development. The health and productivity of the ribbon seal population however, depends on the health and vigor of the Bering sea ecosystem. Significant environmental insults of any type, therefore, may indirectly and directly affect abundance or availability of prey or appears to be of particular importance to ribbon seals. Increased exploitation of fisheries or development of any kind in that area should be undertaken with caution.

The perceived major potential conflict affecting ribbon seals in the Bering sea is the effect of intensive commercial fishing. Commercial fishing affects the distribution and abundance of some important forage fishes, thus directly reducing available food and altering relationships of inter-specific competition among birds, mammals, and fishes. This conflict does not appear acute at present. Sound multi-species management policies and practices should ensure an equitable distribution of resources and the future health of the ribbon seal population.

I. Harvest Levels

Although they had long been known to coastal residents and later to early whalers, significant utilization of ribbon seals did not begin until the 1950's when commercial taking by the Soviets began. Prior to that period, the generally offshore nature of the species prevented coastal hunters from taking significant numbers. Harvest of ribbon seals in the Okhotsk Sea began in 1954 with annual harvests as high as 18,500 recorded. Harvests in the Bering Sea began in 1961 and averaged about 10,000 annually through 1967. The highest recorded harvest in the Bering Sea was 14,600 animals in 1966. Reduction of the Bering Sea harvest through regulation was begun in 1968. The annual harvest was reduced to 3,000 by 1969 and has been at or below that level since then. Harvested seals were processed for hides, oil, and meat. In addition to the animals retrieved, an estimated additional 14 percent were wounded but lost.

Bullet scars found on harvested animals indicated that many of the wounded did not die.

The taking of ribbon seals by Alaskan hunters is strongly dependent on the extent of spring ice which determines the proximity of the ice front and remnants to coastal settlements. Annual harvests are usually less than 250 animals. The highest recorded harvest was estimated at 1,100 in 1967, a year of very minimal ice. Ribbon seals are taken primarily for their skins which are tanned and used for garments. Skins of males are preferred due to their more distinct markings. Since many adults are molting during the time they are available to hunters in the northern Bering Sea, much of the harvest is comprised of immature animals. Pups have good quality skins throughout the spring, and subadults complete the annual molt earlier than do the adults.

Due to provisions of the Marine Mammal Protection Act of 1972, Native hunters are presently allowed to take ribbon seals, but cannot sell raw products such as skins except to other Natives. Since only a small number of skins can be used annually in the manufacture of Native handicrafts, hunters make little use of ribbon seals in years when they are abundantly available.

J. State Management Objectives

The primary management objectives which the State of Alaska would pursue relative to ribbon seals are protection of adequate habitat and maintenance of a healthy and productive population. If necessary the harvest would, to the extent possible by the State, be limited such that the long-term average annual take does not disadvantage the population or cause it to fall below the optimum sustainable population level. Harvests of ribbon seals and other marine resource species would be balanced to ensure the health and stability of the Bering-Chukchi ecosystem. Human intrusions into ribbon seal habitat could be prevented, mitigated, or regulated where possible to avoid long-term detrimental effects to the population or the capacity of the habitat to sustain ribbon seals.

Secondarily, the State would provide for beneficial uses of the ribbon seal resource by all people. As provided for in State statutes, preference in the harvest of ribbon seals would be given to residents with a customary and traditional dependence on them for subsistence. Economic benefits consistent with the primary objectives would be maximized in regions where alternate sources of income are limited. If, after subsistence needs are met, a harvestable surplus remains, ribbon seals could be harvested by recreational hunters. Other beneficial uses would be encouraged. All uses would be regulated in such a manner that the health of the ribbon seal population is maintained while conflicts with other resources are minimized, and the greatest overall benefit to all people is obtained.

K. Problems

Present provisions of the MMPA preclude actual management of the ribbon seal population and regulation of its users. Although ribbon seals are an available and valuable subsistence resource, Native hunters can make comparatively little use of them.

No major problems are anticipated with regard to future State management of ribbon seals. In the absence of large commercial or subsistence harvests, and given the secure status of the population, the amount of biological data gathered would be small. Emphasis would continue to be placed on monitoring harvest levels. Collection of biological data through specific and directed study of ribbon seals is costly due to logistic requirements. Biological sampling would be accomplished in conjunction with other studies on a continuing basis. In the absence of significant harvests, the opportunity and need for close monitoring of population parameters would be reduced.

During the formulation and implementation of plans for development and conservation of resources in the Bering-Chukchi region, it will be necessary to take into account the well-being of the ribbon seal population. Available data will be integrated into management plans and significant data gaps will be filled, wherever possible.

L. Biological Impacts of Current and Proposed Management Plans

The present U.S. management policy for ribbon seals has little, if any, biological impact on the species. Few ribbon seals are taken by U.S. citizens, and the population is stable or slowly growing. A similar situation would prevail under the proposed management plan. The proposed plan would allow for management of ribbon seals in a multi-species, ecosystem-based context. For example, by manipulating bag limits and sex and age of harvested animals when warranted, it would be possible to regulate the effect of harvests on population size and productivity in order to maintain a stable relationship between ribbon seals and other ecosystem components.

M. Projections

If management authority for ribbon seals were regained by the State, a management program would be initiated to meet the specified management objectives. As presently envisioned, all residents dependent on ribbon seals as a resource would be allowed to hunt them without season or bag limit restrictions. If a harvestable surplus remains, other persons may be allowed to take limited numbers of ribbon seals. Sale of raw parts would allow efficient and full utilization of harvested animals. The magnitude of the American harvest would be closely monitored, and biological specimens would be collected from harvested animals whenever practical. The total annual take of ribbon seals would be maintained at a level such that the

population remains within the range of optimum sustainable population.

At present, based on the difficulty of access to ribbon seals and the lack of demand for products made from them, it is likely that future harvests would remain small. If, however, a favorable market for skins is developed, harvests as high as 1,500 animals could occur in some years, as happened in 1967. Management strategies and regulations could ensure that the harvest does not disadvantage the population. Long-term average annual harvests are unlikely to exceed 500 animals.

Consideration would be given to ribbon seals in the formulation of State conservation and management plans and in State input to relevant Federal plans and actions.

Resumption of State management is expected to have no adverse impact on ribbon seals or their users. Resident hunters in coastal Alaska would not be jeopardized by State management since they would be allowed to harvest ribbon seals within acceptable biological limits and sell raw products from them. The preference for subsistence utilization would be maintained.

N. Economic Analysis

Under present circumstances, the economic value of ribbon seals to U.S. citizens is very small. It is probable that the skins of ten to 50 animals are used annually in Native handicrafts with a total value of perhaps $1-5,000.

The possible value of ribbon seal skins depends on a large number of factors, but it is likely that properly processed skins in good condition would be worth an amount similar to other seal species, about $40 apiece. Carcasses of harvested seals, although not preferred for human food, are certainly usable for animal feed. A reasonable value for meat and blubber is $0.77/kg; therefore the value of an average seal for food would be about $40. Based on these figures, a harvest of 500 ribbon seals would be worth $20,000 if only hides were taken and sold raw, or $40,000 if both hides and carcasses were retrieved.

It is possible that the unique attributes and coloration of ribbon seals may encourage some recreational viewing, photography, and hunting of them. However, due to the remote location of ribbon seals during the season in which they haul out and can be observed, few people will ever view the species in the wild. Ribbon seals have thus far proven difficult to maintain in captive situations such as oceanaria.

O. Management Effectiveness

After Alaska Statehood and prior to passage of the MMPA, ribbon seal harvests were subject to regulations similar to those for other ice-inhabiting seals. Since the average annual take was small, it was not necessary to enact season or bag limit restrictions or quotas. The harvest of ribbon seals was monitored each year in conjunction with other marine mammal management programs. Biological samples were collected from harvested animals whenever possible. During scientific expeditions in the Bering Sea, particular attention was devoted to gathering data on ribbon seal distribution, abundance, and life history.

After enactment of the MMPA, State regulations on take of ribbon seals were no longer in effect. Since the species was not designated depleted, no regulations were (or could be) effected with regard to take by Natives. Monitoring of the harvest and associated research programs were continued by State biologists through 1979. These programs have since been discontinued. The responsible Federal agency (National Marine Fisheries Service) has not monitored recent harvests and has not developed significant research programs on ribbon seals.

P. Selected References

Burns, J. J. 1969. Marine mammal report. Alaska Department of Fish and Game, Juneau. Annu. Proj. Seg. Rep., Vol. 10. 25pp.

Burns, J. J. 1981. Ribbon seal-*Phocafasciata*. Pages 89-109. In R. J. Harrison and S. H. Ridgway, eds. Handbook of Marine Mammals, Vol. 2. Academic Press, London and New York.

Burns, J. J. and F. H. Fay. 1970. Comparative morphology of the skull of the ribbon seal, *Histriophocafasciata*, with remarks on systematics of Phocidae. J. Zool. 161:363-394.

Fedoseev, G. A. 1973. (Morphological-ecological characteristics of ribbon seal populations and factors affecting the conservation of usable stocks.) Izv. TINRO 86:158-177. In Russian. (transl. by Transl. Bur., Dep. Sec. State, Ottawa, Ont., Canada, Fish. Mar. Serv. Transl. Ser. No. 676796, 1975, 50pp.)

Frost, K. J. and L. F. Lowry. 1980. Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring. Can. J. Zool. 58:1601-1607.

Shustov, A. P. 1965. (The effect of sealing on the state of the population of Bering Sea ribbon seals.) Izv. TINRO 59:173-178. In Russian. (Transl. by Bur. Commer. Fish., Off. Foreign Fish. (Translations), U.S. Dep. Inter., Washington, D. C., 11pp.)

Shustov, A. P. 1965. (Some biological features and reproductive rates of the ribbon seal (*Histriophoca fasciata*) in Bering Sea.) Izv. TINRO 59:183-192. In Russian. (Transl. by F. Essapian, Miami, Fla., 1968, 17 pp.)

Shustov, A. P. 1965. (The food of ribbon seals in the Bering Sea). Izv. TINRO 59:178-183. In Russian. (Transl. by F. Essapian, Miami, Fla., 1968, 10 pp.)

Shustov, A. P. 1969. (Relative indices and possible causes of mortality of Bering Sea ribbon seals). Pages 83-92 in (Marine Mammals). Akad. Nauk, Moscow. In Russian. (Transl. by F. H. Fay, Univ. Alaska, Fairbanks, 18 pp.)

The Ringed Seal *(Phoca hispida)*

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Ringed Seal
Phoca hispida

A. Introduction

Ringed seals, *Phoca hispida,* are the most widespread and abundant marine mammals in ice-covered regions of the Northern Hemisphere. They are circumpolar with seasonal sea ice. Historically, ringed seals were important in both subsistence and commercial economies of residents of the far north. Today they remain an important subsistence species to Eskimos of those regions.

Ringed seals were first described as *Phoca hispida* by Schreber in 1775. At least five subspecies of *P. hispida* are presently recognized. *Phoca hispida hispida* is the most widespread and numerous of these and is the subspecies which occurs in the polar basin and adjacent seas including the Bering, Chukchi, and Beaufort seas.

Ringed seals, like other pinnipeds, are adapted to swimming and feeding in water, but require a solid substrate on which to bear their young and molt. They are members of the Family Phocidae (true seals) and differ from other pinnipeds such as walruses and sea lions by having no external ear pinnae and hindflippers which cannot be turned forward. The muzzle of a ringed seal is short, and the face is catlike, rather than long and doglike, as in spotted and harbor seals. Body shape is rotund, somewhat resembling a short, plump cigar, with girth at the foreflippers often exceeding 80% of the zoological length during winter.

As the common name "ringed seal" suggests, these seals are characterized by prominent gray-white rings found on the generally dark gray backs of adults. The rings may be separate or somewhat fused together. The belly is usually silver. Ringed seal pups are born with a white wooly natal coat (lanugo) which is longer and finer than the adult coat. The lanugo serves to maintain heat and prevent the pup from melting into and puddling the ice until it has acquired an insulating layer of blubber. Pups begin to shed the lanugo two to three weeks after birth and are completely molted by the time they are six to eight weeks old. The coat of a newly molted pup is fine-textured, silver on the belly, and dark gray on the back, sometimes with traces of the adult ringed pattern.

Ringed seals are the smallest of all northern phocids. Pups at birth weigh about 4.5 kg and average 65 cm in length. By June when they are about two months old pups have grown to approximately 13 kg and 72-74 cm. Mean standard length for one-year-old seals is about 75% of mature adult size. Growth continues throughout the first eight to ten years of life. Ninety-three to 98% of the final body length of 120-140 cm is attained by sexual maturity at six to eight years. The size attained by adult ringed seals varies geographically, and in all age classes there is great individual variation in length and weight. Males on the average are slightly longer than females. The average weight of an adult ringed seal in Alaskan waters is about 50 kg, while pregnant females may exceed 100 kg. Body weight and blubber thickness fluctuate markedly throughout the year. Physical body condition, as measured by weight and blubber thickness, is best during the winter and poorest in July-August after a prolonged period of reduced feeding associated with breeding and molting.

B. Distribution and Migration

The subspecies *P. h. hispida* is found throughout the arctic basin along the arctic coasts of North America and Eurasia including Greenland, Baffin Island, Novaya Zemlya, Spitsbergen, and Labrador. Ringed seals range seasonally into the North Atlantic, Hudson and James bays, and the Bering Sea.

Sea ice appears to be the major factor affecting ringed seal distribution. Since ringed seals often prey on pelagic organisms, their distribution does not appear to be limited by water depth. They are found over abyssal depths of the high arctic as well as in shallow waters of the continental shelf.

Ringed seals are the most ice-adapted of all northern pinnipeds and are the only seals in the Northern Hemisphere that regularly inhabit the fast ice. Densities are greatest in the fast ice which is occupied mostly by breeding adults that make and maintain breathing holes and excavate subnivian lairs in which to rest, give birth, and nurse their pups. Ringed seals are also found in the flaw zone adjacent to the fast ice and in moving pack ice, where the proportion of immature animals is high. Densities in the pack ice are much lower than in the fast ice. Due to the vast areas of pack ice, however, seals there probably far outnumber those associated with the fast ice. Few ringed seals are found in the ice front and fringe zones at the southern extent of seasonal sea ice in the Bering Sea.

During winter and early spring, ringed seals are abundant in northern Bering Sea, Norton and Kotzebue sounds, and throughout the Chukchi and Beaufort seas. They occur as far south as Nanivak Island and Bristol Bay, depending on ice conditions in a particular year, but generally are not abundant south of Norton Sound except in nearshore areas. Most animals which winter in the Bering and Chukchi seas migrate north in spring as the ice retreats and melts, hauling out on disintegrating ice to bask and molt. Many pass through Bering Strait in May and June. A small proportion of the population, mainly juveniles, may remain in ice-free areas during summer, but most ringed seals spend the summer in the pack ice of the northern Chukchi and Beaufort seas, as well as in nearshore ice remnants in the Beaufort Sea. With the onset of freezeup in autumn, many ringed seals undertake a southward migration and are abundant in grease and slush ice in areas south of the advancing pack.

It is unknown whether all ringed seals undertake an annual migration, or whether seals use the same wintering and summering areas every year. Consequently, questions concerning identity and degree of interchange among populations of this subspecies remain unanswered. The only substantial study of movements based on marking was conducted in northwest Canada, where 300 seals were marked at Herschel Island and Cape Parry. Of four recoveries, two were essentially local and two indicated substantial westward movement to Point Barrow, Alaska and East Cape, Siberia.

C. Habitat Requirements

Suitable ringed seal habitat must include an adequate food supply, freedom from excessive predation, and physical conditions appropriate for completing major life history events such as reproduction and molting. Requirements are not static, but change seasonally and with age and physiological condition of the seals.

Most ringed seals are associated with sea ice year-round. The ice provides a stable platform on which to bear and nurse young and haul out to complete the annual molt cycle. It also affords some protection from predators and exposure to extreme weather conditions. Additionally, the presence of ice influences the distribution and availability of prey species. Ringed seals require regular access to air and water through the ice cover. Because they are able to make and maintain breathing holes by frequent use and by abrading the ice with the claws of the front flippers, they can occupy areas of heavy, unbroken ice unsuitable for other northern pinnipeds. The total sea ice habitat is partitioned by seals on the basis of age, sex, reproductive condition, or a combination thereof.

During winter and spring, highest densities of breeding adult seals occur on stable landfast ice. During spring adults appear to be territorial, as indicated by frequent vocalization, the occasional exclusion of immature animals from breathing holes, and intraspecific aggression indicated by the presence of numerous small cuts and scratches on the flippers and body of adult individuals. Subadults may be excluded from fast ice where adults are numerous during the pupping and mating period. Subadults comprise the most numerous age cohorts in the adjacent flaw zone. Seals of all ages are present at low densities throughout pack ice. Breathing holes are numerous along cracks or refrozen leads and polynyas.

Pups are born in birth lairs hollowed out of snow which has accumulated around relief features on the ice. Relatively stable ice is a prerequisite for the survival of pups to the age of independence at 4-6 weeks. It has been suggested that geographical differences in the size attained by adults may be attributable to varying ice conditions. In the Canadian Arctic, pups born along complex coastlines on stable ice tend to be larger at weaning than pups born along simple coastlines and on less stable ice. Ice tends to break up later along complex coastlines, thus allowing a longer nursing period. In Alaska, pups born on shorefast ice tend to be larger than pups born in the moving pack ice.

During late spring and early summer, ringed seals use ice as a solid substrate on which to haul out and complete their annual molt. They use the fast ice as well as relatively large flat floes in the pack and are usually seen near cracks, leads, or holes where they have rapid access to water.

Ringed seals feed mostly on a variety of small fishes and crustatceans. As discussed in Section F (Food Habits), there are seasonal, geographical, and age-related differences in diet. In Alaskan waters, arctic and/or saffron cod generally make up over 90% of the diet during late autumn. The preferred association of ringed seals with fast ice is probably due not only to the requirement for stable pupping substrate but also to the abundance near shore during autumn and spawn under the fast ice in winter.

During the spring and early summer molting period when seals are hauled out on the ice, feeding intensity is greatly reduced and the availability of food is probably not a major factor in determining suitability of habitat. In summer and early autumn, ringed seals feed intensively, restoring fat reserves depleted during the molt. Since the major food at this time is small crustaceans, each weighing less than a gram, prey must be very dense for a seal to be able to catch an adequate daily ration. Few data are available on prey distribution and patchiness or the factors which determine them. Those factors, however, must also indirectly influence the distribution and abundance of ringed seals by determining the availability of adequate food.

Major predators of ringed seals include polar bears, arctic foxes, and humans. Ringed seals of all ages constitute the main food of polar bears. In Alaskan waters, polar bear predation is greatest in the flaw zone and broken pack ice where seals are accessible, and less intense in the fast ice. Bears often wait at breathing holes or dig into lairs. Arctic foxes are major predators on the fast ice where they kill pups in birth lairs. Predation by humans is discussed in Section I.

D. Abundance and Trends

As is the case with most species of marine mammals, there is no completely satisfactory method of accurately censusing ringed seals, and the estimation of population size is far from simple. Aerial surveys in which seals are counted on the ice provide indices of abundance but not estimates of total numbers, since the proportion of hauled out seals relative to total numbers is unknown. Surveys are nonetheless valuable for year-to-year comparisons of density, for determination of habitat preference, or, when correction factors are applied, for providing minimum estimates of abundance.

Ringed seals comprised more than 99 percent of the marine

mammals seen during aerial surveys over the fast ice of the Beaufort and Chukchi seas in June 1970, 1975, 1976, and 1977. The density of seals ranged from a low of 0.4 seals/nm2 between Flaxman and Barter islands in 1976 to a high of 6.2 seals/nm2 between Wainwright and Barrow in 1975. The average density of hauled-out ringed seals in the pack ice in 1976 was 0.2 and 0.1/nm2 in the Chukchi and Beaufort seas. Densities of ringed seals in favorable habitat of the eastern Canadian Arctic are considerably higher, with estimates of ten to 35 ringed seals/nm2 in the fast ice within one mile of shore and five seals/nm2 at greater than one mile offshore. Densities from Alaskan surveys when applied to estimates of available habitat of various types produce estimates of at least 250,000 ringed seals on the shorefast ice and a total population in Alaska of one to 1.5 million. Based on polar bear predation rates, these estimates are probably conservative.

Nothing is known of historical population levels of ringed seals. All indications, however, are that present levels are not much different than during the 18th and 19th centuries and that the population is probably stable or increasing slightly due to a decline in human harvest in recent years.

E. Vital Parameters

The biology of ringed seals has been studied in conjunction with U.S. and Canadian subsistence and Soviet commercial/research harvests for more than 25 years. Consequently, most of the basic vital parameters of ringed seals are relatively well known.

Sexual maturity occurs at about the same age in males and females, between five and seven years. In males, sexual maturity is marked by a rapid increase in testes and baculum size and by the onset of spermatogenetic activity. Males are territorial, but it is not known whether they breed one female or many. While female ringed seals may ovulate for the first time at three years of age, successful pregnancy does not occur until the fourth to seventh year of life. Reproductive rates appear constant from age ten to maximum life expectancy, which is about 40 years, although average life expectancy is between 15 and 20 years.

Most breeding occurs in late April and early May within one month after parturition. Implantation of the fetus, which is delayed for about 3½ months after fertilization, occures in late August. Most pups are born from March to early April for the total gestation period (including delayed implantation) of 10-½ months. Although twinning has been reported, a single pup is by far the most common. At birth, as in adulthood, the sex ratio is one to one.

The gross productivity of ringed seals is basically dependent on the proportion of mature females in the population and the frequency with which they produce pups. The proportion of mature females depends on age at sexual maturity and the adult sex ratio, both of which are reasonably well known, as well as the age structure of the population. The latter is known with less certainty since data are obtained from harvests and may reflect geographical differences in age structure or differential susceptibility of age classes to hunting mortality. Based on harvest data, seals seven years or older make up 44% of all seals older than pups, and therefore mature females, assuming an adult sex ratio of one to one, make up 22% of the population. Since breeding occurs shortly after pupping, the normal interval between production of pups is one year. However, for various reasons some mature females do not produce young each year. The observed pregnancy rate for ringed seals in Alaska in 1975-1977 was 72% for females seven years or older or 84% for females ten years or older. This would result in a gross productivity of 16-18%. Since a small proportion of the females younger than seven produce young, gross productivity is actually somewhat higher.

Mortality rates for ringed seals are difficult to estimate, although most causes of mortality are known. In many northern pinnepeds, mortality in the first year may exceed 50% due to a variety of causes including exposure to extreme weather conditions prior to the accumulation of adequate insulating blubber layers, crushing by ice or other animals, starvation while the pup is first learning to feed, and predation. Based on life tables derived from harvest data, pup mortality in ringed seals may be as low as 30%. This is probably due to several factors: the birth of pups in lairs where they are protected from extreme weather conditions and some predation, the choice by experienced females of stable landfast ice as a pupping substrate, and a protracted nursing period. Mortality for age classes five to 15 is about 10% per year, increasing gradually after that.

Ringed seals host a variety of parasitic helminths, but rarely do such infestations cause death or have apparent detrimental effects. Natural predators are polar bears, arctic foxes, and occasionally walruses. The intensity of arctic fox predation in Alaska is unknown. In the Canadian Arctic, foxes (during the high in their cycle) may kill more than 40% of newborn pups; this, however, is apparently not the case in most areas surrounding Alaska. Polar bears are the most significant cause of mortality in seals older than pups. It has been estimated that each bear may kill and eat one ringed seal or the equivalent every six to seven days. The Alaskan population of 9,500 bears, therefore, could kill up to 530,000 seals annually if they took only ringed seals, or 265,000 per year if ringed seals comprised only 50% of their annual food. Human hunting of ringed seals is a relatively insignificant source of mortality. The combined Soviet and American harvest now averages approximately 10,000 seals per year.

Estimates of annual mortality suggest that the present population estimate of one to 1.5 million ringed seals may be quite low. Annual sustainable yield of ringed seals in the Canadian Arctic has been estimated as 8% which appears to be in agreement with figures from Alaska. If polar bears

remove the entire sustainable yield and the population is stable, as it appears to be, ringed seals in Alaska must number 3.3-6.6 million. Since human hunting and death due to other causes also occur, the actual population size may be even larger.

F. Food Habits

Ringed seals exhibit seasonal, geographical, and age-related differences in feeding. In late summer, autumn, winter, and early spring they spend much of their time in the water feeding. During late spring and early summer, when the annual molt occurs and the seals haul out on ice to bask, feeding intensity is greatly reduced. These seasonal changes in feeding intensity are reflected in the body condition of the seals. Seals are fattest in autumn and winter and leanest in May-July.

Ringed seals feed on a variety of organisms. Fishes of the cod family (especially arctic and saffron cods), pelagic amphipods, euphausiids, shrimps, and other small crustaceans such as mysids and amphipods make up the bulk of the diet. During winter arctic cod comprise 90% or more of the diet in most areas, and volumes of stomach contents are usually quite large. During spring, when food intake is low, a variety of epibenthic crustaceans is eaten, especially shrimps and amphipods. In late summer and fall, when feeding intensifies, pelagic crustaceans (euphausiids and hyperiid amphipods) or arctic cod are the major prey. This general pattern is somewhat variable on a geographic basis. Near Nome, for example, arctic cod are the major prey in midwinter, but saffron cod are predominant in autumn and spring. Shrimps are relatively more important to seals in Norton Sound than elsewhere, whereas seals near St. Lawrence Island eat more amphipods. Pup and subadult ringed seals eat proportionately more crustaceans and less fish than do adults. Crustaceans comprise a progressively smaller proportion of the diet as age increases from zero to about five years, while the proportion of fish increases. The exception to this generalization is the Beaufort Sea, where pups as well as adults eat large quantities of arctic cod.

G. Ecological Significance

Ringed seals are a major ecological component of the arctic and subarctic marine fauna. They are a major prey of polar bears and of arctic foxes living on the sea ice. Human hunters in coastal Alaska have traditionally depended on the harvest of ringed seals to provide nutritional and other needs.

Ringed seals are one of the most numerous high trophic level vertebrates in the arctic and compete for food with other marine mammals, seabirds, and fishes. On a seasonal basis, arctic cod, which are the major prey of ringed seals during winter, are also the major prey of seabirds foraging offshore, spotted and ribbon seals, belukhas, and humans. Nektonic crustaceans, important to ringed seals in summer and autumn, are also major prey of arctic cod, a variety of anadromous fishes, seabirds, and some whales. It is possible that competition for food resources could occur and affect the population status of ringed seals and other species which utilize zooplankton. For example, ringed seals, arctic cod, and bowhead whales form an interesting and closely linked ecological triangle in the Beaufort Sea. Arctic cod provide much of the annual nutrition of ringed seals. These fish consume zooplankton which are also utilized by ringed seals and bowhead whales. Ringed seals would compete with bowheads for food to some degree, especially if zooplankton were limited by natural or man-caused changes in the environment. Predation on arctic cod by seals certainly affects and may limit cod populations; seal foraging, therefore, may enhance bowhead food availability by reducing competition with arctic cod.

H. Conflict Situations

Increasing human activity in coastal and marine areas has led and continues to lead to increased interaction between humans and ringed seals.

Petroleum exploration and development are scheduled to occur in Norton Basin and the Chukchi Sea and have already commenced in the Beaufort Sea. Potential disturbances associated with such development include not only the possible catastrophic events resulting from blowouts or spills, but also, and perhaps more importantly, routine noise and activity associated with normal operations. In the Beaufort Sea in 1975-1977, preliminary data indicated that in areas where seismic profiling operations were conducted the densities of ringed seals were 25-50% of what they were in adjacent nondisturbed "control" areas. Furthermore, in this region, most seismic work occurs on shorefast ice where the density of breeding adults is greatest, thus increasing the likelihood of displacing females with pups. Similar seismic operations may occur in the Chukchi and Bering seas. Because of their association during winter with stable shorefast ice, ringed seals are more likely than many other seals (such as bearded seals found mostly in the offshore pack ice and transition zone) to occur in areas utilized by humans, who also require a stable platform on which to operate.

The effects of human activity on the food species of ringed seals are poorly known. Fishes of the cod family, especially the eggs and larvae, are very sensitive to hydrocarbon pollutants. Both arctic and saffron cod concentrate to spawn in nearshore areas under the fast ice. These regions of fast ice are where human activity during winter is most likely to occur.

Developing commercial fisheries in Alaska are less likely to affect ringed seals than other species such as spotted or ribbon seals. The major fishes eaten by ringed seals—arctic and saffron cods—are not and probably will not become

commercially important. They are utilized on a small scale by coastal subsistence fishermen.

I. Harvest Levels

Ringed seals have traditionally provided a portion of the subsistence needs of all Eskimo settlements along the coast of western Alaska from Kuskokwim Bay to Demarcation Point. They remain a dependable and basic source of food. By-products are made into articles of local use such as clothing, floats for hunting, and blubber for fuel at spring whaling camps. Some hides are used in cottage industry as raw materials for handicrafts providing a source of cash income in areas where economic opportunities are otherwise very limited. Between 1962 and 1972, the harvest of ringed seals by Alaskan residents ranged from about 7,000 to 15,000 animals annually, and the combined Soviet and American harvest varied between 9-16,000 ringed seals per year. Since 1972 harvests of ringed seals by coastal Eskimos have decreased markedly. From 1973 to 1977, the harvest of ringed seals, which comprised an estimated 65% of the total ice seal harvest, was 3-6,000 animals annually. By 1979 that harvest was estimated at 2-3,000 and comprised about 30% of the total seal harvest. The decrease in annual harvest can probably be attributed to a change in lifestyle and to the Marine Mammal Protection Act of 1972. Starting in the early 1960's, snow machines, for the most part, replaced sled dogs for transportation. This change has greatly reduced the need for marine mammal meat for dog food. In most villages, the importance of cash in the economy has increased dramatically in recent years. Prior to the MMPA, many seal skins were sold to provide needed cash resources. Since implementation of the MMPA, seals and seal products can no longer be sold to non-Natives unless they are first transformed into Native handicrafts. Hunters now have no immediate large-scale outlet for surplus skins. In addition, under the MMPA the right to harvest marine mammals is based strictly on ethnic considerations rather than on lifestyle or demonstrated need.

J. State Management Objectives

The maintenance of healthy and productive populations of ringed seals is the foremost goal of the proposed State marine mammal management programs. Within those guidelines, the State of Alaska considers the continuation of legitimate subsistence utilization of ringed seals by all coastal residents to be the first priority of management. This and other uses would be accommodated based upon the biological productivity and population status of the species. These objectives require that the ringed seal population be maintained within that range of abundance which constitutes an optimal sustainable population level.

The State recognizes the importance of maintaining suitable habitat for ringed seals and advocates comprehensive resource planning and, where required, the institution of controls on the use and development of the coastal and marine environments important to ringed seals and other living resources.

The State recognizes that ringed seals are part of a complex marine ecosystem where many species interact and utilize available resources. Management of any single species must be implemented with the understanding that changes in population status of that species may cause concurrent changes in prey populations and/or other consumer populations.

K. Problems

Problems in managing ringed seals under the MMPA stem from several sources: inability to implement a comprehensive management and regulatory program; inability to optimize benefits which could be obtained from this resource; inability to work toward or achieve an ecosystem approach to marine resource development; and exclusion of valuable scientific and financial support of the State of Alaska, which is required to protect and maintain this resource.

Under the provisions of the MMPA, ringed seals may be harvested only by Alaska Natives. Although ringed seals are an available and valuable subsistence resource, Natives can sell to non-Natives only those parts of the seal which have been converted into articles of Native handicraft.

The management of marine mammals, once considered a relatively straightforward matter of monitoring the status of populations and regulating harvests in accordance with population size and recruitment, is no longer so simple. Managers must consider the more subtle effects of exploration, development, and transportation of fossil fuels, extraction of minerals, expansion of commercial fisheries, increases in the human population, and intensified human activity in the coastal zone. A jurisdictional framework for coastal zone management, habitat protection, regulation of commercial fisheries, and multi-species management is prerequisite to confronting those issues. The MMPA does not provide such a framework. It was designed to protect declining or depleted marine mammal stocks from direct human harvests, primarily through prohibiting hunting and curtailing incidental mortality associated with commercial fisheries. In Alaska, where marine mammal populations are generally healthy, high, and either stable or increasing, such protection has been biologically unnecessary and in most cases, has created hardship and confusion among coastal residents and conflict with commercial fisheries. Moreover, for species or circumstances where protection and/or regulation are warranted, the Act exempts Alaskan Natives from regulation and thus potentially precludes effective preventive or corrective action.

L. Biological Impacts of Current and Proposed Management Plans

Under the MMPA, the options for management of ringed seals are few. Indirect evidence and indices of abundance

indicate that the ringed seal population size is high and stable, and that the present population level is probably not much different than during previous years. The harvest of ringed seals in Alaska has decreased from an average of about 11,000 seals per year in the 1960's, to less than 6,000 seals per year in the late 1970's. This decrease in hunting pressure, due to a combination of changing lifestyle and removal of a market for raw ringed seal products, may have resulted in a slight increase in the numbers of ringed seals, with probable concurrent changes of unknown magnitude in predator, prey, and other consumer populations. Since the number of polar bears may also have increased since enactment of the MMPA, the decrease in human predation may have been offset by increased bear predation.

The sale of raw products, such as surplus meat and skins, would be legal. In light of such changes in existing policy, the harvest of ringed seals might increase somewhat. It is unlikely that the increase, if it occurs, would be very great since the harvest is naturally controlled by weather, ice conditions, and seasonal availability of the seals. Moreover, since dogs are no longer used as a primary means of transportation, the need for marine mammal meat for dog food has been greatly reduced.

M. Projections

Proposed State management would allow the taking of ringed seals for subsistence use without bag limit or seasonal restrictions since hunting is effectively controlled by regional climatic conditions and seasonal availability of seals. It is anticipated that an increase in harvests could occur, but such an increase would be moderate in light of altered lifestyles and reduced use of marine mammal products. The harvest would probably remain less than pre-MMPA levels.

Under the MMPA, the State has no authority to impose regulations on the harvest of ringed seals, nor can it require information from hunters about that harvest. Resumption of State management would once again provide a legal basis for conducting a program to monitor the harvest and institute the other required components of a management program including continuing biological research and enforcement efforts.

No adverse impacts are expected from State management of ringed seals. Ringed seal populations will benefit from multi-species management and habitat protection programs. Coastal residents will benefit since their ability to use ringed seals as a source of food and cash income will be enhanced.

N. Economic Analysis

Ringed seals are one of the major subsistence species in northern Alaska. Their skins are used for clothing, containers, floats, and in the manufacture of handcrafted items for sale. It is difficult to assign a value to raw skins since their sale to non-Natives has been prohibited in the U.S. since 1972. Moreover, prices fluctuate from year to year depending on the fur market and the condition of the skins. In the early to mid-1970's prices ranged from $8-$40/skin. At today's prices $25-$40/skin is probably a realistic estimate of value. If the sale of skins on the open market were legal, a harvest of 6,000 ringed seals would have an economic value of $150-$240,000. This contribution would accrue to people who have little opportunity to secure an adequate income.

Although ringed seals are relatively small, their meat and blubber are valued for human consumption. Ringed seal meat is currently selling in Nome, Alaska for $4.36/kg, and oil for $10.23/kg. At those prices, assuming a yield of 40% meat and 40% oil, a harvest of 6,000 ringed seals represents about $350,000 in meat and $820,000 in oil. If half of the meat and oil were used by people and the other half used for animal food, valued at about $0.77/kg, the value of that same harvest would be $206,000 for meat and $442,000 for oil. Thus, the approximate total market value for a moderate harvest of 6,000 ringed seals is $650,000-$1,170,000 for meat and oil or $800,000-$1,400,000 for meat, oil, and skins.

It is unlikely that ringed seals will attract the attention of many sport hunters or tourists. There is some opportunity for viewing and photography in spring while the seals are hauled out and molting, and it is possible that small scale tourism might be developed.

O. Management Effectiveness

Prior to the MMPA, an ongoing State program monitored the seal harvest at major coastal hunting villages and produced reliable estimates of the magnitude and sex and age composition of the harvest. When the authority to regulate the seal harvest, and, concurrently, to require information and biological specimens from hunters, was eliminated by the MMPA, the State's ability to accurately monitor the harvest was severely hindered. Reliability of harvest estimates and availability of biological specimen material have steadily decreased since that time. At present the agency responsible for management of ringed seals (National Marine Fisheries Service) is not monitoring harvests nor does it have an organized research program for the species. Management concerns such as the impacts of coastal development, seismic exploration, and interspecies competition are being addressed by the State under funding from a variety of sources, as available. Thus, programs are of relatively short duration and directed at specific, localized problems rather than at important, overall information needs.

P. Selected References

Burns, J. J. and S. J. Harbo, Jr. 1972. An aerial census of ringed seals, northern coast of Alaska. Arctic 25:279-290.

Eley, T. J. 1978. An analysis of polar bear predation on Alaskan ice-inhabiting pinniped populations. AK. Dept. of Fish and Game, unpubl. ms., 12pp.

Fedoseev, G. A. 1965. Food of the ringed seal (*Pusa hispida* Schr.) Izv. TINRO 59:216-223 (in Russian).

Fedoseev, G. A. 1975. Ecotypes of the ringed seal (*Pusa hispida* Schreber, 1777) and their reproductive capabilities. Rapp. P.-V. Cons. Int. Explor. Mer 169:156-160.

Finley, K. J. 1978. Behavior and densities of ringed seals (*Phoca hispida*) during haul out in the high arctic, June 1977. Report prepared for Polar Gas Project by LGL Ltd. Toronto, Ontario. 107pp.

Lowry, L. F., K. J. Frost, and J. J. Burns. 1978. Food of ringed seals and bowhead whales near Point Barrow, Alaska. Can. Field-Nat. 92:67-70.

Lowry, L. F., K. J. Frost, and J. J. Burns. 1980. Variability in the diet of ringed seals, *Phoca hispida*, in Alaska. Can. J. Fish. Aquat. Sci. 37:2254-2261.

McLaren, I. A. 1958. The biology of the ringed seal, *Phoca hispida*, in the eastern Canadian Arctic. Bull. Fish. Res. Board Can. 118:97pp.

Pastukhov, V. D. 1969. Onset of sexual maturity of the female ringed seal. Fish. Mar. Serv. Transl. Ser. No. 1474.

Smith, T. G. 1973. Population dynamics of the ringed seal in the Canadian eastern Arctic. Fish. Res. Board Can. Bull. 181. 55pp.

Smith, T. G. 1973. Censusing and estimating the size of ringed seal populations. Fish. Res. Board Can. Tech. Rep. No. 427. 18pp.

Smith, T. G. 1976. Predation of ringed seal pups (*Phoca hispida*) by the arctic fox (*Alopex lagopus*). Can. J. Zool. 54:1610-1616.

Smith, T. G. and I. Stirling. 1975. The breeding habitat of the ringed seal (*Phoca hispida*): The birth lair and associated structures. Can. J. Zool. 53:1297-1305.

Stirling, I. and W. R. Archibald. 1977. Aspects of predation of seals by polar bears. J. Fish. Res. Board Can. 34:1126-1129.

The Spotted Seal *(Phoca largha)*

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Spotted Seal
Phoca largha

A. Introduction

Because they resemble the ubiquitous harbor seal, *Phoca vitulina*, of north temperate regions, spotted seals, *Phoca largha*, are familiar looking animals to most people. The morphological and behavioral similarities are so great that until recently the spotted seal was considered a northern subspecies of harbor seals, and was designated as *Phoca vitulina largha*. Recent studies of natural history and taxonomy of North Pacific phocids have concluded that the sum of the differences in the two seals warrants their distinction as separate species. Taxonomic confusion has been a problem in evaluating results of some earlier studies.

The English common name is a simple description of the coloration of spotted seals. About the time of weaning, when they are three to five weeks old, young seals shed their off-white lanugo and the spotted pelage characteristic of the species becomes evident. A typical spotted seal has many small, dark, irregularly shaped spots on a background of variable color. Spots are most numerous on the back and sides making these areas darker than the silver gray belly. There is considerable variation in background coloration with shades of yellow, off-white, and blue occasionally evident. The pattern of markings may be more or less dense and small, light-colored rings may sometimes be mixed with the spots.

The specific name *largha* is the Native name given this species in the western Okhotsk Sea. Largha (also spelled larga) is frequently used as a common name for the species in Soviet scientific and popular literature. The word largha is sometimes translated common seal which can cause it to be confused with the ringed seal. The shape of the head of spotted seals is like that of harbor seals which were called "sea dogs" by Europeans because of the long, dog-like snout. Inupiat Eskimos in Alaska refer to this seal as "kasegaluk."

Spotted seals are similar in size to ribbon and harbor seals. Pups at birth weigh about 10 kg and are approximately 85 cm long. Their weight increases rapidly while nursing but declines during the subsequent two to three months as the young animals learn to swim and feed. Adult seals are 142-170 cm in nose-tail length and weigh about 100 kg. Proportions of the body vary with seasonal and other changes in blubber thickness. Spotted seals are of medium build, neither as plump as ringed seals nor as lean as ribbon seals. Males and females are generally of similar size and appearance.

B. Distribution and Migration

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of sea ice in the Okhotsk and Bering seas. As is true for ribbon seals and many other species, the degree of interchange between seals in these ecologically similar regions is unclear. Since they are isolated during the breeding season, spotted seals of the Okhotsk and Bering seas are considered separate stocks. This report deals primarily with the Bering stock which also ranges seasonally into the Chukchi and Beaufort seas.

Although both ribbon and spotted seals occur throughout the fringe and front of seasonal sea ice, spotted seals are more common closer to open water in the smaller and more dispersed floes of the southern front and fringe. Regional variations in abundance are evident, but their causes are poorly known. In late April and early May, adult spotted seals seen on the ice occur in female-pup or male-female pairs or in male-female-pup triads. Subadults occur in larger groups. During late May and early June, spotted seals occur in loose groups of up to 200+ animals in the ice remnants of the northern and western Bering Sea. Many subadults, which complete the molt earlier than adults, appear not to remain in the ice remnants but rather move to the Bering Sea coast where several species of fishes become concentrated at that time. This movement to and dispersal along the coast continues throughout the period of ice degradation and recession.

During summer months, spotted seals are found primarily in the Bering and Chukchi seas, but some range into the Beaufort and perhaps the East Siberian seas. At this time of year, an unknown proportion haul out on mainland beaches and offshore islands and bars and are seldom found in pack ice except when it is very near shore. Seals are common in bays, lagoons, and estuaries, often in areas also frequented by belukha whales. Their distribution in summer and autumn coincides with that of the schooling fishes on which they feed.

Spotted seals seem poorly adapted to arctic winter conditions and leave the northern portions of their range with the onset of freezeup. At that time, they become increasingly evident along the Bering Sea coast, often hauling out on newly formed ice. Thickening ice cover forces them southward to their pupping areas at the southern edge of the ice.

C. Habitat Requirements

Unlike the closely related harbor seals which bear and nurse their young on coastal rookeries, spotted seals complete these important life history events on sea ice. Many of the ecological and behavioral attributes of spotted seals result from this association with ice. Floes selected for pupping are usually less than ten meters across, separated from adjacent floes by slush ice or water, and subject to rapid dispersal and compaction by winds and currents.

Pups are mobile from birth, but swim poorly for many weeks and, therefore, generally move passively with the ice on which they are born. Ice characteristics in pupping areas appear to balance regular access to water, provided by moving floes, with physical instability caused by proximity to the open ocean and the effects of storm-caused turbulence. The reason for selection of particular pupping areas may be their proximity to prey concentrations or future summering regions. Competition for food and space with other ice-breeding species, particularly ribbon seals, may be of some importance. Non-breeding spotted seals, although often clumped in fairly large groups, generally occur over a larger area.

Many spotted seals complete their molt in late spring while associated with ice remnants. Since they commonly haul out on land, however, association with remnants is probably not critical for molting. Newly weaned seals are passively transported in a generally northward direction by the receding ice and use remnants during the period of developing independence. In general, availability of food seems poor where and when remnants usually occur.

The behavior of and habitat used by spotted seals during ice-free months is similar to that of harbor seals. The coastal zone they inhabit also supports large concentrations of resident, anadromous, and coastal spawning fishes. Necessary characteristics of hauling areas are poorly known, but proximity to food and freedom from disturbance are obviously important. The function of haulouts is also unclear but may be related to energetic considerations.

Other than during pupping and breeding, access to prey and avoidance of predation and disturbance are probably the most important factors affecting spotted seal distribution. Predators of possible significance include sharks, killer whales, walruses, sea lions, and humans. Seals are wary, but probably difficult to disturb significantly while in the water. They are easily chased from ice or land, however, and such disturbance, if repetitive, could result in abandonment of pups or hauling areas.

Several other species of marine mammals are also abundant in the Bering-Chukchi region. In the northern Bering and Chukchi seas in summer, spotted seals mainly inhabit nearshore waters which are also occupied in that season by belukha whales. During winter many of these same areas are occupied by ringed seals. At the southern extent of their range, Karaginski and Bristol bays on the Siberian and Alaskan coasts and the Pribilof Islands, they mingle with harbor seals which replace them entirely farther to the south. Many species of marine mammals and birds share the abundant food resources of the southern Bering Sea. Competition for resources undoubtedly affects suitability of spotted seal habitat.

D. Abundance and Trends

Estimation of spotted seal abundance is difficult. They can be counted while hauled out on either ice or land. The area over which they range, although extensive, can be surveyed if a large commitment of funds and personnel are provided. A major difficulty is encountered in the extrapolation of counts to the probable total number of animals present in an area. Hauling behavior may vary with season and sex and age of individuals, and for all seals is affected by weather conditions and diurnal patterns. Available data indicate that the proportion of animals hauled out and countable from the air varies widely during spring. No data are available on summer haul out patterns.

Shipboard and aerial observations of spotted seals during spring have been made for several years by Soviet and American scientists. Although these observations have been of great value in determining distribution, relative abundance, and group composition, they have been of limited use in population enumeration. However, observations have shown that during late April and early May, members of pupping pairs and triads are hauled out during many of the daylight hours. The estimated population of spotted seals in the Bering Sea is 200-250,000.

No data are available to indicate possible trends in spotted seal abundance. Considering that harvests in past and recent years have been relatively low and stable, however, it is likely that population size has been fairly constant.

E. Vital Parameters

Vital parameters of spotted seals are poorly known in comparison with some other northern phocids. Studies of samples from Soviet harvests in the Okhotsk and Bering seas combined with materials which have been collected over a number of years from seals taken by Alaskans, provide a basic understanding of the biological characteristics of spotted seal populations. Nonetheless, their biology remains less studied than that of more widely distributed or intensively harvested species.

Sexual maturity is achieved at age three to four in spotted seal females and four to five in males. Breeding age animals comprise about 60% of the population excluding pups. Breeding is monogamous, and 85-95% of all adult females become pregnant in a given year. Sex ratio is probably one to one. If mortality between conception and birth is about 10%, i.e. 75-85% of adult females produce young, gross annual production of pups is 22-25%.

Age structure data have been analyzed only for Okhotsk Sea spotted seals. Mortality in the first year of life was estimated as 45% and declined to 5-6% annually at sexual maturity. Maximum longevity in spotted seals is about 35 years. Pups die from accidents, including crushing by ice, abandonment and subsequent starvation, and from predation by walruses, killer whales, sharks, and sea lions.

Human hunting is probably the primary source of mortality for adult animals. The influence of disease and parasitism is poorly known. Sustainable harvest has been estimated at 4-5%.

F. Food Habits

Spotted seals are weaned at three to four weeks when they have acquired a thick blubber layer. They require several weeks to become proficient at swimming and feeding during which time their weight may decrease by 20%. Crustaceans (shrimps, mysids, euphausiids, and amphipods) and a variety of small fishes are eaten by young seals. Adults rely primarily on several species of abundant pelagic and demersal fishes although shrimps and cephalopods (octopus and squid) may be important foods in some areas. Spotted seals are not deep divers and feed almost exclusively on the continental shelf.

While spotted seals are associated with the southern Bering Sea ice front, their major foods are capelin and pollock. In ice remnants in May and June, a greater variety of species is eaten including herring, capelin, sand lance, arctic cod, saffron cod, and sculpins. Feeding, however, is reduced in ice remnants since the primary activity is basking in the sun and molting. The prey species eaten during summer and autumn vary with the area and time of year. Direct observations are quite limited; however, herring, capelin, smelt, saffron cod, and arctic cod are probably all of major importance. Seals may be selective with respect to species and size classes of fishes consumed.

Other than a reduction of feeding by adults during May-June, seasonal variations in food intake are not known. It is likely that the sequentially abundant coastal spawning fishes (herring, capelin, smelt, saffron cod, and arctic cod) can be caught easily in large quantities. These species are probably of great importance in the annual diet of spotted seals and other marine mammals.

G. Ecological Significance

Throughout the year, spotted seals occur principally in areas where sea ice or land provide convenient hauling areas in close proximity to food resources. Depending on the area and season, many other species of marine consumers share the same prey species. In the southeastern and southcentral Bering Sea, forage fishes such as pollock, capelin, and herring are eaten by ribbon and harbor seals, fin, minke, humpback, and belukha whales, as well as harbor porpoises, fur seals, sea lions, and many species of seabirds. Competition for food among spotted seals and other species may be most intense in the rich waters near the Pribilof Islands and in outer Bristol Bay. Farther to the north, trophic overlap is greatest with belukha whales and ringed seals. Effects of competition for food on population parameters of the various marine mammal species are not known. The removals of prey species by these marine consumers and commercial fisheries certainly influence distribution, abundance, and productivity of fish stocks.

The spotted seal, adapted to use sea ice for reproduction, replaces the harbor seal in areas of seasonal sea ice within the Bering Sea. In areas where both species occur, such as along the coast between Bristol Bay and the Yukon-Kuskokwim delta, they may compete for hauling areas as well as for food. In winter, when fast ice excludes spotted seals from the coastal zone, they are replaced by the truly ice-adapted ringed seals. Competition for pupping and nursing areas is unlikely due to the vastness of the ice front and partitioning of habitats among the various species of marine mammals.

Although they are occasionally eaten by large non-human predators, spotted seals are of greatest nutritional importance to coastal subsistence hunters. They are one of the major species among available subsistence resources, particularly along the Bering and Chukchi Sea coasts. Utilization will be discussed more fully in Section I.

H. Conflict Situations

From February to May, the ice front of the Bering Sea is used by spotted seals as an area in which to give birth, breed, molt, and feed. In its usual position during late winter-spring, the ice front overlies biologically productive regions of the Bering Sea shelf. Species such as fur seals and fin whales migrate annually to these regions to feed on abundant forage fishes. These same forage fishes, particularly walleye pollock and herring, occur in such abundance as to be target species for modern high seas fisheries. Herring stocks are being fished in coastal waters at increasing levels. Stocks of both herring and pollock were reduced in the recent past due to excessive take by commercial fisheries and marine consumers. Future management plans and policies should, to the extent possible, avoid such extreme fluctuations in stock size as they may be detrimental to productivity of spotted seals and other marine mammal species.

Activities such as offshore oil and gas exploration and development, which are scheduled to occur throughout much of Alaskan waters, pose multiple threats to the spotted seal population. Pupping areas frequently occur in the North Aleutian Shelf and St. George and Navarin basins. Although disturbance caused by normal activities could occasionally contribute to pup mortality, the greatest threat is from hydrocarbon contamination of the environment. Pups in the area of a spill are very likely to become oiled since wind and wave action will cause oil to cover the ice as well as the slush and open water between floes. Mothers are also likely to become oiled. Pups exposed to such physiological and perhaps nutritional stress are likely to experience reduced survival rates. In addition, hydrocarbons in the water may affect prey populations which could cause a longer lasting reduction in spotted seal productivity.

Large numbers of spotted seals occur in the northern Bering Sea in June while basking and molting and passing north through the Bering Strait. Offshore oil operations in the Norton and Hope basins are a major potential problem with respect to disturbance and contamination. Weaned pups are stressed as they learn to swim and capture prey and may be particularly vulnerable if exposed to oil in the environment.

During open water months while distributed in coastal waters, spotted seals are probably most vulnerable to disturbance, contamination, and competition for food. Like harbor seals, spotted seal hauling areas are usually remote and normally subject to little disturbance. Seals are easily frightened into the water and may abandon hauling areas where they are repeatedly disturbed. Contamination of their habitat from industrial sources and extraction of nonrenewable resources is insignificant at present but will increase greatly in the near future. The tolerance of spotted seals and their major prey for such contamination is poorly known. The abundant fishes which spotted seals eat during summer and autumn can also be efficiently caught and utilized by people. At present commercial utilization of these species occurs primarily south of Bering Strait while subsistence fishermen harvest comparatively small quantities wherever they are available. Future plans for increased exploitation of abundant coastal fishes will have to consider the food needs of marine mammals such as spotted seals and belukhas.

I. Harvests Levels

Spotted seals are hunted in the Bering and Chukchi seas for both subsistence and commercial purposes. Alaskan Eskimos take these seals for food and use skins for making garments and other products. Where they are abundant, in regions such as Bering Strait and the Yukon-Kuskokwim delta, they are hunted in such numbers that they may be one of the major subsistence resources. Spotted seals are hunted commercially by the Soviets for hides, oil, and animal food.

Total annual Soviet harvest of spotted seals in the Bering-Chukchi region from 1966 to 1976 ranged from 1,800 to 5,600 with an average of about 3,850. Approximately 89% of the total was taken by commercial vessels, and the remainder by land-based hunters. Annual harvests during the comparable period along the Alaskan coast have ranged from 850-3,600 with an average of about 2,400.

J. State Management Objectives

The primary objective which the State of Alaska would pursue in regard to spotted seals is the maintenance of a healthy and productive population. Harvests would be limited as necessary to ensure that the population remained within the optimum sustainable range. Intrusions into spotted seal habitat could be prevented, mitigated, or regulated to avoid long-term detrimental effects to the population or the capacity of the habitat to sustain spotted seals.

The second major objective would be to provide for the beneficial uses of the spotted seal resource by all people. As provided for in State statutes, preference in the harvest of spotted seals would be given to residents with a customary and traditional dependence on them for subsistence. If, after subsistence needs are met, a harvestable surplus remains, spotted seals could be harvested by recreational hunters or commercial interests. Other beneficial uses would be encouraged. As may be required, uses would be regulated in such a manner that the health of the population is maintained while conflicts with other resources are minimized and the greatest overall benefit to all people is obtained. It is realized that the maintenance of spotted seals within the OSP range will involve some unavoidable conflicts with other resources.

K. Problems

Present provisions of the Marine Mammal Protection Act (MMPA) preclude realistic management of the spotted seal population and its uses. Native hunters are not allowed to sell raw parts or products, such as skins from harvested animals, to non-Natives. As a result, coastal residents are not allowed to fully utilize the spotted seal resource, which in some instances causes greater pressure on other resource species. Multi-species, ecosystem-based management is not occurring since it is not possible to regulate the magnitude and characteristics of the harvest.

The increasing pace of development in marine offshore and coastal waters mandates immediate attention to protection of spotted seal habitat. Disturbance and contamination must be minimized in pupping and molting areas as well as near coastal hauling and feeding locations.

Of major concern at present is the development of management policies and plans which will provide for adequate distribution of forage fish resources among marine consumers and present and future commercial and subsistence fisheries. Food needs of spotted seals must be taken into account during formulation of such policies and plans.

L. Biological Impacts of Current and Proposed Management Plans

The present situation of protection under terms of the MMPA does not allow management or efficient utilization of spotted seals. Native take cannot be regulated to affect spotted seal population size and parameters so that population health and stability are ensured and the ecosystem components balanced. Although present Native harvests are well below sustainable yield, non-Natives are prohibited from taking spotted seals.

A State management plan could allow utilization of spotted seals within limits designed to maintain population health and productivity. Management would be based on multi-species ecosystem-based concerns. By manipulating the magnitude and composition of harvests, it is possible to regulate the effects of harvests on population size and productivity and to maintain a stable relationship between spotted seals and other ecosystem components. Protection of spotted seal habitat could be actively pursued.

M. Projections

If management authority for spotted seals is resumed by the State, a management plan will be initiated to meet the specified objectives. At present it is anticipated that season and bag limit restrictions would not be required. Sales of raw parts could be allowed and efficient and complete utilization of harvested animals encouraged. The magnitude of the harvest would be monitored and biological specimens collected from harvested animals. The total annual take can be maintained at a level to keep the population within the optimum sustainable range. Spotted seals would be managed as one of a group of interacting marine resource species. Stock sizes of the various species may be manipulated through regulation of harvests in order to offset environmental factors, balance biological interactions, or alleviate conflicts.

Spotted seals are abundant and available to coastal hunters at many localities in the Bering and Chukchi seas. Since their skins produce quality fur and they are suitable for human food, an increase in total harvest may occur when sales of skin and meat are allowed. However, considering present trends in population distribution and economics of coastal villages, increases in harvest are expected to be slight, if any. The average annual total harvest in Alaska will probably remain below 3,000 animals.

Research programs would be continued and expanded in order to better understand habitat use by spotted seals. Critical habitat areas within State waters could be protected by statute or regulations. Consideration would be given to spotted seals in formulation of State conservation and management plans and in State input to relevant Federal plans and actions.

Resumption of State management is expected to have no adverse impact on spotted seals or their users. Hunters in coastal Alaska would benefit by State management since they would be allowed to harvest spotted seals within acceptable biological limits and sell products from them. The spotted seal population would benefit from ecosystem-based management and an effective program of habitat protection.

N. Economic Analysis

The present value of the spotted seal harvest to coastal residents is difficult to calculate. Skins are used primarily for clothing which is worn both locally and sold throughout the State. Meat and oil are used locally for human and animal food. The average annual harvest of about 2,400 animals undoubtedly is worth in excess of $100,000 to coastal residents.

The probable market value of spotted seal meat, blubber, and skins can only be estimated at present. Based on a value of $40 apiece for skins and $0.77/kg for meat and blubber, an average seal would be worth about $90. A harvest of 2,400 animals would be worth $216,000 if both hides and carcasses were retrieved and completely utilized.

Potential nonconsumptive uses include viewing and photography of wild and captive animals. Since they closely resemble the ubiquitous and abundant harbor seal, the potential for major development of such nonconsumptive uses of spotted seals appears slight.

O. Management Effectiveness

After Alaska Statehood and prior to passage of the MMPA, spotted seal harvests were subject to regulations similar to those for other ice-inhabiting seals. Since the annual take was small, it was not necessary to enact season or bag limit restrictions or quotas. The harvest of spotted seals was monitored and samples were collected from harvested animals to determine basic population parameters.

After enactment of the MMPA, State regulations on take of spotted seals were nullified. Harvest monitoring and associated research programs were continued by State biologists through 1979. The responsible Federal agency (National Marine Fisheries Service) has not monitored recent harvests and has not developed significant research programs on spotted seals.

P. Selected References

Bukhtiyarov, Y. A., K. J. Frost and L. F. Lowry. In press. New information on foods of the larga seal in the Bering Sea in spring. In F. H. Fay, ed. Soviet-American Cooperative Studies on Marine Mammals. Vol. 1. Pinnipeds.

Burns, J. J. 1978. Ice seals. Pages 192-205 in D. Haley, ed. Marine mammals of eastern North Pacific and Arctic waters. Pacific Search Press, Seattle, WA.

Burns, J. J., G. C. Ray, F. H. Fay and P. D. Shaughnessy. 1972. Adoption of a strange pup by the ice-inhabiting harbor seal, *Phoca vitulina largha*. J. Mammal. 53:594-598.

Burns, J. J. and S. J. Harbo, Jr. 1977. An aerial census of spotted seal, *Phoca vitulinalargha*, and walruses, *Odobenus rosmarus*, in the ice front of the Bering Sea. NOAA/OCSEAP Final Report RU-231. 73pp.

Shaughnessy, P. D. and F. H. Fay. 1977. A review of the taxonomy and nomenclature of North Pacific harbour seal. J. Zool., Lond. 182:385-419.

Wildlife Technical Bulletin Series

1. The distribution and movement patterns of caribou in Alaska — by James E. Hemming. 1971.
2. Effects of hunting on rock ptarmigan along the Steese Highway — by Robert E. Weeden. 1972.
3. A bibliography of the parasites, diseases and disorders of wild ruminants of the northern hemisphere — by Kenneth A. Neiland and Clarice Dukeminier. 1972.
4. Game transplants in Alaska — by Oliver E. Burris and Donald E. McKnight. 1973.
5. Ram horn growth and population quality — by Wayne E. Heimer and Arthur C. Smith, III. 1975
6. Wolf-prey relationships in Interior Alaska — by William Gasaway, Robert Stephenson, and James Davis. 1983.
7. Marine mammals species accounts — by John Burns, Sr., et al. 1984.