Marine Mammals

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Abstract

Seven species of large cetaceans, 12 species of medium and small cetaceans, six species of pinnipeds, and one species of marine mustelid use the Gulf of Alaska. Marine mammals are important components of the marine ecosystem. Human harvesting of these mammals prior to colonization was primarily for use as a source of food and clothing. However, Russian exploration brought a quest for furs which decimated sea otters and fur seal populations.

The protection provided for marine mammals in the Gulf has taken many forms. Federal legal protection was extended to both sea otters and fur seals by the Fur Seal Treaty Act of 1911. The International Whaling Commission regulates the legal harvest of whales. The Marine Mammal Protection Act places a moratorium on the taking of all marine mammals in the United States (except fur seals), while the Endangered Species Act extends special protection to those species in danger of becoming extinct. The State of Alaska also managed and protected several species of marine mammals between the time of statehood (1959) and the passage of the Marine Mammal Protection Act (1972).

This chapter presents a detailed review of the 14 most common species including their:

- habitat requirements
- movements
- distribution and numbers
- vital statistics
- food habits
- food requirements.

Marine mammals in the Gulf are top trophic-level feeders, annually consuming 7.55×10^6 mt of euphausiids, copepods, fishes, cephalopods, and crustaceans. The fin and the sei whales have the highest annual consumption rates followed by Dall's porpoises and Steller sea lions.

The chapter also reviews the interactions between marine mammals and humans, looking at:

- the incidental catch of sea lions during pollock fishing in Shelikof Strait
- the entanglement of marine mammals in marine debris
- how sea otters use commercially important invertebrates
- whale viewing and suspected disturbance
- public awareness of marine mammals.

For the Gulf, there is a lack of information on all aspects of the biology of both beaked whales and most small cetaceans. Belukha whale food habits, taxonomic status, movements, and numbers need more study, as do the food habits of the sea otters. Current declines of pinniped populations warrant immediate attention.

Introduction

The Gulf of Alaska is rich in terms of both the abundance and the diversity of its marine mammals (Table 17–1). There are seven species of large cetaceans, 12 species of medium and small cetaceans, six pinniped species, and one marine mustelid (Morris, Alton, and Braham 1983; Consiglieri and Braham 1982; and Calkins, Pitcher, and Schneider 1975). Marine mammals use the Gulf of Alaska for a number of activities, such as migration, intensive summer feeding, or as a year-round range. Most of the Pribilof fur seals and most of the California gray whales travel through the Gulf of Alaska on their seasonal migration to their summering grounds in the Bering Sea. Several species of Cetacea take advantage of the rich summer food resources of the Gulf, then move south to avoid harsh winter conditions.

Some of the Cetacea, two species of pinnipeds, and the sea otter all inhabit the Gulf for their entire life. The Gulf also makes up a major part of the range of harbor seals, Steller sea lions, and sea otters. The Gulf of Alaska, for the purposes of this chapter, will be considered as the North Pacific waters north of 52°N and between 130°W and 165°W, or along the coast from Dixon Entrance to Unimak Pass.

There has been a long and close association between Gulf marine mammals and the people who have lived on its shores. Prior to Alaska's colonization, marine mammals were heavily relied upon for food, clothing, and shelter by the indigenous population. Marine mammals were of paramount importance to coastal dwellers who depended upon them for much of their survival. Natives of the Gulf of Alaska used sea lions in much the same way that walruses were used by people of the Bering Sea region. The flesh was eaten, the hides were used both for clothing and for boat coverings, and the intestines were used to make water-repellent clothing. The fur from sea otters, harbor seals, and fur seals was used for garments, and the flesh was an important food source. Belukha whales were also taken for food in Cook Inlet and other cetaceans may have been used on an opportunistic basis throughout the Gulf.

Table 17–1.
Marine mammals of the Gulf of Alaska and their seasonal abundance.

Common Name	Scientific Name	Seasonal Abundance * Spring	Summer	Fall	Winter
Large Cetaceans					
Blue whale	*Balaenoptera musculus*	R	R	R	–
Fin whale	*Balaenoptera physalus*	C	A	R	R
Sei whale	*Balaenoptera borealis*	A	C	R	R
Humpback whale	*Megaptera novaeangliae*	C	A	C	R
Gray whale	*Eschrichtius robustus*	C	R	C	A
Pacific right whale	*Balaena glacialis*	R	R	R	–
Sperm whale	*Physeter macrocephalus*	C	C	C	–
Medium and Small Cetaceans					
Minke whale	*Balaenoptera acutorostrata*	A	A	?	?
Killer whale	*Orcinus orca*	C	C	C	C
Belukha whale	*Delphinapterus leucas*	C	C	C	C
Short finned pilot whale	*Globicephala macrorhynchus*	–	R	–	–
Rissos dolphin	*Grampus griseus*	R	R	–	R
Bering sea beaked whale	*Mesoplodon stejnegeri*	?	?	?	?
Cuvier's beaked whale	*Ziphius cavirostris*	R	R	R	R
Northern right whale dolphin	*Lissodelphis borealis*	–	R	–	–
Baird's beaked whale	*Berardius bairdi*	R	R	?	?
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	C	A	R	R
Dall's porpoise	*Phocoenoides dalli*	C	C	C	C
Harbor porpoise	*Phocoena phocoena*	C	C	C	C
Pinnipeds					
Pacific walrus	*Odobenus rosmarus*	R	R	R	–
Steller sea lion	*Eumetopias jubatus*	C	C	C	C
Northern fur seal	*Callorhinus ursinus*	C	C	A	A
Harbor seal	*Phoca vitulina richardsi*	C	C	C	C
Northern elephant seal	*Mirounga angustirostris*	–	C	–	–
California sea lion	*Zalophus californianus*	R	R	–	–
Mustelid					
Sea otter	*Enhydra lutris*	C	C	C	C

* Modified from Morris, Alton, and Braham (1983).
C = Regularly present
A = Greatest abundance
R = Rare visitor
– = Not known or expected to occur
? = No recent data

The rich fur resources of Alaska were probably the driving force that brought most of the early Russian explorers. Bering's second voyage of 1741 created an awareness of these valuable fur resources (Chavigny 1965). The two most highly prized furbearing mammals were the sea otter and the fur seal. The Russian settlements at Kodiak and Sitka were established primarily to serve as bases of operation for fur collection. Operating out of these two bases (occasionally imposing involuntary servitude on local Natives), the Russians harvested sea otters until the sea otter stocks were decimated. During the later period of Russian occupation, some degree of protection was afforded both the fur seal and the sea otter. This protection continued until the Russians sold Alaska to the United States in 1867.

After the U. S. purchased Alaska, unrestricted harvesting was resumed until 1911, when the first International Fur Seal Treaty was signed by the United States, Great Britain, Japan, and Russia. This treaty gave full protection to both fur seals and sea otters. The Pribilof Islands are the breeding grounds for most northern fur seals found in the Gulf of Alaska (Fiscus 1978). This population was reduced to such low levels that commercial harvest ceased until 1917 and then was resumed only for those males considered surplus to reproduction (Baker, Wilke, and Baltzo 1970). In 1956, harvesting of females was resumed on the Pribilof Islands under strictly controlled conditions and continued through 1968 (Chapman 1973).

The Fur Seal Treaty of 1911 gave full protection to sea otters in U. S. waters (Kenyon 1969). By this time, the sea otter had been totally eliminated from much of its former range in the Gulf, although remnant populations remained in Prince William Sound, in the Kodiak Island area, and along the Alaska Peninsula. Once they were given protection, the survivors expanded their population until they repopulated much of their former range. In many areas, the sea otter population has reached the habitat's carrying capacity. In other parts of their range, where otters historically occurred at low density, their numbers have increased markedly and the range they occupy has greatly expanded (Calkins and Schneider 1985).

In addition to the Fur Seal Convention of 1911 and the Fur Seal Treaty Act and its various amendments, there have been numerous state, national, and international laws, conventions, and treaties designed to manage and protect marine mammal stocks. Among the most notable of these are the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the International Whaling Convention.

Prior to passage of the Marine Mammal Protection Act, responsibility for management and conservation of marine mammals was delegated to the individual states. The state of Alaska pursued a vigorous management and conservation program for harbor seals, sea lions, sea otters, and belukha whales in the Gulf. All other species commonly found in the Gulf were governed by federal authorities. Passage of the Marine Mammal Protection Act curtailed all state management of marine mammals, although provisions were made to return management to the state when certain conditions were met.

The primary objective of the Marine Mammal Protection Act was to maintain the health and stability of the marine ecosystem and—whenever consistent with this primary objective—to obtain and maintain optimum sustainable populations. The act as amended defines an optimum sustainable population as the population level that maximizes species productivity, keeping in mind both the carrying capacity of the habitat and the health of the ecosystem.

Classification of a species as 'endangered' under the Endangered Species Act of 1973 extends special protection to those species that are considered in danger of extinction throughout all or a significant portion of their range (Breiwick and Braham 1984). A species is considered 'threatened' if it is likely to become 'endangered' in the foreseeable future. All seven species of large cetaceans listed in Table 17–1 are presently listed as 'endangered' under the Endangered Species Act of 1973.

The present form of whale management was preceded by the International Whaling Agreement, signed in 1937. It required the signatories to observe a three-month season, limited the number of vessels that could take part, and placed a ban on harvesting gray and right whales (Chapman 1973; Gaskin 1982). Although there was some reference to conservation, according to Gaskin (1982), the participants were far more interested in regulating whale-oil prices. The International Convention for the Regulation of Whaling (drawn up in 1946 and ratified in 1948) gave treaty status to previous agreements and formed the basis for modern whale management (Chapman 1973; Gaskin 1982). This treaty established the International Whaling Commission, which had the power to amend the regulatory provisions from previous agreements and to "organize studies and investigations relating to whaling."

Setting quotas became immediately controversial. Lasting quota allocations were not agreed upon until 1961 (Chapman 1973). The commission was severely limited in its effectiveness because of the provision that allowed any nation to enter an objection to any amendment within 90 days following the annual meeting (Gaskin 1982). Any nation that filed a formal objection was not bound by that amendment.

In 1975, the commission introduced a management policy based on three categories of whale stocks. The first category is the 'protection stock'. Species in this category have populations which have fallen more than 10% below the maximum-sustainable-yield level. No hunting is allowed on these species. The second category is the sustainable management stock. The population of these species is between 10% below and 20% above the level that gives a maximum sustainable yield. A sliding scale for harvesting these species ranges from 0 to 90% of the maximum sustainable yield. The third category is the initial management stock, which includes species whose population level is estimated to be more than 20% above the maximum sustainable yield level. The permitted catch for these species can be as high as 90% of the maximum sustainable yield.

The most effective (if inadvertent) conservation measure for large whales appears to be the overall economics of whaling. When species become depleted and difficult to find, it becomes more costly to operate long distances from home

ports, raising prices and thus reducing demand for whale products. In addition, more individual species of great whales have been protected legally. Worldwide, most species appear to be on the brink of total protection from commercial whaling (Gaskin 1982; Chapman 1973).

All of the great whales except the sperm whale are baleen whales, which feed primarily on euphausiids and copepods. The blue whale is considered to be the largest animal to have ever lived, exceeding 30 m in length and weighing in excess of 100 tons (Rice 1978a). Of the seven species of these great whales which inhabit or transit the Gulf, all have been subjected to heavy commercial exploitation. Pacific right whales were reduced to such low levels that they may be considered severely depleted and their chance of recovery remains uncertain. Gray whales were protected in time for the population to recover to what appears to be near its pre-exploitation level (Reilly 1981).

Our knowledge of the food habits, reproductive biology, size, growth, and internal structure of large whales was derived from animals taken in commercial harvests and from reports of the International Whaling Commission. As commercial whaling decreases, information of this type becomes less available.

The other 12 species of Cetacea are medium and small whales and include beaked whales and porpoises. All except the minke are toothed whales, which feed primarily on fish and squid. Belukhas, or white whales, reside year-round in the northern portions of the Gulf, while many of the other whales probably migrate southward out of the Gulf in the autumn and winter, returning in spring (Mitchell 1978; Wolman 1978; and Braham 1984). Very little information is available about beaked whales. These animals are generally considered deep diving, pelagic species which have not been commercially harvested in the Gulf in recent years (Rice 1978b). Most of our information on beaked whales was derived from examining a few stranded individuals, which were in varying states of decay.

Of the six pinniped species found in the Gulf, only two—the Steller sea lion and the harbor seal—are lifelong residents. Most northern fur seals pass through the Gulf on their annual migration, although some individuals are found in the Gulf during all seasons. The northern elephant seal is a regular summer visitor, found primarily in southeastern Alaska waters. Pacific walruses and California sea lions are also occasional visitors to the Gulf.

The sea otter is the only truly marine mustelid that inhabits the North Pacific. The mustelids also include weasels, mink, skunks, river otters, and wolverines. Unlike all other marine mammals, which rely on blubber or on a combination of fur, hair, and blubber for insulation, the sea otter depends on thick, heavy fur (and guard hairs) and an elevated metabolic rate in order to survive in Arctic waters (Kenyon 1969). The tips of the guard hairs stick together and form a barrier which water (due to its surface tension) does not penetrate. Thus, the otter's skin remains dry even though the otter spends much of its life in the water (Kenyon 1969).

Common Marine Mammals

The following is a brief summary of selected ecological aspects of the species that are commonly found in the Gulf of Alaska (Table 17-1). This summary is not intended to report all that is known about each species, but instead describes some of the more important points of our scientific knowledge of these species.

Fin Whale

The fin whale (*Balaenoptera physalus*) is among the largest of the great whales, second in size only to the blue whale. They are members of the family Balaenopteridae—the groove-throated mysticetes, or rorquals. This family can be divided into two genera: the humpback (genus *Megaptera*) and the finner (genus *Balaenoptera*), which includes blue, fin, sei, Bryde's, and minke whales (Mitchell 1978). Fin whales can attain lengths of up to 24 m, although 22 m is considered large (Leatherwood, Reeves, Perrin, and Evans 1982).

The head of a fin whale is V-shaped; the dorsal fin is prominent and falcate and can be 2 to 3 m tall. The fin whale has between 56 and 100 ventral grooves, which extend at least to the navel. Its color is a uniform dark gray on the back and sides with white underneath and occasionally a grayish-white chevron on the back (Leatherwood *et al.* 1982). Probably the most distinctive characteristic of the fin whale's external morphology is the white coloration on the right lower lip, on the right side of the mouth, and on the right side of the baleen (Leatherwood *et al.* 1982).

Most fin whales found in the Gulf spend the winter in subtropical and temperate waters off coastal California and Baja California, Mexico, where they breed and calve (Leatherwood *et al.* 1982). Most sightings in the Gulf have been in waters either along or inshore of the continental shelf; that is, in waters shallower than 200 m (Nemoto and Kasuya 1965; Consiglieri and Braham 1982). Fin whales begin their northward migration in spring, reaching the western Gulf of Alaska and the eastern Aleutians by April and May. Two main areas used by fin whales in the Gulf during the summer (Fig. 17-1) are the waters around Kodiak Island and those south of Prince William Sound (Hall and Tillman 1977). Use of Prince William Sound is limited to April, May, and June, when fin whales are migrating through the Gulf of Alaska to the Bering Sea (Hall 1979).

Winter sightings of fin whales in the Gulf of Alaska are rare (Consiglieri and Braham 1982), but this may be due to a lack of surveys or to poor sighting conditions. Although fin whales start their southward migration in August, most of them move south in September (Consiglieri and Braham 1982; Nasua 1974; and Slepstov 1961). Fin whales exploit a wide variety of food species whose distributions are highly variable. Accordingly, the fin whale distribution in the Gulf also varies. They are frequently found in coastal waters and can be found offshore to the edge of the continental shelf (Nemoto and Kasuya 1965; Consiglieri and Braham 1982).

Two tagging studies (Nemoto 1959; Fugino 1960) indicated little east/west movement across the North Pacific and supported the hypothesis of Tomilin (1957) and Nishiwaki

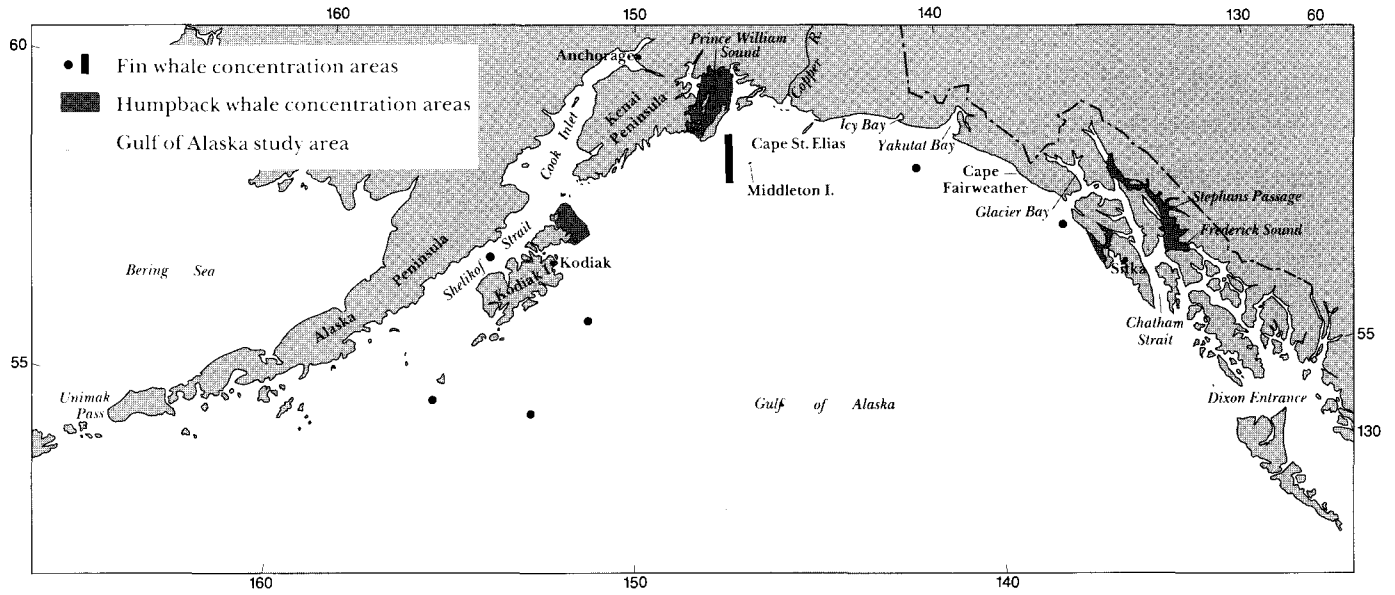

Figure 17–1. Summer sightings of fin and humpback whales in the Gulf of Alaska. (Modified from Consiglieri and Braham 1982.)

(1966) that fin whales are divided into eastern and western stocks. Both stocks migrate north and south, although the Gulf of Alaska stock stays closer to the North American coastline (Mitchell 1978).

The historical population of North Pacific fin whales was estimated at between 42,000 and 45,000 animals (Tillman 1975). The North Pacific stock is presently estimated at 17,000 whales (Ohsumi and Wada 1974). Consiglieri and Braham (1982) estimated that the population of fin whales from the Gulf of Alaska to the Bering Sea probably does not exceed 10,000 whales. Rice and Wolman (1981) estimated that 159 fin whales were present in an area of 76,117 mi^2 in the north central Gulf of Alaska. Although the International Whaling Commission granted protected-stock status to North Pacific fin whales in 1976, Allen (1974) suggested that it may take as long as 25 years for the population to recover to 90% of its original size.

Calves are born about 6.5 m in length, and lactation lasts until they double in size—which usually takes about 6 months (Ohsumi, Nishiwaki, and Hibiya 1958). Females are generally larger than males and take longer to reach sexual maturity. Sexual maturity occurs at about 18.6 m in females and at 17.5 m in males (Rice 1963). Physical maturity is reached at about 20 m for females and 19 m for males (Rice 1963; Ohsumi *et al.* 1958). The largest female recorded in the North Pacific was 24.4 m, and the largest male was 23.8 m (Tomilin 1957).

Fin whales have a breeding cycle that varies from biennial to triennial (Mitchell 1978). Gestation lasts between 11 and 12 months (Ohsumi *et al.* 1958). The breeding season extends from September through June, peaking in mid-winter (from November through January). Births occur over a similarly protracted period.

Both the abundance and the location of prey for the fin whales are related to seasonal planktonic blooms in the Gulf. Kawamura (1982) reported that fin whales may switch prey species from euphausiids (abundant in late spring and early summer) to copepods (most abundant in summer and fall). Other less-used prey include fish and cephalopods, which are consumed more during the summer than during the spring (Kawamura 1982).

Calanoid copepods and several species of euphausiids are among the most important prey for the fin whales (Kawamura 1980; Nemoto 1957; Nemoto 1959; and Nemoto and Kasuya 1965). Important species include *Calanus cristatus, C. plumchrus, C. finmarchicus,* and *Metridia lucens.* These species dwell in warmer surface waters, as does the euphausiid *Thysanoessa spinifera,* which is also heavily used by fin whales (Kawamura 1980).

T. spinifera is a dominant neritic species of euphausiid found in the Gulf (Kawamura 1980). It is restricted to depths of 100 m or less in the shallower, nearshore waters. Other euphausiids preyed upon by fin whales include *Euphausia pacifica, Thysanoessa longipes,* and *T. inermis,* which migrate vertically in the water column, generally rising at night (Barnes 1974; Nemoto and Kasuya 1965).

Lockyer (1976a) estimated that fin whales feed twice daily for an average daily consumption rate of 1,000 to 1,500 kilograms. Nemoto (1959) reported that one 17.5-m male fin whale had 759 kg of fish in its stomach.

Sei Whale

Sei whales (*Balaenoptera borealis*) are large balaenopterids which grow to 16 m in length (rarely longer) in the North Pacific (Leatherwood *et al.* 1982). Lengths of physically mature females captured off California averaged 15.6 m; males averaged 13.7 meters. At birth, sei whales are between 4.3 and 5.3 m long (Leatherwood *et al.* 1982; Tomilin 1957; and Masaki 1976). Sei whales are dark gray or bluish gray on the back and sides and on the posterior portion of the ventral surface. On the abdomen, there is a region of grayish white that is almost always confined to the area of the ventral grooves. The right lower lip and mouth cavity are uniformly

gray, unlike on the fin whale. The body often has a 'galvanized' appearance due to scars inflicted either by lampreys (*Lampetra* sp.) or by parasitic copepods (Leatherwood *et al.* 1982).

Sei whales are seasonal residents of the Gulf. They are generally most abundant in the spring (Consiglieri and Braham 1982), although they apparently form local concentrations in summer in certain areas. Masaki (1976) stated that in spring sei whales migrate from the southern breeding and calving areas (20° to 30°N) to the northern feeding grounds. From May through August, the areas of greatest sei whale densities are in the northwestern and the northeastern parts of the Gulf (Masaki 1976).

Sei whales are found throughout the Gulf, although there may be local seasonal concentrations which can change from year to year as the abundance of copepods and euphausiids fluctuates (Nemoto 1959). Sei whales apparently leave the Gulf in late summer and by September, most have departed for southern waters (Masaki 1976). Apparently few sei whales remain in the Gulf during winter, although Consiglieri and Braham (1982) reported one sighting of five animals near the Fairweather grounds during winter months. Rice (1974) conjectured that sei whales winter offshore. Masaki (1976) indicated that sei whales are distributed between 20° and 30°N during January and February.

Heavy commercial exploitation of sei whales did not take place in the North Pacific until 1963, when other, more desirable species became depleted. Tillman (1977) estimated that prior to 1963, the number of sei whales in the North Pacific was on the order of 42,000 animals. By 1966, the sei whale population in the North Pacific had been designated a protected stock by the International Whaling Commission. Tillman (1977) estimated the North Pacific population at 8,600 sei whales.

Breeding and calving occur between October and March when sei whales are in warmer, southern waters. Calving peaks in November and breeding peaks in December (Masaki 1976). Both sexes are thought to attain sexual maturity by seven years; gestation lasts about 10.5 months, with calves born every other year (Masaki 1976).

The diet of sei whales in the North Pacific has been studied by examination of stomach contents of whales taken in the commercial fishery. Kawamura (1980) summarized the examination results for 12,000 whales and found that the most important food was copepods (primarily *Calanus plumchrus*), which accounted for 83% of the diet. Euphausiids made up 13% of the diet, fishes made up 3%, and squids accounted for 1 percent. Tomlin (1957) and Klumov (1963) found that fishes eaten by sei whales include:

- smelt (Osmeridae)
- sand lance (*Ammodytes hexapterus*)
- arctic cod (*Boreogadus saida*)
- rockfishes (*Sebastes* sp.)
- greenlings (*Hexagrammos* sp.)
- pollock (*Theragra chalcogramma*)
- capelin (*Mallotus villosus*)
- sardines (*Sardinops sajax*).

Little information is available on the food requirements of sei whales. Lockyer (1976a) estimated the average stomach-content weight for sei whales at 180 to 230 kg for those whales 13 to 17 m in length. Sei whales consume 1.5×10^3 kg of food per day, according to Lockyer (1976a).

Humpback Whale

The humpback whale (*Megaptera novaengliae*) is the only living representative of the genus *Megaptera* and a member of the family Balaenopteridae (rorqual). Newborn calves are between 4.5 and 5.0 m long and females (which are larger than males) reach lengths of 16 m as adults; sexual maturity is reached by both at about 11 to 12 m (Leatherwood *et al.* 1982). Body color is generally gray or black with some white on the ventral surface. The flippers are unusually long (one-fourth to one-third the total body length) and are usually white underneath. Humpbacks have between 14 and 22 throat or ventral grooves which extend to the navel. The baleen is short (seldom more than 80 cm) and numbers between 270 and 400 plates (Leatherwood *et al.* 1982).

Humpbacks are generally found in coastal areas or near oceanic islands (Berzin and Rovnin 1966; Leatherwood *et al.* 1982). They appear to have a strong affinity for nearshore waters, particularly for highly productive fjord-like areas such as southeastern Alaska and Prince William Sound. Those few sightings from the central Gulf of Alaska were probably of animals in transit (Consiglieri and Braham 1982). Humpbacks move seasonally from the warm, southern waters where they winter to the rich, productive waters of the north where they summer.

Humpbacks from the North Pacific winter in three locations: 1) off the Hawaiian Islands, 2) off the Mexican coast, and 3) near the Ryuko, Bonin, and Marianas Islands and Taiwan in the Western Pacific (Berzin and Rovnin 1966; Wolman 1978). Their northward migration begins in March and April, and they arrive in southeastern Alaska in April and May. They remain in the Gulf through the summer and fall and begin their southward migration in November. Some humpbacks apparently spend the winter in southeastern Alaska. There have been a few sightings in the Gulf in February (Consiglieri and Braham 1982), but most whales move further south.

In summer, humpbacks can generally be found in three nearshore areas of the Gulf: 1) near Kodiak Island, 2) in Prince William Sound, and 3) in southeastern Alaska (see Fig. 17-1). Offshore, humpbacks are typically sighted off Kodiak Island, Cape St. Elias, Yakutat, and the Fairweather grounds (Consiglieri and Braham 1982).

In 1966, the International Whaling Commission protected humpbacks from commercial whaling, after more than 50 years of overexploitation of this species. Prior to 1905, the North Pacific population of hump backs was estimated at 15,000 (Wolman 1978). Over 28,000 humpbacks were killed between 1904 and 1965. A recent estimate places the North Pacific population at 1,200 whales (Johnson and Wolman 1984). According to Consiglieri and Braham (1982), this gives the humpback whale the unenviable status of being the second-most depleted whale in the North Pacific, after the North Pacific right whale.

Hall and Johnson (1978) estimated that there were 50 humpbacks in Prince William Sound, while Rice and Wolman (1981) extrapolated their counts in the Gulf to provide an estimate of 306 whales. Von Ziegesar and Matkin (1985) obtained photographs of 96 whales in Prince William Sound. Baker, Herman, Perry, Lawton, Straley, and Straley (1985) estimated that there are between 270 and 373 humpbacks in southeastern Alaska.

Breeding for the humpback takes place in their wintering areas during the period from October to April, with peak activity occurring in December. Gestation lasts 11 to 11.5 months, and lactation continues for an additional 11 months (Tomilin 1957; Rice 1963), resulting in a two-year reproductive cycle. Chittleborough (1960) estimated that a female humpback whale may live for 47 years and give birth to as many as 15 calves.

Wolman (1978) assumed that humpbacks, like other rorquals, feed heavily during summer while they are in high latitudes and then live off the energy stored in their body fat during the winter. However, this assumption has not been tested (Morris *et al.* 1983; Wolman 1978). Nemoto (1959) found that humpback foods consisted primarily of fish and euphausiids. Important fishes were herring (*Clupea harengus pallasii*), capelin, saury (*Cololabis saira*), pollock, and Pacific mackerel (*Scomber japonicus*). Their principal prey varied with location. Kreiger and Wing (1985) suggested that in Glacier Bay, humpbacks switched from their primary diet of euphausiids in the mid-1970s to a diet in the early 1980s that consisted primarily of fish. However, they also found that most of the whales they sighted in Stephens Passage, Frederick Sound, and Chatham Strait were feeding on euphausiids in 1984.

Humpbacks have been observed using several feeding methods. In southeastern Alaska, they use a technique called 'lunge feeding'. During lunge feeding, they plough through prey concentrations with their mouths open. During 'flick feeding', they move their flukes forward at the surface and then dive through the concentrated food. In a third feeding method, they produce a 'bubble net' by swimming in a circle below agitated prey (such as a school of herring) while releasing air bubbles from their blowhole. The bubbles rise to the surface, forming a curtain; this presumably frightens the prey and concentrates them in the center of the rising ring of bubbles. The humpback then rises swiftly through the prey with its mouth open, engulfing the food (Ingebrightsen 1929; Jurasz and Jurasz 1979).

The only information available on the food amounts consumed by humpbacks is from Tomilin (1957) who reported on the prey he found in two stomachs that contained large volumes of food. He found 500 kg of *Thysanoessa longipes* in the stomach of a 14.3 m female and 600 kg of saffron cod in the stomach of a male of unspecified length.

Gray Whales

Gray whales (*Eschrichtius robustus*) are morphologically distinct from other baleen whales (Barnes and McLeod 1984). Apparently, the incomplete fossil record does not provide any basis for understanding the evolutionary history of gray whales. Their baleen is considered to be primitive because there are fewer plates and the plates are thicker than those of other balaenopterids (Barnes and McLeod 1984).

Gray whales grow to a maximum length of ~14 m and typically weigh ~33 t (Leatherwood *et al.* 1982). They are strongly tapered at both ends, have a narrow, triangular head, have a slightly arched mouthline, and exhibit a low hump on their back. The skin is mottled gray due to both natural pigmentation and extensive scarring from barnacles (Leatherwood *et al.* 1982). The short, coarse baleen plates number between 138 and 180 per side and are colored yellowish-white to white.

Gray whales migrate through the Gulf of Alaska on their way both to and from summer feeding grounds in the Bering and Chukchi Seas (Fig. 17-2). Generally, gray whales are found within 4 km of shore except when crossing the entrance to Prince William Sound or when going from Kodiak Island to the south side of the Alaska Peninsula (Rugh 1984). Rice and Wolman (1971) report that gray whales are seldom found in waters deeper than 180 meters. Pike (1962) suggested that gray whales use topographical clues for orientation. Their migratory routes may be most influenced by the availability and the composition of food (Braham 1984).

Gray whales winter along the west coast of Baja California, Mexico, and migrate the 9,000 to 14,000 km to the Bering and Chukchi Seas each spring. The migration route through the Gulf of Alaska is entirely coastal (Braham 1984). Animals segregate by sex and age during the migration, with single adults arriving first followed by pregnant females, subadults, postbreeding males, and finally by the cows with their calves (Rice and Wolman 1971). In 1977 and 1978, the migration past Cape St. Elias peaked during the third week of April (Cunningham and Stanford 1979). Generally, the migration through the Gulf of Alaska and into the Bering Sea is complete by the end of June or by early July (Braham 1984).

Some whales remain south of the Bering Sea in summer (Pike 1962; Pike and MacAskie 1969; Rice and Wolman 1971; and Darling 1984). Summer distribution of gray whales in the Gulf of Alaska is not well documented. Consiglieri and Braham (1982) recorded sightings of gray whales at a variety of sites: 1) the south side of Kodiak Island, 2) in the Hinchinbrook Entrance to Prince William Sound, and 3) between Cape St. Elias and southeastern Alaska. All their sightings were in waters very near shore. These sightings may have been local feeding groups or may have been cows with their slower calves.

The peak of the southbound migration in the Gulf lasted from late November to early December (Rugh 1984; Consigleiri and Braham 1982; and Rugh and Braham 1979). Most gray whales have left the Gulf by early January. The route of the southward migration is not as well understood as the route of northward migration; however, sightings have been made both nearshore and offshore in the fall and early winter. Braham (1984) suggested that the few sightings which have been made indicate that the whales follow a coastal route, although possibly farther offshore.

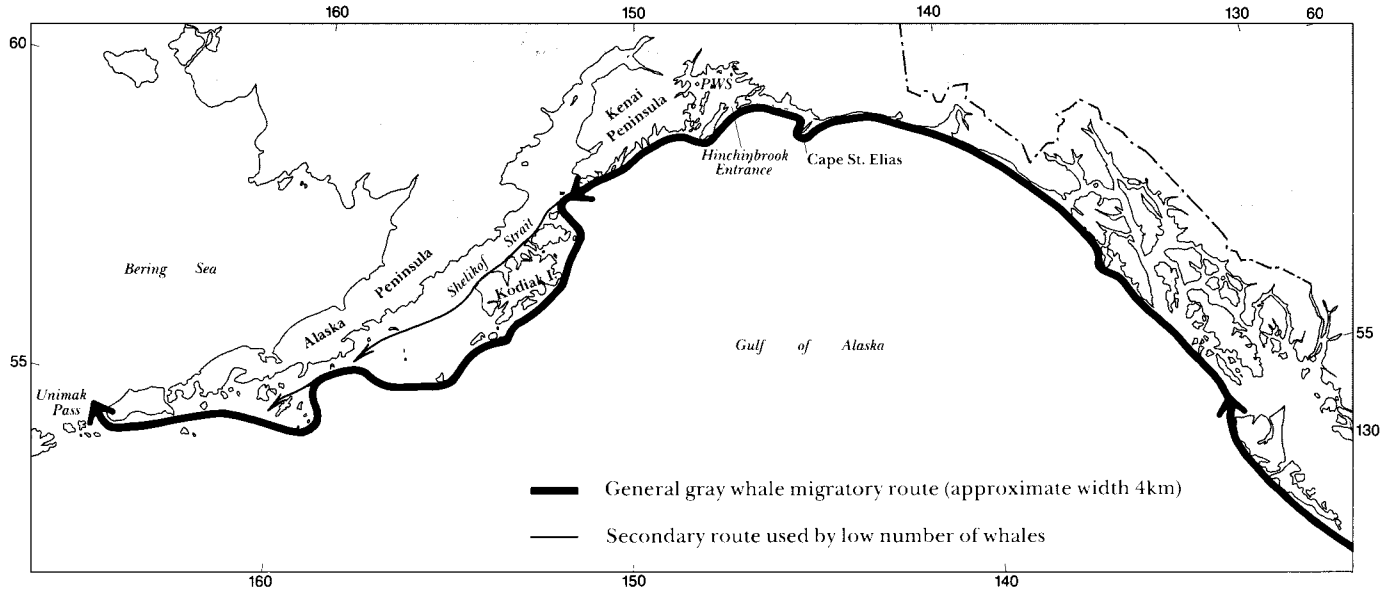

Figure 17–2. Generalized spring migratory route of gray whales through the Gulf of Alaska.

Nineteenth-century commercial exploitation of gray whales was devastating to the population because it took place in the wintering lagoons where cows and calves were easily taken (Henderson 1984). Reilly (1981) estimated the original gray whale population at between 15,000 and 24,000; Henderson (1984), however, suggested that the population did not exceed 15,000 when whaling began in the southern calving areas during 1845–1846. Approximately 4,000 whales still survived in 1874—when nineteenth-century gray whaling in the calving lagoons effectively ended (Henderson 1984).

Whaling on gray whales continued into the twentieth century. However, the emphasis was shifted to pelagic whaling. In 1966, commercial whaling on gray whales was terminated when they were designated a Protected Stock. In 1979, gray whales were redesignated a 'Sustained Management Stock', and currently a subsistence take is allocated to (or on the behalf of) the coastal Natives of the Soviet Union and the United States.

The eastern North Pacific gray whale population appears to have recovered to near pre-nineteenth century exploitation levels and probably is now nearing the carrying capacity of its range (Reilly 1981). The most recent population estimate is between 13,000 and 17,000 whales (Reilly 1981, 1984). The population apparently grew at a rate of 2.5% annually between 1968 and 1980 (Reilly 1981). This stock has been considered endangered by the United States; however, the National Marine Fisheries Service has initiated action to have the stock reclassified as threatened (S. Zimmerman, National Marine Fisheries Service, Juneau, AK., pers. comm., 1985).

Female gray whales become sexually mature at lengths of between 11.7 m and 12 m, while males reach sexual maturity between 11.0 m and 11.1 m (Blokhin 1984; Rice and Wolman 1971). Calving occurs off Baja California during January and February, although some calves may be born in the Gulf (Consiglieri and Braham 1982). Estrus and conception occur in late November or in December (Rice and Wolman 1971) although sexual activity has been observed at other times of the year (Cunningham and Stanford 1979). Lactation continues until August (Rice and Wolman 1971). Gray whales take two years to complete a reproductive cycle; a female may reproduce for nearly 40 years and produce as many as 12 calves (Consiglieri and Braham 1982; Rice and Wolman 1971).

Generally, gray whales move to northern latitudes annually to take advantage of rich food resources. Some whales apparently linger along the coast to feed, rather than to complete the migration into the Bering Sea, while some feed at select locations along the route (Nerini 1984). Gray whales feed on several species of benthic amphipods in the Bering Sea and may also eat polychaetes, mysids, planktonic decapods, gastropods, and some bivalves. The extent to which these resources are used in the Gulf of Alaska has not been documented (Nerini 1984). Schooling fishes such as herring or capelin may be important during migration, since they are abundant near Kodiak Island and off southeastern Alaska (Consiglieri and Braham 1982; Morris *et al.* 1983).

Zimushko and Lenskaya (1970) estimated that a gray whale consumes ~300 kg of food per feeding. Lowry, Frost, Calkins, Swartzmann, and Hills (1982) assumed four feeding bouts per day, based both on their own observations of other baleen whales as well as on the field observations of Zimushko and Lenskaya (1970). They estimated a daily food consumption of 1,200 kg in the Bering and Chukchi Seas. We can only infer consumption amounts for the Gulf of Alaska because we have no feeding-rate estimates.

The Gulf of Alaska is important to gray whales primarily as a migratory corridor, although some feeding and reproductive activity probably occur there. The Gulf is used by nearly the entire eastern gray whale stock as it moves along its route between the breeding and calving lagoons of Baja California and the rich feeding areas of the north.

Sperm Whale

The sperm whale (*Physeter macrocephalus*) is the largest representative of the odontocetes or toothed whales and is classified as endangered by the United States under the Endangered Species Act of 1973. According to Leatherwood *et al.* (1982), sperm whales are among the easiest of the large whales to identify because of the disproportionately large head. Much of the bulk of the head consists of the spermaceti organ. The development of a spermaceti organ—which consists of an oil-filled structure that appears to have a role in controlling buoyancy—is a specialization peculiar to the physeterids (Gaskin 1982).

The sperm whale's huge head accounts for one-fourth to one-third its total length; the blowhole, an S-shaped structure, is located on the forward half of the head (Rice 1978c). The dorsal hump or fin is usually rounded at the peak, but is sometimes triangular shaped. It is located about two-thirds of the way back from the front of the head (Leatherwood *et al.* 1982). Sperm whales usually are dark brownish-gray with white areas on the belly, on the front of the head, and around the mouth.

The sperm whale's mandible has about 25 teeth per side and can be as much as 1.5 m shorter than the snout (Rice 1978c; Leatherwood *et al.* 1982). Maxillary teeth are usually rudimentary, seldom erupting through the gums. Adult males can reach lengths of 17 m and average 15 meters. Adult females are generally smaller, rarely exceeding 12 m (Leatherwood *et al.* 1982). At birth, calves are about 3.5 to 5 m long and weigh about 1.0×10^3 kilograms.

In the Gulf, sperm whales are found near the continental slope and in the deeper waters beyond (Smith 1980; Ohsumi 1980). According to Berzin (1970), sperm whales feed from mid-water depths to the ocean bottom.

Sperm whales spend the winter months in more temperate waters of the North Pacific from the equator to approximately 40°N (Berzin 1970). Pike and MacAskie (1969) reported the appearance of sperm whales off the coast of British Columbia in spring, and the young (subadult) males remain there throughout the summer. The northern limit of the females' range appears to be the 15C isotherm (or 50°N)—well south of the Gulf of Alaska. Consequently, adult females and immatures (maternity schools) would be rare visitors to the Gulf.

Apparently, the distribution of sperm whales shifts further offshore in summer, because Rice and Wolman (1981) sighted 36 individuals over deep water beyond the continental shelf. Very few sperm whale sightings have been made in the Gulf of Alaska in autumn. However, Consiglieri and Braham (1982) and Pike and MacAskie (1969) thought that the sightings were consistent with other records that indicated a southward movement. Consiglieri and Braham (1982) reported one winter sighting in the Gulf when a single sperm whale was observed on the Fairweather grounds in 1979.

Although sperm whales were continuously harvested for over three centuries, substantial numbers of animals were not taken prior to 1947 (Berzin 1970; Tillman 1976). Apparently, few sperm whales were taken from the Gulf of Alaska over the last several decades. Rice (1978c) estimated the sperm whale population in the North Pacific at 7.4×10^5 individuals. The eastern North Pacific population is currently (1982) estimated at 1.74×10^5 whales (Gosho, Rice, and Brewick 1984). No estimate is available for the numbers of sperm whales that occur in the Gulf of Alaska.

Sperm whales mate in waters south of the Gulf of Alaska in spring or early summer (Rice 1978c). Females reach maturity at about nine years (Ohsumi 1965; Lockyer 1976b). According to Gosho *et al.* (1984), puberty is prolonged in the males, beginning at about nine years of age and reaching completion when the testes are fully spermatogenic at about 20 years.

Calves are born between June and October with peak calving activity occurring in August. The total gestation period is ~14 to 17 months (Best 1968; Ohsumi 1966), and lactation lasts from 12 to 24 months. With a reproductive cycle of between 3 and 6 years, sperm whales may have the lowest reproductive potential of any marine mammal (Gosho *et al.* 1984).

Throughout the North Pacific, sperm whales eat mainly cephalopod mollusks—particularly squid of the family Gonatidae—and bottom-dwelling fish (Gosho *et al.* 1984; Kawakami 1980; Okutani and Nemoto 1964; and Rice 1963). They are noted for their ability to make prolonged, deep dives (Rice 1978c). Sperm whales have been reported to feed on bottom-dwelling sharks in water depths over 3,049 m off South Africa (Rice 1978c). In the Gulf of Alaska, Okutani and Nemoto (1964) found fish to be the predominant prey, but gave no species identification. The most commonly eaten fish include rockfishes, cod (Gadidae), skates (Rajidae), lancet fish (*Alepisaurus ferox*), lumpfish (Cyclopteridae), and rattails (*Coryphaenoides* sp.) (Berzin 1959, 1970; Okutani and Nemoto 1964; and Kawakami 1980). Daily food consumption rates for sperm whales ranges from 2 to 4% of the total body weight (Lockyer 1976b; Kawakami 1980).

In the North Pacific, two stocks of sperm whales are currently recognized: the eastern and the western stocks (Best 1975; Harwood and Garrod 1980; Bannister and Mitchell 1980; and Gosho *et al.* 1984). The boundary between the two stocks runs through Amchitka Pass in the western Aleutians at 50°N, 180°W, then southeast to the Hawaiian Islands (20°N, 160 °W).

Minke Whale

The minke whale (*Balaenoptera acutorostrata*) is the smallest baleen whale in the Gulf. Its nicknames—'little piked whale' or 'sharp-headed finner'—refer to its narrow head and pointed rostrum. The rostrum is divided sagitally by a distinctive ridge running forward from the blowhole (Leatherwood *et al.* 1982). Minke whales are usually black or dark gray, with white on the belly and undersides of the flippers. The most conspicuous marking is a white band across the top of the flippers (Leatherwood *et al.* 1982). The dorsal fin is tall and falcate and there are between 50 and 70 thin ventral grooves, the longest ending slightly forward of the navel. The size of minke whales at birth varies from 2.1 to 2.8 m and they double in size by six months (Omura and Sakiura 1956). Females, which are larger than males, reach physical matu-

rity at about 8 m, although they sometimes reach lengths of 10 m (Leatherwood *et al.* 1982).

With spring, sightings of minke whales become common over the continental shelf and in the nearshore waters of the Gulf. Over 95% of the sightings are shoreward of the 200-m contour (Consiglieri and Braham 1982). North Pacific minkes are distributed from the equator north to the Chukchi Sea (Leatherwood *et al.* 1982), and are most abundant in Alaska waters during the summer. They are less common in British Columbia and southeastern Alaska than they are in the waters of the Gulf of Alaska and the eastern Aleutian Islands (Scattergood 1949).

In a 1980 survey of the Gulf, Rice and Wolman (1981) found minkes in nearshore waters from southeastern Alaska to Kodiak Island; only three individuals were seen in oceanic waters of the Gulf. They are frequently observed in some bays of Kodiak Island in summer (T. Emerson, Alaska Department of Fish and Game, pers. comm. cited in Consiglieri and Braham 1982), as well as in Prince William Sound and Yakutat Bay. Their summer movements may be local and related to territoriality. In an area of 660 km^2 of Puget Sound, 16 whales used at least three adjoining, exclusive ranges (Dorsey 1983). At least part of this range was probably seasonal.

Minkes move into the Gulf in April and summer there. By October, most have left coastal Gulf waters, and have moved south. Of the five recorded minke whale sightings in winter in the Gulf of Alaska, two were south of Icy Bay and three were near Sitka (Consiglieri and Braham 1982).

Minkes are found near shore for the most part. In Japan, no minke whales were taken beyond the 185-m contour (Omura and Sakiura 1956). Sexual segregation was reported for minke whales off the coast of Japan, where the immature males remained in southern waters, while the mature animals—mostly adult females as well as some immature females—migrated to northern feeding grounds (Omura and Sakiura 1956).

There is no current population estimate for North Pacific minke whales, but they are considered abundant. There is no current minke whale harvest in the area nor has there been an historically heavy take (Consiglieri and Braham 1982; International Whaling Commission 1981). The worldwide population was estimated at 3.25×10^5 individuals (Scheffer 1976).

Based on samples taken from Antarctic minke whales, the mean age at sexual maturity has dropped from 14 years to 6 years for males and from 14 years to 7 years for females (Masaki 1979). Masaki (1979) suggested this might be a result of the intense exploitation of baleen whales, including the increased harvest of minke whales. There is no data available on age of sexual maturity of minke whales in the Gulf. Sexual maturity in minke whales off Japan was reached at 7.4 m for females and at 6.8 m for males (Omura and Sakiura 1956). Gestation takes from 10 to 11 months. Lactation, which lasts approximately 6 months, has been observed during ovulation in Antarctic minke whales, indicating an annual reproductive cycle (Lockyer 1981). The reported minimum pregnancy rate is 0.86 (International Whaling Commission 1981).

Very little information is available on the food of minke whales in the Gulf. In general, euphausiids and schooling fishes are their main foods (Ohmura and Sakiura 1956; Tomilin 1957; Nemoto 1959; and Klumov 1963). Fishes eaten include pollock, salmon (*Oncorhynchus* sp.), cod, sand lance, and herring. One whale found stranded on Unalaska Island had small pollock in its stomach (Frost and Lowry 1981). The main euphausiids taken are probably *Thysanoessa spinifera* and *Euphausia pacifica* (Nemoto and Kasuya 1965). Lockyer (1981) estimated daily food consumption by minkes at 4% of the total body weight in summer.

Killer Whale

Killer whales (*Orcinus orca*) are among the most widely distributed of all marine mammals. They occur in all oceans, major seas, and all ocean zones of the world (Dalheim, Leatherwood, and Perrin 1982). There are certain areas where they concentrate, such as within a few hundred kilometers of the coast and in the higher latitudes (Perrin 1982). Killer whales have a conspicuous, prominent mid-dorsal fin which in adult males can be 1.8 m tall. Females and juveniles have a smaller, somewhat falcate dorsal fin, usually less than 1 m tall (Leatherwood *et al.* 1982). The large flippers, which are shaped like broad, rounded paddles, are also distinctive (Leatherwood *et al.* 1982). Coloration in killer whales is sharply contrasting white and black. There is a large oval white patch above and behind each eye, the chin and throat are white, and the ventral surface is white. The white on the ventral surface narrows between the flippers, then continues up on each side of the flanks. Most animals have a light gray saddle behind the dorsal fin. Male killer whales reach lengths of 9.5 m (average ~8 m) and weigh approximatly 8 mt, while females reach lengths of 8.2 m (average ~7 m) and weigh approximatly 4 mt (Dalheim 1981). Newborns are 2.1 m to 2.4 m in length and weigh about 180 kilograms.

Killer whales are ubiquitous and abundant in the Gulf of Alaska. According to Consiglieri and Braham (1982) and Leatherwood, Balcomb, Matkin, and Ellis (1984) they are especially common near Kodiak Island, in Prince William Sound, and in the coastal waters of southeastern Alaska. Some killer whales are probably year-round Gulf residents (Braham and Dalheim 1982). In spring, killer whales can be found throughout the Gulf, primarily in the shelf waters shallower than 200 meters. The summer concentration areas are south and east of Kodiak, over Portlock Bank, in Prince William Sound, and in the inland waters of southeastern Alaska (Consiglieri and Braham 1982).

No specific, well-defined seasonal migrations have been documented for killer whales in the Gulf, although sightings of whales in waters as far as 100 nautical miles offshore have been interpreted by Consiglieri and Braham (1982) to be migrating animals. A group estimated to contain 500 killer whales sighted near Middleton Island in April 1973 (Jim Branson, National Marine Fisheries Service, pers. comm. cited in Calkins, Pitcher, and Schneider 1975) could represent a northward spring migration. According to Dalheim (1981), both the movements and the distribution of killer

whales are related to fish movements in summer and autumn. They are known to prey on shoreward-migrating schooling fish such as salmon and herring both in southeastern Alaska and in Prince William Sound (Nishiwaki and Handa 1958; Fiscus 1980).

No reliable estimate of killer whale abundance is available. Leatherwood *et al.* (1984) counted a minimum of 286 killer whales in three study areas (173 in Prince William Sound, 96 in southeastern Alaska, and 17 in the Shelikof Strait area). These direct counts only represent a fraction of the total number of whales present in those areas and an even smaller fraction of the total number of killer whales in the Gulf of Alaska.

Age at sexual maturity is not known, but is inferred both from the size of collected specimens and from the known growth rates of captive animals. Based on commercial catches of killer whales by Norway (Jonsgård and Lyshoel 1970), few pregnancies occur in females that are less than 4.9 m (16 ft) long. There is a marked increase in pregnancies in females over 4.9 m (16 ft). Gestation ranges from 12 to 16 months (Nishiwaki and Handa 1958; Perrin 1982). No direct evidence is available on the length of lactation in killer whales, but the calf remains closely associated with the cow for a period of between one and two years (Perrin 1982; Dalheim 1981).

Killer whales prey on a variety of fish and marine mammals, but appear to prefer fish when they are abundant. Lowry *et al.* (1982), after extensively reviewing the literature, conclude that they have one of the most diverse diets of all marine mammals. The relative importance of individual food species in the diet has not been determined, but they are known to eat fur seals, walruses, sea lions, elephant seals, harbor porpoises, Dall's porpoises, minke whales, cods, flatfishes (Pleuronectidae), and salmon (Tomilin 1957; Nishiwaki and Handa 1958; Bychkov 1967; Rice 1968; Fiscus 1980; and Dahlheim 1981). The daily food intake for four captive killer whales was estimated by Sergeant (1969) to be between 3.6 and 4.4% of their total body weight.

Belukha Whale

The belukha (beluga, or white whale) (*Delphinapterus leucas*) is the only medium-sized odontocete, common in the Gulf, that lacks a dorsal fin. Adult male belukhas reach lengths of between 3.2 and 4.4 m and weigh 520 to 1,200 kilograms. Females can be between 3.1 and 3.6 m in length and weigh 480 to 700 kilograms. Most newborn calves are about 1.6 m long (Kleinenberger, Yablokov, Bel'kovich, and Terasovich 1964; Leatherwood *et al.* 1982). Most adults are completely white, while newborns and immature animals are gray-shaded with blue or brown. Males become white as they reach nine years of age or older, while the females may become white as early as age six—but may retain some gray coloration for as long as 21 years (Burns and Seaman 1985). Belukhas are closely related to narwhals (*Monodon monoceros*), and in the eastern Canadian Arctic, these two whales are sympatric.

Belukhas are generally found in the open waters of those arctic and subarctic regions that are seasonally covered with ice. The Cook Inlet stock in the northern Gulf of Alaska is thought to be an isolated population. The nearest belukhas to the Cook Inlet stock are found in Bristol Bay on the north side of the Alaska Peninsula. No interchange between these stocks has been documented (Calkins 1984). Fay (University of Alaska, pers. comm., 1979) suggested the possibility of morphological differentiation between these stocks. He examined a limited series of skulls from Cook Inlet and compared them to skulls from other areas. The Cook Inlet sample was too small to conclude that the skull morphology differed from whales of the Bering Sea population (Calkins 1984).

Belukhas are sighted mostly in coastal or continental shelf waters. They frequent shallow waters, bays, and estuaries, and often enter rivers. Belukhas commonly concentrate in the mouths of rivers during calving, possibly because of a thermal advantage to newborns and other age classes (Sergeant 1973; Sergeant and Brodie 1975; and Fraker, Sergeant, and Hoek 1978). In Cook Inlet, belukha concentrations have been observed near the mouths of the Susitna, Lewis, and Beluga rivers in late May and June. They may be attracted to these areas by large numbers of anadromous fish, particularly eulachon (*Thaleicthys pacificus*), which are abundant there during the spring (Calkins 1984).

Belukhas move seasonally in relation to the ice that forms over much of their range. Virtually all of the belukhas from the Bering, Chukchi, and Beaufort Seas spend the winter along the Bering Sea ice fringes (Kleinenberger *et al.* 1964; Fay 1974; Seamen and Burns 1981). In the Gulf of Alaska, belukhas follow a seasonal pattern: they move into upper Cook Inlet in the spring, they concentrate near the mouths of rivers in the early summer (May and June), they can be found throughout Cook Inlet through late summer, and then probably move to the lower Inlet in winter (Fig. 17-3).

Some belukhas have been seen in Yakutat Bay (Calkins and Pitcher 1977) on an irregular basis. Consiglieri and Braham (1982) reported annual observations in Yakutat Bay by local fishermen. However, those reports are anecdotal and lack sufficient documentation to conclude that there is a small, resident population in Yakutat Bay. The belukhas that are seen in Yakutat Bay are probably members of the Cook Inlet stock and move across the north Gulf of Alaska. Other sightings reported outside Cook Inlet were at the Barren Islands, Marmot Bay north of Kodiak Island, Montague Island, and Shelikof Strait (Consiglieri and Braham 1982). In July 1983, approximately 200 belukhas were sighted in Prince William Sound just south of Bligh Island. These are assumed to have been part of the Cook Inlet stock.

No systematic, thorough surveys have been made of the Cook Inlet belukhas. Klinkhart (1966) estimated this stock at between 300 and 500 animals. Recent census work has not appreciably changed that estimate (Murray and Fay 1979; Calkins 1984). Estimates of between 300 and 500 individuals were based on direct counts and do not account for those animals that were underwater (and not seen) or for animals which were beyond the survey area. It is possible that there may be as many as 2 to 4 times more belukhas in the area than the current estimate.

Female belukhas are capable of breeding late in their third or fourth year. Males are sexually mature by the eighth year (Brodie 1971; Sergeant 1973; and Seaman and Burns

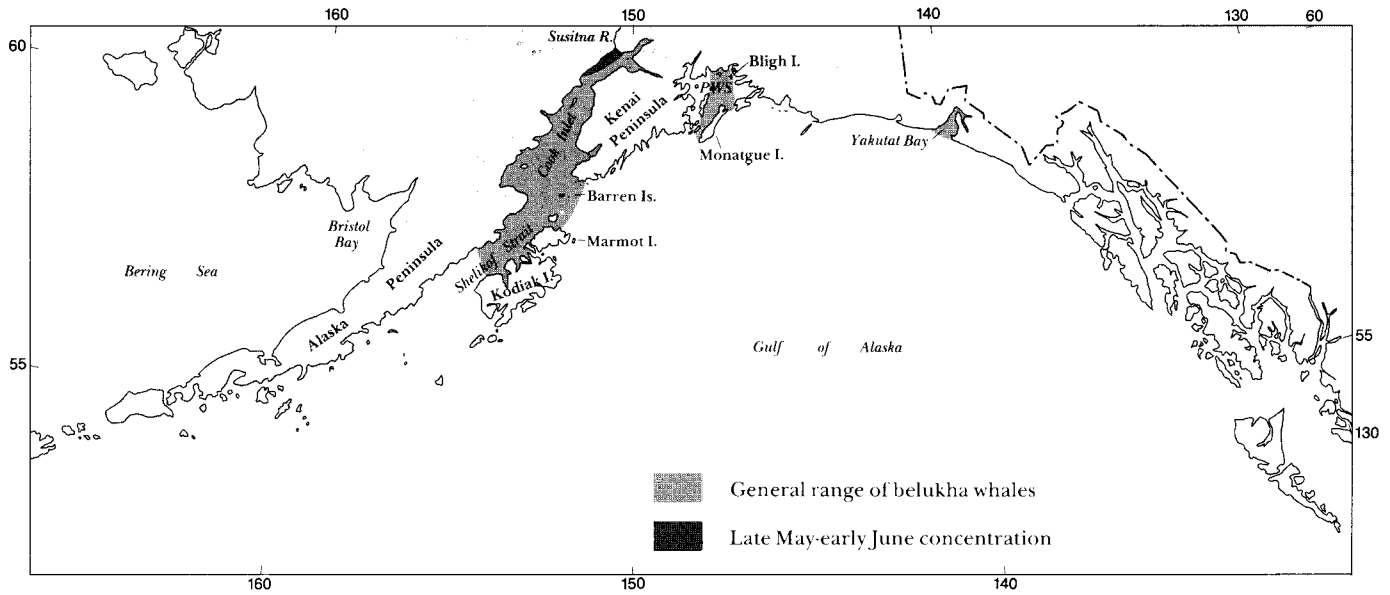

Figure 17–3. Distribution of belukha whales in the Gulf of Alaska.

1981). Breeding occurs in May and calving takes place in July or August after a gestation period of about 14 months (Lensink 1961; Fraker 1977; and Seaman and Burns 1981). Calving is followed by a two-year nursing period (Brodie 1971; Sergeant 1973) that completes a triennial breeding cycle.

Belukhas feed both on fish and on some invertebrates. Although they are capable of diving deeper, they feed primarily in the upper 10 m of water (Kleinenberger *et al.* 1964). Little information is available on the feeding habits of belukhas in Cook Inlet. However, Calkins (1984) observed whales (assumed to be feeding), in association with concentrations of anadromous fishes such as salmon or eulachon. In other parts of their range, belukhas eat over 100 species (Kleinenburger *et al.* 1964). Common in their diet are smelt, capelin, eulachon, herring, and saffron cod (*Eleginus gracilis*).

In offshore waters, Arctic cod and pollock may be important prey, along with shrimps, octopus, and sculpins (Lowry, Frost, and Seaman 1985). Sergeant (1969) presented data on the feeding rates of captive belukhas. He estimated that their consumption rate was between 4 and 7% of their body weight per day, with the highest percentage representing the feeding rate of a calf.

Pacific White-sided Dolphin

Pacific white-sided dolphins (*Lagenorhyncus ololiquidens*) are also commonly called lags, a term that is an abbreviation of the genus *Lagenorhynchus*. They are strong swimmers and leapers, sometimes turning complete aerial somersaults (Leatherwood *et al.* 1982). Lags reach a length of at least 2.3 m and may weigh as much as 150 kilograms. They have a moderately tall, strongly recurved dorsal fin that is situated in the mid-back. Their coloration is usually distinctive: a black back, light gray sides, and a white belly. A white or light-gray stripe starts at the forehead and face, then curves upward over the top of the head, continues along the back to the area of the dorsal fin, and finally widens and curves toward the anus, forming a prominent, light gray patch on the flank. The dorsal fin is dark on the forward one-third and light gray on the rear two-thirds (Leatherwood *et al.* 1982).

Pacific white-sided dolphins frequent the continental shelf slope and the coastal heads of deep-sea canyons (Leatherwood and Reeves 1978). They range throughout the Gulf of Alaska. There is not enough information to characterize their seasonal movements as migrations, although they are seasonally abundant in some areas (Consiglieri and Braham 1982).

Pacific white-sided dolphins become increasingly abundant in the spring, particularly in the eastern Gulf. The period of highest abundance is during the summer, when they concentrate over the Fairweather Ground and Portlock Bank (Consiglieri and Braham 1982). Autumn sightings have been reported from both the northeast and the northwest Gulf. Winter sightings have been rare (Consiglieri and Braham 1982).

Lags are extremely gregarious and groups of over 1,000 individuals have been sighted in the Gulf. Groups consisting of over 100 lags are common (Morris *et al.* 1983). While no reliable estimate of the total number of Pacific white-sided dolphins in the Gulf was found, it is estimated that there are between 2,000 and 3,000 individuals.

Reproductive biology of Pacific white-sided dolphins is not well understood. Males are sexually mature at between 1.7 and 1.8 m and females mature at between 1.8 and 1.9 meters. Most calving apparently takes place in the summer (Leatherwood *et al.* 1982).

Almost no information is available about the feeding habits of Pacific white-sided dolphins in the Gulf. Near shore in California and Puget Sound, the usual prey consists of anchovies (*Engraulis mordax*), hake (*Merluccius productus*), and squids (Leatherwood and Reeves 1978). Lags are opportunistic feeders that consume a variety of small schooling

fishes and cephalopods similar to those taken by Dall's porpoise (Stroud, Fiscus, and Kajimura 1981). No information on their food requirements was found. It can be assumed, however, that similar to Dall's porpoise, they require approximately 10% of their body weight per day.

Dall's Porpoise

Dall's porpoises (*Phocoenoides dalli*) are the most common small cetacean of the northern North Pacific (Leatherwood *et al.* 1982). They are ubiquitous year-round residents throughout much of the Gulf of Alaska (Consiglieri and Braham 1982). They grow to a length of 2.2 m and weigh ~300 kg (Leatherwood *et al.* 1982). Dall's porpoises are stocky, with males exhibiting much thicker bodies than the females. Their striking black-and-white color pattern makes identification relatively easy. The body is shiny black, with large, oval, white patches on each side at about mid-body. The patches meet ventrally at the midriff and end below the dorsal fin. The upper half of the dorsal fin and the upper rear margin of the flukes are also white (Leatherwood *et al.* 1982).

Dall's porpoises can be found in the waters of the continental shelf and slope. They tend to prefer wide straits and areas of merging currents, or the channels between islands (Scheffer 1949; Cowan 1944). Hall (1979) rarely saw Dall's porpoises in less than 20 m of water in Prince William Sound. The only continental shelf or slope areas of the Gulf that are not frequented by Dall's porpoises are those shallow, turbid waters such as upper Cook Inlet and Icy Bay (Consiglieri and Braham 1982).

Dall's porpoises show evidence of seasonal movements, but no directed, consistent migrations have been documented. Kasuya (1976) described north/south, summer/winter movements in Japan, while Leatherwood and Fielding (1974) described seasonal on-shore and offshore movements in California. Hall (1979) documented clear seasonal population declines from summer to fall in Prince William Sound.

According to Bouchet (1981), the North Pacific population of Dall's porpoises is estimated at between 8.37×10^5 and 1.3×10^6, excluding those animals found in the coastal waters of California, Oregon, and Washington. The Gulf of Alaska population estimates range from between 1.37- and 2.54×10^5 individuals. Density estimates in the Gulf range from 0.277 to 0.514 porpoises/nmi^2.

Parturition occurred between June and August for those Dall's porpoises that were taken in gillnets incidental to the North Pacific Japanese salmon fishery (Newby 1982). Morejohn (1979) reported that calving occurred year-round in northeastern Pacific waters from Alaska to California, while Kasuya (1976) found that parturition occurred from August to September in the western Pacific. Newby (1982) found that males became sexually mature at 183 cm or at 5.7 years, while females mature sexually at 171 cm or 3.3 years. At birth, calves are about 95 cm long and weigh 16.5 kilograms. Weaning occurs after one to two months.

Stomach content data from 457 Dall's porpoise taken during the high seas salmon gillnet fishery in 1978 and 1979 show that they eat squids (primarily of the family Gonatidae), as well as 29 fish species (Jones, Newby, Crawford, and Treacy 1980). Of the fishes eaten, a major proportion were from the family Myctophidae. Other important fishes were bathylagids and sand lance (Scheffer 1953). Based on a review of the available literature, Lowry *et al.* (1982) concluded that a daily food intake of about 10% of the body weight is necessary in order to sustain a Dall's porpoise in the Bering Sea.

Harbor Porpoise

The harbor porpoise (*Phocoena phocoena*) is the smallest cetacean that inhabits the Gulf of Alaska. It grows to a maximum length of about 1.8 m and a maximum weight of about 90 kg (Leatherwood *et al.* 1982). The harbor porpoise is dark brown or gray above and gray or white below, with the white coloration extending onto the chin. The upper jaw and lower lip are both dark, and a dark stripe extends from the corners of the mouth to the flippers.

Harbor porpoises appear to prefer coastal areas—particularly harbors, bays, and the mouths of rivers (Tomilin 1957). They dive to at least 80 m in search of food (Scheffer and Slipp 1948). No specific migrations have been documented for harbor porpoises, although several investigators (Consiglieri and Braham 1982; Hall 1979; and Leatherwood and Reeves 1978) have noted changes in seasonal abundance. Hall (1979) estimated the winter population in Prince William Sound to be about half the summer population. The Prince William Sound concentration of harbor porpoises may be the largest in the eastern North Pacific (Leatherwood and Reeves 1978).

No population estimate is currently available for the Gulf of Alaska. Hall (1979) estimated 590 harbor porpoises in Prince William Sound in the winter and 946 in the summer. There is extensive suitable habitat in the Gulf of Alaska and sightings are numerous. This led Morris *et al.* (1983) to suggest that harbor porpoises are abundant, and to estimate that there may be between 2,000 and 3,000 in the Gulf.

Little is known about the reproductive biology of harbor porpoises in the eastern North Pacific. Tomilin (1957) thought that breeding periods were similar for the North Atlantic, North Pacific, and the Black Sea stocks. In the Black Sea, harbor porpoises mate from June to October, with peak activity occurring in August. Calving occurs in May and June after a gestation period of between 10 and 11 months (Tomilin 1957). In the Atlantic stock, sexual maturity is reportedly attained by males at age 4 to 5 years and by females at age 6 years (Prescott and Fiorelli 1980; Fisher and Harrison 1970).

Harbor porpoises in the North Atlantic feed on cod (*Gadus morhua*), herring, and Atlantic mackerel (*Scomber scombrus*) (Smith and Gaskin 1974). Frost and Lowry (1981) found the remains of small fish (primarily saffron cod) and crustaceans in the stomachs of three harbor porpoises from Norton Sound. The predominant food species in the North Atlantic were pelagic, schooling fishes that were often of some economic importance (Smith and Gaskin 1974).

In the Gulf of Alaska, harbor porpoise probably feed on fishes such as herring, capelin, pollock, and eulachon—although no data are available to verify that. Hall (1979)

reported harbor porpoises at the mouth of the Copper River and assumed they were foraging on those fish species that concentrate in the area where the Copper River water mixes with water from the Gulf. Little information on food requirements exists for harbor porpoises. Sergeant (1969) and Prescott and Fiorelli (1980) all suggested a daily feeding rate for harbor porpoises of between 8.3 and 10% of their body weight.

Harbor Seal

The harbor seal (*Phoca vitulina richardsi*) is found in all coastal areas of the Gulf of Alaska, where Pitcher (1985) considered it to be the most widely distributed of the Pinnipedia. Harbor seals are relatively small 'earless' seals, with stiff, bristle-like hair and short limbs. There is a considerable variety in their coloration and markings—ranging from spots of white-gray to dark brown or black along with rings, and splotches that occur on a background of similar colors (Bigg 1981). The average birth size of harbor seal pups in the Gulf of Alaska varied by area. Near Kodiak, for example, newborn pups weighed 12 kg and measured 78 cm in length while in the northeastern Gulf, they weighed 10 kg and were 73 cm in length (Pitcher and Calkins 1979). Adult males averaged 155 cm in length and weighed 85 kg, while females were 145 cm in length and 77 kg in weight throughout the Gulf.

Harbor seals use land areas known as terrestrial haulouts for resting and nurturing their young. Haulout substrate is highly variable, ranging from rocky intertidal reefs to broad, flat sandy beaches and calved glacial ice. According to Pitcher (1985), some important characteristics of seal haulouts are: ready access to water, isolation from disturbance, protection from wind and wave action, and access to food.

There are thousands of locations in the Gulf of Alaska where harbor seals haul out. However, Pitcher and Calkins (1979) list only 103 locations where more than 25 seals were sighted (see Fig. 17-4). During the early to mid-1970s, Tugidak Island off the south end of Kodiak Island had the largest concentration of harbor seals on the west coast of North America. However, the numbers have recently declined and Tugidak no longer holds this distinction (Alaska Department of Fish and Game, unpubl. data).

Harbor seals, although often considered to be sedentary and limited to coastal areas, are known to move relatively long distances and have been sighted as far as 100 km offshore (Pitcher and Calkins 1979; Wahl 1977; and Spalding 1964). The movements of 31 radio-tagged seals in the Gulf of Alaska were documented by Pitcher and McAllister (1981). The longest movement was 194 km along the shores of Kodiak Island. One of the tagged seals crossed 74 km of open ocean to occupy a different hauling area, then subsequently returned to the site where it was tagged. At least for adults, there appears to be considerable fidelity to haulout sites as demonstrated by the fact that 23 of the 31 harbor seals tagged by Pitcher and McAllister (1981) remained at the capture site. There is no evidence of true migration. Both the numbers and the distributions of seals in the Gulf of Alaska remain relatively constant throughout the year.

In the Gulf, most harbor seal pups are born between the 5th and the 25th of June (Pitcher and Calkins 1979). Pups nurse for a period of between three and six weeks—after which they completely separate from the female. Ovulation occurs between mid-June and mid- to late July, shortly after weaning in those females that have pupped, but implantation is delayed for approximately 11 weeks. Age of first ovulation is from 3 to 7 years, and the pregnancy rates for females 8 years old and older is 92 percent. Male seals in the Gulf become sexually mature by age 6 (Pitcher and Calkins 1979).

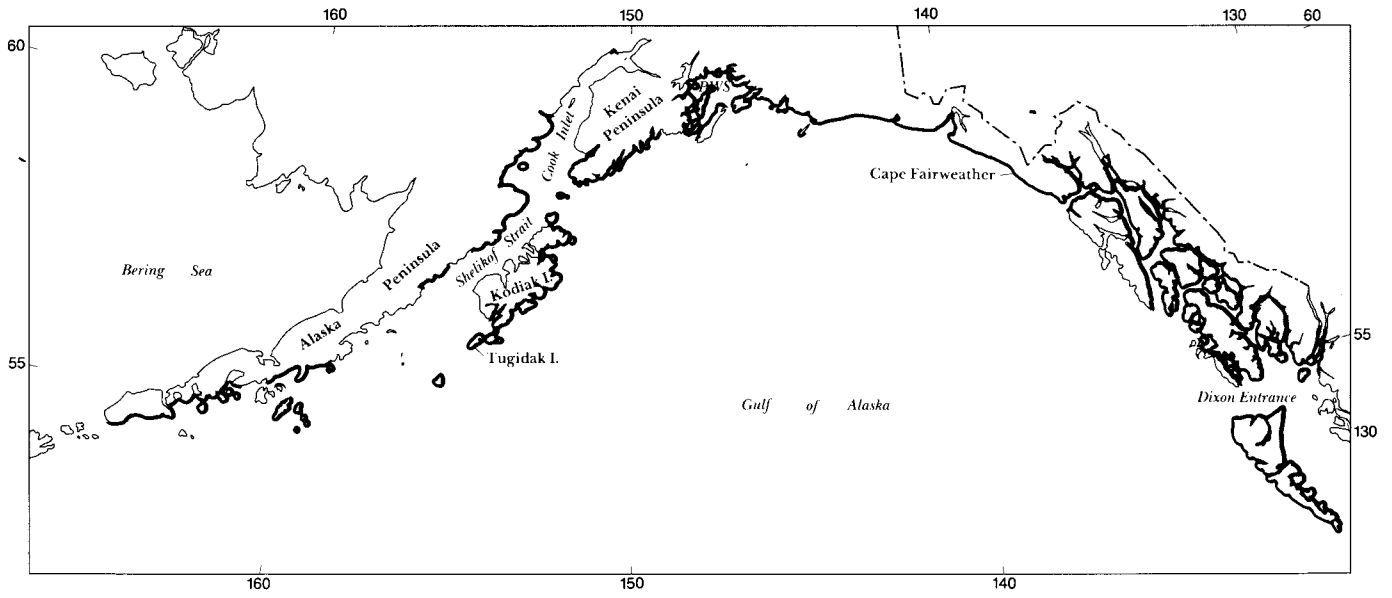

Figure 17-4. Areas of known concentrations of harbor seals in the Gulf of Alaska. (All sightings were made of hauled-out animals only.)

The prey of harbor seals (by frequency of occurrence) consisted of 73.8% fishes, 22.2% cephalopods—both octopus and squid—and 4.1% decapod crustaceans (primarily shrimps). Twenty-seven species of fishes belonging to 13 families were identified as harbor seal prey. The three most-important prey were pollock, octopus (*Octopus* sp.), and capelin (Pitcher and Calkins 1979). Most investigators agreed upon a daily consumption rate for harbor seals of 7.5% of the seal's body weight (Ashwell-Erickson and Elsner 1981).

Because harbor seals are distributed in small groups throughout coastal areas and because of their relatively shy nature, they are very difficult to count. Various methods have been used to estimate their numbers in a given area, including direct counts of those that are hauled out at a given time, as well as estimates based on harvest statistics. Those estimates that are based on harvest data are probably the most accurate because they take into account the entire population rather than the instantaneous number that are hauled out at a given time.

Based on harvest statistics, Pitcher (1985) estimated the abundance of harbor seals in the Gulf of Alaska 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 the south side of the Alaska Peninsula—55,000. The total estimate for the Gulf of Alaska was 155,000 harbor seals. These estimates were originally made for an environmental impact statement in 1973. No data are available to update these estimates, although Pitcher (K. Pitcher, Alaska Department of Fish and Game, pers. comm., 1985) considers them to be imprecise. Recent information gathered by ADF&G suggests that this stock may have declined substantially since 1973.

Steller Sea Lion

The Steller sea lion (*Eumetopias jubatus*) is the largest and one of the most conspicuous pinnipeds inhabiting the North Pacific Ocean—and its range is restricted to this area. The Steller sea lion is the largest of the eared seals, the Otariidae. The only other member of this family that is found commonly in the Gulf of Alaska is the northern fur seal (*Callorhinus ursinus*).

The pups are chocolate brown, but because they lack pigment in the tips of their hair, they have a frosty appearance. The pups appear to gradually grow lighter in color as the animals get older. Many adults are a yellowish cream color on the back, although some remain darker. Males generally remain darker on the front of the neck and chest and grow a short mane over the back of the shoulders and neck. The mane and the large front shoulders and neck resemble the terrestrial lion—thus the name sea lion. The common name 'Steller' is used to honor the German naturalist G. W. Steller, who first described this species in 1751.

Steller sea lions show a pronounced sexual dimorphism in size. Males average more than twice the weight of females and are about 20% longer. Calkins and Pitcher (1982) found that sea lion pups weigh approximately 23 kg at birth and are 110 cm long (curvilinear length). Average weight and standard length for adults was 263 kg and 228 cm for females and 566 kg and 282 cm for males.

Steller sea lions are widely distributed over the continental shelf and throughout the coastal waters of the Gulf of Alaska. Offshore, they are normally found at depths shallower than 2,000 m and are frequently found in greatest numbers near the 200-m contour (Consiglieri and Braham 1982).

Sea lions use terrestrial haulouts for resting and they tend to gather on traditional, well-defined rookeries in order to pup and breed. Calkins and Pitcher (1982) listed 61 locations in the Gulf where sea lions haul out on a regular basis and 46 more locations which are used irregularly. The latter are referred to as stopover areas. The majority of pups are produced at 11 pupping rookeries (Fig. 17-5). Generally, stopover areas are used by small numbers of animals—usually less than 200. Haulouts can be used by as few as 50 or as many as 4,000 animals. Rookeries are usually used by several thousand animals during the breeding season. All rookeries become haulouts during non- breeding periods. Some rookery haulouts are used by only a few hundred individuals during winter months while other areas continue to be used by up to 3,000 animals in winter.

The haulout behavior of sea lions is complicated and not completely understood. At some haulouts during some periods, there appears to be specific sex and age segregation and usage. On rookeries, non-territorial males apparently stay on the fringes while parturient females and territorial males use the central part of the rookery. The intervening area is used by a mixture of all age classes and by both sexes.

Adult sea lions gather on the rookeries beginning about mid-May. Males defend territories on the rookeries and generally exclude other males. Territorial boundaries are often defined by the physical features of the rookery. Females enter and move about within the territories at will, although there appears to be some competition among females for particular locations on the rookery. It is not known whether they are competing for the most desirable location for parturition or for the most desirable males within the territories. Certainly, there is evolutionary advantage to mating with the fittest males, although Gentry and Withrow (1978) point out that some females may give birth in one territory, mate in another, and spend the majority of their time in still another.

The total range of Steller sea lions extends from the California Channel Islands along the North Pacific Rim to northern Japan. The center of abundance is the western Gulf and eastern Aleutian Islands. Loughlin, Rugh, and Fiscus (1984) estimated a total world population of 2.45- to 2.90×10^5 individuals. Calkins and Pitcher (1982) estimated that there were 1.4×10^5 sea lions in the Gulf of Alaska in 1979. However, recent surveys of all age classes suggest this population may be declining (Calkins 1985a).

Pups are born from about May 15 through July 15. The females breed again about 11 days after giving birth (Gentry 1970; Sandegren 1970). Early embryonic growth temporarily ceases at the blastocyst stage which does not implant on the uterine wall until late September or October (Pitcher and Calkins 1981).

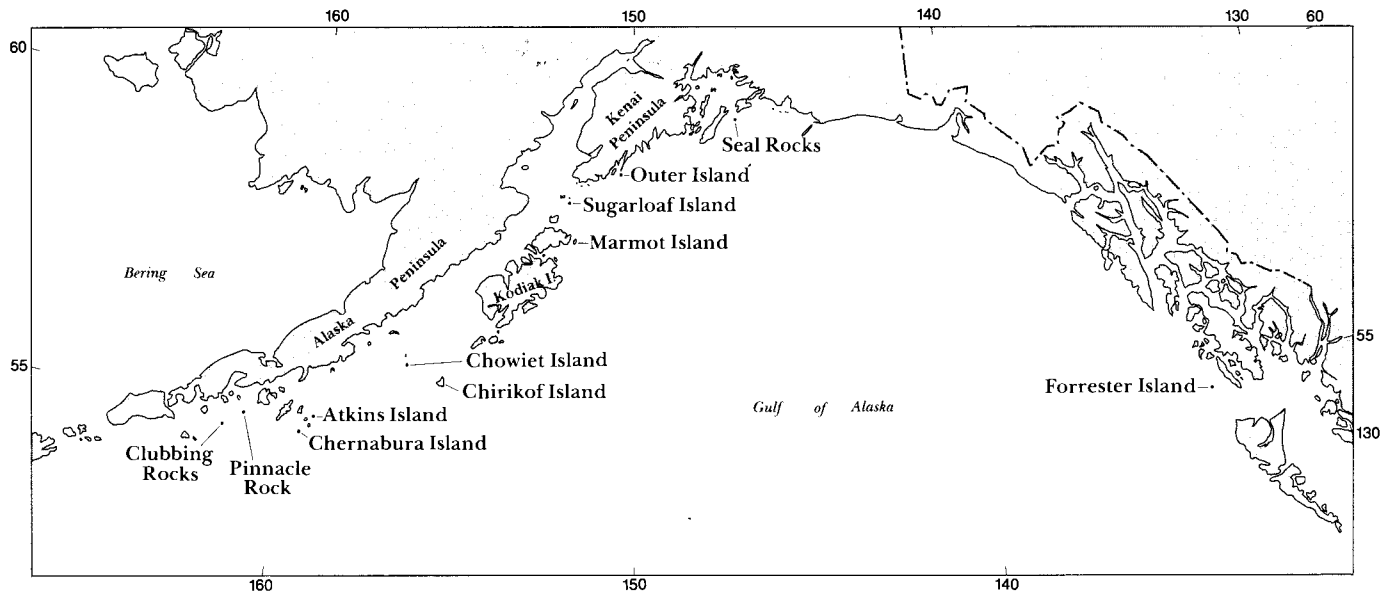

Figure 17–5. Locations of major Steller sea lion pupping rookeries in the Gulf of Alaska.

Some males are physiologically capable of breeding at three years of age and most are probably capable of breeding by age seven years. However, they are not large enough and strong enough to defend territories until about their tenth year. Some females breed for the first time in their third year and bear the first pup at age 4. Most females attain sexual maturity by age 6 and bear a pup each year (Pitcher and Calkins 1981).

Pollock is the most important prey species for sea lions in the Gulf of Alaska. Pitcher (1981) found the diet of Steller sea lions in the Gulf to consist of 67% pollock by frequency. Other important prey found were:

- squids (Gonatidae)—23%
- octopus—13%
- Pacific cod (*Gadus macrocephalus*)—19%
- Pacific herring (*Clupea harengus pallasii*)—16%
- capelin—16%
- salmon—6%
- sculpins (Cottidae)—6%
- flatfishes—7%
- rockfishes—4%.

Harbor seal remains have rarely been found in the stomachs of sea lions in the Gulf of Alaska (Pitcher and Fay 1982). Although information on the food requirements of sea lions is incomplete, Keyes (1968) concluded that sea lions consume from 6 to 10% of their body weight per day.

Northern Fur Seal

The northern fur seal (*Callorhinus ursinus*) has a thick, heavy, water-repellent coat of underfur, along with unusually large flippers. Adults appear yellowish brown on the rookeries, but at sea they appear black with a gray or light-colored throat. Adult females in prime condition usually weigh between 37 and 40 kg, while males average 127 kilograms. At birth, female pups weigh about 4.5 kg and males weigh about 5.5 kg (Fiscus 1978).

For much of their life, fur seals are pelagic and rarely come ashore except on their home islands during the breeding season. The northern fur seal is found in the Gulf of Alaska primarily on a seasonal basis, although Kajimura (1980) stated that they can be found in all parts of their range in any month of the year. They are most abundant in the Gulf in the spring, during their annual migration to the Pribilof Islands breeding grounds (Consigleiri and Braham 1982). The spring fur seal distribution in the Gulf of Alaska is shown in Figure 17–6.

Some young males and non-pregnant females remain in the Gulf during summer. Small numbers of fur seals regularly haul out in summer on Sugarloaf Island in the Barren Islands and at Forrester Island off Dixon Entrance in southeastern Alaska (Fiscus 1983). Most of the adult population moves to the Pribilof Islands for both pupping and breeding, which take place from mid-June through mid-August (Bartholomew and Hoel 1953; Kajimura 1980; and Fiscus 1983).

After the breeding season, fur seals remain at the Pribilof Islands until late October when some of the females begin the southward migration. As this southward migration escalates, the number of fur seals increases in the Gulf. Some breeding-age males remain in the southeastern Bering Sea, although most of the animals move into the Gulf of Alaska and southward towards their wintering areas (Kajimura, Lander, Perez, York, and Bigg 1980a). Some older males spend the winter in the Gulf (Alexander 1953), while most younger males and females move south to winter along the continental shelf off British Columbia, Washington, Oregon, and California (Kajimura *et al.* 1980a). Consiglieri and Braham (1982) stated that one large group of fur seals winters off Baranof Island. Fur seals have also been seen during the winter on the edge of Portlock Bank and in the deep waters of the central Gulf (Consiglieri and Braham 1982; Kajimura *et al.* 1980a).

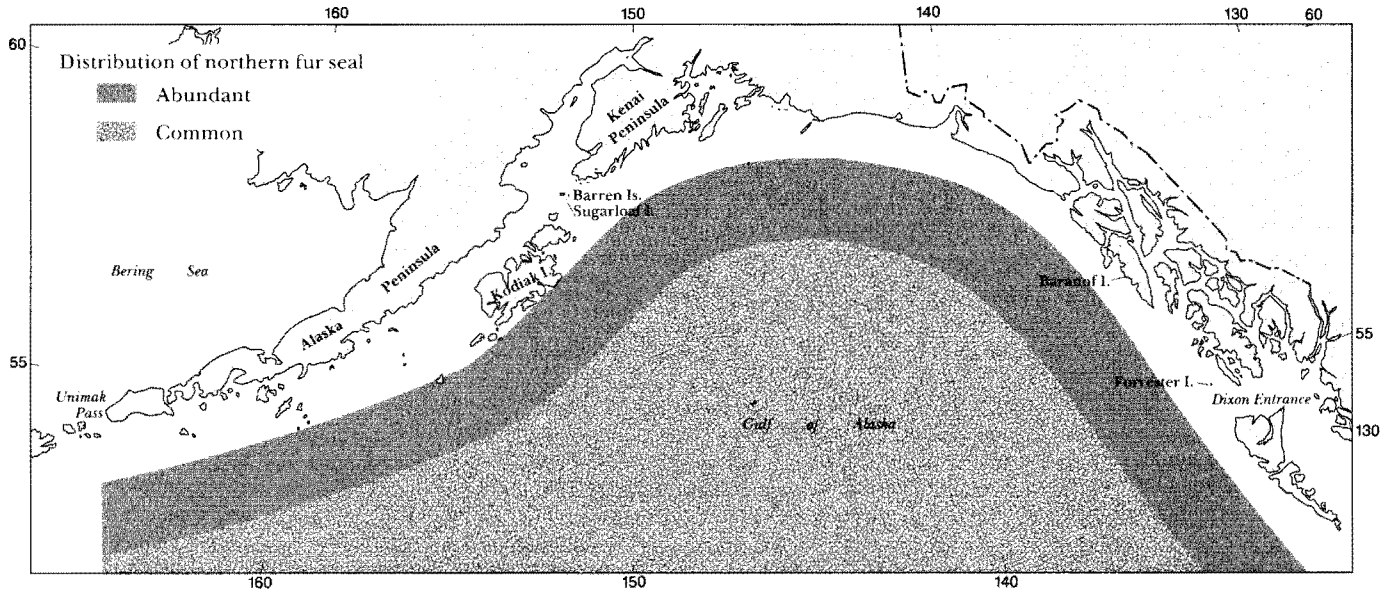

Figure 17–6. General distribution of northern fur seals in the Gulf of Alaska during spring. (Modified from Consiglieri and Braham 1982.)

When hunters began killing fur seals commercially for their skins in 1786, the Pribilof fur seal population was estimated at 2.5×10^6 animals. The herd steadily declined to a low point in 1835, when Russia provided some protection. The herd was allowed to grow to relatively high numbers (numbers unknown) until the United States purchased Alaska in 1867 (Gentry 1981). The herd again decreased until 1910 when fewer than 2.0×10^5 animals remained.

The Fur Seal Treaty in 1911 both protected the seals and regulated their harvest and the herd was again allowed to grow. By 1950, the herd was producing over 4.0×10^5 pups annually (Lander and Kajimura 1976). An attempt to stimulate reproduction by harvesting females between 1956 and 1968 resulted in another herd reduction (Fowler 1982; Gentry 1981; and Chapman 1973). The Pribilof fur seal herd was estimated at 2.1×10^6 in 1951 and most recently at 8.77×10^5 individuals (Briggs and Fowler 1984).

During the breeding season, male fur seals defend their territories and mate with the females shortly after the females give birth to pups (Fiscus 1978). The blastocyst does not implant on the uterine wall until October or November. Most females attain sexual maturity at four or five years of age (Kajimura *et al.* 1980a) and from that point on, over 80% of the females between the ages of 6 and 17 years become pregnant each year (Kajimura *et al.* 1980a).

Fur seals feed on a wide variety of fish and cephalopods (Kajimura *et al.* 1980b), and they are capable of diving to 200 m in search of prey—although most feeding dives have been reported to be in the range of 20 to 100 m (Kooyman, Gentry, and Urquhart 1976). Their principal prey in the Gulf of Alaska includes pollock, capelin, sand lance, herring, and several species of squid (Kajimura *et al.* 1980b). Scheffer (1950) calculated the daily food requirement of fur seals to be 6.7% of the total body weight, whereas Miller (1978) estimated a minimum feeding rate of 14% of body weight per day.

Sea Otter

The sea otter (*Enhydra lutris*) is the only marine representative of the mustelid family in North America. It inhabits the nearshore areas of the North Pacific from California to the Kuril Islands. The best paleontological evidence suggests that otters, including sea otters, descended from common Asiatic ancestors (Kenyon 1969). Three races of sea otters have been described, and those otters found in the Gulf belong to the race *Enhydra lutris lutris* (Kenyon 1981).

Sea otter pups appear yellowish because of the light coloration in their guard hairs, although their dense underfur is brown (Kenyon 1969). Adults typically tend to be dark-bodied with buffy to light gray heads. The head tends to become lighter with age, and a more grizzled coloration may appear on other parts of the body. Body color varies from light buff (rare) through shades of brown to nearly black. The coloration of their guard hair ranges from dark to silver white (Kenyon 1969). Sea otters may vary in size according to nutritional conditions, and therefore their overall average size may not be the same for different areas. Based on data from Kenyon (1969), mean body sizes for sea otters in the Aleutian Islands are:

- newborns—2 kg in weight and 57 cm in length
- adult female—21 kg in weight and 125 cm in length
- adult males—28 kg in weight and 135 cm in length.

Sea otters are found in nearshore habitats throughout the Gulf of Alaska. Although they are apparently capable of diving to depths in excess of 90 m, they prefer depths of less than 55 m (Kenyon 1981). Their preferred habitat appears to be those waters that are adjacent to rocky coasts that have extensive areas of submerged reefs. Although sea otters favor areas where kelp beds (*Alaria* sp., *Macrocystis* sp., and *Nereocystis* sp.) occur, this does not appear to be a requirement (Kenyon 1969).

Certain areas are occupied exclusively by the males, while other areas are used both by females with pups and by small numbers of territorial males. Those areas occupied solely by males tend to be in more exposed, newly colonized locations while areas occupied by females tend to be in better-protected locations (Garshelis, Johnson, and Garshelis 1984). This pattern indicates that different sexes and age classes may have different habitat requirements (Calkins and Schneider 1985). Sea otters make use of terrestrial haul-out sites, using some sites more frequently than others. Abundant food at accessible depths is probably the most rigid habitat requirement; other habitat characteristics may be desirable, but not necessarily required.

The seasonal movements of the otters between their male and female areas are apparently influenced by factors such as breeding, pup-rearing, boat traffic patterns, and protection from inclement weather (Garshelis and Garshelis 1984)—as well as by the availability of food. Although much of the Gulf coast is considered potential sea otter habitat, not all areas have been completely repopulated. At the time when the United States gave protection to sea otters (1911) under the Fur Seal Treaty, several isolated locations of the Alaskan coast had small, remnant populations of sea otters. Those groups that had survived were apparently located in Prince William Sound, at Kodiak Island, on the south side of the Alaska Peninsula, and near Sanak Island (Kenyon 1969).

These nucleus populations increased and expanded until they occupied much of Prince William Sound, including the area of Controller Bay and Kayak Island, the Kenai Peninsula, lower Cook Inlet, the Barren Islands, much of the south side of the Alaska Peninsula, and most of the Kodiak Island area (Fig. 17-7). There are still scattered areas that are not fully repopulated throughout the Gulf. The unoccupied areas west of Cape St. Elias are small and otter populations are increasing within those areas. The Gulf coast from Cape Spencer to Cape St. Elias supports only scattered small groups and individual animals.

During the period from 1965 through 1969, the Alaska Department of Fish and Game (in cooperation with the Atomic Energy Commission) perfected techniques for large-scale sea otter translocations (Burris and McKnight 1973). A total of 413 sea otters were reintroduced into areas of former habitat both in the northeastern Gulf and in southeastern Alaska between Yakutat Bay and the Barrier Islands. Data from surveys in 1983 showed this population had grown to more than 1,500 animals (Johnson, Jameson, Schmidt, and Calkins, 1983) and probably exceeded 2,000 animals (Alaska Department of Fish and Game, unpubl. data).

Sea otter populations have been increasing throughout most areas of the Gulf of Alaska since 1911. The most recent population estimates by Calkins and Schneider (1985) are shown in Table 17-2.

Table 17-2.
Estimate of sea otter numbers in the Gulf of Alaska (from Calkins and Schneider 1985).

LOCATION	ESTIMATE
Southeast Alaska	2,000*
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 Islands)	4,000–6,000
South side of Alaska Peninsula	22,000–25,000
Total	34,600–42,600

* From Johnson *et al.* (1983) and Alaska Department of Fish and Game (unpubl. data).

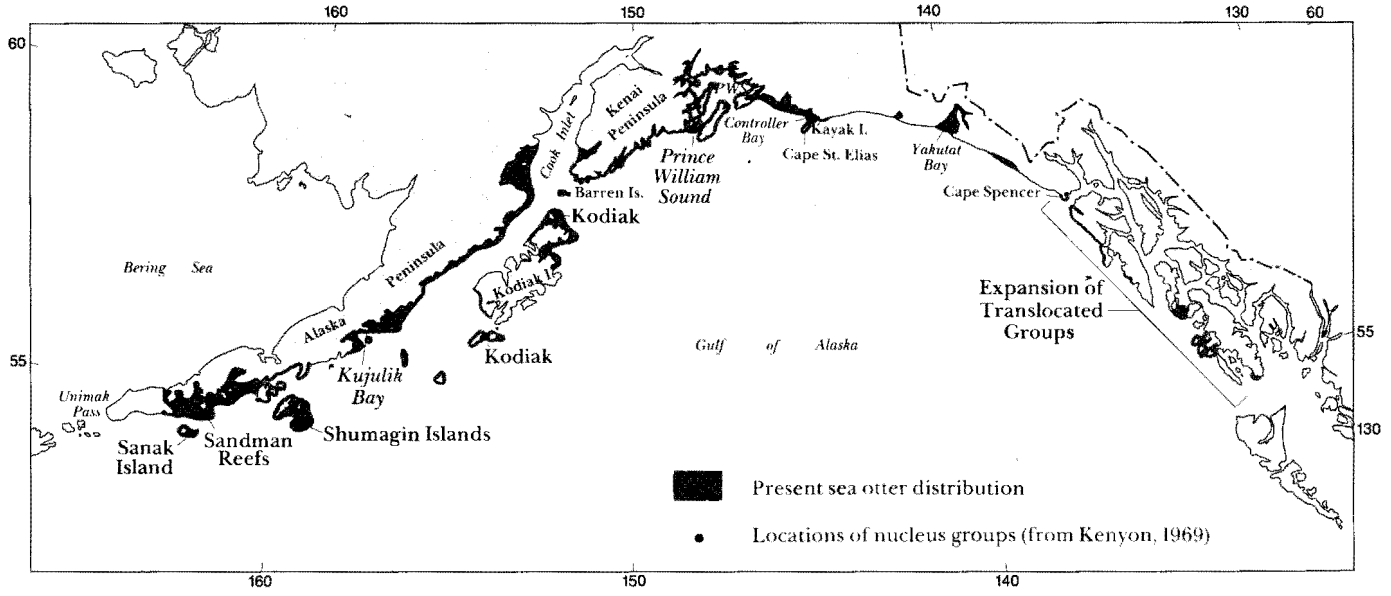

Figure 17-7. Present distribution of sea otters in the Gulf of Alaska with assumed locations of nucleus groups and expansion of translocated populations.

Productivity and reproduction in sea otters have not been completely studied. There appears to be variability in the timing of events between growing populations and those populations that have become well established and exist at a level that is near the habitat's carrying capacity. Sea otters apparently mate and give birth at any time of the year (Murie 1940; Fisher 1940; Barabash-Nikiforov 1947; Lensink 1962; and Kenyon 1969). Schneider (1972) found that in the Aleutian Islands, breeding activity peaked in September and October and parturition reached a peak in April, May, and early June. The average gestation period was estimated to be about 7.5 months. A delayed implantation lasted approximately half of the gestation period.

Schneider (1972) found that most females became sexually mature at age 3 and bore their first pup at age 4. The females nursed their pups for as long as a year and rarely became pregnant during this period. Thus, a two-year breeding cycle was postulated for sea otters in the Aleutians (Schneider 1972). However, recent studies in Prince William Sound indicated that pupping may occur annually in areas where the population is well below the habitat's carrying capacity (A. Johnson, U. S. Fish and Wildlife Service, Anchorage, AK., pers. comm., 1984).

Sea otters feed on a wide variety of bottom-dwelling invertebrates and fishes. Generally, they feed heavily on invertebrates until they deplete the supply, then the otters move to unoccupied habitat or consume fish. Kenyon (1969) found that at Amchitka Island sea otters ate a variety of species, including:

- chitons (*Cryptochiton stelleri*)
- snails (*Buccinium* sp.)
- mussels (*Musculus vernicosa*)
- octopus
- rock oysters (*Pododesmus macrochisma*)
- crabs (*Cancer* sp.)
- green sea urchins (*Strongylocentrotus droebachiensis*)
- globe fish (*Cyclopterichthys glaber*)
- red Irish lords (*Hemilepidotus hemilepidotus*).

In the Gulf of Alaska, Calkins (1978) found that otters ate clams, primarily *Saxidomus giganteus* (81%), but also took octopus, crabs, and sea stars (*Evasterias troschelii*). Daily consumption rates of from 20 to 30% of body weight were estimated for otters (Morrison, Roenmann, and Estes 1974; Kenyon 1969).

Other Marine Mammals

Two species of the large cetaceans listed in Table 17-1—the blue whale (*Balaenoptera musculus*) and the Pacific right whale (*Balaena glacialis*)—are considered endangered. They both exist in such low numbers that their recovery may be extremely slow, and has probably not yet even begun (Mizroch, Rice, and Breiwick 1984; Braham and Rice 1984).

For a variety of reasons, the Pacific right whale was highly sought after by commercial whalers and was consequently reduced to such low levels that the population was dangerously near extinction. Less than 200 right whales may remain in the entire North Pacific (Braham and Rice 1984).

Blue whales, although present in higher numbers than the right whales, are also rarely sighted; and very little is known about either their biology or their ecology in the Gulf. Blue whale sightings have been recorded in the western Gulf in the summer, and they apparently migrate south in the winter (Berzin and Rovnin 1966; Rice 1978a; and Consiglieri and Braham 1982).

The short-finned pilot whale (*Globicephala macrorhynchus*) and Risso's dolphin (*Grampus griseus*) are both rarely sighted in the Gulf. Their range lies mostly to the south and the few sightings that have been made have usually been in summer (Consiglieri and Braham 1982). The northern right whale dolphin is also a species that occurs in more southern, temperate waters. Consiglieri and Braham (1982) state that there are no reliable sightings of northern right whale dolphins north of 50°N, although they list three tentative sightings north of 54°N.

The Bering Sea beaked whale (*Mesoplodon stejnegeri*), Cuvier's beaked whale (*Ziphius cavirostris*), and Baird's beaked whale (*Berardius bairdi*) are found in the Gulf, but little is known about them. No population estimates are available for any beaked whales in the Gulf. Bering Sea beaked whales have not been commercially exploited, so little is known about their life history. The only specific information comes from a few sightings of stranded animals. Morris *et al.* (1983) speculated that Bering Sea beaked whales inhabit the deep waters of the continental slope. However, the recent strandings of three individuals in Cook Inlet, during the autumn of three successive years indicate that they may, at least occasionally, be attracted to nearshore waters.

Although Cuvier's beaked whale and Baird's beaked whale have both been commercially taken in small numbers by Japan, little information is available about either species in the Gulf. They are both thought to inhabit water deeper than 1,000 m (Nishiwaki and Oguro 1971, 1972). Squid and deep water fish appear to be important prey for both species (Nishiwaki 1972; Nishiwaki and Oguro 1971, 1972). Neither food-habit data nor population estimates are available for any of the beaked whales in the Gulf of Alaska.

Pacific walruses (*Odobenus rosmarus*) have occasionally been sighted in the Gulf (Murie 1959; Calkins *et al.* 1975; Bailey and Faust 1981; and Fay 1982). Fay (1982) reviewed several sightings of walruses which had apparently entered the Gulf through Unimak Pass in the winter of 1979, and then in the spring had moved north along the south side of the Alaska Peninsula as far as Cook Inlet. He considered these to be extralimital sightings. Walrus sightings continue to be reported from Cook Inlet.

California sea lions (*Zalophus californianus*) have been reported in the Gulf of Alaska on at least two occasions: once from Point Ellrington, outside of Prince William Sound, in June of 1974 (K. Schneider, Alaska Department of Fish and Game, pers. comm., 1974) and once at Point Lull, on Baranof Island, southeastern Alaska, in April 1982.

Northern elephant seals (*Mirounga angustirostris*) are regular summer visitors to southeastern Alaska where each year small numbers are found in the inside waters. Southeastern Alaska can be considered the northern limit of their range. Several individuals have been found stranded at other locations in the Gulf. For example, a subadult male elephant seal

was found stranded on Middleton Island in April 1975, and a young female was found stranded on Unalaska Island (in the eastern Aleutian Islands) in October 1976 (R. Nelson, Alaska Department of Fish and Game, pers. comm., 1976). In addition, a badly decomposed elephant seal was found in February 1977 at Wide Bay on the Alaska Peninsula.

Discussion and Conclusions

Marine mammals in the Gulf of Alaska are ecologically situated as high trophic-level consumers. They feed on a variety of nektonic, benthic, and planktonic animals. The most common prey for marine mammals in the Gulf are:

- copepods
- euphausiids
- schooling fishes such as herring, cod, pollock, capelin, and salmon
- cephalopods—primarily squids
- other crustaceans.

I used the daily consumption rates presented for each species in this chapter as the basis for calculating an annual consumption rate of 7.55×10^6 metric tons of food consumed by the common marine mammals of the Gulf (Table 17-3). This total does not take into account the marine mammals discussed in the section 'Other Marine Mammals'.

The method I used to derive this total was to multiply the estimated average daily consumptions by the estimated number of days spent in the Gulf annually, and then multiply that total by the estimate for the total number of individuals in the Gulf. This is among the simplest methods for deriving annual consumption rates. It does not fully take into account factors such as differential feeding rates between age classes or between seasons, nor does it consider the different caloric values of the foods that were consumed. Where information was not available, I interpolated it from comparisons with other marine mammals of similar size and with similar prey selection. Therefore, the information presented in Table 17-3 is crude, and is probably a conservative approximation.

The most accurate and useful information from Table 17-3 is the comparison of the total amount of food that was consumed by the different species. Among cetaceans, the fin whales consumed the most, followed by the sei whales and Dall's porpoises. It seems apparent that the largest species, such as fin and sei whales, should rank high. However, the Dall's porpoise also ranks high, even though it is a small cetacean, primarily because of the relative abundance of this species in the Gulf.

Steller sea lions had the highest consumption among the pinnipeds. This was because their large size requires a relatively high consumption rate. The annual food consumption of 5.5×10^5 mt by the Gulf sea lions is over twice as high as the 2.6×10^5 mt of groundfish harvested by commercial fishermen in the Gulf during the 1981 season (Kajimura and Loughlin, in press; Morris *et al.* 1983).

Marine mammals depend, to a large extent, on food species that are also harvested commercially by man. This means that numerous conflicts have developed between the marine mammals and fishermen. Interactions between man and marine mammals have resulted in actions ranging from inconsistent federal legislation to more direct conflicts between the marine mammals and the fishermen (Metlef and Rosenberg 1984). The complexity of the problem is often reflected in management policy. For example, the Marine Mammal Protection Act of 1972 requires that marine mammals be managed to maintain the health and stability of the ecosystem. In contrast, the (Magnuson) Fisheries Conservation and Management Act of 1976 mandates that fisheries be managed to provide maximum sustainable yield under current environmental conditions.

Numerous conflict situations have developed between commercial fishermen and marine mammals. An example is the Shelikof Strait pollock fishery. This fishery was developed in order to take advantage of the enormous spawning schools of pollock which aggregate in Shelikof Strait between January and March (Loughlin and DeLong 1983). One thousand ninety-three sea lions were caught and killed incidental to this fishery in 1982, and 222 were killed in 1983. Since 1983, the number of sea lions that were killed in this fishery has been lower than the 1983 level (T. R. Loughlin, National Marine Mammal Laboratory, pers. comm., 1985). It is assumed that the reason a large number of sea lions were killed in 1982 involved both the timing and the location of the fishery, coupled with the inexperience of the fishermen (Loughlin and DeLong 1983). Since then, the fishing has taken place earlier in the year and further south in Shelikof Strait—and the fishermen have gained experience in avoiding sea lions.

Another serious problem that arises from the marine mammal/fisheries interaction is the entanglement of marine mammals in marine debris. Over the last decade, there has been an alarming increase in the amount of debris that is deposited into the world's oceans (Shomura and Yoshida 1985). Much of this debris is discarded net fragments. Uchida (1985) estimated that 5,500 km of trawl nets are used in the North Pacific. Trawl-net fragments are commonly seen on both fur seals and sea lions and nets are the most common debris in which these species become entangled (Fowler 1982; Scordino 1985; and Calkins 1985b).

The closed, plastic packing bands which are commonly discarded into the ocean are the second most common type of debris that entangles fur seals and sea lions. Entanglement in marine debris can cause mortality in marine mammals and it has been implicated as being partly responsible for the continuing decline in the Pribilof fur seal herd (Fowler 1982). Although it probably does cause some mortality in sea lions, entanglement is probably not responsible for the decline in these populations.

Sea otters are involved in fisheries conflicts because they can substantially reduce benthic invertebrate populations—some of which are commercially valuable. In Prince William Sound, sea otters have been blamed for the decline of shellfish (Garshelis and Garshelis 1984). Substantial (>80%) reductions in the dungeness crab population (*Cancer magister*) were noted in Orca Inlet following an influx of large numbers of otters. (A. T. Kimker, Alaska Department of Fish and Game, unpubl. data, 1985; Garshelis and Garshelis 1984). Other crab stocks that are close outside

Table 17–3.
Estimates of annual consumption rates of food by marine mammals in the Gulf of Alaska.

SPECIES	TYPES OF FOOD CONSUMED	AVERAGE DAILY CONSUMPTION (kg)	EST. NO. OF DAYS IN GULF	EST. NO. OF INDIVID. USING GULF	EST. OF TOTAL ANNUAL CONSUMPTION (mt)
Fin whale	Copepods, euphausiids, fish	1,500	150	10,000	2.25 million
Sei whale	Copepods, euphausiids, fish	1,500	120	8,600	1.55 million
Humpback whale	Euphausiids, fish	1,100[a]	210	1,200	277,000
Gray whale	Unknown in Gulf	600[b]	45	13,000	351,000
Sperm whale	Cephalopods, fish	1,000	120	3,000[a]	360,000
Minke whale	Euphausiids, fish	270[a]	210[a]	3,000[a]	170,000
Killer whale	Fish, marine mammals	240[a]	365[a]	300	26,300
Belukha whale	Fish, cephalopods, shrimp	51	365	500	9,310
Pacific white-sided dolphin	Fish, cephalopods	15[a]	300[a]	3,000[a]	13,500
Dall's porpoise	Fish, crustaceans	30	300[a]	150,000[a]	1.35 million
Harbor porpoise	Fish, crustaceans	6	365	3,000[a]	11,000
Total food consumed by common cetaceans					6.59 million
Harbor seals	Fish, cephalopods, crustaceans	6	365	155,000	340,000
Sea lions	Fish, cephalopods	14.3	365	105,000	548,000
Fur seals	Fish, cephalopods	7	45	450,000	142,000
Sea otters	Benthic invertebrates, fish	10	365	41,000	150,000
Total food consumed by common pinnipeds and sea otters					1.18 million
Total food consumed by all common marine mammals					7.77 million

[a] Actual numbers not available; numbers inferred from data available compared to other species.
[b] Gray whale feeding in the Gulf not documented.

Prince William Sound may be in jeopardy if the otters follow their pattern of depleting abundant benthic invertebrates and moving to nearby unused habitat.

In other areas near Kodiak Island and in lower Cook Inlet commercial fishermen have complained that sea otters are heavily foraging on the already depleted king crab (*Paralithodes camtschatica*) and tanner crab (*Chionoecetes bairdi*) populations. Generally, reports of depleted clam populations are common from both sportsmen and subsistence users soon after the otters expand into areas of recently vacant habitat. If they are allowed to expand unchecked, little doubt remains that sea otters will deplete some commercially valuable or highly favored invertebrate populations. Although the present legal framework under which sea otters are managed (the Marine Mammal Protection Act of 1972) was supposedly designed to promote both the health and the stability of the marine ecosystem, no provisions were made that would give the managing agencies the latitude necessary to resolve conflicting situations—particularly situations where marine mammals are responsible for depleting other species.

Whale viewing has become a popular activity in recent years. In Glacier Bay National Park, the annual return of humpback whales attracts numerous tour vessels and private operators intent on viewing these whales. The substantial reduction in the number of resident whales in Glacier Bay that began in 1978 and lasted through 1984 has prompted a concern for the whales (Kreiger and Wing 1985). It was assumed that there were two reasons why numbers of resident whales decreased: 1) the increase in vessel traffic and/or 2) changes in the forage in Glacier Bay.

The National Park Service took steps to reduce vessel traffic in Glacier Bay during the months of June, July, and August, and also regulated vessel speeds in those areas where whales concentrated (Krieger and Wing 1985). Concurrently, studies were initiated in order to 1) determine the acoustic environment of humpback whales in Glacier Bay and in Frederick Sound; 2) determine the effect of vessel traffic on whale behavior; and 3) determine both the distribution and the abundance of whale prey. Krieger and Wing (1985) concluded that the main reason for the decline of resident whales in Glacier Bay was variation in whale forage. They predicted that changes in the availability of whale forage will continue and that the humpbacks will respond by varying their use of Glacier Bay.

Generally, disturbance from both vessels and aircraft has been noted to have some effect on several different marine mammal species that are commonly found in the Gulf. Fraker *et al.* (1978) described the disturbance of belukhas by both vessels and aircraft. Johnson (1977) estimated that 10% of the harbor seal pup mortality could be attributed to aircraft disturbance at Tugidak Island. Loughlin (1974) believed the absence of seals in two bays in California was due to extensive commercial and sport boat traffic. Calkins (1979) described disturbance of sea lions by aircraft in the Gulf.

Public awareness of and attention to marine mammals have been growing in recent years. A notable example of this is the attention given a proposal to take killer whales for public display from Prince William Sound and southeastern Alaska. Concurrent with their capture proposal, Hubbs Sea World Research Institute began a long-term study of killer whales in those areas (Leatherwood *et al.* 1984). Public outcry has jeopardized the capture proposal, even though only 10 whales were to be taken. Certainly, the removal of 10 whales could not have affected the current population of killer whales in these areas, even if all 10 were taken from one area.

A great deal of information is available on marine mammals in the Gulf of Alaska even though some of the biological parameters of all the species remain unknown. Commercial whaling—which resulted in the decimation of the populations of great whales—also provided most of the information on distribution, numbers, and general biology. Much is yet to be learned about these animals. However, information will be more difficult to obtain because in some cases, the species' numbers are so low that even sightings are rare occurrences. Almost no information is available on beaked whales in the Gulf of Alaska; much is yet to be learned about the breeding biology, food habits, distribution, and numbers of these species.

Studies of belukha whales in the Gulf of Alaska have been supported through the Outer Continental Shelf Environmental Assessment Program (OCSEAP) and through the state of Alaska's Environmental Assessment Program for hydroelectric projects on the Susitna River (Calkins 1984). Both of these efforts were relatively small and provided only distributional information. Little is known about the food habits, the movements, or the numbers of the belukhas that inhabit the Gulf.

Work on Dall's porpoise by the National Marine Fisheries Service (in response to incidental catches on the high seas) is the best and only extensive work which has been performed on a small cetacean in the Gulf.

Much of the recent information on pinnipeds in the Gulf was gained through the OCSEAP-sponsored research efforts; however, pinniped research under that program has been terminated in the Gulf. Some information has been provided through studies supported by the National Marine Fisheries Service. However, much work remains to be done on both the distribution and the numbers of pinnipeds in the Gulf. Recent information indicates a decline in both sea lion and harbor seal stocks. Immediate investigation of this problem is critical. Very little is known about either the sea otter's food habits or its abundance over much of its range in the Gulf, and more work is needed to determine the significance of this species in the ecosystem.

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