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THE MARINE MAMMAL FAUNA OF POTENTIAL OTEC SITES IN THE GULF OF MEXICO AND HAWAII

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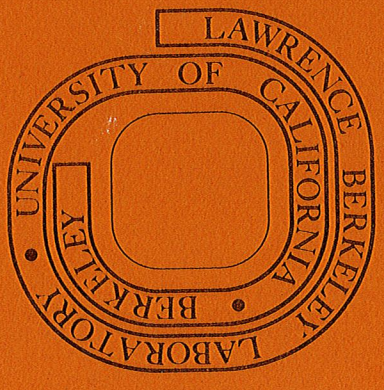

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Abstract

Twenty-seven marine mammal species have been recorded for the Gulf of Mexico, including 7 Mysticetes or baleen whales, 17 Odontocetes or toothed whales, 1 Sirenian (manatee), and 1 or 2 Pinnipeds or seals. The most common species in the Gulf is *Tursiops truncatus*, the bottlenosed dolphin, an inshore species. Offshore, *Stenella plagiodon*, the spotted dolphin, is fairly common. Most other species are recorded from very few sightings or strandings. None of the endangered species is common in potential OTEC sites in the Gulf of Mexico. Twenty-two marine mammals may occur in Hawaii; 2 Mysticetes, 19 Odonotocetes, and the endemic monk seal. The monk seal *(Monachus schauinslandi)*, an endangered species, lives in the extreme northwestern island chain away from potential OTEC sites. Among the most common cetaceans in Hawaii is the endangered humpback whale *(Megaptera novaeangliae)*. *Stenella longirostris*, the spinner dolphin; and *Tursiops* sp., the bottlenosed dolphin are also fairly common. The baleen whales feed on zooplankton during the summer in polar waters, and are migratory, while the toothed whales feed mainly on fish and squid, and are found in temperate or tropical regions year-round. The manatee is vegetarian and the pinnipeds are fish- or squid-eaters. Environmental effects of OTEC which may affect mammals are: toxic effects of biocide release or ammonia spill, biostimulating effects of seawater redistribution, oil spills, or effects of the physical presence of OTEC plants.

Introduction

A knowledge of marine mammal distribution, migrations, and feeding habits in relation to OTEC siting and operation is necessary because of the importance of mammals in the marine environment. Marine mammals are often top predators in marine food chains, show complex social systems, communication, and high intelligence, and are an integral part of the ocean environment. In addition, many marine mammals have an endangered or threatened status and are protected under the Endangered Species Act of 1973, and all marine mammals in United States waters are given protection under the Marine Mammal Protection Act of 1972.

This report surveys current literature on tropical marine mammal ecology in the Gulf of Mexico and Hawaii. Much information was found in reviews (Caldwell and Caldwell, 1973; Gunter, 1954; Hershkovitz, 1966; Layne, 1965; Lowery, 1974; Marcuzzi and Pilleri, 1971; and Moore, 1953) as well as newly published records and accounts scattered throughout the literature. Where possible, distribution maps are presented and food habits are discussed.

General Information

The marine mammals potentially found at OTEC sites in the tropical ocean are divided into three main groups; the Sirenia or manatees and dugongs, the Pinnipedia or seals and sea lions, and the Cetacea or whales, dolphins, and porpoises.

Order Sirenia

The order Sirenia contains only two species, the manatees *(Trichechus* sp.) and dugongs *(Dugong* sp.), but only the manatee is found near potential OTEC sites. Manatees are wholly aquatic inhabitants of salt water bays or slow-moving brackish or fresh water streams. The front limbs are modified into flippers, there are no external hind limbs, and there is a broad, flat tail. They may measure up to 15 feet long and weigh over 1/2 ton. Manatees are entirely vegetarian. Based on anatomical considerations, they are considered to be close to the evolutionary line which gave rise to the elephants.

Order Carnivora, Suborder Pinnipedia

The suborder Pinnipedia includes the seals, sea lions, fur seals, and walruses. In tropical OTEC sites, the only pinniped representatives are true seals in the family Phocidae, and possibly one feral sea lion in the family Otariidae. Seals and sea lions have limbs modified as flippers for swimming. True seals have no external ears, and the hind flippers cannot be brought under the body, making movement on land difficult. They are mostly aquatic but do come on to land for breeding and basking. Pinnipeds are carnivorous mammals which feed mainly on fish and squid.

Order Cetacea

Most marine mammals are in the order Cetacea, which contains the whales, dolphins, and porpoises. A wholly aquatic group, they are represented in all oceans and seas of the world. Like other marine mammals, they have the front limbs modified as flippers and there are no external hind limbs. The body is streamlined for efficient locomotion and skeletal and physiological modifications for deep diving are present. The cetaceans are divided into two suborders; the Mysticeti or baleen whales and the Odontoceti or toothed whales. The mysticetes have the embryonic teeth replaced by beleen or whalebone, and feed by straining small crustaceans and molluscs through the baleen plates. Most feed in Arctic or Antarctic seas during the polar summer, and undertake long migrations to tropical seas to breed. Included in the baleen whale group is the blue whale *(Balaenoptera musculus)*, the largest animal that has ever lived.

Most living cetaceans are toothed whales or odontocetes. They have no baleen, but may contain anywhere from a few to a great many calcified teeth. The skull has undergone great modification, including pronounced telescoping. Some species possess a "melon" or spermaceti organ in the skull, thought to function in echolocation. Whales and dolphins often show complex social systems, and are considered highly intelligent. They feed mainly on fish and squid, although the killer whale *(Orcinus orca)* also feeds on other whales and seals.

Marine Mammals of the Gulf of Mexico

Twenty-seven marine mammal species, mostly cetaceans, have been seen or stranded within the Gulf of Mexico (see Table 1). The most common are the bottlenosed dolphin *(Tursiops truncatus)* inshore, and the spotted dolphin *(Stenella platiodon)* offshore. Both of these small odontocetes are primarily fish-eaters, and travel in groups. The common dolphin *(Delphinus delphis)* is also fairly numerous, and the false killer whale *(Pseudorca crassidens)* and pygmy killer whale *(Kogia breviceps)* may be sighted less frequently. Although six endangered marine mammals have occasionally been seen or stranded in the Gulf of Mexico, none of the endangered species is common there. The West Indian manatee *(Trichechus manatus)*, an endangered species, is fairly numerous in Florida, but it is found so close inshore that it will be little affected by offshore OTEC operation. Some effects could occur with large surface chemical spills or shore buildings unless knowledge of the manatee is considered.

Table 1 Marine Mammals of the Gulf of Mexico and Hawaii

Species	Gulf of Mexico	Hawaii
Order Sirenia		
Family Trichechidae		
**Trichechus manatus*, West Indian manatee	common inshore	—
Order Carnivora, Suborder Pinnipedia		
Family Phocidae		
**Monachus shauinslandi*, Hawaiian monk seal	—	Common away from OTEC sites
**M. tropicalus*, Caribbean monk seal	extinct?	—
Family Otariidae		
Zalophus californianus, California sea lion	Rare, introduced	—
Order Cetacea, Suborder Mysticeti		
Family Balaenidae		
**Balaena glacialis*, Black Right whale	Rare	—
Family Balaenopteridae		
Balaenoptera acutorostrata, Minke whale	Rare	—
B. borealis, Sei whale	Rare	—
B. edeni, Bryde's whale	Rare	Occasional
**B. musculus*, Blue whale	Rare	?
**B. physalus*, Fin whale	Rare	?
**Megaptera novaeongliae*, Humpback whale	—	—
Suborder Odontoceti		
Family Delphinidae		
Delphinus delphis, Common dolphin	Fairly common	Fairly common†
Feresa attenuata, Pygmy killer whale	Rare	Fairly common
Globicephala macrorhyncus, Shortfinned pilot whale	Rare	Rare
Grampus griseus, Risso's dolphin	Rare	Rare
Lagenodelphis hosei, Shortsnouted whitebelly dolphin	—	Rare
Orcinus orca, Killer whale	Rare	—
Peponocephala electra, Little blackfish	—	Rare
Pseudorca crassidens, False killer whale	Fairly common	Fairly common
Stenella attenuata, Spotted dolphin	—	Fairly common
S. coeruleoalba (= S. styx), Striped dolphin	Fairly common	Fairly common
S. frontalis (= S. clymene, Bridled dolphin	Fairly common	—
S. longirostris, Spinner dolphin	Rare	Common
S. plagiodon, Spotted dolphin	Common	Rare
Steno bredanensis, Roughtoothed Dolphin	Rare	Rare
Tursiops gilli, Pacific bottlenosed dolphin	—	Fairly common
Tursiops truncatus, Bottlenosed dolphin	Common	Fairly common
Family Physeteridae		
Kogia breviceps, Pygmy sperm whale	Common inshore in western Gulf	Rare
K. simus, Dwarf sperm whale	Rare	Rare
**Physeter catodon*, Sperm whale	Fairly common in past, now rare	Occasional
Family Ziphiidae		
Mesoplodon densirostris, Densebeak whale	—	Rare
M. europaeus, Gulfstream beaked whale	Rare	—
Ziphius cavirostris, Goosebeak whale	Rare	Rare

*denotes endangered or threatened species

Trichechus manatus, West Indian manatee

The West Indian manatee is widespread in the eastern Gulf of Mexico, especially peninsular Florida (Caldwell and Caldwell, 1973). They are concentrated in Florida during the winter, but may be found as far north as North Carolina during summer (Irvine and Campbell, 1978). Manatees are adversely affected by cold temperature and generally remain within 5 km of a warm water source. Preferred manatee habitat is shallow salt-water bays and fresh- or brackish-water sluggish, coastal rivers (Moore, 1951), and they feed on aquatic vegetation such as eelgrass. The manatee is protected under Florida law, and the population, which numbers somewhere near 1000, has shown an increase in recent years. Manatees are located in coastal areas, and this endangered species should not be affected by offshore OTEC operation unless unforeseen large surface chemical spills occur.

Suborder Mysticeti, Baleen whales

Of the seven baleen whales which have been reported for the Gulf of Mexico, five are classified as endangered or threatened species. These are the black right whale *(Balaena glacialis)*, sei whale *(Balaenoptera borealis)*, blue whale *(B. musculus)*, fin whale *(B. physalus)*, and the humpback whale *(Megaptera novaengliae)*. The other two mysticetes which may occur in the Gulf are the minke whale *(B. acutorostrata)* and Bryde's whale *(B. edeni)*. All are apparently rare within the Gulf. The humpback whale apparently was common in the Gulf of Mexico in the past, as commercial whaling for this species in the central Gulf and off of Florida occurred during the 19th century (Townsend, 1935).

Delphinus delphis, Common dolphin

The common dolphin may be one of the most numerous cetaceans near potential OTEC sites. The common dolphin is widely distributed in warm temperate and tropical waters of all oceans (Rice, 1977). It is a pelagic migrant which follows the migrations of its food source, especially sprat *(Clupea sprattus)* and anchovy *(Engraulis encrasicholus)* (Marcuzzi and Pilleri, 1971). Sightings of common dolphins in the eastern Gulf of Mexico from both coastal and offshore areas are shown in Figure 1. They have been observed in the Gulf in waters 1200-1500 meters (m) deep and 120-148 miles from land (Caldwell, 1955).

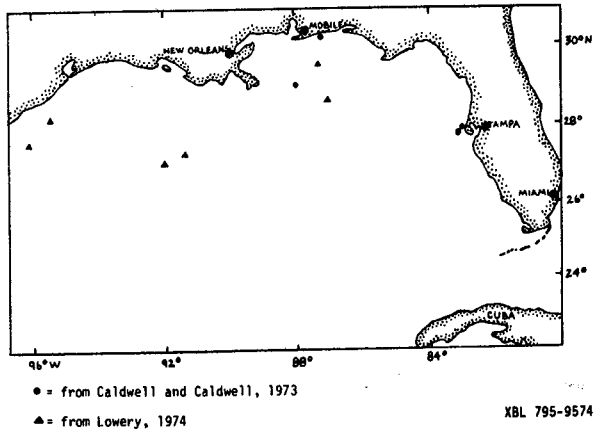

Fig. 1 Sightings of the common dolphin, *Delphinus delphis*, in the Gulf of Mexico.

Stenella spp., Spotted and spinner dolphins

The spotted dolphin *(S. plagiodon)* is probably the most common cetacean species offshore in the Gulf of Mexico. Spotted dolphins occur 12 or more miles offshore, in waters greater than 10 m deep (Caldwell and Caldwell, 1966). During the spring they move close inshore off of Florida, which suggests either an annual northward migration or a seasonal inshore-offshore movement at the same latitudes. Groups of from 1 to 30 spotted dolphins have been seen offshore in the Gulf of Mexico (Caldwell, 1955; Caldwell, 1960) (see Figure 2), and are apparently fairly numerous in potential OTEC areas. They feed on cephalopods and fish, including herring (Clupeidae), anchovies (Engraulidae), and the carangid fishes *Decapterus* sp. and *Selar* sp. (Caldwell and Caldwell, 1966). Occasional records of other *Stenella* species have been recorded for the Gulf. *S. coeruleoalba*, the striped dolphin, and *S. longirostris*, the spinner dolphin were reported by Caldwell and Caldwell (1973), and *S. frontalis*, the bridled dolphin, by Schmidly et al. (1972).

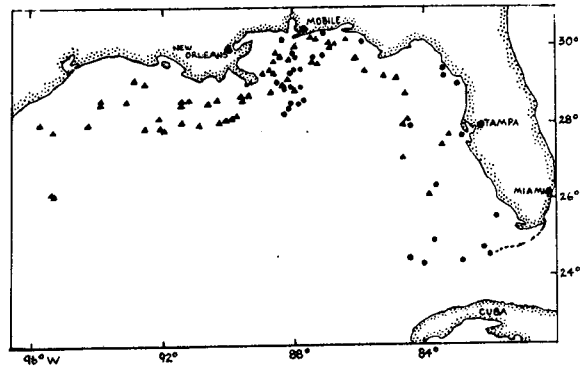

Fig. 2 Sightings of the spotted dolphin, *Stenella plagiodon*, in the Gulf of Mexico.

Tursiops truncatus, bottlenosed dolphin

The bottlenosed dolphin is the most common inshore cetacean species in the Gulf of Mexico, with a continuous distribution around the Gulf from Texas to Florida (Caldwell and Caldwell, 1973) (see Figure 3). *Tursiops* probably rarely exceeds the limit of the continental shelf offshore, beyond which it is replaced by the spotted dolphin, *Stenella plagiodon*. It occurs most frequently in bays and brackish water, and near large passes in Texas (Gunter, 1942). A food habits study of the bottlenosed dolphin in Texas (Gunter, 1942) showed that they eat a variety of species, with mullet *(Mugil cephalus)* constituting 83% of the fish eaten (see Table 2). Nine different fish species were reported in this study, and Odell (1975) reports six more fish species eaten by *Tursiops*, as well as eel and squid (Table 2).

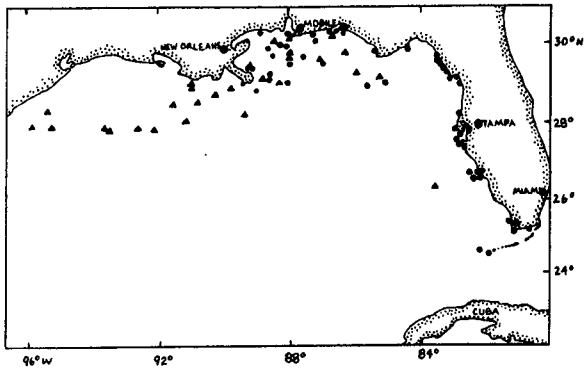

Fig. 3 Sightings of the bottlenosed dolphin, *Tursiops truncatus*.

Table 2 Prey items of the bottlenosed dolphin *(Tursiops truncatus)* in the Gulf of Mexico

Species	Number taken	Source
Mugil cephalus, Striped mullet	423 (83%)	Gunter, 1942
Dorosoma cepedianum, Gizzard shad	40	
Sphoeroides marmoratus Puffer	3	
Archosargus probatocephalus Sheephead	2	
Strongylura marina, Needle-gar	1	
Pogonias cromis Black drum	1	
Cynoscion nebulosis Spotted trout	1	
C. arenarius Sand trout	1	
Paralichthys lethostigmus Flounder	1	
Leiostomus xanthurus Spot	12?	
Micropogon undulatus Croaker	12?	
C. arenarius Sand trout	12?	
Penaeus setiferus Shrimp	1	

Species		Source
Astroscopus y-graecum	Stargazer	Caldwell and Caldwell, 1972
Galeicthys felis	Sea catfish	
Scaenidae	Croaker and Drum	
Clupeidae	Herring	Reported in Odell, 1975
Belonidae	Needlefish	
Eels		
Squid		

Other Delphinids

The remaining dolphins within the family Delphinidae listed in Table 1 as occurring in the Gulf are in general little known and not expected to occur in large numbers near potential OTEC sites. The pygmy killer whale *(Feresa attenuata)* is one of the least known cetaceans. Its distribution is thought to be circumglobal (Caldwell and Caldwell, 1971). A single specimen has been recorded from the Gulf of Mexico in Texas (James et al. 1970).

The short-finned pilot whale *(Globicephala macrorhynca)* is represented in the Gulf of Mexico by numerous strandings along the southern Florida coast, Louisiana, and Texas (Caldwell and Caldwell, 1973). Strandings of this species far outnumber those of other cetaceans, and the seasonality of stranding data suggest either that actual seasonal movements occur, or that seasonal biological or abiological factors may affect the tendency to strand (Layne, 1965). The pilot whale has not been frequently sighted at sea, however.

Risso's dolphin *(Grampus griseus)* is a cosmopolitan, pelagic species found in all seas. It is uncommon in the Gulf; one stranding has been reported in Florida (Paul, 1968). Risso's dolphin may winter in southern waters and move north during summer (ibid.).

The killer whale *(Orcinus orca)* is a pelagic and oceanic species which occurs circumglobally, although more frequently in cold seas (Marcuzzi and Pilleri, 1971). The killer whale is carnivorous and feeds on a wide variety of prey, including other whales and seals as well as fish and squid. The killer whale is uncommon in the Gulf of Mexico. (Caldwell and Caldwell, 1973; Moore, 1953).

The false killer whale *(Pseudorca crassidens)* has been sighted in the central Gulf at 26°30'N, 89°15'W (Bullis and Moore, 1956), and Texas (Schmidly and Melcher, 1974). Brown et al. (1966) report that fishermen working in the northeast Gulf from shore to 50 miles offshore have seen "blackfish" *(Pseudorca)* singly or in herds up to 100, in waters 60 m deep or greater, and 20+ miles offshore. It is considered a very social form, as evidenced by the large herds at sea and mass strandings. False killer whales have been observed feeding on amberjack *(Seriola lalandi)* and bonito *(Sarda lineolata)*, and are frequent predators on large pelagic fishes.

The rough-toothed dolphin *(Steno bredanensis)* is recorded in the Gulf of Mexico from an unpublished record offshore and one in Texas (Schmidly and Melcher, 1974), and from a mass stranding of 16 dolphins in Florida (Layne, 1965). Stomach content analysis of the stranded dolphins revealed that they had fed on the blanket octopus *(Tremoctopus violaceus)*, a fairly common pelagic cephalopod.

Family Physeteridae, sperm whales

There are three members of the family Physeteridae; the sperm whale *(Physeter catodon)*, pygmy sperm whale *(Kogia breviceps)*, and dwarf sperm whale *(K. simus)*. The sperm whale, classified as a threatened species, is the largest Odontocete cetacean. It is found in all oceans except polar ice-fields (Rice, 1977), and most often in tropical, subtropical, and very warm currents (Marcuzzi and Pilleri, 1971). Deep water is preferred, and sperm whale distribution coincides with areas of major upwelling. At one time sperm whales were common enough in the Gulf to support whaling efforts, especially in the area

from 28-29°N and 88-90°W, and in the central Gulf (Caldwell and Caldwell, 1973). Since 1910, four strandings in Florida have occurred, and two in Texas. Sperm whales are now rarely seen or stranded in the Gulf. They feed primarily on squid, and also on octopuses, sharks, skates, and bony fishes (Lowery, 1974).

The pygmy sperm whale and dwarf sperm whale are closely related pelagic species which occur in warm waters worldwide (Marcuzzi and Pilleri, 1971). It is not known whether they migrate. Both have been stranded in the Gulf several times in Florida and Texas, and the pygmy sperm whale is considered one of the most common cetaceans in coastal Texas waters (Shane and Schmidly, 1978). A seasonal distribution of strandings suggests that *Kogia* spp. may move northward toward the pole in summer to feed and return to warmer waters to breed during winter (Schmidly and Melcher, 1974). The stomach contents of a specimen of the dwarf sperm whale from the Gulf of Mexico were examined by Raun, et al. (1970). Squid beaks predominated, and of these only *Ommastrephes* sp. could be identified. Also found were the mysid shrimp *Gnathophausia ingens*, and the peneid shrimp *Aristaemorpha foliacea*, a pelagic shrimp from depths of below 300 m.

Family Ziphiidae, Beaked whales

Two beaked whales have been reported in the Gulf of Mexico; the Antillean or Gulf Stream beaked whale *(Mesoplodon europaeus = M. gervaisi)* and the goose-beaked whale *(Ziphius cavirostris)*. The Gulf Stream beaked whale occurs in the North Atlantic and a few strandings have occurred in the Gulf of Mexico (Moore, 1966). A specimen from Texas first identified as *M. densirostris* (Gunter, 1955) was later found to be *M. europaeus* (G. Gunter, pers. comm., and Moore, 1960).

The goose-beaked whale has stranded in the Gulf on six occasions, in Florida, Louisiana, and Texas (Schmidly and Melcher, 1974).

The Marine Mammals of Hawaii

Twenty-two marine mammal species may occur in Hawaii, including two mysticetes, 19 odontocetes, and one pinniped (see Table 1). In contrast to the Gulf of Mexico site, where no endangered species are common offshore, one of the most abundant cetaceans in Hawaii is an endangered species, the humpback whale *(Megaptera novaengliae)*. This large mysticete occurs in Hawaii during the winter months, where it migrates to breed. Another endangered species, the Hawaiian monk seal *(Monachus schauinslandi)* is present in fairly large numbers in Hawaii and nowhere else in the world, but its habitat is the far northwestern island chain, away from potential OTEC sites in Hawaii. As in the Gulf of Mexico, dolphins in the genus *Stenella* are the most numerous small odontocetes in Hawaii. They have been sighted in coastal areas throughout the island chain, and a 250-member population of *Stenella longirostris*, the spinner dolphin, occurs off of Keahole Point, a potential OTEC area. The bottlenosed dolphin, *Tursiops* spp., is also fairly common in Hawaii, while the false killer whale *(Pseudorca crassidens)* and pygmy killer whale *(Feresa attenuata)* may be sighted less frequently.

Monachus schauinslandi, Hawaiian monk seal

The Hawaiian monk seal is a member of the rare pinniped genus *Monachus*, which includes the now extinct Caribbean monk seal *(M. tropicalus)* which once flourished in the Gulf of Mexico, and the rare Mediterranean monk seal *(M. monachus)*. Hawaiian monk seals, an endangered species endemic to Hawaii, breed on Kure, Pearl, Lisianski, Laysan, and French Frigate Shaoals atolls in the leeward island chain. Breeding occurs from late December through mid-August, with a peak between March and May (Kenyon, 1973). The population is considered non-migratory, although occasional individuals may "straggle" as far as the big island of Hawaii. They are bottom feeders whose diet consists of coral-reef and shallow-water cephalopods and fish. Because the population is localized far from potential OTEC sites, they should not be impacted by OTEC operation.

Megaptera novaengliae, Humpback whale

Of the larger cetaceans which may occur in Hawaii, the humpback whale is encountered most frequently. The estimated worldwide population of humpbacks, protected as an endangered species since 1970, is 5200-7000, 1200 of which are found in the north Pacific, and no more than a few hundred of these east of 140°W. (Jurasz and Wolman, 1977). In 1977, a census of the Hawaiian population indicated a population estimate of 500 (Rice and Wolman, 1978). Humpback whales feed in colder temperate and sub-polar waters during summer, and migrate to tropical waters to breed during winter. Hawaii is one of five breeding areas in the world. The whales are at the Hawaiian breeding ground from December to May, and are usually found on the leeward sides of islands, in waters less than 180 m deep (see Figure 4). Calving occurs in five shallow sand-bottomed areas in Hawaii, four of which are shown in Figure 4 of this report. They are found most frequently in areas with little human disturbance, and there is evidence that the whales may be leaving certain areas of human activity. The humpback whale is probably the most important marine mammal to consider when examining potential OTEC sites and operation in Hawaiian waters.

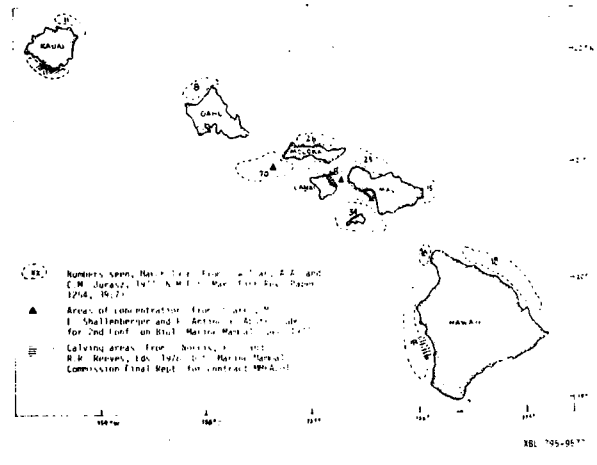

Fig. 4 Humpback whale *(Megaptera novaeangliae)* distribution in Hawaii.

Other Mysteceti

The Bryde's whale, *Balaenoptera edeni*, has been sighted in Hawaii (DeLong and Brownell, 1977). Although most likely of the rorquals (genus *Balaenoptera)* to be found near Hawaii, the scanty data suggests that its presence is not common. The Bryde's whale feeds primarily on herring and also on *Euphausiacea* (Marcuzzi and Pilleri, 1971). Other balaenopterids may occur near Hawaii only as occasional migrants.

Delphinus delphis, Common dolphin

The common dolphin is widely distributed in warm temperate and tropical waters, and in the eastern tropical Pacific is often found in association with other dolphins *(Stenella* spp.*)* and yellowfin tuna *(Thunnus albacares)*. It may be expected to occur near Hawaii. A wide variety of fish is eaten by these dolphins, which may be deep-water or bottom-feeders (200 m depth) (Fitch and Brownell, 1968).

Feresa attenuata, Pygmy killer whale

The pygmy killer whale is considered a regular resident of the Hawaiian Islands (Pryor, et al., 1965). It may be one of the more common odontocetes at potential OTEC sites, although its habits are not well known.

Pseudorca crassidens, False killer whale

The false killer whale may be fairly common in Hawaii. It has been observed feeding on dolphinfish *(Coryphaena* sp.*)* off the Kona coast of Hawaii (Brown, et al. 1966). It is a frequent predator on large pelagic fishes.

Stenella spp., Spinner, spotted and striped dolphins

Three main groups of dolphins in the genus *Stenella* may be differentiated based upon differences in snout length and color pattern (Rice, 1977). Most abundant of the small odontocetes in Hawaii is the spinner dolphin, *S. longirostris* (see Figure 5). Also present are the spotted dolphin, *S. attenuata*, and the striped dolphin, *S. coeruleoalba*. Spinner dolphin distribution in Hawaii is heterogeneous, with concentrated areas of congregation and stretches where the dolphins are not seen (Norris and Dohl, 1978). A 250-member population at Keahole Point moves offshore from shallow rest areas to waters of 2000 m depth. They are nocturnal feeders which feed upon fish and crustaceans which approach the surface only at night.

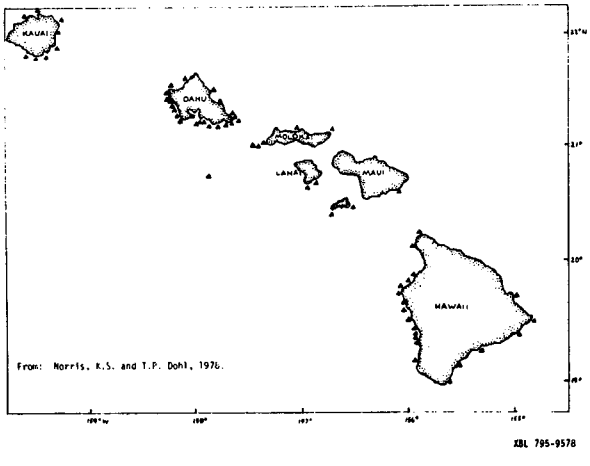

Fig. 5 Sightings of spinner dolphins *(Sterella longirostris)* off Hawaii.

Both spotted and spinner dolphins are often found in close association with yellowfin tuna *(Thunnus albacares)* in the eastern tropical Pacific ocean. The dolphins are sometimes taken in tuna nets incidental to tuna fishing. Stomach-content analysis of 140 spotted and 46 spinner dolphins was performed by Perrin, et al. (1973). Of the 46 spinner dolphin stomachs examined, 19 were empty. Squid and fish, especially myctophids, each made up approximately one-half of the stomach contents of the remaining dolphins. An ommastrephid squid, probably *Doscidius gigas*, was the predominant squid species. *Benthosema panamense*, *Diogenichthys* sp., *Vinciguierra* sp., and *Bregmaceros* sp. were important fish species in the spinner dolphin stomachs (see Table 3).

Table 3. Summary of important fish and squid species from stomachs of Stenella sp. taken in the Eastern Tropical Pacific*

	Spotted *S. attenuata*	Spinner *S. longirostris*
Fishes:		
Oxyporhampus micropterus	+ + + +	
Auxis Sp.	• • •	
Diogenicthys sp.	+ +	•
Benthosema panamense		+ •
Vinciguierra sp.	+	+ •
Bregmaceros sp.	+ +	•
Squids:		
Onykis sp.	+ •	+ •
Ommastrephid A (*Doscidius gigas*?)	• • • • •	• •
Ommastrephid B (*Symplectoteuthis*?)	+ + + + • •	
Abraliopsis affinus	+ + + •	
	6 hauls examined	2 hauls examined

+ = present in one haul

• = common in one haul

The stomachs of 140 spotted dolphin, taken from six net hauls were examined in this same study. In four of six hauls, squid predominated, especially *Symplectoteuthis* sp. (see Table 3). In two of the net hauls, ommastrephid squid made up over 85% of the food content by number. Onyctoteuthid squid, especially *Onykis* sp., were also found. Small mesopelagic fishes are apparently a much less significant food source for the spotted dolphin as compared to the spinner dolphin. Of the fish present, *Oxyporhampus micropterus*, *Diogenichthys* sp., and *Bregmaceros* sp. were found most often.

Spinner dolphin and spotted dolphin apparently have mostly different prey items and feed at different times of day. Spotted dolphins feed at the surface and largely on epipelagic prey; while the spinner dolphin feeds in deeper water and mainly on mesopelagic ommastrephid squid.

Steno bredanensis, Rough-toothed dolphin

The rough-toothed dolphin, a pelagic species which inhabits deep water, is fairly common in Hawaiian waters. It has been reported from the eastern tropical Pacific by Perrin and Walker (1975). Little is known of the habits or actual numbers of this species at potential OTEC sites.

Tursiops spp., Bottlenosed dolphin

Both *Tursiops truncatus* and the closely related form *T. gilli* may be found near Hawaii. *T. truncatus* was sighted most frequently during cetacean observations in the leeward Hawaiian chain (DeLong and Brownell, 1977). The size of the Hawaiian *Tursiops* population, not including the leeward chain, is estimated at 500-1000 individuals (Orr, 1978). No migration patterns are known; the animals apparently stay near the islands, and travel in groups of 5-20 individuals.

Other Delphinidae

Little literature exists on the other members of the family Delphinidae listed in Table 1. All are tropical species which are expected to occur in Hawaiian waters.

Family Physeteridae, Sperm whales

The sperm whale *(Physeter catodon)* is the largest of the toothed whales. Sperm whales are at the apex of the food chain, feeding on giant squid, a second or third level predator. Cephalopods such as squid occur in large numbers where warm and cold currents meet, coinciding with higher sperm whale density (Gulland, 1974). North Pacific catch records show that sperm whales were found near Hawaii in the summer and more frequently in winter (Rice, 1974). Sperm whale populations have decreased as a result of whaling, and they may occasionally be seen near Hawaii. They are classified as a threatened species.

The pygmy sperm whale *(Kogia breviceps)* and dwarf sperm whale *(K. simus)* are little-known, relatively uncommon relatives of the sperm whale. They feed on squid, crabs, and shrimp (Handley, 1966).

Family Ziphiidae, Beaked whales

The densebeak whale, *Mesoplodon densirostris*, is a widely but sparsely distributed species which has been reported for Hawaii by Moore and Gilmore (1967). The goosebeak whale, *Ziphius cavirostris*, is a cosmopolitan, pelagic species which undertakes long migrations. Little is known of the habits of these two species, and they are probably uncommon in Hawaii.

Possible Environmental Effects of OTEC Plants

Operation of OTEC plants in the Gulf of Mexico and Hawaii may have several environmental effects which could affect marine mammals. These include (modified from U. S. Dept. of Energy, 1979):
(1) toxic effects of discharge of chlorinated compounds (biocides) used in cleaning heat exchangers;
(2) toxic effects of accidental spillage of working fluid (NH_3) from storage tanks, or heat exchanger leaks;
(3) biostimulating effects of redistribution and release of deep nutrient-rich seawater to the photic zone;
(4) a possible petroleum spill due to increased boat traffic at the site;
(5) toxic effects of release of some waste effluents;
(6) effects due to the physical presence of an OTEC plant.

Discharge of chlorinated compounds might cause a change in phytoplankton species composition if chlorination were continuous, depending on the different species' resistances to total residual organics. Zooplankton and fish might then be affected also; a change in biomass at all trophic levels may adversely affect the ichtyophagous cetaceans which normally feed in an OTEC area.

Continuous discharge of chlorinated compounds might cause a change in phytoplankton, zooplankton, and fish depending on resistances to total residual organics. A change in biomass at all trophic levels may adversely affect the ichtyophagous cetaceans which normally feed in an OTEC area.

Accidental ammonia spillage would probably be detected by taste or smell by marine mammals in the vicinity, and the animals would rapidly move away. Since the ammonia spills are likely to be a thin plate of toxicant moving mostly downstream, they should be relatively easy to avoid.

The redistribution of cold, nutrient-rich seawater to a higher level in the water column may increase primary productivity. Increases in zooplankton are expected to be small and effects on planktophagous marine mammals will be negligible since they apparently do not feed in tropical waters. If the biostimulating effects of OTEC could affect fish or squid, it is highly unlikely that any such indirect effects on cetaceans will be detectable.

Mammals in the vicinity of a temporary oil spill from boat traffic will be less affected than most other organisms because they will most likely be able to avoid the area.

Release of waste effluents such as sewage should have a minimal effect on air-breathing mammals if the effluent is rapidly diluted.

The physical presence of an OTEC plant may induce avoidance behavior in mammals or desertion of the area, especially if construction is prolonged. Eventual habituation to its presence may occur, or they may even be attracted to it. As the OTEC plant will cause some fish or squid to be attracted, this may affect the feeding ecology of ichthyophagous cetaceans in the area.

Special attention must be given to siting of an OTEC plant away from the critical habitat of any endangered species. The humpback whale in Hawaii is the most numerous endangered species at potential OTEC sites; construction of an OTEC plant there should be restricted to periods when the humpbacks are not present (i.e., summer) and the site should be away from humpback calving and breeding areas.

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