Part Two

THE BIOTA OF THE GULF OF MEXICO

MARINE MAMMALS IN THE GULF OF MEXICO: CURRENT KNOWLEDGE AND RECOMMENDATIONS FOR THEIR CONSERVATION

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INTRODUCTION

The group known as "marine mammals" includes vertebrates of the mammalian class that spend most of their lives and obtain most of their food in the aquatic environment whether this is marine or fresh water. This group is not a taxonomic group in the true sense, but a collection of mammals of three orders: Carnivora (seals, sea wolves and walrus, known as pinnepeds), Sirenia (manatees and dugongs) and Cetacea (whales, dolphins and porpoise). In the Gulf of Mexico, 30 species of marine mammals have been documented: one carnivore species, one siren species and 28 cetacean species (Jefferson and Schiro 1997; Wursig *et al.* 2000).

The only carnivore species that inhabited the Gulf in the contemporary period is the Caribbean monk seal (*Monachus tropicalis*). It became extinct by the middle of the 20th century due to hunting by the inhabitants of the Caribbean region (Villa-R. *et al.* 1985; LeBoeuf *et al.* 1986). The West Indian manatee (*Trichechus manatus*) is the only species of siren in the region. The cetacean species of the suborder Odontoceti (dolphins and whales with teeth) that have been documented in the Gulf of Mexico are: cachalot (*Physeter macrocephalus*), pygmy cachalot (*Kogia breviceps*), dwarf cachalot (*K. sima*), short-finned pilot whale (*Globicephala macrorhynchus*), pygmy killer whale (*Peponocephala electra*), Fraser dolphin (*Lagenodelphis hosei*), Risso dolphin (*Grampus griseus*), Clymene dolphin (*Stenella clymene*), striped dolphin (*S. coeruleoalba*), Atlantic spotted dolphin (*S. frontalis*), pan-tropical spotted dolphin (*S. attenuata*), spinner dolphin (*S. longirostris*), rough-toothed dolphin (*Steno bredanensis*), grampus whale (*Orcinus orca*), false killer whale (*Pseudorca crassidens*), pygmy grampus whale (*Feresa attenuata*), bottlenose dolphin (*Tursiops truncatus*), Gervais' beaked whale (*Mesoplodon europaeus*), Blainville beaked whale (*M. densirostris*), Cuvier beaked whale (*Ziphius cavirostris*) and Sowerby beaked whale (*M. bidens*). In the cetacean suborder Mysticeti, that includes mustached whales, the following species have been documented in the Gulf: northern white whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), common rorqual (*B. physalus*), tropical rorqual (*B. edeni*), northern rorqual (*B. borealis*), minke whale (*B. acutorostrata*) and humpback whale (*Megaptera novaeangliae*) (Jefferson and Schiro 1997; Würsig *et al.* 2000).

DISTRIBUTION

DISTRIBUTION OF THE WEST INDIAN MANATEE IN THE GULF OF MEXICO

The West Indian manatee lives in shallow waters in marine zones, estuaries, lagoons, rivers and channels. It can live in both fresh and salt water. When it lives in marine environments it needs to be near freshwater for drinking purposes, and this can be spring water or in the discharge from rivers. Manatees can move over several hundred kilometers and their movement can be influenced by seasonal changes in water levels, by changes in salinity and water temperature in estuaries, changes in the food availability, and as a consequence of reproductive behavior (Colmenero R. and Hoz Z. 1986; Reynolds and Odell 1991). Driven by these factors,

the manatees can move between riverine environments towards the coast and vice versa. It is thought that the populations of manatees in the Gulf of Mexico move back and forth between coastal and palustrine habitats.

There are two subspecies of the West Indian manatee in the Gulf of Mexico, the Florida (*T. m. latirostris*) and the Caribbean (*T. m. manatus*) (Rice 1998). The Florida manatee is resident along the Florida coastline, in bays and rivers south of the Crystal River. In summer, some individuals move north towards Georgia and to the west towards Louisiana. The historic distribution of the Caribbean manatee inside the Gulf of Mexico extends from Tamaulipas to Yucatan (Lefebvre *et al.* 2001). However, the distribution of this subspecies is fragmented as a result of overexploitation for meat and loss of habitat due to coastal development. The core of manatee populations in Mexico, in terms of population size, are: a small, dispersed population that inhabits several rivers in the state of Veracruz; a second population on the coast of Quintana Roo, mainly in the southern part; and the largest population, that inhabits the Grijalva and Usumacinta river basin.

DISTRIBUTION OF CETACEA IN THE GULF OF MEXICO

Seasonal and spatial distributions of cetaceans are influenced by physiographic and oceanographic characteristics, distribution of prey, distribution of predators and availability of suitable areas for breeding. In the Gulf of Mexico, water depth is the main environmental variable that influences distribution of cetaceans. Significant differences have been observed in the depth of water inhabited by the different species (Davis *et al.* 1998; Baumgartner *et al.* 2001, Davis *et al.* 2002; Ortega-Ortiz 2002). The majority of cetacean species inhabit oceanic waters more than 200 m deep. Only three species normally inhabit the neritic zone on the continental shelf: the bottlenose dolphin, the Atlantic spotted dolphin and the rough-toothed dolphin (Delgado-Estrella 1994; Jefferson and Schiro 1997; Wursig *et al.* 2000; Ortega-Ortiz 2002; Fulling *et al.* 2003). The spinner dolphin has been documented on the northern part of the Yucatan shelf (Jefferson 1995; Ortega-Ortiz 2002), however, this species is generally oceanic and its sighting near the coast could be associated with upwelling (as suggested by Merino 1997).

The bottlenose dolphin is the only cetacean that inhabits coastal lagoons, river deltas, littoral zones and neritic and oceanic zones of the Gulf of Mexico. Morphological and genetic evidence suggests the existence of two ecotypes or parapatric populations of bottlenose dolphin, one coastal and the other neritic-oceanic (Hersh and Duffield 1990; Mead and Potter 1995; Hoelzel *et al.* 1998; Torres *et al.* 2003). Although there is not detailed delineation of the two distributional areas for the two ecotypes, a study of the Atlantic coast of the United States of America showed that all bottlenose dolphins observed up to 7.5 km from the coast were of the coastal ecotype, whereas all observed more than 34 km from the coast were of the neritic-oceanic ecotype (Torres *et al.* 2003). Coastal bottlenose dolphins are more frequently found inside coastal lagoons and near river deltas. It addition, dolphins use specific areas for feeding and others for breeding within coastal lagoons (Delgado-Estrella 2002). In the north of the Gulf, the neritic-oceanic ecotype of bottlenose dolphin has been seen in two different regions: on the continental shelf at depths of up to 150 m, and over the slope near the continental margin. In both regions, dolphins are more frequently observed in areas with highly variable temperatures and salinities suggesting that their distribution is associated with water mass fronts (Baumgartner *et al.* 2001).

The Atlantic spotted dolphin is generally found in waters between 20 and 200 m deep. They have occasionally been observed in oceanic waters near the continental margin (Mullin and Hansen 1999). Griffin and Griffin (2003) compared the distribution of bottlenose dolphin and Atlantic spotted dolphin in depths of < 20 m on the west coast of Florida. These authors observed that the Atlantic spotted dolphin was found in deeper waters, with higher salinity and clearer water than those that are inhabited by bottlenose dolphin.

The oceanic cetaceans of the Gulf of Mexico are most frequently found in the continental slope and areas with greater concentrations of chlorophyll, such as in the cyclonic gyres and the areas of confluence between anticyclonic and cyclonic gyres (Biggs *et al.* 2000; Baumgartner *et al.* 2001; Davis *et al.* 2002; Ortega-Ortiz 2002). In addition to bottlenose dolphin, the species of that is more frequently found in the upper slope near the continental margin and at depths of 200-750 m are the Risso dolphin and the short-finned pilot whale. Also on the upper slope (200-1,000 m), but not necessarily near the shelf margin, the cachalot, pygmy cachalot, dwarf cachalot, rough-toothed dolphin, and the spinner dolphin are frequently found. On the lower slope of the shelf (>1,000 m), the striped dolphin, beaked whales, and the pan-tropical spotted and Clymene dolphins are found (Davis *et al.* 1998; Baumgartner *et al.* 2001; Davis *et al.* 2002). Little information has been published on the distribution of cetaceans in the deep region (>2,000 m) in the Gulf of Mexico.

The mustached whales are rare in the Gulf of Mexico. With the exception of the tropical rorqual, observations of mysticetes are perhaps due to individuals that have lost their way during their migration between the north Atlantic and the Caribbean Sea (Jefferson and Schiro 1997; Wursig *et al.* 2000). The tropical rorqual has been documented as occurring year-round in the Gulf of Mexico. The majority of the sightings of the tropical rorqual are on the shelf, very near the continental margin. It is possible that the Gulf is a portion of the distribution area of a small and dispersed population of this species (Jefferson and Schiro 1997).

CURRENT CONDITION OF POPULATIONS

With the exception of the Sowerby beaked whale, all species of marine mammals in the Gulf of Mexico are included in the list of species at risk according to the Norma Oficial Mexicana (NOM-059-ECOL-2001; D.O.F. 2002). In these standards, the Caribbean monk seal is considered extinct in the wild state, the the northern white whale and the West Indian manatee are considered in danger of extinction and the rest of the species are subject to special protection.

CURRENT CONDITIONS OF WEST INDIAN MANATEE POPULATIONS

There is little information on the current condition of manatee populations in the southern Gulf of Mexico. This is due, in part, to the difficulty of studying a species in the wild. In 1976 it was estimated that there could be as many as 5,000 manatees in Mexico (Heinsohn 1976), however due to hunting and habitat loss it is very probable that the population has decline considerably since then. The only systematic counts to evaluate population trends of manatees in Mexico have been carried out in southern Quintana Roo (Morales V. and Olivera G. 1994; Morales-Vela 2000). Counts in the Caribbean are easier to conduct because the animals can be easily seen in the transparent waters of the Caribbean Sea, and this is not possible in the majority of the bodies of waters in the Gulf of Mexico.

The Mexican Government declared a permanent closed season on manatees in 1921 to help conserve the species in Mexico. Presently, in addition to being included in the list of species in danger of extinction by the Norma Oficial Mexicana, the West Indian manatee is also on the "Red List" of the International Union for the Conservation of Nature and Natural Resources (IUCN) as a threatened species, in Appendix 1 of the species in danger of extinction in the Convention on International Trade in Endangered Species (CITES), and on the list of threatened species in the Endangered Species Act of the United States (U.S. Fish and Wildlife Service 1999). The situation of the manatee in each of the Mexican states in the southern Gulf of Mexico is described below.

Tamaulipas

The state of Tamaulipas in Mexico and the state of Texas in the United States are considered the northern limit of distribution for both subspecies of manatees (Colmenero R. and Hoz Z. 1986; Lefebvre *et al.* 2001). It is thought that the two subspecies may spatially overlap in this area; however, the lack of genetic studies, as well as marking and the consistent follow-up of the manatee population in the region mean that it is not possible to clarify this supposition. Manatees have been seen sporadically on the northern coast near the border with Texas. It is thought that these are not resident animals, but come from the south of Tamaulipas. There are reports on findings of manatee bones in the Río Soto La Marina (Lazcano-Barrero and Packard 1989), but observations have not been common in this area recently. More recent sightings have been made that indicate that there is still a small population in the Río Panuco and the lagoon system El Chairel-Champayan (Ortega-Argueta, pers. obs.)

Veracruz

There is information that the manatee is abundant in the southern part of the state of Veracruz, whereas in the northern region there is no information because studies have not been carried out. Reports of manatees exist for the Nautla, Tecolutla, Papaloapan, Calzadas, Coatzacoalcos and Tonala rivers and the Alvarado lagoon system (Colmenero R. and Hoz Z. 1986; Ortega-Argueta 1999). The manatees live mainly in estuaries and riverine areas, although they have been observed in the marine zone of Alvarado. Presently, it is estimated that there are 250 animals in Veracruz (Ortega-Argueta, pers. obs.). Local conservation efforts are led by an inter-institutional group that rescues and rehabilitates orphaned animals, those caught in nets, and previously captured animals; this group has also developed an ongoing education/outreach campaign (Portilla Ochoa *et al.* 1999; Ortega-Argueta 2000). There are currently six manatees in the aquarium in Veracruz that are being rehabilitated.

Tabasco

Tabasco has extensive wetland areas that are suitable habitats manatees and this state probably has the largest population of manatees in Mexico at present. Manatees are found mainly in the interior wetlands of Pantanos de Centla and the basin of Grijalva and Usumacinta rivers (Colmenero R. 1986; Colmenero R. and Hoz Z. 1986). The bodies of water with the largest population of manatees are Barra de Chiltepec, the Gonzalez, Grijalva and Tabasquillo rivers in the north and San Antonio, San Pedrito, Chashchoc, Chacamax, Chable and Usumacinta rivers

and lagoons in the central and southern part of the state (Arriaga Weiss and Contreras Sanchez 1993). There are approximately seven manatees enclosed in Yumka state park and the Jonuta children's center, and an undetermined number in semi-enclosure in the Illusions Lagoon and the Camellones Chontales community reserve.

Chiapas

Although the state of Chiapas does not have a Gulf of Mexico coastline, there is an important population of manatees in the northern part of the state that move between the lagoons and the tributaries of the Río Usumacinta. This is why the manatees have to be considered as part of the same population as in Tabasco. A resident group of manatees is found in the Catazaja Lagoon where they live in semi-isolation because of the construction of a system of dikes (Chanona Hernandez 1997). When this lagoon overflows during the rainy season, some manatees move to the adjacent lagoons such as San Juan lagoon. However, the movement of animals has also been reported during the low water season (Morales Vela and Olivera Gomez 1996).

Campeche

The region with the largest distribution of manatees in the state of Campeche is the Laguna de Términos and the river delta-lagoon systems such as the Río Palizada-Laguna del Este, Río del Este-Laguna Atasta, Chumpam-Balchacah rivers, and the Río Candelaria (Colmenero R. and Hoz Z. 1986). The manatees can move between the Río Palizada and the Tabasco wetland system. They are found in marine environments, estuaries and shorelines, and move between habitats in accordance with changes in the water level during the rainy and the dry season (Perez-Cortes Moreno 1985). In the northern portion of the state the manatees are very scarce due to the lack of suitable habitats. It is possible that some emigrants move along the coast to the north of Yucatan.

Yucatán

Sightings of manatee in the Yucatán have been very rare during the last 15 years. There have been some sporadic sightings in the north coast, in the mangrove zones around Celestun, Ría Largatos and Puerto Progreso (Colmenero R. and Hoz Z. 1986; Morales-Vela *et al.* 2003). Although the Yucatán coast has no rivers, there are marine habitats with submerged aquatic vegetation and sources of freshwater from springs. It is thought that there is not a resident population in the state, and that the few manatees that have been sighted in the north coast could be emigrants that have come from the southern part of Campeche and Quintana Roo (Morales-Vela *et al.* 2003).

Quintana Roo

The manatee was common in the Laguna Yalahau and the mouth of the Río Yalkini to the southeast of Isla Holbox, where it lived in marine and estuarine environments (Colmenero R. and Hoz Z. 1986). Currently, manatees are sighted only occasionally in this zone. Morales-Vela *et al.* (2003) state that manatees stopped being common around Isla Holbox after Hurricane Gilbert in 1988.

CURRENT STATE OF CETACEAN POPULATIONS

Over the last ten years, the U.S. National Marine Fisheries Services and Texas A&M University of have undertaken research on the distribution and abundance of cetaceans in the United States exclusive economic zone in the Gulf of Mexico. In contrast, there is no information in the scientific literature on the distribution and abundance of cetaceans in the southern Gulf of Mexico, with the exception of some studies on coastal populations of dolphins (Delgado-Estrella 1991; Heckel Dziendzielewski 1992; Delgado-Estrella 1994; Lechuga Medina 1996; Escatel Luna 1997; Lopez Hernandez 1997; Delgado-Estrella 2002) and some observation cruises (Ortega-Ortiz 2002). A general description of the abundance of cetaceans in the United States exclusive economic zone follows below, and this is followed by an overview of the research into bottlenose dolphins in the southern Gulf of Mexico. Further information on the population estimates can be found in the original references (Davis *et al.* 2000; Waring *et al.* 2001; Delgado-Estrella 2002; Waring *et al.* 2002).

The estimates of the minimum abundance in the different stocks of bottlenose dolphins in the northern Gulf of Mexico are: 3,933 bottlenose dolphin in bays, lagoons and estuaries; 2,938 coastal bottlenose dolphins in the northeastern Gulf (from the Rio Grande to the Mississippi River); 3,518 coastal bottlenose dolphins in the north-central Gulf (from the 84º W latitude to Key West, Florida); and, 25,320 neritic bottlenose dolphins. (Waring *et al.* 2001, 2002; Fulling *et al.* 2003). Estimates of the minimum abundance of the other two species that inhabit the continental shelf, the Atlantic spotted dolphin and the rough-toothed dolphin are 30,772 and 1,238 individuals, respectively (Fulling *et al.* 2003).

In the oceanic region, the pan-tropical spotted dolphin is the most abundant species with a minimum estimate of 26,510 individuals, followed by bottlenose dolphins (4,530), spinner dolphins (4,465), Clymene dolphins (4,120), striped dolphins (3,409), pygmy killer whales (2,888), Risso dolphins (2,199), rough-toothed dolphin (660), cachalot (411), pygmy grampus whale (285), false killer whale (236), grampus whale (197), short-finned pilot whale (186), Fraser dolphin (66), Cuvier beaked whale (20) and the tropical rorqual (17). There is no information on the abundance of other cetacean species of documented in the Gulf.

The estimates of the abundance of cetaceans in the southern Gulf of Mexico come mainly from photo-identification studies of bottlenose dolphins. Unlike the estimations of the abundance above-mentioned species in the northern Gulf, which are derived data collected along line transects using distance methods (Buckland *et al*. 1993; Buckland and York 2002), photo-identification studies analyzed using mark-recapture methods (Hammond *et al.* 1990; Ortega-Ortiz, J. G. 2000; Buckland and York 2002) to determine population sizes in specific locations. Bottlenose dolphin populations in the northern Gulf of Mexico are estimated at: Boca de Corazones, Veracruz – 58 (Heckel Dziendzielewski 1992); Laguna de Términos, Campeche – 1,400 (Delgado-Estrella 2002); and Laguna de Yalahau and the coast of Holbox, Quintana Roo – 500 individuals (Delgado-Estrella 1996). On the coast of Tabasco, the population fluctuates between 300 and 573 individuals depending on season (Lopez Hernandez 1997).

INTENTIONAL CAPTURE

The meat, fat and skin of manatees are highly valued. Manatee hunting dates from pre-Hispanic times (McKillop 1985), and has significantly contributed to reductions in the populations of the species. Despite being prohibited by law, manatee hunting persists in several locations. During the last 10 years the hunting and sale of manatee meat has been reported in some communities near Cuidad de Carmen and the Río Paliza in Campeche (Morales-Vela *et al.* 2003), and in Alvarado lagoon, Veracruz (Ortega-Argueta 1999). In Tabasco and Yucatan, the tradition of hunting manatee also persists although it has diminished recently.

The capture of bottlenose dolphins for use as shark bait meat was common in the Gulf of Mexico until 1974 (Kasuga 1968; International Whaling Commission 1980). Despite being prohibited since at least 1980 (International Whaling Commission 1980), the capture of the bottlenose dolphins and Atlantic spotted dolphins since then has been documented in Campeche and Veracruz (Hugentobler and Gallo 1985; Gallo-Reynoso 1986; Ortega-Argueta *et al.* 1999). Gallo-Reynoso and Pimienta (1989) have found machete cuts in the cranium of Antilles beaked whale in IslaAguada, Campeche. Although it is not known if the animal was captured or if it was beached, it is evident that the remains were used, probably as meat.

For more than thirty years, bottlenose dolphins have been captured in Mexico for aquariums. From 1961-1972, 40 to 60 bottlenose dolphins were captured in Mexico, and from 1973-1977, 18 to 25 were capture (Leatherwood and Reeves 1982). In 1977, 5-8 bottlenose dolphins were captured and sent to England and in 1978, 12 were sent to Switzerland and Germany (International Whaling Commission 1980). A report by the International Whaling Commission indicates that 58 bottlenose dolphin have been captured in Mexico since 1984 (International Whaling Commission 1984). These reports do not specify the capture location and therefore it is not possible to know how many of these bottlenose dolphins were taken from the Gulf of Mexico. The first confirmed capture in this region was in about 1975 in the Laguna de Términos, Campeche (Perez-Cortes Moreno 2002). Since 1996, the reports that the Mexican government sends to the International Whaling Commission include information on the location of capture of cetaceans destined for captivity; the following numbers of bottlenose dolphins were captured in the Gulf of Mexico: 1995 – 12; 1998 – 4; and 2000 – 15 (International Whaling Commission 1997, 2003). Because the inventory of captured dolphins in Mexico is not complete, the elaboration and publication of a report is necessary that contains precise data on the total number of individuals that have been captured, including their sex, age, location and date of capture and destination of each individual.

Until 2001, no specific regulations existed for the capture of bottlenose dolphins and it was authorized through a system of permits and quotas. Conditions and restrictions were outlined within each permit for capture that was granted. In some cases, the party seeking the permit committed to carry out population studies over a minimum of one year, but it was not until 1991 that the first studies were done that were related bottlenose dolphin capture permits (Perez-Cortes Moreno 2002). Unfortunately, these studies are over very short periods of time and do not follow the populations after the bottlenose dolphins have been captured, and the results are not published. This is why it is difficult to know the consequences of capture in bottlenose dolphin populations in the southern Gulf of Mexico.

The capture of marine mammals is presently included in several administrative and penal regulations in Mexican legislation. As mentioned above, the majority of species of marine mammals in the Gulf of Mexico are protected by current legislation. The federal Penal Code (Article 420, Section 1) imposes a sentence of 1-9 years imprisonment and a fine that equivalent to 300-3,000 times the daily wages of the offender for illicit capture, injury or death of any marine mammal, or the collection and storage of their products or sub-products. In 2001, the Norma Oficial Mexicana de Emergencia (NOM-EM-135-SEMARNAT-2001; D.O.F. 2001) was promulgated to regulate capture, transport exhibition, handling and maintenance of marine mammals in captivity. On 10 January 2002 the *Diario Oficial de la Federación* published a decree reforming the Ley General de Vida Silvestre (General Law of Wildlife) and the capture of all species of marine mammals was prohibited in Mexico, whether for commercial or subsistence purposes, with the exception of capture for scientific investigation and accredited higher education institutions (D.O.F. 2002b).

INCIDENTAL CAPTURE & INTERACTION WITH FISHING

Several cases of net entanglement and death of manatees have been reported in Alvarado, Veracruz and Catazaja, Chiapas (Ortega-Argueta 1999; Morales Solis 2001). These incidents have generated conflicts between fishermen and environmental authorities because the hooked nets that the manatees get tangled in are prohibited. In Tabasco, entanglement in fishermen's nets or being run over by small boats with outboard motors has been reported in areas where fishing activity is high.

In addition, cetaceans are subject to incidental capture due to different fishing methods used in the Gulf of Mexico (Gallo-Reynoso 1986; Delgado-Estrella 1997; Ortega-Argueta *et al.* 1999; Patino Valencia *et al.* 2000; Waring *et al.* 2002). The fishing methods involved in incidental capture and the species that are captured include: hooked nets – bottlenose dolphin, Atlantic spotted dolphin, and pan-tropical spotted dolphin, trawl – bottlenose dolphin, trotline – Risso dolphin, short-finned pilot whale, pygmy killer whale; and crab and lobster traps – bottlenose dolphin. Sometimes fisherman attack cetaceans to prevent them from eating the fish they have captured and to prevent them from damaging their fishing equipment. One example of this type of interaction is when the short-finned pilot whale takes tuna off a trotline (Patino Valencia *et al.* 2000). Fishermen have used firearms to shoot short-finned pilot whales to keep them off the trotline. Some shrimp fishermen believe that bottlenose dolphins destroy their nets so they shoot them when they come near their boats (Delgado-Estrella 1997).

LOSS OF HABITAT

The habitat available for manatee and coastal bottlenose dolphins has been reduced in some locations in the southern Gulf of Mexico due to construction of infrastructure for hydrocarbon exploration, extraction and transport, and structures associated with navigation. In other places, habitat reduction is due to extensive ranching and agriculture. Examples of both these situation are found in the Tabasco wetlands and the central coast of Veracruz. At the level of species, the problem is not so critical for the bottlenose dolphin since their distribution area is extensive and individuals can move to less affected areas. Although it is possible that bottlenose dolphins abandon some locations, taken together the species is not threatened. In contrast, populations of manatee in the southern Gulf are small and fragmented and their distribution is

reduced, and this means that habitat loss is a grave threat for the species. For example, a study of manatee habitat in Alvarado, Veracruz, estimated that of the total surface of the lagoon system, 57% of the land was used for extensive agriculture and ranching operations and these activities have significantly modified the wetlands (Ortega-Argueta 2002).

Conservation of the manatee depends largely on their successful reproduction. Lactation for manatee calves lasts approximately two years, and they reach sexual maturity between three and five years; their gestation period is 12-14 months and they have single births at intervals of three to five years (Reynolds and Odell 1991; Bossart 2001). Since their reproductive rate is low and maintenance costs are high, repopulation programs based on the reproduction of manatees in captivity are not a very viable strategy (Bossart 1999). This is the reason why a more adequate manatee conservation program must include the installation of enclosures around natural protected areas. A good example of this is found in the manatee sanctuaries in the Bahía Chetumal and Laguna de Catazajá. Well-preserved wetland areas have been identified in all the states of the Gulf. Connection of these areas with important manatee habitats through designation of new protected natural areas that will form of an ecological corridor should a focus in the management of this species.

Global climatic change is another factor that must be considered in relation to habitat loss, particularly for marine mammals inhabiting the coastal region (Wursig *et al.* 2002). The consequences of global climate change could include acceleration of habitat loss of as sea level rises and changes occur in the position of the coastline and because of increasing magnitude of fluvial discharges. In addition, the secondary effects of global changes could alter habitat conditions that favor marine mammals. Examples of changes of this type are altered current patterns, changes in primary production and increased red tides that could result in losses of suitable habitat for marine mammals (Wursig *et al.* 2002).

POLLUTION

Marine mammals are susceptible to the bioaccumulation and bio-magnification of contaminants because they are long-lived animals that are usually found in or near the top of the food web (Kannan *et al.* 1997). In the layer of subcutaneous fat that is used by these animals for thermoregulation it is possible to accumulate large quantities of fat-soluble contaminants (Mossner and Ballschmiter 1997). In addition, accumulated contaminants in the adipose tissue are transferred to the young during suckling. Taking these factors into consideration, marine mammals have been proposed as an indicator species for analysis of the prolonged exposure to low doses of contaminants in the marine environment (Mossner and Ballschmiter 1997). However, few studies have been undertaken to analyze the concentration of contaminants in marine mammals in the Gulf of Mexico. Organochlorine compounds (PCB and DDE) have been documented in the tissue of coastal bottlenose dolphins in the northern Gulf of Mexico (Kuehl and Haebler 1995; Salata *et al.* 1995). Although a cause-effect relationship between presence of these contaminants and death of bottlenose dolphins was not established (Colbert *et al.* 1999), a correlation between concentration of contaminants and reduction in immune responses was observed (Lahvis *et al.* 1995). The presence of a large number of petroleum extraction, transport and refining installations on the continental shelf means that the coastal zone and wetlands in the Gulf of Mexico are a potential contamination risk for the species that inhabit the region. For this reason it is important that there are ongoing evaluations of contaminant concentrations.

Another source of contamination that can have a negative effect on coastal populations of marine mammals is wastewater discharge. Toxic compounds, pathologic microorganisms and even the pharmaceuticals contained in these discharges can affect marine mammals. For example, Miller *et al.* (2002) observed that the occurrence of toxoplasmosis (*Toxoplasma gondii*) in otters on the southern California coast was related to the discharge of waters contaminated with cat feces. Toxoplasmosis infections in cetaceans could also be related to discharges water contaminated with this microorganism (Resendes *et al.* 2002).

MARITIME TRAFFIC

A main cause of mortality in Florida manatees is collisions with boats. In fact, significant differences in the survival manatees have been observed between areas where navigation is restricted and areas with intense boat traffic (Langtimm *et al.* 1998). Because the distribution of manatees in the southern Gulf of Mexico is generally restricted to remote locations where boat traffic is not very intense, this factor is not a very serious problem at present. However, if boat traffic increases in areas where manatees occur, it is probable that it would become a problem that would restrict their colonization of some areas and affects the recovery of the species.

Collision with ships is a frequent cause of mortality among whales. A study carried out by Laist *et al.* (2001) indicates that the collisions occur with all types and sizes of ships, but fatal collisions occur with ships that are at least 80 m long and that travel at more than 25.9 km/h (14 knots). Deaths caused by collisions with ships can significantly affect these small populations of whales. In the case of the Atlantic northern white whale, more than a third of documented deaths were due to collision with ships. An increase in traffic in the ports in the southern Gulf of Mexico could lead to an increase in larger vessels in areas with high densities of cetaceans. Given this, it would be prudent to follow-up the incidence of collisions between ships and whales in order to detect and prevent possible risks to the populations of these cetaceans.

GEOLOGICAL EXPLORATION & DEMOLATION OF ASSOCIATED STRUCTURES

Two other types of human activities that can have a negative affect on populations of marine mammals in the Gulf of Mexico are geological exploration and the demolition or removal of associated structures using explosives. Both activities are associated with the exploitation of petroleum reserves on the marine floor. Seismic exploration of the ocean floor is carried out using low frequency waves generated by explosives. At the beginning, dynamite was used to generate these wages but now pistons or “pistols” of compressed air are used. The waves generated by the explosion travel through the water column and penetrate the sea floor and are then differentially reflected towards the surface, depending on the discontinuities present in the sediments. The echo is registered on the surface by a series of hydrophones and later analyzed in order to determine sediment structure and the presence of probable reserves. The explosives used in this type of geologic exploration produce high intensity sounds that can have harmful effects on marine mammals and their prey (Richardson *et al.* 1990; Engas *et al.* 1996; Goold and Fish 1998). Although geological exploration has been carried out very frequently in the Gulf of Mexico, studies have not been done to determine the effects it has marine mammal populations.

The removal or demolition of offshore oil platforms is frequently accomplished with explosives. The massive wave that they cause can lead to the death of marine mammals that are near the explosion (Klima *et al.* 1988). In the U.S. exclusive economic zone, industries are

obliged to avoid the mortality of marine mammals and turtles during structure demolition. To achieve this, observers are present during demolition operations and they are responsible for halting work if marine mammals or turtles are near the demolition site. A similar program in the southern Gulf of Mexico would be a positive step forward.

ECOTOURISM

The observation of marine mammals in their natural environment has become very popular. Although in Mexico this type of activity has focused on observation of whales on the Pacific coast and Gulf of California, it is probable that activities related to the observation of dolphins or manatees will be developed on the coast of the Gulf of Mexico. Ecotourism can offer development alternatives for some coastal communities in the southern Gulf, but it is important that and that the activity is regulated and precautions are taken to ensure its sustainability (Young 1999; Heckel *et al.* 2003). If ecotourism is not developed correctly, observation of marine mammals can have negative effects on the populations involved (Janik and Thompson 1996; Constantine 2001; Heckel. 2003). The regulation that regulates ecotourism in Mexico (Norma Oficial Mexicana NOM-131-ECOL-1998; D.O.F. 2000) only refers to the observation of whales and does not include other species. It is important that ecotourism activities involving all marine mammal species are included in the regulations.

RECOMMENDATIONS FOR SUSTAINABLE MANAGEMENT OF MARINE MAMMALS IN THE GULF OF MEXICO

Despite regulations that grant special protection to marine mammals, cetacean research in the region is scarce and almost limited to the coastal zone. In order to generate the basic information that is necessary for adequate management of the marine mammal populations in the southern Gulf of Mexico we make the following recommendations:

a) Undertake studies to obtain precise and current information on the distribution, abundance and critical habitat of marine mammals;

b) Define units of management (stocks), preferably by molecular genetic studies of the populations of marine mammals;

c) Quantify the mortality of marine mammals caused directly by human activities (intentional capture, incidental capture, interactions with fishing and collisions with ships).

d) Provide additional resources to environmental authorities in those areas that are important for marine mammals, particularly in the coastal zone.

e) Develop education and outreach programs to inform citizens of the importance of protecting marine mammals and their habitat.

f) Promote marine mammals in such a way that they symbolize conservation of aquatic ecosystems.

g) Grant financial and logistic support to organizations that actively participate in the conservation of marine mammals, such as the Subcomité Técnico Consultivo para la Recuperación del Manatí (Technical Consultative Subcommittee for the Recovery of the Manatee). Since 1997, this subcommittee has met annually with a group of experts to propose management measures and research on the species. The conservation directives of the organization are presented in the Proyecto de Recuperación del Manatí en México

(Project for the Recovery of the Manatee in Mexico; Environment and Natural Resources Ministry 2001).

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