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Sightings of Cetaceans in the Northern Caribbean Sea and Adjacent Waters, Winter 1995

CAROL L. RODEN AND KEITH D. MULLIN

Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA, P.O. Drawer 1207, Pascagoula, Mississippi 39568

ABSTRACT.—**A multi-objective research cruise was conducted in the northern Caribbean Sea and the adjacent Atlantic Ocean from 29 January through 8 March 1995. One aspect of the cruise was to determine the feasibility of using ship-based line-transect survey methods to estimate the abundance of cetaceans in waters of Puerto Rico and the U.S. Virgin Islands. Cetacean surveys were also conducted during daylight between ichthyoplankton sampling stations in the Atlantic Ocean east of the Virgin Islands, while in transit, and around Pedro Bank, Jamaica. Cetaceans were sighted 65 times (including three two-species sightings) and 4275 transect km were surveyed. At least nine cetacean species were identified, including (number of groups sighted) humpback whale (*Megaptera novaeangliae*), 12; minke whale (*Balaenoptera acutorostrata*), 1; sperm whale (*Physeter macrocephalus*), 8; *Mesoplodon* spp., 2; shortfin pilot whale (*Globicephala macrorhynchus*), 9; bottlenose dolphin (*Tursiops truncatus*), 3; Atlantic spotted dolphin (*Stenella frontalis*), 8; pantropical spotted dolphin (*S. attenuata*), 6; and striped dolphin (*S. coeruleoalba*), 1. Eighteen groups could not be identified to species.**

INTRODUCTION

The U.S. National Marine Fisheries Service, as mandated by the U.S. Marine Mammal Protection Act, is responsible for protecting cetacean and other marine mammal populations in U.S. waters. The NMFS meets this responsibility, in part, by conducting surveys to monitor the diversity, abundance, and distribution of cetaceans in U.S. waters. Surveys may also include adjacent international waters and, when permission is granted, waters of other countries that may be inhabited by transboundary cetacean populations.

The Caribbean Sea supports a diverse cetacean fauna that includes at least 26 species that are tropical/subtropical or broader in distribution in the Atlantic Ocean (Debrot et al., 1998; Mignucci-Giannoni, 1998). Seventeen of these species occur in or near U.S. waters in the northeastern Caribbean (Mignucci-Giannoni, 1996, 1998). Except for the humpback whale (*Megaptera novaeangliae* [Lacepède]) which occurs in specific areas during winter to breed and calf, abundances of cetaceans are poorly known in all waters of the Caribbean region. Abundance surveys in the U.S. Gulf of Mexico, which is inhabited by many of the same species, have revealed that cetaceans are relatively abundant in continental shelf and oceanic waters (Blaylock and Hoggard,1994; Mullin and Hoggard, 2000). Similar abundance surveys have not been conducted in the Caribbean Sea.

In winter 1995, a research cruise was conducted by the NMFS in the northern Caribbean region. The primary cetacean objective was to conduct a pilot study to determine whether ship-based line-transect surveys were feasible to estimate the abundance of cetaceans in U.S. waters off Puerto Rico and the U.S. Virgin Islands. Another cruise objective was to collect ichthyoplankton samples in the adjacent Atlantic Ocean, where commercial longline fishing for swordfish (*Xiphias gladius* [Linnaeus]) is frequently conducted (Lee et al., 1995). Cetacean surveys were also conducted between ichthyoplankton sampling stations, while in transit, and around Pedro Bank, Jamaica. Here we report details of the cetacean sightings (e.g., species, locations, water depth, group-size, behavior) and discuss how future surveys to estimate

cetacean abundances in U.S. waters in the Caribbean region might be designed and conducted.

METHODS

The survey was conducted from the 51-m NOAA Ship *Oregon II* between 29 January and 8 March 1995. Data for estimating cetacean abundances were collected visually using line-transect methods (Buckland et al., 1993) for ship surveys similar to those used in the Pacific Ocean (e.g., Barlow, 1995) and Gulf of Mexico (Hansen et al., 1996; Mullin and Hoggard, 2000). The survey was designed to cover a broad range of water depths around Puerto Rico and the Virgin Islands (Fig. 1). In those waters, surveys began at the location where they ended the previous day, providing contiguous trackline coverage. During transits, and in the swordfish longlining area, the ship was underway 24 hr/day and trackline coverage of those areas was more disjunct. The waters bordering Pedro Bank, south of Jamaica, were also surveyed for two days. Target survey speed was 18.5 km/hr (10 nm/hr) but varied with conditions.

Line-transect data were collected during daylight hours, weather permitting (i.e., no rain, Beaufort sea state <6), by two teams of three observers skilled in shipboard cetacean observation and identification techniques. Observers used two pairs of 25× binoculars mounted on stanchions on the left and right sides of the ship's flying bridge, about 10 m above the surface of the water. An observer was positioned at each pair of binoculars and searched for cetaceans from the left or right beam, respectively, to 10° past the bow. The third observer maintained a search of the area near the ship using hand-held 7× binoculars and unaided eye, and recorded data with a computer using a BASIC data acquisition program. Observer teams worked 2 hr on/2 hr off watches where individuals rotated through each position every 40 min. The computer was interfaced with a Global Positioning System (GPS) unit and downloaded the ship's position, speed, and heading every 2 min. Data collected on the survey environment included weather, glare, Beaufort sea state, and wind direction. When a cetacean sighting was made, the bearing and reticle (a measure of radial distance) to the sighting was recorded, and the ship was diverted from the transect-line to approach the animals for identification, group-size counts, and behavioral observations. Cetacean sighting data included species, group-size, presence of calves, sea surface temperature, water depth, and behavioral observations. A cetacean calf was defined as an animal one-half the length or less of the accompanying animal. Identification to species was not always possible due to sea state or behavior of the animals.

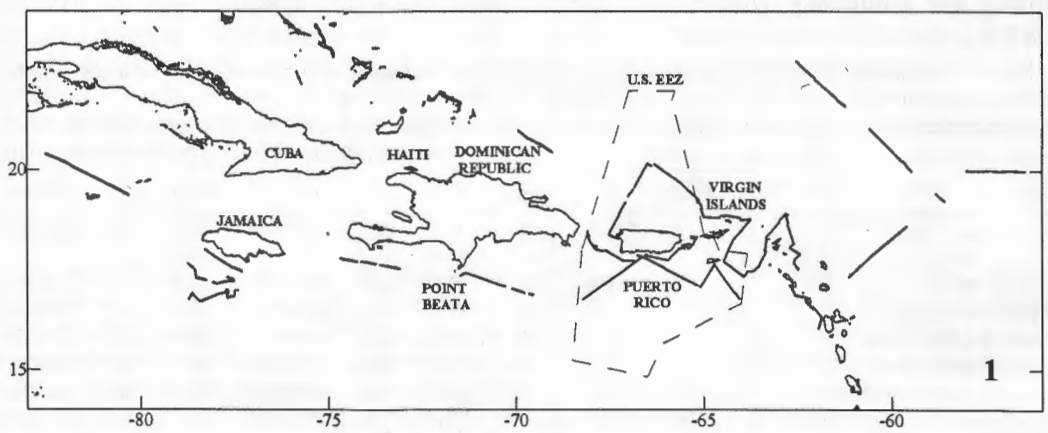

FIG. 1. The tracklines visually surveyed for cetaceans from NOAA Ship *Oregon II* during winter 1995. The boundary of the U.S. Exclusive Economic Zone (EEZ) is also shown.

In some cases, cetaceans could only be classified as unidentified Balaenopteridae, Ziphiidae, large whales (>7 m long), small whales (non-dolphin, <7 m), dolphins, or odontocetes.

RESULTS

Cetacean surveys were conducted on 26 days during the 46-day cruise. Daily survey effort ranged up to 11 hr/day and 254 km/day (Fig. 1). A total of 238 hr and 4275 transect km of survey effort was accomplished. Adverse weather reduced or eliminated surveys on four days. Cetaceans were encountered 65 times and at least nine species were sighted. These included one sighting of minke whales (*Balaenoptera acutorostrata* [Lacepède]) while the ship was stopped at night (Table 1). The humpback whale, shortfin pilot whale (*Globicephala macrorhynchus* [Gray]), Atlantic spotted dolphin (*Stenella frontalis* [Cuvier]), and sperm whale (*Physeter macrocephalus* [Linnaeus]) were the most commonly sighted species. Eighteen groups could not be identified to species. Of these, five were balaenopterids, two were large whales, six were small whales, two were dolphins, one was a ziphiid, and two were odontocetes. Two species were sighted together three times; humpback whales and shortfin pilot whales, twice, and humpback whales and unidentified odontocetes, once.

Group sizes averaged <4 animals per group for humpback whales and sperm whales, 9.0 animals per group for bottlenose dolphins (*Tursiops truncatus* [Montagu]), and 20-30 animals per group for shortfin pilot whales, Atlantic spotted dolphins, and pantropical spotted dolphins (*S. attenuata* [Gray]) (Table 1). The only sighting of striped dolphins (*S. coeruleoalba* [Meyen]) contained an estimated 140 dolphins and was the largest group recorded.

Calves were sighted for six of the nine species recorded and were frequently present. Calves were seen in most groups of pilot whales (5/9), sperm whales (5/8), Atlantic spotted dolphins (5/8), and pantropical spotted dolphins (4/6). Of the 50 groups identified to species, 22 included at least one calf. One group of 19 Atlantic spotted dolphins included at least seven calves.

Cetaceans were encountered in all areas surveyed (Figs. 2, 3). Due to the bottom topography of the region (i.e., shallow banks, narrow continental shelves, and steep continental slopes) and the size of the ship, most of the waters surveyed were >200 m deep and the average bottom depth of sightings for all species, except bottlenose dolphins, exceeded 1700 m (Table 1). The bottom depth of the three bottlenose dolphin sightings ranged from 229 to 556 m.

Forty-nine percent of the total survey effort (2079 transect km) occurred in and near U.S. waters in the northeastern Caribbean and adjacent Atlantic. Thirty-nine of the cetacean groups were sighted in these waters as follows: shortfin pilot whale - 8, humpback whale - 7, sperm whale - 6, Atlantic

TABLE 1. Summary statistics on group size, water depth, and sea surface temperature for cetaceans sighted during winter 1995.

	Group size				Water depth (meters)			Surface temp. (°C)		
Species	n	Mean	SE	Range	Mean	SE	Range	Mean	SE	Range
Humpback whale	12	1.8	0.25	1-4	2877	747	27-7503	26.6	0.09	26.0-27.3
Minke whale	1	3.0	—	—	5490	—	—	26.8	—	—
Sperm whale	8	3.6	0.56	2-6	1739	467	750-4538	26.8	0.14	25.9-27.3
Mesoplodon spp.	2	2.0	—	2-2	1915	—	1830-2000	26.5	—	26.2-26.8
Shortfin pilot whale	9	21.1	3.99	8-43	1912	737	549-7503	26.6	0.11	26.3-27.3
Bottlenose dolphin	3	9.0	3.51	5-16	353	102	229-556	27.1	0.17	26.8-27.3
Atlantic spotted dolphin	8	29.8	2.83	19-48	2267	560	494-5642	26.9	0.09	26.3-27.1
Pantropical spotted dolphin	6	28.7	14.38	12-100	2247	516	1171-4447	26.1	0.14	26.7-27.5
Striped dolphin	1	140.0	—	—	3200	—	—	26.6	—	—

— = SE was not estimated for species with <3 sightings.

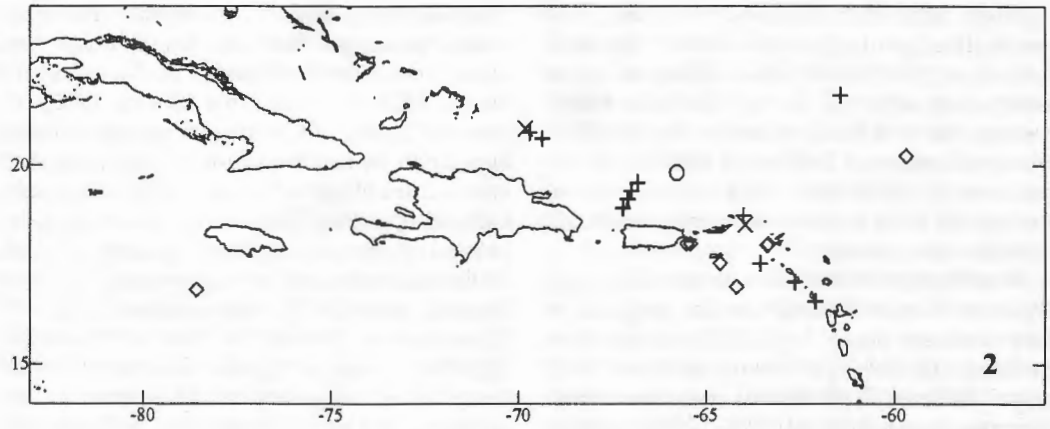

FIG. 2. Locations of sightings of groups of humpback whales (+), minke whales (○), sperm whales (◇), and *Mesoplodon* spp. (×) during winter 1995.

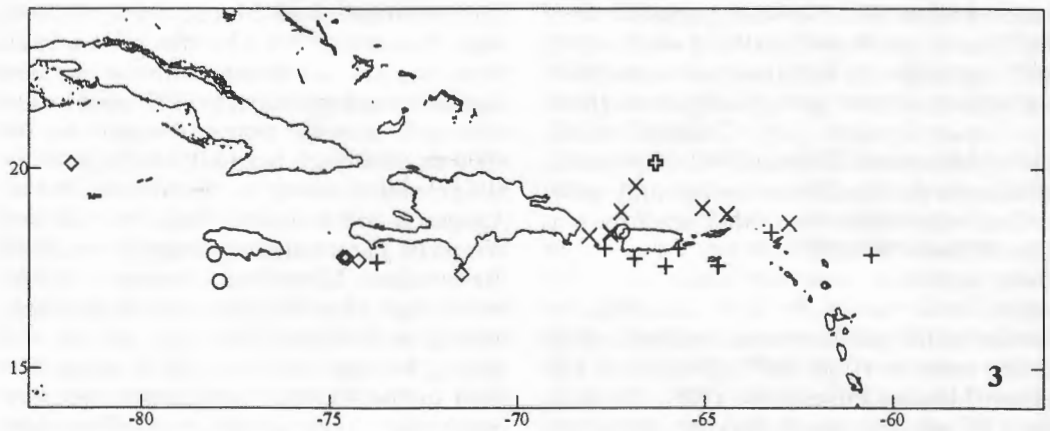

FIG. 3. Locations of sightings of groups of Atlantic spotted dolphins (+), pantropical spotted dolphins (◇), bottlenose dolphins (○), striped dolphins (⊕), and shortfin pilot whales (×) during winter 1995.

spotted dolphin - 6, minke whale -1, *Mesoplodon* sp. -1, bottlenose dolphin -1, striped dolphin -1, unidentified Balaenopteridae - 2, unidentified small whale - 4, unidentified large whale -1, and unidentified dolphin -1.

DISCUSSION

As stated earlier, at least 26 species of cetaceans are known from the Caribbean. Information on species other than the humpback whale and the sperm whale comes primarily from opportunistic sightings, opportunistic surveys, and strandings (e.g., Taruski and Winn, 1976; Watkins and Moore, 1982; Jefferson and Lynn, 1994; Debrot et al., 1998; Mignucci-Giannoni, 1998). Records from cetacean fisheries in the eastern Caribbean (Caldwell et al.,1971; Caldwell and Caldwell, 1975) and off Venezuela (Romero et al., 1997) have also been important sources of information.

Of the 17 cetacean species reported for the northeastern Caribbean (i.e., near Puerto Rico and the Virgin Islands) (Mignucci-Giannoni, 1998), at least eight were sighted during the winter 1995 survey in these waters. A ninth species, the pantropical spotted dolphin, was sighted only to the west of this area (Fig. 3). Of the species that were common (i.e., >30 sightings) in Mignucci-Giannoni's (1998) study, only the

spinner dolphin (*S. longirostris* [Gray]) was not sighted during winter 1995. Mignucci-Giannoni (1998) provided information on number of sightings, group size, and distribution for historical cetacean sightings in the northeastern Caribbean; and while the number of sightings for each species from the winter 1995 survey was generally small, results were similar.

Most humpback whales from all known western North Atlantic stocks migrate in late autumn from high latitude feeding grounds to the Caribbean to breed and calve. At least 7100 whales from the North Atlantic population of 9300-12 100 humpback whales are estimated to inhabit Caribbean breeding areas during winter (Smith et al., 1999). Most of these whales congregate on Silver and Navidad banks north of the Dominican Republic (Winn et al., 1975), but sightings of humpback whales have been made at least sporadically throughout the Lesser Antilles (e.g., Caldwell et al., 1971; Debrot and Barros, 1994). Humpback whales in the Caribbean are strongly-associated with banks and other shallow waters. Winn et al. (1975) noted that 99 % of their sightings were on banks in water depth <183 m. Of the 1597 sightings recorded in the northeastern Caribbean, only a few were seen on the shelf edge or offshore (Mignucci-Giannoni, 1989). The winter 1995 surveys could only be conducted in deeper waters that skirt the banks or other shallow water, but whale blows were observed five times on the horizon in the direction of shallow water. Since the whales could not be approached, they were recorded as unidentified Balaenopteridae, although they were very likely humpback whales. Humpback whales were also sighted in very deep water. Ten of the 12 humpback whale sightings were in waters >183 m; the water depth of all sightings averaged 2877 m. Both sightings of humpback whale calves were in deep water. One calf was in a group of three animals in a depth of 5124 m north of the Mona Passage, and the second was in a group of four animals in a depth of 1016 m but near shallow water (<100 m) between Montserrat and Guadeloupe.

Sperm whales are widely distributed in the Caribbean and are common in the deep water passages between the islands and along continental slopes (e.g., Taruski and Winn, 1976; Watkins and Moore, 1982). In the northeastern Caribbean, sperm whales appear to be more common during the fall and winter (Erdman et al., 1973; Mignucci-Giannoni, 1998). They were the third most common species sighted during winter 1995 and only one of eight sightings was beyond continental slope waters (Fig. 2). Calves were present in five of the eight sightings made. Mignucci-Giannoni (1998) found that only two of 43 sperm whale sightings in the northeastern Caribbean included calves.

The shortfin pilot whale has a wide distribution in the Caribbean (e.g., van Bree, 1975; Watkins and Moore, 1982; Mattila and Clapham, 1989). Shortfin pilot whales were the second most common species sighted during winter 1995 and were sighted in a wide range of water depths >500 m. Although originally thought to be a summer visitor to the West Indies (Caldwell and Erdman, 1963), Taruski and Winn (1976) recorded sightings throughout the winter. Mignucci-Giannoni (1998) found that shortfin pilot whale sightings more than doubled during the winter and spring. Taruski and Winn (1976) stated that most of the shortfin pilot whale sightings were over deep water, but often near banks. They also found that shortfin pilot whales were not very common near the islands during winter. About 45 % of the sightings reported by Mignucci-Giannoni (1998) were in waters less than 183 m deep.

Sightings and strandings of beaked whales, especially Cuvier's beaked or goosebeak whale (*Ziphius cavirostris* [Cuvier]), have been reported from many locations in the Caribbean, leading several researchers to conclude that these animals may be fairly common (Debrot and Barros, 1994). Caldwell and Caldwell (1975) noted that Cuvier's beaked whale had been taken in a fishery in the southeastern Caribbean. During winter 1995, two beaked whale sightings, each consisting of a pair of animals, were identified as *Mesoplodon* sp. and a single animal as unidentified Ziphiidae. Three of the unidentified small whale sight-

ings were suspected to be beaked whales, but cryptic behavior and rough seas precluded positive identification.

Minke whales have been reported from around the Caribbean and adjacent Atlantic waters (Erdman et al., 1973; Mattila and Clapham, 1989). The only sighting of minke whales during winter 1995 was made after the ship was stopped for the night in waters 5490 m deep about 160 km northeast of Puerto Rico (Fig. 2). At 2130 hr, whale blows could be heard but the animals stayed out of the ship's lights. Eventually the animals swam into the light and were identified based on the pointed rostrum and white flipper patches. Over the course of at least two hours, three minke whales stayed with the ship and gradually swam closer and more slowly around the vessel. They were observed several times spy hopping just a few meters off the stern. Curious and inquisitive behavior by minke whales has been noted by several researchers, including Mignucci-Giannoni (1989) who reported 13 sightings of minke whales in the northeastern Caribbean, mostly in groups of two or three. These sightings were primarily in or near continental shelf waters.

Four species of dolphins were sighted on the winter 1995 survey. Although the bottlenose dolphin is the most frequently seen odontocete in the northeastern Caribbean (Erdman et al., 1973; Mignucci-Giannoni, 1989), it has been sighted primarily over the shelf or near the shelf-edge, habitats not extensively surveyed during winter 1995. Bottlenose dolphins inhabit similar waters in the Gulf of Mexico (Hansen et al., 1996; Mullin and Hoggard, 2000).

Records of striped dolphins in the Caribbean are not common (Debrot et al., 1998; Mignucci-Giannoni, 1998). Jefferson and Lynn (1994) observed striped dolphins on three occasions in groups ranging from 1-30 animals. One striped dolphin group of an estimated 140 animals was observed north of Puerto Rico during winter 1995.

The other two species of dolphins encountered were Atlantic spotted dolphins and pantropical spotted dolphins. Records of spotted dolphins (e.g., Erdman, 1970) are difficult to interpret prior to the taxonomic work of Perrin et al. (1987), due to confusion over the number, names, and descriptions of "spotted" dolphin species. However, Caldwell et al. (1971), Caldwell and Caldwell (1975), and Taruski and Winn (1976) clearly distinguished the two species (with different names) as they are currently recognized. Atlantic spotted dolphins were the most commonly observed dolphins during the winter 1995 survey, with all nine sightings at water depths deeper than 400 m. All but one of the sightings were very near islands (Fig. 3). Mignucci-Giannoni (1998) reported only the Atlantic spotted dolphin around Puerto Rico and the Virgin Islands, and it was the fifth most common odontocete in that study. He found that 85 % of these sightings were at depths less than 183 m and that the species was rarely seen offshore. Jefferson and Lynn (1994) reported two sightings of Atlantic spotted dolphins at 40 and 5425 m but noted that the latter sighting was in the vicinity of shallow water.

During the winter 1995 survey, observers noted that individual Atlantic spotted dolphins were smaller, less robust, and often had less spotting than the animals typically seen in the Gulf of Mexico. This description is consistent with the "oceanic island" form of the Atlantic spotted dolphin described by Perrin et al. (1994). In the northern Gulf of Mexico, only the heavier coastal form is found and it occurs on the continental shelf and the extreme upper continental slope (<500 m) (Hansen et al., 1996; Mills and Rademacher, 1996).

Pantropical spotted dolphin groups were observed on six occasions, all west of Point Beata, Dominican Republic (Fig. 3). This species was the most frequently observed cetacean by Jefferson and Lynn (1994) in the southwestern Caribbean, with eight widely distributed sightings. In the oceanic Gulf of Mexico, the pantropical spotted dolphin is by far the most abundant cetacean (Mullin and Hoggard, 2000). Whereas Jefferson and Lynn (1994) reported that the Caribbean pantropical spotted dolphins were lightly spotted or sometimes not spotted at all, observers on this survey noted them to be generally more heavily spotted and more robust than the animals observed in the Gulf of Mexico.

The common dolphin (*Delphinus* spp.) has been reported from around the Caribbean. Mignucci-Giannoni (1998) reported 13 sightings from the northeastern Caribbean. Common dolphins were not observed during the winter 1995 survey or by Jefferson and Lynn (1994). Though reported from the Gulf of Mexico (Schmidly, 1981), extensive shipboard and aerial surveys of the northern Gulf since 1991 have found no common dolphins (Hansen et al., 1996; Blaylock and Hoggard, 1994; Jefferson, 1996; Mullin and Hoggard, 2000) and none of the Gulf stranding records are valid (Jefferson, 1995). We believe that previous Caribbean Sea common dolphin sightings without photographic records should be viewed with caution. In tropical regions, where common dolphins are routinely sighted, they are found in upwelling modified waters (Au and Perryman, 1985; Reilly, 1990; Ballance and Pitman, 1998). The one notable location where coastal upwelling occurs in the Caribbean, northeast Venezuela (Longhurst and Pauly, 1987), is also one of the few places where *Delphinus capensis* (Gray) is taken in fisheries (Romero et al., 1997). It is also possible that Clymene dolphins (*S. clymene* [Gray]), as suggested by Evans (1994), and pantropical spotted dolphins could be misidentified as *Delphinus* spp. One common name of *Delphinus* spp. is the "saddleback dolphin". Both the Clymene and pantropical spotted dolphins have distinct dipping capes which could easily be misinterpreted as the "saddle" of *Delphinus* spp., and both are abundant in the Gulf of Mexico (Mullin and Hoggard, 2000).

In both mixed-species sightings of humpback whales and shortfin pilot whales, there was interaction between the two species. The first sighting involved one humpback whale and 18 pilot whales, including a calf, in waters 3752 m deep. The humpback whale was swimming slowly, often partially submerged. The pilot whales were very close to the humpback whale, and even swam back and forth over the top of the partially submerged animal. At one point, the humpback whale rolled onto its back and extended its pectoral fins out of the water, as the pilot whales swam through the pectoral fins. There was much physical contact between the two species, but it did not appear to disturb or abruptly change their behavior. The second interaction involved two humpback whales and 15 pilot whales in waters 7503 m deep. One of the humpback whales was much smaller than the other. No physical contact between the species was observed; however, as before, neither species seemed disturbed by the presence of the other. The humpback whales were swimming slowly and when they dove, the shortfin pilot whales continued to move along the same track as the submerged humpback whales, and were always in the immediate area when they surfaced. We found no other reports of associations between humpback whales and shortfin pilot whales, but Mattila and Clapham (1989) reported that four of the five groups of rough-toothed dolphins (*Steno bredanensis* [Lesson]) they observed were traveling in association with humpback whales. Pilot whales (*Globicephala* spp.) are commonly associated with other cetacean species, including large whales off the northeastern U.S. (CeTAP, 1982).

The results of the winter 1995 survey indicate that estimating the abundance of cetaceans in waters of the northeastern Caribbean Sea will be challenging due to low group sighting rates. Sighting rates would improve in calmer seas. For example, the overall group sighting rate in or near U.S. waters, excluding humpback whales, on days when the sea state was Beaufort 3 or less was 2.0 groups per 100 km surveyed, compared to 0.8 groups per 100 km when the sea state was greater than Beaufort 3. However, these sea state conditions are typical in the northeastern Caribbean (Atlas of Pilot Charts, U.S. Defense Mapping Agency). Even with better survey conditions, the sighting rates are probably a result of lower overall densities of cetacean groups in the northeastern Caribbean. For example, in the Gulf of Mexico sighting conditions are similar in spring (April and May), when ship surveys are conducted in similar water depths, but group sighting rates are more than twice as large.

To estimate the abundance of a cetacean species with line-transect methods, at least

60-80 group sightings of each species or species with similar sighting characteristics (e.g., large whales, small dolphins, small whales/large dolphins) are recommended to estimate the critical parameter *f(0)* (see Buckland et al., 1993). In practice, as few as 15-20 group sightings are sometimes used (e.g., Barlow, 1995; Mullin and Hoggard, 2000). Therefore, more than twice as much survey effort (i.e., > 4000 km) would be needed in one survey or for pooled surveys to estimate the abundance of the most commonly sighted species in U.S. Caribbean waters (i.e., sperm whales, shortfin pilot whales, Atlantic spotted dolphins). Because of the multiple objectives of the cruise, the effort in U.S. waters was not random or entirely uniform, as it would need to be to obtain unbiased estimates of abundance. Although this estimate of effort may not coincide completely with that from a properly designed survey for U.S. waters, it should represent a reasonable starting point.

Aerial line-transect surveys have been successful in the Gulf of Mexico (Mullin and Hoggard, 2000) and in other areas, and should be considered when designing future abundance surveys in U.S. and other Caribbean waters. Aerial surveys can cover a large area in a relatively short time, can wait out poor weather periods at reduced cost compared to large vessels, and can exploit short periods of calmer weather that may occur on a daily basis in the Caribbean, especially in the morning. Aerial surveys can also target areas of interest that ships cannot due to bottom topography (i.e., banks, island shelves, submerged ridges, etc.). Results of aerial surveys could be used to delineate areas where cetaceans concentrate and where intensive ship surveys, that include both visual and acoustic sampling, could be more efficiently conducted.

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