SC/64/O12

Spatial distribution of humpback whales (*Megaptera novaeangliae*) in Samaná Bay, Dominican Republic

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ABSTRACT

Observations of humpback whales (location, number and social groupings) were collected on board commercial whale watch vessels in January, February and March, 1999 to 2011, at the eastern end of Samaná Bay and the surrounding oceanic waters. These data represent the only information available for this area over a 20-year period. During the twelve years of study 3,281 sightings were documented in 1,590 trips. Humpback whales were sighted over insular shelf waters (less than 100m depth) in the extreme northeast of Samaná Bay, in the north and east of the Samaná Peninsula and in the surrounding oceanic waters (100m to 1,300m depth). Sightings were most frequent (~92%) in a 30nm^2 area towards the mouth of the bay. Distinct local variation patterns in biweekly spatial distribution were found, during the three months of the whale watch season. Mothers with calves were most frequently sighted at inner and shallower positions over the 0-10m and 10-20m depth intervals. Sighting frequencies of groups without calves were comparatively lower in these same depth intervals. This study expands the spatial distribution of humpback whales to other areas of Samaná Bay and extends the temporal interval of observations to the end of the breeding season. Nearly two decades of observations corroborate earlier investigations, that Samaná Bay is one of the most important winter habitats in the West Indies for humpback whales from all over the North Atlantic. Information on the spatial distribution of humpback whales obtained from data collected aboard whale watch vessels has played a vital role in the Marine Spatial Planning of Samaná Bay and the creation of a conservation zone with restricted fisheries and tourism activities during the whale season.

KEYWORDS. Humpback whales, *Megaptera novaeangliae*, distribution, Samaná, Dominican Republic.

INTRODUCTION

Humpback whales from all feeding grounds in the North Atlantic migrate to the Caribbean during the winter to reproduce (Katona and Beard, 1990). The majority concentrate on the Navidad and Silver Oceanic Banks to the North of the Dominican Republic (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila *et al.* 1989). The remaining whales are dispersed between Samaná Bay (Mattila *et al.,* 1994), the Engaño Bank, the Mona Passage, the northwest coast of Puerto Rico, the Virgin Islands (Sanders *et al.,* 2005) and along the arc of the Lesser Antilles to Venezuela (Swartz *et al.,* 2003).

In this geographical context, Samaná Bay's importance as both a mating ground and significant nursery area was first established by Clapham *et al.* (1992; 1993) and Mattila *et al.*, (1994). Based on the relative abundance of humpback whales, the frequency with which calves and competitive groups were observed and the prolonged residency of mothers, it was suggested that the bay is qualitatively more important than other eastern breeding grounds. Today, Samaná Bay is part of the Marine Mammal Sanctuary of the Dominican Republic (along with the Navidad and Silver Banks) and is considered one of the most important tourism based whale watch destinations in the Caribbean (Hoyt, 1999). The Marine Mammal Sanctuary currently receives more than 40,000 visitors during the whale watch season (January to March) with a direct benefit to the community of US$ 2.3 million (AGROFORSA 2012).

The present study will analyze the spatial and temporal distribution of humpback whales in Samaná Bay from sighting data collected onboard commercial whale watch vessels, in January, February and March, 1999 to 2011. These observations were not collected based on a random survey design and should be considered an opportunistic model that may be effectively used to describe and analyze the local distribution patterns of humpback whales in a multiple-use area such as Samaná Bay, with very important management applications. These data represent the only systematic and updated information on the distribution of humpbacks in Samaná Bay and the Marine Mammal Sanctuary of the Dominican Republic in the last 20 years.

METHODS

Description of the study area

Samaná Bay is located in the northeast of the Dominican Republic at latitude 19°10′N and longitude 69°25′W. It has a length of 23.9nm from its western end to Punta Palometa at its mouth, with an approximate width of 9.5nm, measured in a straight line from Punta Palometa to its southern coast (Fig. 1). The western inner bay receives a significant contribution of freshwater from the Yuna and Barracote Rivers, creating the largest estuary in the Dominican Republic. The most outstanding feature of this semi-enclosed basin is the sharp contrast between estuarine and oceanic conditions (from west to east) creating a gradient of ecological conditions where diverse ecosystems (mangroves, soft bottoms, sea grasses, coral reefs and open ocean) have developed (Herrera-Moreno, 2005). Samaná Bay is a multiple-use basin that, in addition to its role as a commercial port, supports various types of fisheries (estuarine, shallow reef, deep and pelagic) as well as multiple marine-based tourism activities (nature excursions, parasailing, recreational boating, diving, cruise ships and whale watching).

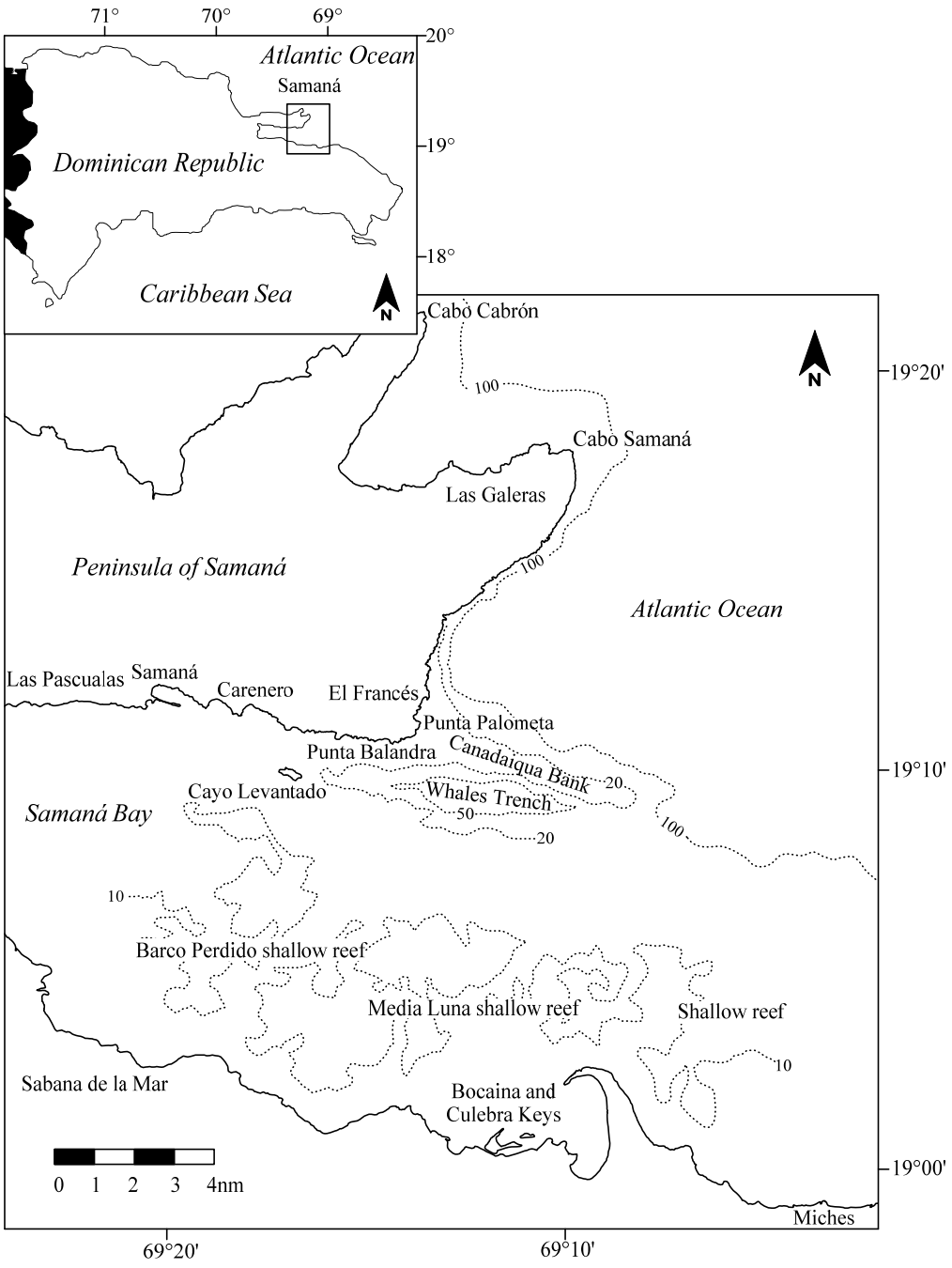

Figure 1. Map of the study area in the eastern region of Samaná Bay, Dominican Republic.

The study area includes the eastern end of Samaná Bay and the surrounding oceanic waters, where historically, whale watch vessels have encountered humpback whales since 1985 (Hoyt, 1999). Calculating the entire extension where sightings have occurred, the whale watch study area in Samaná Bay occupies a total surface area of 192nm^2. The average depth is 16.7m with a maximum depth of 105m. The depth is reduced towards the north approaching the mainland, to the west in the vicinity of Cayo Levantado and to the south, a region of very complex bottom topography due to the presence of the shallow reefs of the Barco Perdido and Media Luna Shoals. The depth rapidly increases towards the east where the ocean floor drops off abruptly to depths of more than 2000m. Canadaiqua Bank, a shallow area (10m to 20m) on the edge of the drop off, extends like a tongue from the southern tip of the Samaná Peninsula (Punta Palometa) to the southeast for a distance of 6nm.

South of the Canadaiqua Bank and two miles east of Cayo Levantado, there is a submarine depression known as the Whale Trench. Oriented from west to east, this trench is 6.2nm long, 1.3nm wide, with a surface area of 8.1nm² and a maximum depth of 105m. The whale watch study area also includes a narrow insular shelf bordering the east and north coasts of the Samaná Peninsula from Punta Palometa to Cabo Cabrón and the adjacent oceanic waters with depths from 100 to 2000m. Betancourt and Herrera-Moreno (2007) provide information about the main oceanographic features of the whale watch area (temperature, salinity, density, nutrients and photosynthetic pigments).

Data collection and analysis

Data were collected between mid-January and late March, from 1999 to 2011, on board different types of commercial whale watch vessels. The earliest trip was January 15th and the latest on March 31st, following the whale watch schedule established in the Marine Mammal Sanctuary. This study does not include whale sightings in the first half of January although whales can be seen in the bay from the end of December. Mattila *et al.* (1994) conducted their 1988-1989 surveys from January 3 to March 16; the current study will present the first data on sightings during the second half of March, the final stage of the whale watch season.

Three types of commercial whale watch vessels served as platforms for data collection: boats, speed boats/catamarans and runabouts or "yolas". Boats are displacement hull vessels, 46ft to 70ft in length with a capacity for 50 to 75 passengers. They depart from the port of Samaná and spend up to 4 hours in the whale watch area, covering distances from 5 to 35nm. Boats stay longer in the observation area and cover more distance at less speed than the other vessel types, offering a higher probability of multiple sightings. Speed boats/catamarans, some with tuna towers, are 29ft to 56ft in length and travel at speeds between 15 and 30 knots. They depart from the Port of Samaná, carrying 22 to 84 passengers and spend up to 3 hours in the whale watch area, covering distances ranging from 9 to 30nm. The sighting rates per trip are generally lower in speed boats /catamarans. Runabouts or "Yolas" are shallow-draft boats, 19ft to 23ft in length with a single outboard engine. They depart from the Port of Carenero with no more than 12 passengers, making short trips, less than 2 hours, covering distances from 3 to 14nm and averaging a single sighting per trip (Betancourt and Herrera-Moreno, 2007). No vessel followed a fixed pattern; the route, direction and distance was determined by the captain on a daily basis depending on weather conditions, successful encounters with whales on previous trips and distribution of other whale watch vessels in the area.

All data were collected by the authors or by trained personnel including local students, national and international researchers and volunteers, as part of a Monitoring Program coordinated by the Centre for the Conservation and Eco-development of Samaná Bay (CEBSE). The Samaná Bay Boat Owners Association (ASDUBAHISA) collaborated, providing space aboard whale watch vessels with experienced crews, used as data collection platforms. This Monitoring Program resulted in a database on humpback whales in Samaná Bay with information on location, social groupings, behaviors, climatic conditions and photo identification, obtained from 1,590 trips, with a total of 3,281 sightings, over a period of 12 years (Table 1). Part of this information is analyzed in this report.

For each sighting, the initial time and position of the whale or group of whales, was recorded using a GPS. Positions correspond to the nearest point of the vessel to the whales. Whales were observed for approximately 30 minutes, a routine tourist based observation and once the observation was terminated, the final time and position were also recorded. During the observation, social groupings were identified as: mother and calf; mother, calf and escort; singletons; pairs; trios and competitive groups (Mattila *et al.,* 1994) but for the purposes of this study analysis was based on groupings with calves and all other groupings without calves. All georeferenced sighting points collected from all trips were considered in order to obtain a distribution map with the highest spatial coverage possible. Sighting dates were divided into 2-week periods to analyze the seasonal variations of spatial distribution in the whale watch area. The entire extension of the whale watch study area (192nm^2) was divided

into a 1nm^2 unit grid in order to estimate the number of sightings/nm^2 during the five biweekly temporal periods of the whale watch season.

Table 1. Number of trips and sightings in the whale watch study area, by month and year.

Years	Month	1999	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
Trips	January	31	11	3	11	32	42	30	22	27	21	3	45	278
	February	59	35	6	34	85	119	114	43	84	44	28	104	755
	March	73	25	4	15	64	103	78	31	43	26	17	78	557
	Total	163	71	13	60	181	264	222	96	154	91	48	227	1,590
Sightings	January	43	25	3	22	55	36	47	78	34	47	9	75	474
	February	82	168	10	88	295	139	186	242	201	121	72	135	1,739
	March	124	72	7	29	170	111	113	141	108	49	43	101	1,068
	Total	249	265	20	139	520	286	346	461	343	217	124	311	3,281

The depth at each sighting location was estimated by a Digital Bathymetric Model constructed from a data set of 53925 XYZ points (Latitude N, longitude W and depth) of Samaná Bay and the adjacent oceanic area (Mercado and Justiniano, 2000). This information was processed by the Krigging Gridding method, utilizing Golden Surfer 9 software. The whale sightings were superimposed on the map/grid and the depth at each sighting recorded. The distributional trend of social groups with regard to depth was analyzed inside the bay, limited by the eastern 100m isobaths. Relative frequency in each depth interval was calculated compiling all data for the following groups: mother and calf (N=599), mother, calf and escort (N=224) and all groups without calves (N=2054). Depth was divided in 10m class intervals. Only data where social grouping was clearly identified were used. To compare the depth distribution of whales to that of the underlying seabed, a polygon enclosing the total area of whale sightings was used to approximate the study area and allow for the calculation of percentage of total area by depth.

RESULTS AND DISCUSSION

General distribution pattern

The distribution of humpback whales in the eastern region of Samaná Bay, with concentrations along Canadaiqua Bank, off Punta Balandra and Cabo Samaná, was described by Mattila *et al*. (1994) providing the first map of humpback whale distribution in Samaná Bay, for the month of February, 1988. The following results corroborate this previous pattern and considerably extend the spatial and temporal distribution of humpback whales in Samaná Bay and the surrounding oceanic waters (Fig. 2).

In the present study, humpback whales were sighted over insular shelf waters (up to 100m depth) in the extreme northeast of Samaná Bay, in the north and east of the Samaná Peninsula and the adjacent oceanic waters (100m to 1300m depth). The majority of sightings from 1999 to 2011 (92%), were located in a 30nm^2 area towards the mouth of the bay, over the Canadaiqua Bank and the Whale Trench. This focal aggregation area, limited by Cayo Levantado to the west and the shallow reefs of Barco Perdido and Media Luna Shoals to the south, has an average depth of 24m and a maximum of 105m (Coordinates 19°09'29.72"N 69°12'35.98"W). The role of the Whale Trench in the distribution of whales and their diving behavior in this aggregation area is not entirely clear but it is important to note that the trench area (8.1nm^2) represents 27% of the effective 30nm² area of whale concentration. It is the only space inside the bay that provides opportunities for deep dives below 30m. The Whale Trench exhibited marked vertical variations of salinity and temperature (Betancourt and Herrera-Moreno, 2007).

From this central cluster of sightings, there is a peripheral area of scattered observations. Towards the southern shore of Samaná Bay, whale distribution is partially limited by the shallow reefs of Barco Perdido and Media Luna Shoals. The most southern sighting, a mother and calf, encountered between La Culebra and Bocaina Keys (Coordinates 19°00'53.86"N 69°10'36.97"W) at a depth of 5m in February, 2004. There are very few sightings west of Cayo Levantado, where depth is not a constraint to whale distribution but other factors such as turbidity, related with the estuarine nature of the inner bay, seem to play a restrictive role. Water transparency is important, as the ability to see conspecifics provides a crucial advantage in breeding grounds. For this reason, it is presumed that whales avoid this area of poor visibility (Mattila *et al.* 1994). The most western sighting was a competitive group in front of Las Pascualas (Coordinates 19°10'12.8"N 69°23'47.66"W) at a depth of 15m in February, 2005. Only a few sightings, predominantly mothers and calves, were documented in the vicinity of shallow reef areas to the south and west of Cayo Levantado.

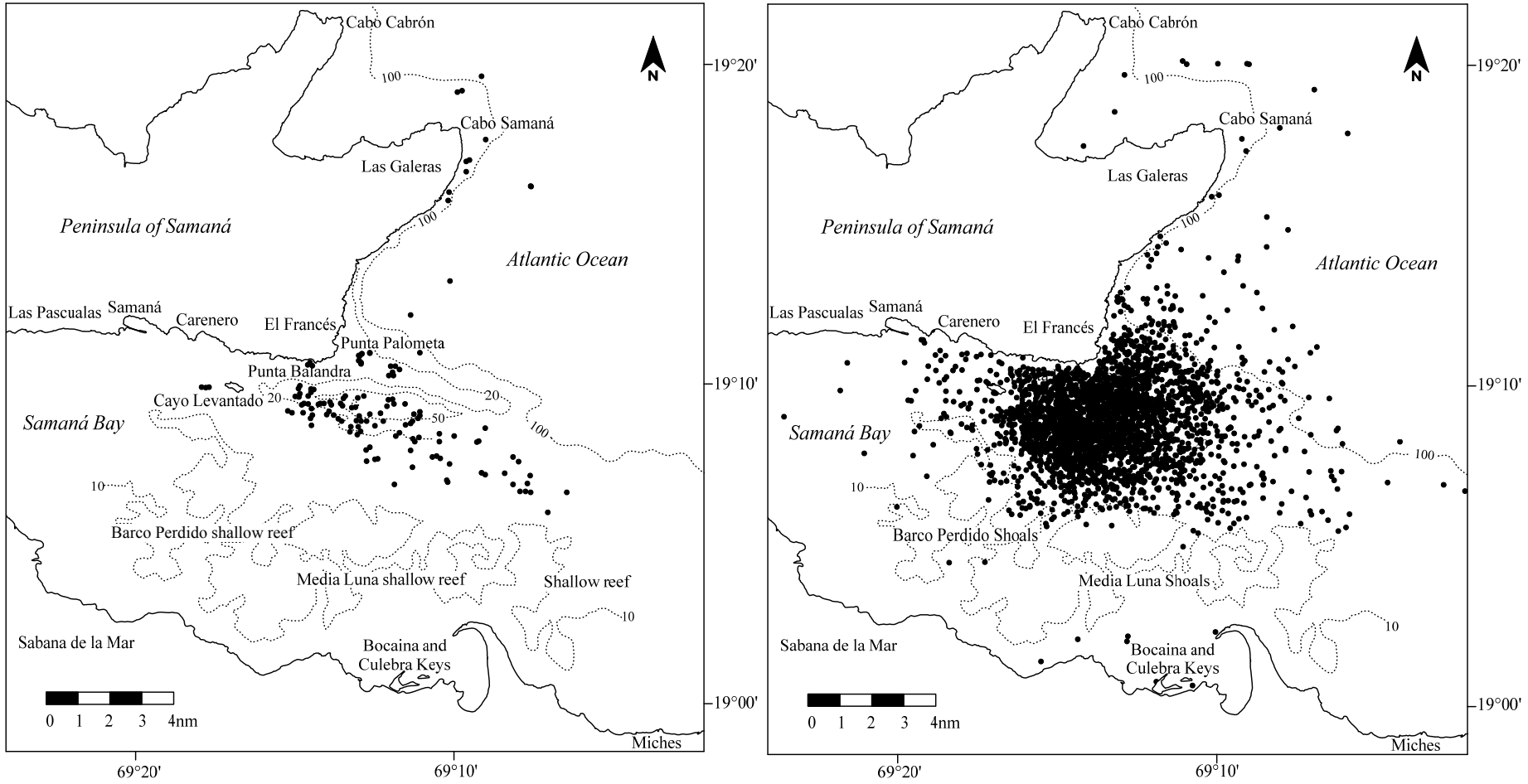

Figure 2. Distribution of humpback whale sightings, eastern region of Samaná Bay: (left) February, 1988 (Mattila *et al.*, 1994) and (right) January to March, 1999 to 2011 (present report).

Outside of the bay, some sightings are distributed along the narrow insular shelf bordering the eastern and northern coastlines of the Samaná Peninsula from Punta Palometa to Cabo Cabrón, however, most of the sightings occur in adjacent oceanic waters. The most distant sighting to the north was a pair of whales, encountered 4.4 miles east of Cabo Cabrón (Coordinates 19°20'59.66"N 69°08'33.78"W) in a depth of 1800m; and to the east a solitary adult whale (Coordinates 19°05'56.89"N 69°35'6.42"W) in a depth of 300m. Both observations occurred at the beginning of the whale watch season in January, 2005, in a region outside the bay that is considered a transitory passage (Mattila *et al.,* 1994). This transitory area plays an important role in terms of sightings, at the beginning and end of each season, when the arrival and departure of humpback whales slightly increases the presence of individuals outside the bay and the commercial whale watch vessels displace to peripheral areas in an attempt to find whales.

Early investigations (Clapham *et al.*, 1992; 1993; Mattila *et al*., 1994) established Samaná Bay as one of the most important winter habitats in the West Indies for humpback whales from all over the North Atlantic. The present study corroborates the importance of Samaná Bay as a breeding ground and nursery area, as more than two decades of observations from 1988 to the present, confirm that humpback whales continue utilizing the same reproductive habitat in the Bay of Samaná.

Biweekly distribution patterns

Considerable variation in abundance was observed within a season and between years (Mattila *et al.,* 1994). The local temporal variation in spatial distribution patterns as related to the variation in whale abundance, were analyzed dividing the data from all sightings in two-week periods. The variations in the biweekly spatial distribution patterns were compared to the number of sightings /nm^2 in the 30 nm^2 focal aggregation area inside the bay and adjacent oceanic waters (Fig. 3).

During the second half of January, humpback whales begin to congregate in the Samaná Bay area. Due to the presence of transitory whales in adjacent oceanic waters, 7.2% of all sightings take place in depths greater than 100m, outside Samaná Bay, off Punta Balandra and Cabo Samaná. Nevertheless, 88.2% of all sightings take place at depths equal to or less than 100m, in the focal aggregation area inside the bay, with a maximum of 26 sightings /nm^2. Only 4.6% of all sightings are encountered to the south, in shallow reef areas or to the west in the vicinity of Cayo Levantado, with mothers and calves occupying the majority of the interior positions.

In the first fifteen days of February, 92.9% of all sightings occur inside the bay in the focal aggregation area with a maximum of 56 sightings /nm^2. West of Cayo Levantado and to the south, in shallow reef areas delineated by the 10m isobath, sightings slightly increase to 4.9%. Only 2.2% of observations take place in oceanic waters, as whale watch vessels easily encounter whales inside the bay, during this period of increased abundance.

During the second half of February, 93.4% of sightings, with a maximum of 62 sightings /nm^2, take place in the focal aggregation area and sightings increase to 5.3% west of Cayo Levantado and to the south in shallow reef areas. The most western and southern sightings also occur during this temporal period and fewer sightings 1.3% take place outside the bay in adjacent oceanic waters. Although the distribution pattern is similar to the first fifteen days of the month, this study, in relation to the preliminary observation that abundance generally peaked in February (Mattila *et al.,* 1994) showed a definite increase in sightings /nm^2 and a quantitative temporal shift of peak abundance into the last two weeks of February.

In the first fifteen days of March, 91.8% of all sightings, take place inside the bay with a maximum of 34 sightings /nm^2. There is a reduction of sightings to 4.2%, west of Cayo Levantado and in the shallow southern reef areas and simultaneously, an increase in sightings to 4%, outside the bay in adjacent oceanic waters.

During the second half of March, sightings are influenced by the departure of whales and the distribution pattern is similar to that found in January. Almost all sightings, 91.1% take place inside the bay however there is an eastward shift towards the bay mouth, with a maximum of 28 sightings /nm^2. West of Cayo Levantado and south in shallow reef areas, sightings are comparatively reduced to 3.7%, while sightings in oceanic waters outside the bay increase to 5.2%. The distribution characteristics presented here for the last fifteen days of March document for the first time the final stage of the whale watch season, as earlier investigations only made observations until the 16th of March (Mattila *et al.*, 1994).

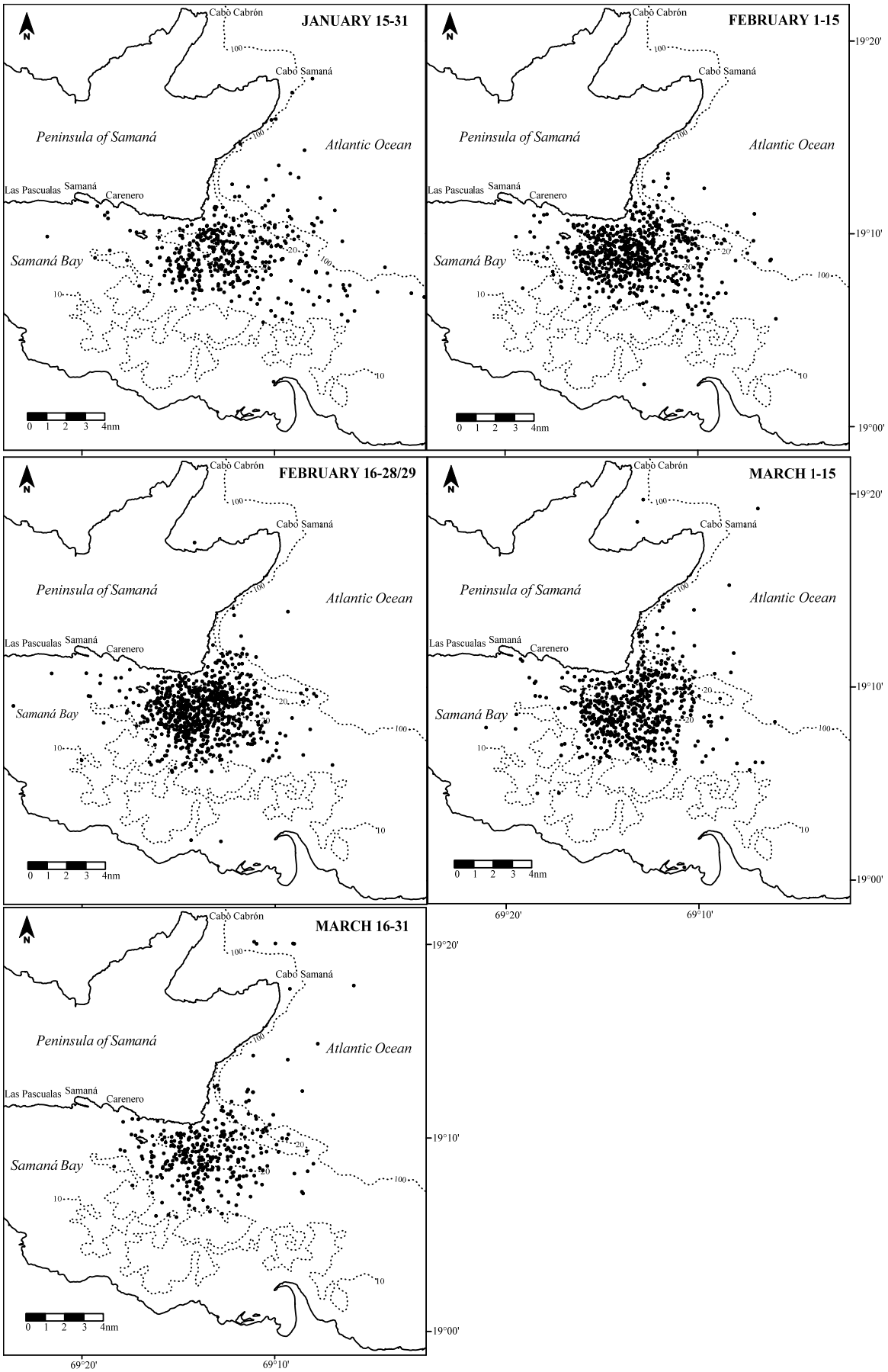

Figure 3. Biweekly distribution of humpback whale sightings in the eastern region of Samaná Bay, Dominican Republic, from January to March, 1999 to 2011.

Although the distribution pattern for the second half of March is similar to January, they differ slightly in the percentages of sightings outside the bay. In January, the sightings outside the bay at depths greater than 100m reach 7.2%, while in late March sightings are slightly reduced to 5.2%. This may suggest that in January, at the beginning of the whale watch season, vessels have sold excursions anticipating the arrival of whales and must make an extra effort to find whales during a period of less abundance, while at the end of the whale watch season in March, vessels are more concerned with finishing the whale watch season with minimal cost and effort.

Relation with depth

Mothers and calves were most frequently sighted in the 0-10m (8%) and the 10-20m (63.8%) depth intervals, with an average depth of 19.8m (Fig. 4). These depth intervals correspond with the shallow areas east of Cayo Levantado along the north coast of Samaná Bay and southwards across the bay towards the reef and shoal areas in the vicinity of Bocaina and Culebra Keys. Mothers, calves and escorts also showed elevated sighting rates in the 0-10m (5.8%) and the 10-20m (60.3%) depth intervals. This grouping had a slight increase in sighting frequency in the 20-30m depth interval (19.6%), in comparison to mothers and calves alone (17.4%), with an average depth of 22.1m.

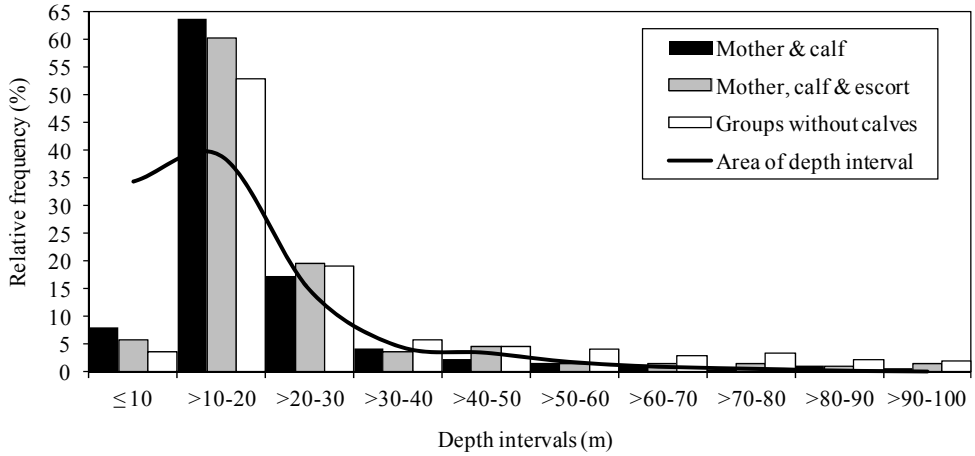

Figure 4. Percentage by depth interval of groups with and without calves in Samaná Bay, 1999 to 2011. For comparison, the percentage of the total area by depth interval is also given.

In the rest of the groups without calves (singletons, pairs, trios and competitive groups) frequencies in the 0-10m (3.6%) and 10-20m (52.9%) depth intervals are comparatively lower and average depths are relatively higher, between 26.2m and 27.8m. This group showed higher frequencies in depths below 40m, coinciding with the submarine depression designated as the Whale Trench. Data suggests spatial distribution differences among groups of whales based on depth, but they are greatly influenced by the bathymetric features of the whale watch area inside the bay, where the 0-10m and 10-20m depth intervals occupy surface areas of 34.4% and 38.9%, respectively.

Distribution by depth is a function of social organization, with mothers and calves showing a strong preference for shallower water compared to all other group types (Ersts and Rosenbaum, 2003). Humpback whale mother-calf pairs have been found to prefer shallower areas in their breeding grounds in Hawaii (Smultea, 1994), Brazil (Martins *et al.,* 2001), Puerto Rico (Sanders *et al.,* 2005), Ecuador (Felix and Botero-Acosta, 2011) and Peru (Santillan, 2011). Maternal females may use shallower water to avoid harassment and injury to calves by sexually active males, turbulent offshore or deep sea conditions and predators (Smultea, 1994).

Management implications

Samaná Bay is not only a significant breeding ground and nursery area for humpback whales from all over the North Atlantic but the most important multi-species fishing ground in the Dominican Republic, a growing international tourist destination and commercial port.

Several types of year round and seasonal fisheries take place in the eastern part of the Samaná Bay. Artisanal reef fisheries are practiced in the vicinity of Cayo Levantado and in the shallow areas of Barco Perdido and Media Luna Shoals, where encounters with mother and calf pairs are frequent. Deep water demersal fisheries are flourishing on the eastern drop off, in depths of 100 to 500m, while pelagic fisheries occur in the adjacent

oceanic waters, including a recently developed market for Diamondback squid off El Francés (Herrera-Moreno *et al.,* 2011). These oceanic areas are important transitory passages for humpback whales entering and leaving the area throughout the breeding season.

Samaná has experienced an expansion and diversification of the tourism industry in the last 20 years. Tourism based marine traffic has surpassed commercial marine traffic in the port of Samaná. The Whale Trench is part of the only deep water channel entering Samaná Bay and during the winter reproductive season, is traversed by hundreds of private yachts, recreational and sailing vessels, cargo and cruise ships. Data suggests that this area is important to social groupings without calves that tend to utilize depths of greater than 40 m. Cruise ships anchor just west of Cayo Levantado, in the area where all sightings for the last twelve years have been, almost exclusively, mothers and calves. Most of the whale watch sightings (50%) from runabouts or "yolas" occur in depths less than 10m and involve mothers and calves, occasionally accompanied by escorts, resulting in repeated and frequent levels of contact with human activity.

The above makes it clear that the management of an area with diverse usage and intense overlap of activities like Samaná Bay requires an adequate knowledge of the spatial and temporal distribution of its marine resources. This information is the foundation on which stakeholders make informed and coordinated decisions about sustainable use that enables the implementation of effective conservation strategies. In this sense, the information resulting from the collection of data onboard whale watch vessels has played an important role in the Marine Spatial Planning of Samaná Bay. Recently, the eastern region of the Bay, along with part of the adjacent oceanic waters, was designated as a Conservation Zone, with restricted use of passive fishing gear (long line, gill net, entangle nets and trammel nets) from January to March during the whale season. Whale watch regulations have been established in the area using a co-management model with the involvement of all local stakeholders and various government ministries that legally govern the resource. Additional measures were taken with "yolas" from the Port of Carenero. Special regulations are under consideration for transient marine traffic and cruise ships. From April to December the whale watch area is compatible with all other tourism or fishing activities permitted by the laws that govern Marine Protected Areas in the Dominican Republic.

We are witnessing a social and cultural benefit with the participation of increasing numbers of young people, local students, national and international researchers and volunteers, along with community organizations and commercial companies in the Monitoring Program of Humpback Whales each winter. This kind of community collaboration creates knowledge and unifies effort, which results in a direct scientific benefit: the opportunity to draw conclusions from data and use it to answer multiple questions about whale conservation today and in the future.

REFERENCES

AGROFORSA, 2012. Estudio del conocimiento, percepción, actitud y aportes económicos de seis áreas protegidas seleccionadas de la Bahía de Samaná y su entorno. Report to The Nature Conservancy (TNC) and the United States Agency for International Development (USAID), 112 pp.

Balcomb, K.C. and Nichols G. 1982. Humpback whale censuses in the West Indies. *Rep. int. Whal. Commn*. 32: 401-406.

Betancourt, L. and Herrera-Moreno A. 2007. *Datos sobre las ballenas jorobadas Megaptera novaengliae de la Bahía de Samaná*. Programa EcoMar (ed.), Punto Mágico Press, Santo Domingo, Dominican Republic, 56 pp.

Clapham, P.J., Palsbøll, P.J., Mattila, D.K. and Vasquez O. 1992. Composition and dynamics of humpback whale competitive groups in the West Indies. *Behaviour* 122 (3-4): 182-194.

Clapham, P.J., Mattila, D.K. and Palsbøll, P.J. 1993. High-latitude-area composition of humpback whale competitive groups in Samana Bay: further evidence for panmixis in the North Atlantic population. *Can. J. Zool.*, 71: 1065-1066.

Ersts, P. and Rosenbaum, H.C. 2003. Habitat preference reflects social organization of humpback whales (*Megaptera novaeangliae*) on a wintering ground. *J. Zool.*, 260: 337-345.

Felix, F. and Botero-Acosta, N. 2011. Distribution and behaviour of humpback whale mother–calf pairs during the breeding season off Ecuador. *Mar. Ecol. Prog. Ser*., 426: 277-287

Herrera-Moreno, A. 2005. *Historical synthesis of biophysical information of Samaná region, Dominican Republic*. Coastal Resources Center, Universidad de Rhode Island, Narragansett, RI USA, 48 pp.

Herrera-Moreno, A., Betancourt, L., Silva, M., Lamelas, P. and Melo, A. 2011. Coastal Fisheries of the Dominican Republic. pp. 175-217. *In*: S. Salas, R. Chuenpagdee, A. Charles & J.C. Seijo (eds.). *Coastal Fisheries of Latin America and the Caribbean.* FAO Fisheries Technical Paper No. 544. Rome, FAO. 544 pp.

Hoyt, E. 1999. The Potential of WhaleWatching in the Caribbean: 1999+. Whale and Dolphin Conservation Society, Bath, UK, pp. 1-80.

Katona, S.K. and Beard, J.A. 1990. Population size, migrations and feeding aggregations of the Humpback Whale, *Megaptera novaeangliae*, in the western North Atlantic Ocean. *Rep. Int. Whal. Comm*. 12: 295-305.

Martins, C.C.A., Morete, M.E., Engel, M.H., Freitas, A.C., Secchi, E.R. and Kinas P.G. 2001. Aspects of habitat use patterns of humpback whales in the Abrolhos Bank, Brazil breeding ground. *Memoirs of the Queensland Museum* 47(2): 83-90.

Mattila, D.K., Clapham, P.J., Katona, S.K. and Stone, G.S 1989. Population composition of humpback whales on Silver Bank. *Can. J. Zool*., 67: 281-285.

Mattila, D.K., Clapham, P.J., Vasquez, O. and Bowman, R.S. 1994. Occurrence, population composition, and habitat use of humback whales in Samana Bay, Dominican Republic. *Can. J. Zool*., 72: 1898-1907.

Mercado, A.I. and Justiniano H. 2000. Digitization of nautical charts and smooth sheets for Dominican Republic, Island of Hispaniola, Caribbean Sea. Sea Grant College Program, University of Puerto Rico, 117 pp.

Sanders, I.M., Barrios-Santiago J.C. and Appeldoorn R.S. 2005. Distribution and relative abundance of humpback whales off western Puerto Rico during 1995-1997. *Carib. J. Sci*., 41 (1): 101-107.

Santillan, L. 2011. Records of humpback whales (*Megaptera novaeangliae*) in Sechura Bay, Peru, in spring 2009-2010. *Journal of Marine Animals and Their Ecology*, 4(1): 29-35.

Smultea, M.A. 1994. Segregation by humpback whale (*Megaptera novaeangliae*) cows with a calf in costal habitat new the island of Hawaii. *Can. J. Zool*. 72: 805–811.

Swartz, S. L., Cole, T., McDonald, M.A., Hildebrand, J.A., Oleson, E.M., Martinez, A., Clapham, P.J., Barlow, J. and Jones, M.L. 2003. Acoustic and visual survey of humpback whale (*Megaptera novaeangliae*) distribution in the eastern and southeastern Caribbean Sea. Caribbean Sea. *Carib. J. Sci*., 39 (2): 195–208.

Whitehead, H. and Moore, M. 1982. Distribution and movements of West Indian humpback whales in winter. *Can. J. Zool*., 60: 2203–2211.