A note on the spatial and temporal distribution of humpback whales (*Megaptera novaeangliae*) off Venezuela, Southeastern Caribbean

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ABSTRACT

This paper presents information on the spatial and temporal distribution of humpback whales in Venezuelan waters. Using a relational database containing information from the museums of Venezuela, published and unpublished records were incorporated into a Geographical Information System (*MapInfo Professional 7.0*). A total of 53 records were gathered, of which sightings made up 72%, followed by acoustic sampling (9%) intentional capture (6%), stranding (6%) and unknown records (8%). Humpback whales were mainly sighted over the continental shelf of the northeastern region in shallow waters of 0-100m in depth. The date on which each record was made supports the seasonal occurrence of North Atlantic humpback whales off the Venezuelan coast. Opportunistic sightings and stranding records from the austral winter months do not give conclusive proof that Southern Hemisphere humpback whales are present during this time, but lead to the hypothesis that whales migrate from Brazil. Systematic research effort (especially photo-identification) is recommended in order to better understand humpback whale movements, distribution and identity.

KEYWORDS: HUMPBACK WHALE; ATLANTIC OCEAN; SOUTH AMERICA; DISTRIBUTION; WHALING-HISTORICAL; NORTHERN HEMISPHERE; CARRIBEAN SEA; MOVEMENTS

INTRODUCTION

The humpback whale (*Megaptera novaeangliae*), has been one of the most intensively studied of the mysticete whales. Its preference for nearshore habitats, its tendency to concentrate on migratory routes and the ease with which individuals can be identified from natural markings, have resulted in numerous field studies over the last two decades (e.g. Clapham, 2000).

In the North Atlantic Ocean, humpback whales feed in the Gulf of Maine, eastern coast of Canada (Newfoundland, Labrador, Gulf of St. Lawrence and Baffin Island) and western coasts of Greenland, Iceland and Norway (Clapham, 2000; Martin *et al*., 1984; Payne *et al*., 1986; Perry *et al*., 1999). In winter they can be found in the northeastern Caribbean Sea, mainly in Dominican Republic (Mattila *et al*., 1994), Puerto Rico and Virgin Islands (Mattila and Clapham, 1989; Mignucci-Giannoni, 1998; Whitehead and Moore, 1982), and appear to be less abundant in the Antillean arch (Mattila *et al*., 1994).

In the Southeastern Caribbean region, humpback whales have been reported off Venezuela (Acevedo, 2007; Acevedo *et al*., 2007; Bolaños and Boher, 1996; Levenson and Leapley, 1978; Naveira, 1996; Naveira and Díaz, 1996; Silva *et al*., 2006; Winn *et al*., 1975). Acevedo (2001) reported it to be the second most common baleen whale species in these waters after the Bryde's whale (*Balaenoptera edeni*). Sporadic surveys and local reports suggest that the area was once an important region of humpback whaling (Mattila *et al*., 1994).

In the 19th century, humpback whales were sufficiently abundant throughout the Lesser Antilles, off the coast of Trinidad and along the Caribbean coast of Venezuela, specifically at Dragon's mouth, to support both shoreline and ship-based whaling (Reeves *et al*., 2001a; Reeves *et al*., 2001b). However, recent studies suggest that the abundance of humpback whales in the eastern and southeastern Caribbean Sea is lower than previously thought (Swartz *et al*., 2003). It is unknown if some humpback whales from the Southern Hemisphere migrate to the Caribbean in the austral winter. The highly seasonal operation of the whaling station off Trinidad during boreal winter months (January to April) along with the winter visiting of American whalers, precludes the consideration of historical records of the occurrence of Southern Hemisphere humpback whales (Reeves *et al*., 2001a).

In order to obtain more information on the spatial and temporal occurrences of humpback whales off the Venezuelan coast, a relational database was used which included information contained within Venezuelan scientific museums, published and unpublished records; all were incorporated into a Geographical Information System database.

MATERIALS AND METHODS

Study area

Venezuela is in northern South America. It represents a considerable proportion of the south and southeastern margin of the Caribbean Sea, as well as being an important extension of the coastal areas in the Equatorial Atlantic Ocean, embracing approximately 760,000km^2 of territorial waters (Fig. 1).

Along the Venezuelan Caribbean coast there are upwelling focal areas. However, there is a spatial gradient in their intensity (decreasing from east to west) plus a coastal influence, particularly with regards to nutrients in the waters of the Orinoco discharge during the rainy season (austral spring and summer).

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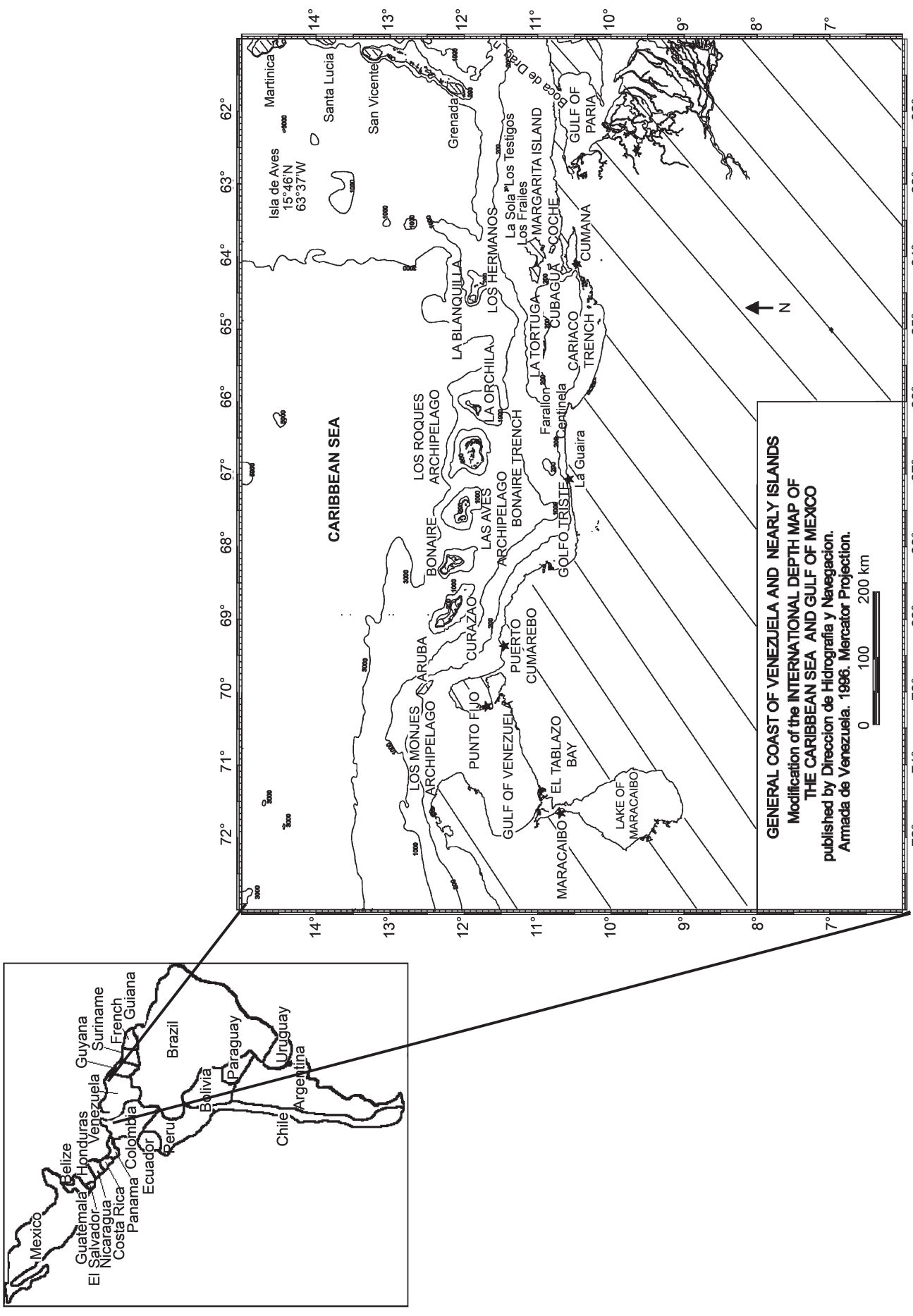

Fig. 1. The study area (modified from (Dirección de Hidrografía y Navegación (DHN), 1996; Travel Notes, 2007).

In relation to topography, the Venezuelan coast can be divided into three main regions: (1) relatively shallow (e.g. Gulf of Paria, internal margin of the Gulf of Venezuela, and the Lake of Maracaibo), characterised by regular bottoms, soft slopes and depths between 20m and 30m; (2) deep with a narrow continental shelf close to shore, typical of the central coast, where the habitat has oceanic like features; and (3) variable depths and high topographical complexity, corresponding to the Northeastern region of Venezuela (Acevedo, 2001).

Records of humpback whales in Venezuela

Data were obtained from published and unpublished records for the period 1853 to 2006. These were collected through Museum visits (Museo de Historia Natural La Salle, Museo de Ciencias Naturales de Caracas, Museo de Biología de la Universidad Central de Venezuela, Museo de Ciencias Naturales de la Universidad Simón Bolívar, Museo de la Estación Biológica Rancho Grande, Museo del Instituto de Zoología Agrícola, Universidad Central de Venezuela, Museo de Biología de la Universidad del Zulia, Museo Oceanológico Hermano Benigno Román and Museo Marino de Margarita), interviews with other cetacean researchers and sightings obtained from opportunistic or systematic surveys involving trained marine mammals observers.

Records without geographical coordinates were referenced through maps and charts from *Dirección de Hidrografía y Navegación* [the local Naval authority] (Dirección de Hidrografía y Navegación (DHN), 1996). All records were filed in a *MapInfo Professional 7.0* Geographical Information System database. Sightings were marked on the chart and depth was recorded as either the nearest known point on the chart with a value or the value of the isobath line. A depth average was used if several values marked on the chart were equidistant.

RESULTS

Seasonal distribution

A total of 53 records of humpback whales along the Venezuelan coast were compiled (Table 1). Sightings corresponded to 72% of the records, followed by acoustic detections (9%), intentional captures (6%), strandings (6%) and unknown records (8%). No humpback whale specimens were found in Venezuelan museums.

The monthly distribution (Table 2) shows that humpback whales have been reported throughout the year, with the highest frequency in March (6 records) and February (5 records), followed by January and April (4), June, September and October (3), May and December (2) and finally July, August and November (1).

Geographical distribution

Geographical distribution of the humpback whale records (Fig. 2) indicates a preference for the continental shelf (within the 200m isobath) of the northeastern region in areas adjacent to the Cariaco Trench, north of Margarita Island and Río Caribe. Whales were most frequently observed in depths ranging from 0-50m (39.63%) and 51-100m (22.64%). Only 9.43% of the records occurred in waters deeper than 200m. Swartz *et al*. (2003), Silva *et al*. (2006) and researchers of CIC (Centro de Investigación de Cetáceos) report mother-calf groups closer inshore, specifically in Los Frailes Archipelago, near Margarita Island (March 2000 and 2001), which has a depth of less than 38m. It is likely that females with calves prefer this area because it offers the conditions necessary for breeding and calving: warm waters protected from heavy sea action and low bathymetry.

DISCUSSION

Seasonal distribution

The monthly distribution of records off the coast of Venezuela shows that humpback whales occur in the region year-round, but the peak of abundance occurs during the boreal winter. This seasonal pattern is consistent with that of North Atlantic humpback whales in their known wintering grounds in the Caribbean (Mattila and Clapham, 1989; Mattila *et al*., 1994; Mignucci-Giannoni, 1998; Whitehead and Moore, 1982).

Historical whaling and recent sighting data also support the theory that the Caribbean coast of Venezuela corresponds to a wintering ground for North Atlantic humpback whales. Data extracted from 19th century American whaling logbooks indicate that humpback whales were hunted in the eastern and southeastern Caribbean, specifically in Guadeloupe, coast of Trinidad (Gulf of Paria) and westwards along the Venezuelan coast (Reeves *et al*., 2001b). Almost all whaling activities occurred during the boreal winter (Reeves *et al*., 2001b). A similar seasonal pattern is seen for whaling grounds near the islands off Trinidad (Reeves *et al*., 2001a). More recent studies conducted in the Eastern and Southeastern Caribbean Sea have also detected humpback whales during the winter (Levenson and Leapley, 1978; Silva *et al*., 2006; Swartz *et al*., 2003; Winn *et al*., 1975).

The existence of a few records during the austral winter may indicate that whales from the Southern Hemisphere, most likely Brazil, may venture into Venezuelan waters. Some of the records observed in this study (e.g. August-October) correspond with the peak of abundance of whales in the Abrolhos Bank, Brazil (Martins *et al*., 2001). However, at present there is little support for this hypothesis because historical whaling did not occur in Venezuela during the austral winter and existing data are too sparse to reach further conclusions. Additional studies need to be conducted to verify if individuals observed during July-November correspond to whales coming from Southern Hemisphere populations.

Geographic distribution

The distribution of humpback whales in Venezuelan wintering grounds seems to exhibit the same general pattern reported elsewhere (Acevedo *et al*., 2007; Felix and Haase, 2005; Frantzis *et al*., 2004), i.e. whales concentrate on or along the edges of shallow banks and islands (e.g. La Tortuga bank), in areas shallower than 200m in depth. Few observations have been made in deeper waters. In the southern Pacific coast of Ecuador, humpback whales are rarely seen offshore in the breeding season, seeking depths of less than 60m, while a cold equatorial front pushes calving whales to the coast (Felix and Haase, 2005).

Mother and calf groups were observed in March (2000 and 2001) close to shore, specifically in the Los Frailes Archipelago, near Margarita Island. This area presumably offers the conditions necessary for breeding and calving, i.e. warm, protected and shallow waters. The inshore distribution of mothers and calves has been observed in a number of other humpback whale wintering grounds, including Puerto Rico (Mignucci-Giannoni, 1998), Silver Bank and Hawaii (Mattila and Clapham, 1989), central Ecuador (Félix and Haase, 2001), South Africa (Findlay *et al*., 1994) and Brazil (Zerbini *et al*., 2004).

Table 1

Humpback whales records in Venezuela, southeastern Caribbean.

Record	Locality	Latitude/longitude	Data collected or observed	Number of whales	Record classification	Source	Observations
1	Venezuela		XIX century	>1	Intentional capture	Townsend (1935); cited by Romero *et al.* (2001)	-
2	Venezuela		Jan.-Apr. 1853	>1	Intentional capture	Logbook bark *Solon* (Romero *et al.* 2001)	-
3	Venezuela		1853	2 or more	Intentional capture	Logbook brig *September* (Romero *et al.* 2001)	-
4	Off Cumaná	10°29'N; 64°15'W	Dec. 1870-Apr. 1871	4	Unknown	Logbook of the *Thriver* (Romero *et al.* 2001)	-
5	Venezuela		1954	>1	Stranding	Anduze (1954); cited by Romero *et al.* (2001)	-
6	Between Carenero and Buche, Miranda state	10°31'N; 66°06'W	1960	1	Unknown	Romero *et al.* (2001)	-
7	40 miles to the northwest, between Araya Peninsula and La Tortuga Island	10°40'360''N; 64°40'360''W	Jan. 1989		Sighting	Naveira (1996)	-
8	La Tortuga. Federal Dependences	10°51'N; 65°18'W	Feb. 1989	1	Sighting	Personal observation of I. Agudo (cited by Romero *et al.* 2001)	-
9	80 miles to Margarita north	11°50'N; 63°50'480''W	Aug. 1989		Sighting	Naveira (1996)	-
10	Between Morro de Puerto Santo and Los Testigos	11°00'N; 63°07'W	Sep. 1989	2	Sighting	Personal observation of I. Agudo (cited by Romero *et al.* 2001)	-
11	Los Testigos. Federal Dependences	11°25'N; 63°05'W	Oct. 1989	1	Sighting	Personal observation of I. Agudo (cited by Romero *et al.* 2001)	-
12	Isla de Aves. Federal Dependences	15°46'N; 63°37'W	Mar. 1990	> 1	Sighting	Personal observation of G. Solé (cited by Romero *et al.* 2001)	-
13	Between Puerto La Cruz and Isla Chimanas	10°16'N; 64°38'W	Apr. 1990	1	Unknown	Revista Producto (1990); cited by Romero *et al.* (2001)	-
14	Playa La Salina, 150m from Puerto Carayaca. Vargas state	10°34'57''N; 67°05'00''W	18 May 1990	1	Stranding	Boher and García (1990)	Male juvenile; length 6.3m
15	10 miles to north of Río Caribe	10°50'194.11''N; 63°05'88.23''W	Oct. 1990	-	Sighting	Naveira (1996)	-
16	5 miles to the west of the Cubagua Island	10°45'247.05''N; 64°15'229.41''W	Sep. 1992	2	Sighting	Naveira (1996)	-
17	Between Píritu and La Tortuga islands	10°20'N; 65°04'W	Jun. 1993	-	Sighting	Naveira (1996)	-
18	Gulf of Santa Fé; near Mochima National Park	10°17'30''N; 64°25'14.01"W	Sep. 1993	1	Sighting	Naveira (1996)	Juvenile; length 10m
19	Gulf of Cariaco. Sucre state	10°30'N; 64°00'00''W	Jun. 1994	1	Sighting	Naveira (1996)	-
20	Puerto Nuevo. Municipio Autónomo Ribero. Sucre state	10°30'N; 63°43'W	10 Oct. 1994	1	Stranding	Naveira and Díaz (1996)	Male; length 9.60m Museo del Mar de Cumaná (UDOMM-0020)
21	Farallón Centinela	10°46'N; 66°04'15''W	Feb. 1995	1	Sighting	Luis Bermúdez-Villapol (personal observation)	Sighting 30mins, after the whale went to Cariaco Trench
22	Off Margarita Island. Near Los Frailes	11°10'N; 63°48'W	17 Mar. 2000	3	Sighting	Swartz *et al.* (2003)	Includes a female-calf pair
23	Isla Las Aves. Federal Dependences	-	11-18 Mar. 2000	2	Acoustic sampling	Swartz *et al.* (2003)	-
24	Isletas de Píritu. Anzoátegui State	-	11-18 Mar. 2000	2	Acoustic sampling	Swartz *et al.* (2003)	-
25	Margarita Island. Nueva Esparta State	-	11-18 Mar. 2000	4	Acoustic sampling	Swartz *et al.* (2003)	-
26	Golfo de Cariaco. Sucre state	-	11-18 Mar. 2000	2	Acoustic sampling	Swartz *et al.* (2003)	-
27	Boca de Dragón. Between Trinidad and Venezuela	-	11-18 Mar. 2000	4	Acoustic sampling	Swartz *et al.* (2003)	-
28	Los Frailes. Federal Dependences	11°10'35''N; 63°43'W	2 Mar. 2000	1	Sighting	CIC database	-
29	Los Frailes. Federal Dependences	11°10'30''N; 63°46'W	10 Mar. 2001	1	Sighting	CIC database	-
30	Los Frailes. Federal Dependences	11°11'20''N; 63°46'30''W	12 Mar. 2001	2	Sighting	CIC database	Adult-calf
31	Los Frailes. Federal Dependences	11°11'20''N; 63°45'30''W	23 Mar. 2001	2	Sighting	CIC database	Adult-calf
32	Golfo de Paria	-	-	-	Unknown	Mattila *et al.* (1994); Mattila and Clapham (1989); Whitehead and Moore (1982)	-

Cont.

Table 1 cont.

Record	Locality	Latitude/ longitude	Data collected or observed	Number of whales	Record classification	Source	Observations
33	Margarita - Los Testigos submarine platform	11°14'N; 64°23'W	09 Feb. 2002	2	Sighting	Silva *et al*. (2006)	Time: 6:48am
34	Margarita - Los Testigos submarine platform	11°13'N; 64°30'W	01 Mar. 2002	3	Sighting	Silva *et al*. (2006)	Time: 9:27am
35	Margarita - Los Testigos submarine platform	11°12'N; 64°40'W	02 Mar. 2002	1	Sighting	Silva *et al*. (2006)	4:25pm. Behaviour: travelling, breaching
36	Northwest of Isletas de Píritu	10°14' 24.7''N 65°07' 44.7''W	03 Mar. 2002	4	Sighting	Silva *et al*. (2006)	-
37	Northwest of Isletas de Píritu	10°15' 17.5''N 65°05' 21.8''W	03 Mar. 2002	2	Sighting	Silva *et al*. (2006)	-
38	Margarita - Los Testigos submarine platform	11°19'N; 64°19'W	07 Mar. 2002	1	Sighting	Silva *et al*. (2006)	11:00am. Behaviour: travelling, breaching
39	Margarita - Los Testigos submarine platform	11°30'N; 63°57'W	10 Mar. 2002	1	Sighting	Silva *et al*. (2006)	11:00am. Behaviour: travelling, breaching
40	Margarita - Los Testigos submarine platform	11°20'200''N; 63°48'50''W	15 Mar. 2002	3	Sighting	CIC database	8:45am. Behaviour: travelling, breaching, side roll
41	Araya west		21 Mar. 2002	1	Sighting	CIC database	9:20-9:27 am. Behaviour: travelling to SSE coast. Adult
42	Araya southwest		21 Mar. 2002	1	Sighting	CIC database	10:12-10:18am. Behaviour: travelling to the coast. Adult. Photograph
43	Margarita - Los Testigos submarine platform	11°16'15''N; 64°16' 58.5''W	29 Mar. 2002	2	Sighting	CIC database	-
44	Margarita - Los Testigos submarine platform	11°15'34.3''N; 64°22' 47.3''W	03 Apr. 2002	2	Sighting	CIC database	-
45	Margarita - Los Testigos submarine platform	11°21'45.4''N; 64°13'24.8''W	03 Apr. 2002	2	Sighting	CIC database	-
46	La Pecha. Los Frailes. Federal Dependences	11º11,360'N; 63º46,333'W	4 Nov. 2004	3	Sighting	CIC database	-
47	Puerto Real. Los Frailes. Federal Dependences	11º11,00'N; 63º44,083'W	4 Nov. 2004	1	Sighting	CIC database	-
48	Margarita-Puerto La Cruz	10º39,247'N; 64º20,167'W	2 Jun. 2005	1	Sighting	CIC database	-
49	Margarita-Puerto La Cruz	10º 21,035'N; 64º31,812'W	7 Jul. 2005	1	Sighting	CIC database	-
50	Margarita-Puerto La Cruz	10º19,911'N; 64º 30,523'W	7 Jul. 2005	2	Sighting	CIC database	-
51	Between Araya Peninsula and Cubagua Island	10°44,313'N; 64°18,375'W	2 Dec. 2005	2	Sighting	CIC database	-
52	5,67 miles off Punta Brasil, between Margarita and Puerto La Cruz	10°45,348'N; 64°16,807'W	2 Dec. 2005	2	Sighting	CIC database	-
53	Margarita-Puerto La Cruz	10°16,569'N; 64°35,292'W	16 Jan. 2006	1	Sighting	CIC database	The whale jumped twice

Table 2

Historical records of humpback whales (the number represents the year of record, independently of the number of whales reported).

	Month											
Years with records of humpback whales	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
	1853	1853	1853	1853	1990	1993	2005	1989	1989	1989	2004	1870
	1871	1871	1871	1871	2005	1994			1992	1990		2005
	1989	1989	1990	1990		2005			1993	1994		
	2006	1995	2000	2002								
		2002	2001									
			2002									
Total	4	5	6	4	2	3	1	1	3	3	1	2

Swartz *et al*. (2003) considered that observations of mother and calf groups suggested that the Lesser Antilles and the Caribbean coast of Venezuela continue to serve as nursing, mating, and possibly calving grounds for humpback whales today. However, the development of oil and gas production facilities and commercial shipping traffic could change the habitats conditions and thus their suitability for humpback whale reproduction. According to Oviedo (2005), humpback whales show a high vulnerability to any coastal development in the northeast coast of Venezuela, due to their high association with sheltered neritic habitats.

The unsystematic nature of available data and limited observation effort along the coast of Venezuela at present are issues that should be addressed in order to provide clarification on spatial and temporal distribution of

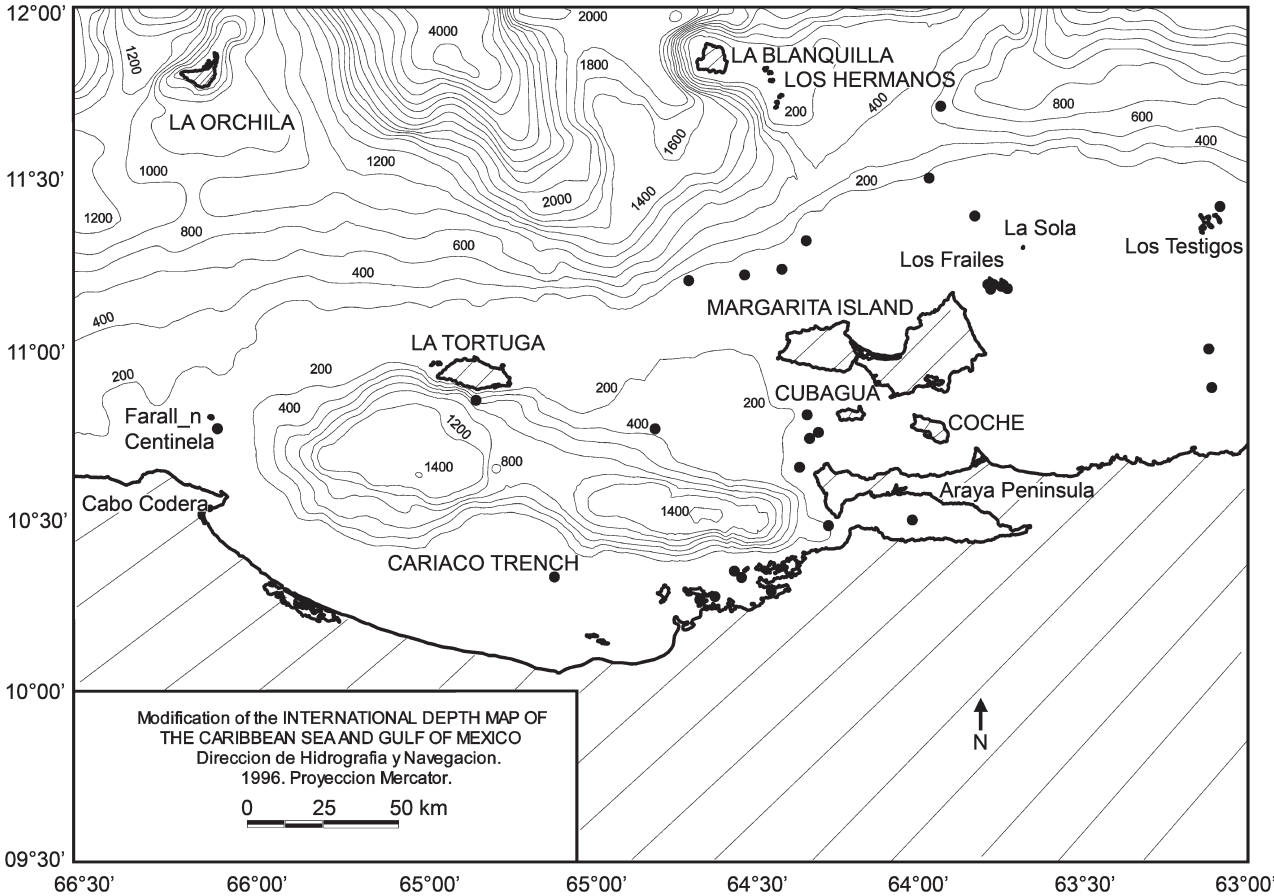

Fig. 2. Distribution of humpback whales off the northeastern region of Venezuela. Dots represent sighting behaviour.

humpback whales in this area. Therefore, future studies such as photo-identification, biopsy sampling for genetics and telemetry, among others, are strongly suggested in order to provide a solid basis for better understanding humpback whale movements, distribution and stock identity, and for any conservation and management actions that may be required in Venezuelan waters.

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