A note on humpback whales off the coast of Ecuador during the 1997 'El Niño' event

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ABSTRACT

The southeastern Pacific humpback whale stock was studied for seven years (1991-1997) on the central coast of Ecuador (1°25'S, 79°55'W) during the breeding season (June-September). Boat trips were conducted from two different sites, Puerto López and Puerto Cayo, following well-defined routes offshore. In 1997, a strong El Niño affected the eastern Pacific area. In order to try and investigate possible climate-induced shifts, results obtained from 1996, a 'normal' year, were compared with those obtained in 1997, when water temperature was 4°C above its historical mean. Four factors were considered: whale encounter rate; distribution; group structure; and crude birth rate. The whale encounter rate decreased in 1997 for both sites: 11.2% for Puerto López and 8.7% for Puerto Cayo, although the differences were not statistically significant ($p > 0.05$). Group distribution in relation to water depth was not significantly different ($p > 0.05$), nor were the mean distances from sighting sites to port ($p > 0.05$). Group size was equal in both years for Puerto López, but in Puerto Cayo it was larger in 1997, although not significantly ($p > 0.05$). Group composition was not significantly different ($p > 0.05$). No difference in birth rate was found in Puerto López. Results for Puerto Cayo are difficult to interpret. No changes in the investigated parameters were found in the study area during El Niño 1997. Since humpback whales do not feed in tropical waters, they may not be as vulnerable to El Niño events as other marine mammals.

KEYWORDS: HUMPBACK WHALE; EL NIÑO; MONITORING; SOUTH AMERICA; PACIFIC OCEAN

INTRODUCTION

During the austral winter (June-September), humpback whales (*Megaptera novaeangliae*) inhabit the warm breeding waters of the Ecuadorian and Colombian coasts. These whales belong to the southeastern Pacific humpback whale stock which feeds in the Antarctic (Dawbin, 1966; Leatherwood and Reeves, 1983; IWC, 1999). Annually, these whales may travel more than 16,000km (round trip) along the west coast of South America (Stone *et al.*, 1990).

Between 1991 and 1997 a population study of humpback whales was carried out on the central coast of Ecuador (Félix and Haase, 1996; 1997a; b; 1998). The study area (around 800km^2) is a wide, shallow cove less than 50m deep that extends 42km offshore from Puerto López to La Plata Island (Fig. 1). During the 1997 season, one of the strongest El Niño events occurred in the eastern tropical Pacific (De la Cuadra, 1999). This anomalous ocean-atmospheric phenomenon causes dramatic changes by temporarily exposing the entire marine ecosystem to a cessation in upwelling and resultant increases in sea surface temperature of up to 7°C. This unusual increase is known to produce a dramatic decrease in primary and secondary productivity with severe effects for higher vertebrates such as fishes, birds and marine mammals (Barber and Chavez, 1983).

The effects (if any) of El Niño on the distribution and migration cycle of larger whales in this part of the Pacific is poorly known. Ramírez and Urquizo (1985) reported changes in distribution of some baleen whales (blue, *Balaenoptera musculus;* fin, *B. physalus;* Bryde's, *B. edeni* and humpback whales) and sperm whales (*Physeter macrocephalus*) in the north of Peru during El Niño 1982/83. The authors reviewed the logbooks and observation records from Peruvian whaling vessels between 15 November 1981 and 15 May 1982 and during an El Niño year from 5 November 1982 to 4 May 1983. They found that whale abundance decreased by up to 65% during the El Niño period off northern Peru, and increased from 1.1% to 13.5% south of 8°S in colder waters. They provided little information on humpback whales since the Peruvian whaling season began when most of the whales were returning to the Antarctic; the only relevant logbook record states that at the end of 1982 no whales were sighted as they had been in 1981.

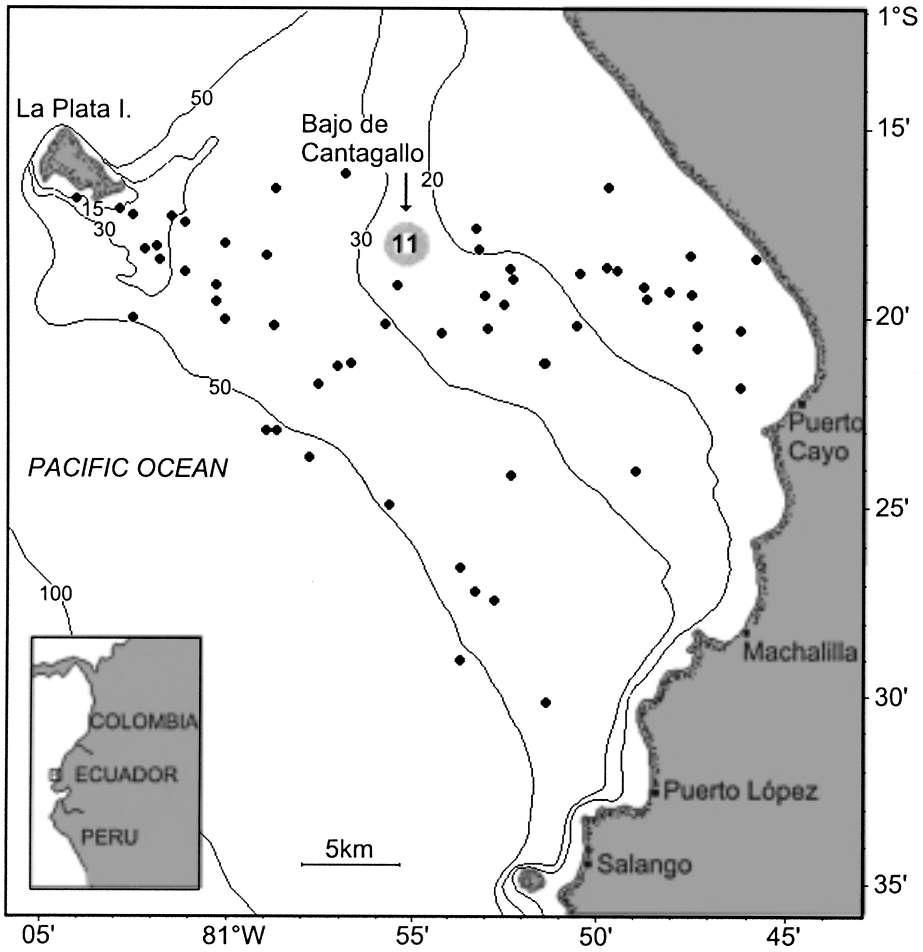
Clarke (1962) also attributed to El Niño the unusual catch of 242 humpbacks in 1925/26 from the bay of Paracas (12°S), central Peru, since in that year the warm waters of the equatorial countercurrent extended exceptionally far to the south along the coast.

This paper uses the results of the final two seasons of the present study in order to see whether they can provide information on any shifts in whale distribution and/or population parameters during the 1997 El Niño event. Possible ecological consequences of El Niño events on humpback whales off Ecuador are also discussed.

METHODS

The research was carried out on board whalewatching boats which departed from two coastal villages 25km apart on the central coast of Ecuador (1°25'S, 79°55'W): Puerto López and Puerto Cayo (Fig. 1). The boats followed two specific routes: (1) Puerto López-La Plata Island-Puerto López (84km) (1991-1997); and (2) Puerto Cayo-Bajo de Cantagallo-Puerto Cayo (38km) (1996-1997). Trips were made during weekends between June and September. At least six different boats were used for this purpose. Boats were similar in capacity (10-20 persons), size (less than 10m length) and height above sea surface (1-2m). Trips lasted between three and eight hours depending on the route and activity.

Once whales were located by eye, they were approached slowly to about 100m. Information on the number of animals, group composition and behaviour was taken. Sightings were positioned using a portable GPS (only in 1996 and 1997). Animals were considered as being part of a group when the whales were within 100m of each other, headed in the same direction and generally exhibited similar behaviour. If more whales were observed nearby (200-3,000m away), they were not considered part of the initial group unless they clearly interacted with it (Félix and Haase, 1998).



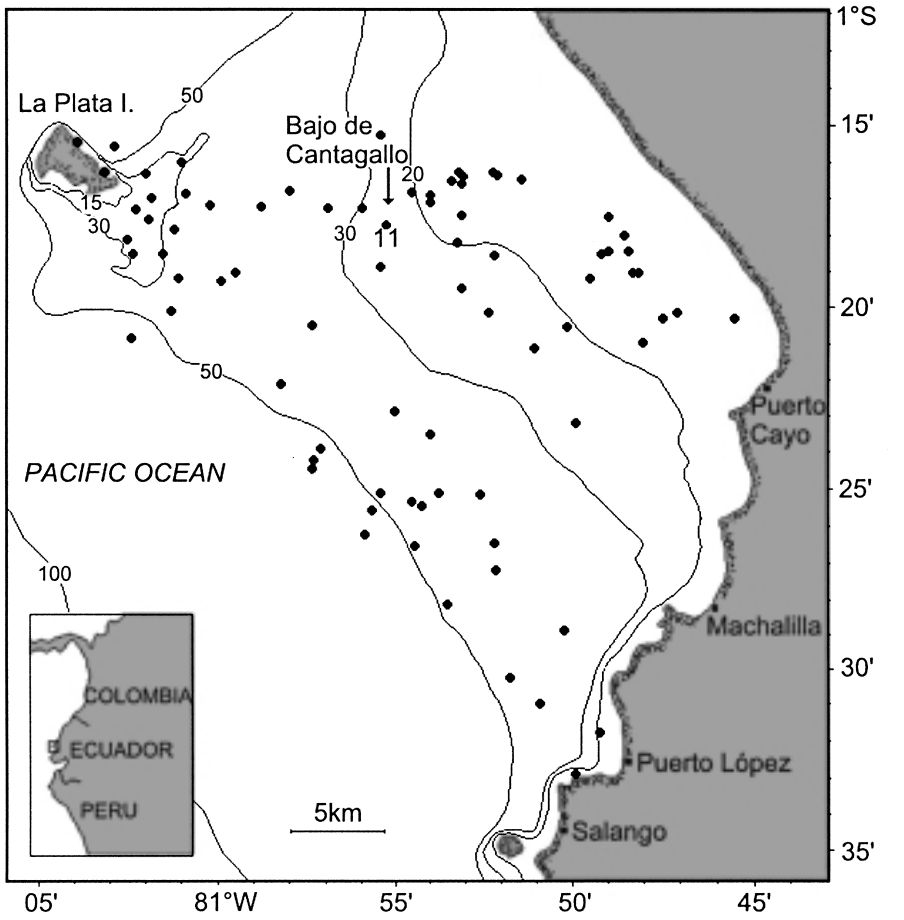


Fig. 1. The study area. Black dots indicate positioned sightings: (a) for 1996 and (b) for 1997. Water depth data (m) was obtained from the navigation chart IOA104 [Instituto Oceanográfico de la Armada del Ecuador (INOCAR)].

When comparing results for 1996 and 1997 (both years together accounted for 71% of the total sighting effort deployed during the seven years of the study), four aspects were specifically evaluated as follows.

Whale encounter rate

Encounter rate was estimated from the total number of whales recorded and the effort carried out by each boat and is expressed as the 'number of whales seen per 100km surveyed'. Data were stratified weekly and then compared for each route. The vessels usually follow very similar routes and thus we believe that use of this encounter rate index reasonably reflects the density of animals in the area.

Whale distribution

Distances in kilometres were compared from the departure port to each GPS-positioned sighting on each route. Straight line distances were obtained directly from the positions recorded by the GPS. Whale distribution in relation to water depth was also analysed. For this purpose, GPS-positioned sightings were stratified by depth and their proportions compared for each route.

Group structure

Group size and age-class composition were analysed for each sighting. Individuals were classified as either: adults (> 10m), subadults (6-10m) and calves (< 6m and always accompanied by a bigger whale, presumed to be the mother). These categories are somewhat subjective and lengths were estimated by eye.

Crude birth rate

The crude birth rate was simply the number of newborn calves relative to the total number of recorded animals. However, due to a lack of effort in September (the peak month, Félix and Haase, 1996) in the more important nursing area of Puerto Cayo (about 60% less in 1997), the value of this index is questionable and the data are provided merely for information.

In addition, temperature data were provided by the Instituto Oceanográfico de la Armada del Ecuador (INOCAR), from its oceanographic station (La Libertad) located 10 miles offshore (2°06'S, 81°03'W).

RESULTS

Effort deployed

Eighty-nine trips were made during the 1996 and 1997 seasons accounting for 323 hours of navigation. A total of 462 whales was recorded in 186 sightings. Tables 1 and 2 provide detailed information of the survey effort for each route and season.

Table 1

Number of trips per month made in each route.

	1996					1997			
Route	May	Jun.	Jul.	Aug.	Sep.	Jun.	Jul.	Aug.	Sep.
Puerto López	0	4	7	10	7	2	8	11	3
Puerto Cayo	1	0	5	8	7	0	6	7	3

Table 2

Number of sightings, whales and navigation time during seasons 1996 and 1997.

	Puerto López		Puerto Cayo	
Item	1996	1997	1996	1997
Total no. sightings	64	50	41	31
Total no. whales sighted	169	134	86	73
Net navigation time (hours)	150.3	75.5	44.7	52.4

Sea surface temperature

Fig. 2 gives the average surface water temperatures during 1997 and the historical mean off Ecuador. On average, water temperature in 1997 was around 4°C above its normal value.

Whale encounter rate

Along the Puerto López-La Plata Island route whales were more abundant during July and August (Fig. 3), whilst along the Puerto Cayo-Bajo de Cantagallo route whales were more abundant in August and September (Fig. 4). On both routes the encounter rate was lower in 1997: by 11.2% for Puerto López, and 8.7% for Puerto Cayo (Table 3). However, the differences were not statistically significant ($\chi^2 = 0.81$, $p > 0.05$ and $\chi^2 = 0.19$, $p > 0.05$, respectively).

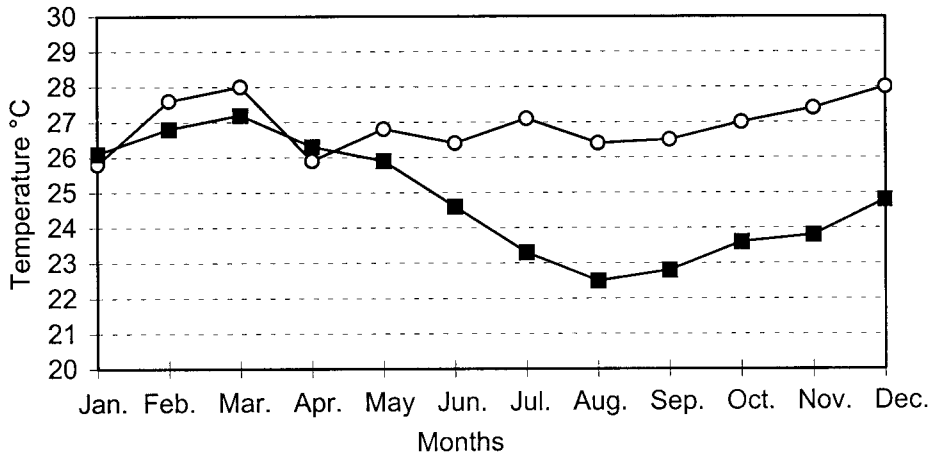


Fig. 2. Mean sea surface temperature during 1997 (circles) and historical average (squares) off Ecuador.

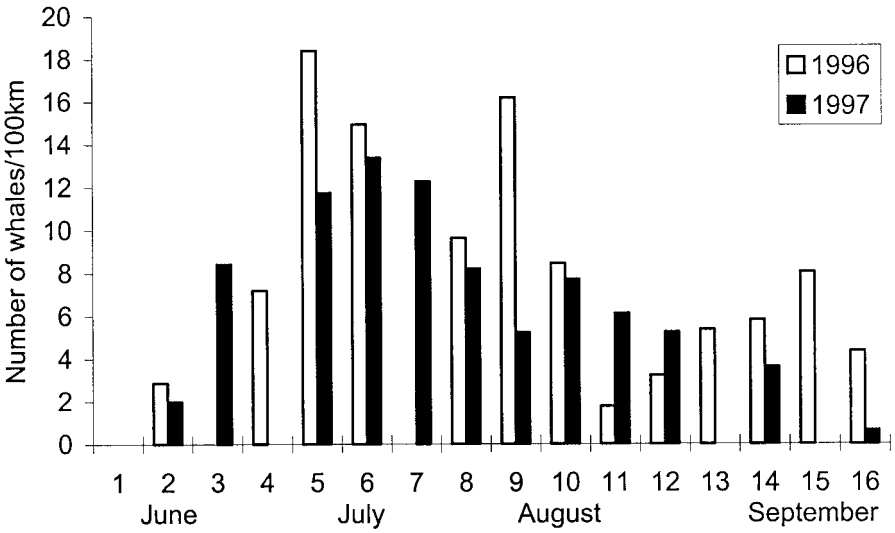


Fig. 3. Whale encounter rate (whales/100km of survey) along the Puerto López-La Plata Island route.

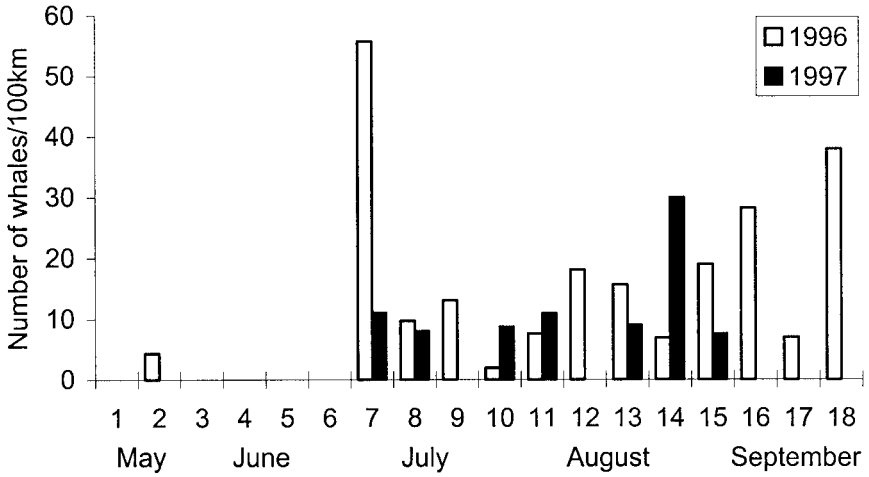


Fig. 4. Whale encounter rate (whales/100km of survey) along the Puerto Cayo-Bajo de Cantagallo route.

Table 3

Values obtained for four parameters evaluated in this study.

	Puerto López		Puerto Cayo	
Item	1996	1997	1996	1997
Average no. whales/100km surveyed	7.1	6.3	10.3	9.4
Mean sighting distance to port (km)	30.5	27.08	12.76	15.26
Group size	2.68	2.68	2.12	2.34
Crude birth rate	0.03	0.03	0.092	0.027

Distribution

Whales were found along both routes, although not uniformly, with some areas having higher concentrations than others (Fig. 1). For example, along the Puerto López route, whales were most common on the east side of La Plata Island within 10km of the coast. Along the Puerto Cayo route, whales were most common between 6 and 10km offshore and at Bajo de Cantagallo (northeastern part), a submarine platform located 19km west Puerto Cayo. Despite this uneven distribution, the mean sighting distances to port along the Puerto López and Puerto Cayo routes were not statistically significant (z-test = 1.38, $p > 0.05$ and t-test = 1.61, df = 40, $p > 0.05$, respectively; Table 3).

Table 4 compares whale distribution with water depth. Along the Puerto López route, most of the groups (48-57%) were recorded in waters 30-50m deep, whilst for Puerto Cayo, 65-68% were seen in waters of 20m or less (see Fig. 1). No significant differences were observed between seasons for Puerto López or Puerto Cayo ($\chi^2 = 1.75$, $p > 0.05$ and $\chi^2 = 0.23$, $p > 0.05$ respectively).

Table 4

Sighting frequency and proportions related to water depth during 1996 and 1997 seasons. Only GPS-positioned sightings were taken into account (n=136).

	Puerto López				Puerto Cayo			
Sighting depth (m)	1996		1997		1996		1997	
	n	%	*n*	%	*n*	%	*n*	%
<20	2	5.7	7	14.0	15	65.2	19	67.9
>20<30	9	25.7	12	24.0	7	30.9	7	25.0
>30<50	20	57.1	24	48.0	1	4.3	2	7.1
>50	4	11.4	7	14.0	-	-	-	-
Total	35	100.0	50	100.0	23	100.0	28	100.0

Group structure

Along the Puerto López route there was no difference in group size between years (2.68 whales/group, SD = 1.61 in 1996 and SD = 1.87 in 1997). Along the Puerto Cayo route, groups in 1997 were on average slightly larger but not significantly so (z-test = 0.84, $p > 0.05$). Group composition is shown in Table 5. Most of the groups recorded on both routes were either adults (A) or adults with subadults (AS). For Puerto López no difference was found between the proportions of A groups ($\chi^2 = 0.35$, $p > 0.05$), nor in Puerto Cayo for A groups ($\chi^2 = 0.33$, $p > 0.05$) or AS groups ($\chi^2 = 0.27$, $p > 0.05$). The number of occurrences in the remaining categories were too small for statistical comparison.

Table 5

Frequency and proportions of groups recorded according to their composition. A=all adults; AS=adults and subadults; MC=mother with calf; ME=mother with calf and one escort; M+=mother with calf and more than one escort; X=unidentified.

	Puerto López				Puerto Cayo			
	1996		1997		1996		1997	
Class	*n*	%	*n*	%	*n*	%	*n*	%
A	28	43.8	18	36.0	11	26.8	10	32.3
S	4	6.3	2	4.0	2	4.9	2	6.5
AS	3	4.7	7	14.0	6	14.6	6	19.4
MC	2	3.1	4	8.0	6	14.6	2	6.5
ME	3	4.7	-	-	2	4.9	-	-
M+	-	-	-	-	1	2.4	-	-
X	24	37.5	19	38.0	13	31.7	11	35.5
Total	64	100.0	50	100.0	41	100.0	31	100.0

Crude birth rate

The results for this index are shown in Table 3 but for the reasons explained earlier, interpretation of them is problematic. However, it should be noted that the results for Puerto López, which are the most comparable, are not significantly different.

DISCUSSION

Despite the fact that during the 1997 breeding season, the water temperature was 4°C above the average off Ecuador, the results for the parameters evaluated here suggest no significant differences in the study area when compared to a 'normal' non-El Niño year (1996). This is in apparent contrast with some data obtained during El Niño 1982/83 in northern Peru by Ramírez and Urquizo (1985), who reported changes in the distribution of some baleen whales and sperm whales. However, those authors considered two species (Bryde's and sperm whales) that live and feed permanently in tropical and temperate waters. Such species would be more affected by changes in the ecosystem during El Niño events. Humpback whales do not usually feed during their breeding season in tropical and subtropical waters (but see e.g. Gendron and Urbán-R, 1993) and thus changes in primary and secondary productivity might not affect them. However, the results presented in the small study area here cannot necessarily be extrapolated to other parts of the eastern tropical Pacific, little is known of humpback whale distribution and movements in the eastern Pacific as a whole.

Dawbin (1966) suggested that the main factor in defining the boundaries of suitable breeding areas for humpback whales in the Southern Hemisphere might be water temperatures of around 25°C and this is a typical value for the June-September period from the central part of Ecuador (around 2°S) northward. However, during El Niño years, such warm water may also be found south of central Ecuador. Ramírez and Urquizo (1985), for example, reported temperatures as high as 30-31°C in coastal waters at 9°S during the 1982/83 El Niño. If water temperature was the dominant factor in delimiting breeding areas, one might expect humpback whales to remain further south during warmer years. However, our results do not support this and it may be that provided the 'minimum' water temperature is reached, other cultural factors, such as well-known areas for meeting other individuals for mating or, physical factors such as shallow and protected sites for nursing (e.g. Flórez, 1991; Ojeda and Hurtado, 1992; Félix and Haase, 1997b), are dominant.

However, there is some information to suggest that El Niño events may affect migration routes. For example, the unusual coastal catch of humpback whales in central Peru during the 1925/26 El Niño (Clarke, 1962) suggests that the whales migrated closer to shore in that season. Humpback whales usually migrated in oceanic water off Peru, avoiding the cold water of the coastal Humboldt current (Clarke, 1957). Such a change in distribution in response to El Niño would also explain why Ramírez and Urquizo (1985) did not report humpback whales during the 1982/83 Peruvian whaling season as most effort was directed towards pelagic species off the coast whilst humpback whales probably passed closer inshore.

It is possible to speculate that higher water temperatures on the breeding grounds during El Niño years might actually benefit whales by reducing the energetic cost of keeping their body temperature constant which might be beneficial for mating, gestation, lactation and calf growth and survival. However, the effects of the intensive 1997 El Niño were also apparent on the feeding grounds. Data from the VII Ecuadorian expedition to Bransfield Strait, Antarctic Peninsula in the summer of 1998 (January-March) revealed higher temperatures but lower salinity (Martínez, 1998), a decrease in primary productivity (Torres, 1998) and a decrease in abundance and a change in distribution of macrozooplankton (Ortega, 1998), compared with previous years. Humpback whales breeding off Ecuador and Colombia use feeding grounds around the Antarctic Peninsula (Stone *et al.*, 1990; Muñoz *et al.*, 1998). This decrease in food availability may have counterbalanced any energetic bonus from tropical waters.

This note represents a preliminary opportunistic attempt to look at the possible effects of El Niño on humpback whales in Ecuadorian waters. As such, we recognise that the available data are insufficient to draw any firm conclusions.

To evaluate the effects of El Niño on humpback whales it is important that properly designed multi-disciplinary studies are implemented. Results from such studies will also be of value in trying to determine possible effects of long-term climate change on whales.

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