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EVIDENCE OF DISTURBANCE OF PROTECTED CETACEAN POPULATIONS IN THE CANARY ISLANDS.

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ABSTRACT

More than 800,000 people participate in watching bottlenose dolphin (*Tursiops truncatus*) and tropical pilot whale (*Globicephala macrorhynchus*) off the SW coast of Tenerife. A study, one year in length, was undertaken to assess the impact of the activity in the area. A total of 636 behavioural samples were collected during 108 sightings of which 82.52% were against the current distance regulations. Statistical analysis show a correlation between the approach of boats and a change of course, speed and group cohesion of the bottlenose dolphins. A similar correlation was found between the increasingly less favourable approach direction of the boats and a change of course by the pilot whales. Presence of calves and mature males varied the response of the groups to the same stimuli. Synergetic and antagonistic effects have been found due to interspecific and intraspecific variations in different social contexts. The government has not yet regulated a maximum number of licenses for whale-dolphin watching boats in the area.

Three Special Areas of Conservation (SACs) have been declared in Canary Islands under the EU Habitat Directive on the basis of the conservation of bottlenose dolphin and loggerhead turtle (*Caretta caretta*) habitats. The cetacean populations in these areas are subject to high anthropic pressures; one of which is the existence of fast ferry routes, that have proven to increase the number of cetaceans killed by boat strikes in the archipelago, affecting mainly to sperm whales females and calves. GIS maps of coastal uses are presented to show how integral management is required in order to conserve the cetacean species and their habitat. Such management is essential for marine protected areas, including the coastal border area. The legal framework of the Habitat directive should avoid management contradictions in its conservation objectives by defining stricter enforcement of standard restrictions of specific actions within a SAC.

KEYWORDS: CANARY ISLANDS; TENERIFE; CONSERVATION; HABITAT; WHALE WATCHING; FAST FERRIES; BOTTLENOSE DOLPHIN; PILOT WHALE; REGULATION.

INTRODUCTION

The aim of this project, funded under a EU LIFE program, was to study the bottlenose dolphin habitat and the impact of human activities in three SAC's in the Canary Islands. The archipelago constitutes a favourable area for cetacean resident and migratory species as it corresponds to its volcanic origin (Evans, 1987). In addition, its particular oceanographic conditions and its geographic situation make it accessible to tropical and temperate species. There are 26 species of cetaceans recorded in the Canary Islands: 19 odontocetes and 7 misticetes (Díaz & Aguilar, 1999); all of them are included in the

Annex IV of the EU Habitat Directive, and two are classified by the IUCN as "in danger of extinction": the northern right whale (*Eubalaena glacialis*) and the blue whale (*Balaenoptera musculus*). The archipelago represents a critical area for the bottlenose dolphin and the tropical pilot whale, since resident populations are present (Martín, 1998; Heimlich Boran, 1993). The same can be said of the sperm whale (*Physeter macrocephalus*), present all year round (André, 1998). It is also an important migratory route for large species such as the northern right whale (Martín, 1998, Aguilar, 1999) and all members of the family *Balaenopteridae* (Díaz y Aguilar, 1999). Other mammmarine als as the monk seal (*Monachus monachus*) was before common but is nowadays rarely recorded (López *et al*, 1995).

The diversity of marine vertebrate species in Canary Islands is higher than in the insular and continental surrounding areas. The important representation of the atlanto-mediterranean ictic species and those from the oriental temperate-warm Atlantic are mixed with pantropical and anfiatlantic species that together with endemic species confer on the archipelago a notorious biogeographic particularity. Also, six of the eight species of marine turtles have been recorded in the archipelago: *Caretta caretta*, *Dermochelys coriacea*, *Eretmochelys imbricata*, *Chelonia mydas*, *Lepidochelys kempii* and, since 1997, *Lepidochelys olivacea* (Brito *et al*, in press).

The mass tourism development in the islands has contributed to the alteration of the coastal habitat. It favours strong whale-dolphin activity off SW Tenerife and Gran Canaria coast, probably one of the most over crowded in the world. In addition to the increase of marine traffic, fast ferries were introduced to the area in 1999. The synergetic effect of all these factors might compromise the conservation of the cetacean populations, marine biocenosis and their habitat in the archipelago, and evidence the inefficiency of the present legal frame to guarantee the right management of protected areas.

METHODS

Short term behavioural reactions of bottlenose dolphins and tropical pilot whales in response to different strategies of approach of the boats were evaluated to identify the most disturbing characteristics of the approach and the most reliable signals of possible distress to the animals. The method selected three main parameters in the response of the animals: change of course (*CC*), change of speed (*CS*) and change of group spacing (*CG*). Four parameters were identified with regard to the approach of the boat: speed of approach (**S**), proximity to the animals (**P**), number of boats present at 200m or less from the animals (**N**) and direction of their approach in relation to the animals (**D**). Every factor of the approach was analysed by statistical correlation independently with every factor of the animals' response. As well, the parameters of the boat's approach were considered jointly to assess their synergetic effect on the overall whale response. The analysis was performed for the two species taking into account the presence/absence of calves and mature males when possible, since bottlenose dolphins' sexual dimorphism is not clear (Wells, 1984), while pilot whales present a clear dimorphism related with age and sex (Kasuya, 1984). Data was recorded from whale-watching boats and from a 3m long inflatable boat, following a method of instantaneous sampling every 3 min. Dbase IV and SPSS software were used for data storage and analysis.

Data on the distribution of fishing activities, sewage pipes, existent and future coastal infrastructures were recorded from official agencies and direct observations. A theodolite was used also to record maritime traffic abundance. Data from a Cetacean Sighting Net and cetacean strandings was used to record fast ferry strikes to cetaceans. Data on the distribution of the benthic communities was gathered by direct sampling, diving transects and video techniques. Data was integrated using ARC-View geographical information system (GIS) to create a comprehensive picture of the SAC management requirements.

RESULTS

1. Whale-dolphin watching impact:

The different factors were correlated individually by the Spearman analysis. Results are shown in Table 1. The same analysis performed considering the combined boat approach factors and the resulting correlation is weak but significant for bottlenose dolphins (r=0.396, p<0.0001) and for tropical pilot whales (r=0.172, p<0.05). In the latter species the reaction is more pronounced with the presence of adult males and calves in the groups (r=0.474, p<0.0001).

Boat Factor	Cetacean Factor	*T. truncatus*		*G. macrorhynchus*	Both Species
		Calves	**Not calves**	**All**	
P	CC	p>0.05	r=0.367 p<0.01	r=0.141 p<0.05 with calves and ♂	R=0.2110 P<0.0001 n=467
	CG	p>0.05	r=0.248 p<0.01	p>0.05	R=0.1484 P<0.001 n=438
	CS	r=0.4 p<0.001	p>0.05	p>0.05	p>0.05
N	CC	p>0.05	r=0.333 P<0.01	r=0.248 p<0.05 with calves	R=0.148 P<0.0001
	CG	p>0.05	p>0.05	p>0.05	p>0.05
	CS	p>0.05	p>0.05	p>0.05	R=0.1 p<0.05 n=516
D	CC	p>0.05	r=0.016 p<0.05	r=0.21 p<0.0001 with calves and ♂	r=0.21 p<0.0001 n=414
	CG	p>0.05	p>0.05	p>0.05	p>0.05
	CS	r=0.29 p<0.05	p>0.05	p>0.05	p>0.05
S	CC	p>0.05	r=0.33 P<0.01	r=0.316 p<0.05 with calves and ♂	p>0.05
	CG	p>0.05	p>0.05	p>0.05	p>0.05
	CS	r=0.28 p<0.05	p>0.05	r=0.2446 p<0.05 with calves and ♂	p>0.05

Table 1. Spearman correlation results. P: proximity of the boats; N: number of boats less than 200m apart; D: direction of approach; S: speed of vessels approach; CC: change of course; CG: change of group spacing; CS: change of speed.

Currently, there are 48 licensed boats that make between 1 and 4 daily whale-dolphin watching trips year round in the Tenerife SAC. The presence of boats within 200m of the animals is variable, with 21.8% of the sightings with more than three, against the current regulations. Duration of the sightings varies from less than 10 min (17.2%) to 50-60min (8%). When arriving at the sighting point, other boats were present with the cetacean group on 45% occasions, also in 43% of the occasions boats were staying with the group when we left, suggesting that very often the animals may be surrounded by boats for several hours.

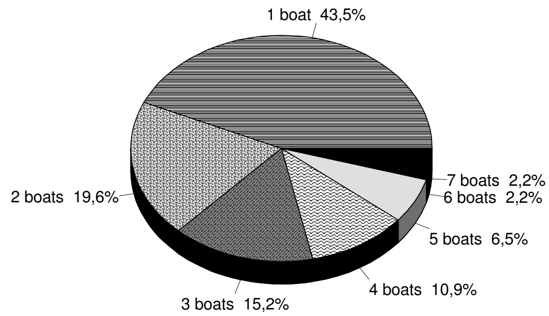


Fig. 2 Number of boats present at 200 m or less from the animals during the sightings.

Conclusions

- Increasing proximity of the boats has the most significant effect on the behaviour of bottlenose dolphins. It produced changes on all studied parameters.
- Short term responses of the cetacean to the same stimuli vary depending on the social composition of the groups. Presence of calves in the dolphin's group favours the change of speed of the animals, while it prevents the change of course and group cohesion.
- Trends within the pilot whales' behaviour were less pronounced. Change of course was the most distinguishable trend, correlating with all studied boat parameters when there were mature males present with the nursery groups.

2.- Fast ferry strikes.

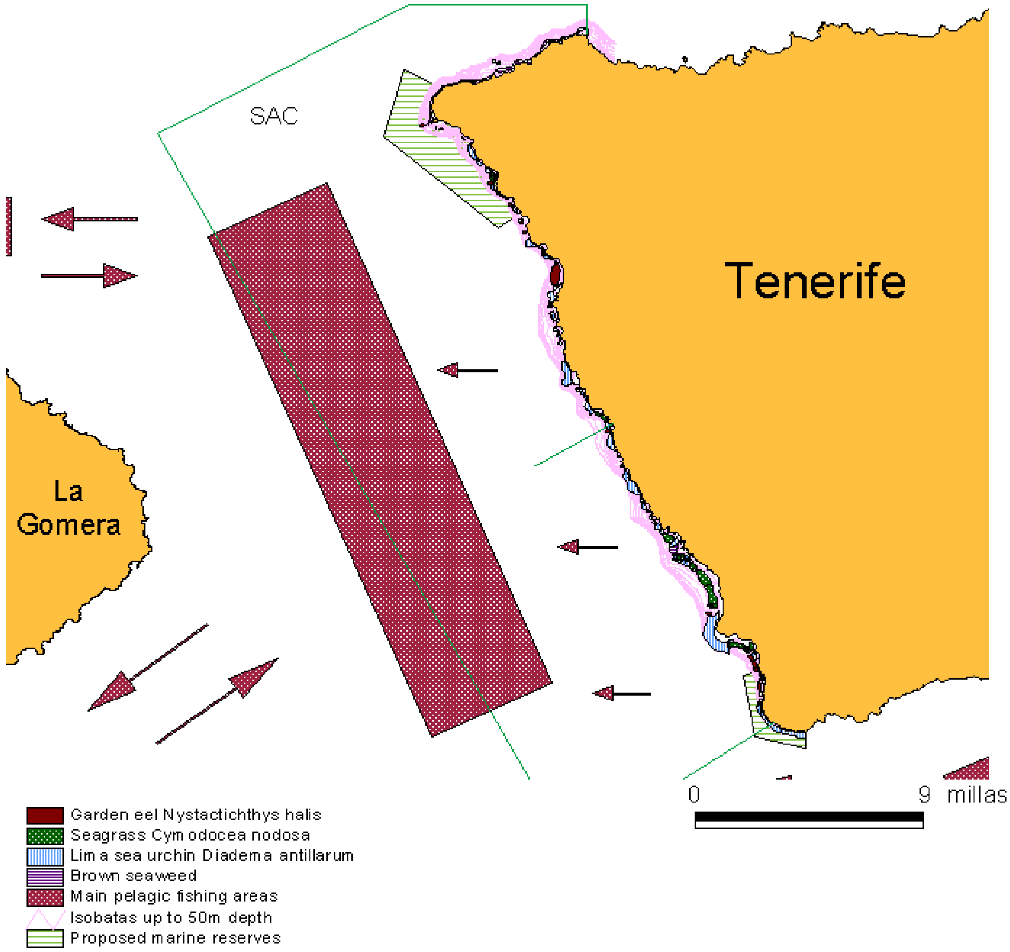
Table 2: List of collisions recorded in Canary Islands since 1985. TF: Tenerife; GC: Gran Canaria; LG: La Gomera. Length data provided for sectioned cetaceans is approximate. No data on observations was taken in 2000. Modified from (Carrillo, Martín & Herrera,2001).

Specie		Date	Island	Comments (S: stranded)
Before the introduction of fast ferries (1985-1998)				
Sperm whale	*P. macrocephalus*	1985	TF-GC	**S** with heavy cuts
Sperm whale	*P. macrocephalus*	7/07/91	TF	♀ **S**. due to jet-foil collision
Sperm whale	*P. macrocephalus*	7/07/91	TF	Calf **S**. same collision
Trop. pilot whale	*G. macrorhynchus*	26/02/92	TF	**S**. heavy cuts
Sperm whale	*P. macrocephalus*	12/07/95	TF	**S**. Sectioned head. Calf 5m
Sperm whale	*P. macrocephalus*	9/04/96	GC	♀ **S**. due to ferry collision
Sperm whale	*P. macrocephalus*	9/04/96	GC	calf **S**. same collision
After the introduction of fast ferries (1999-2000)				
Rorcual sp	*Balaenoptera sp.*	3/05/99	GC	Observed collision
Medium sp.	*G. macrorhynchus*?	10/07/99	TF	Observed collision
Medium sp.	*G. macrorhynchus*?	10/07/99	TF	Observed collision
Sperm whale	*P. macrocephalus*	4/08/99	TF	**S**. Sectioned head
Sperm whale	*P. macrocephalus*	6/08/99	TF	Lactating ♀ **S**. cut on head.
Sperm whale *	*P. macrocephalus*	15/08/99	TF	Suckling calf **S**.
Bryde's whale	*B. edeni*	10/9/99	LG	Drifting with heavy cut
Sperm whale *	*P. macrocephalus*	5/01/00	LG	♀ **S**. not studied. 10m.
Cuvier's beaked	*Ziphius cavirostris*	9/06/00	TF	♀ **S**. sectioned at dorsal fin
Sperm whale	*P. macrocephalus*	11/06/00	TF	Calf **S**. sectioned at dorsal fin. 5m.

The proportion of females and calves may reflect a differential sex proportion on the Canary Islands population of this specie or a more sensitivity of them to the collisions.

3. Bottlenose dolphin habitat in the Tenerife SAC.

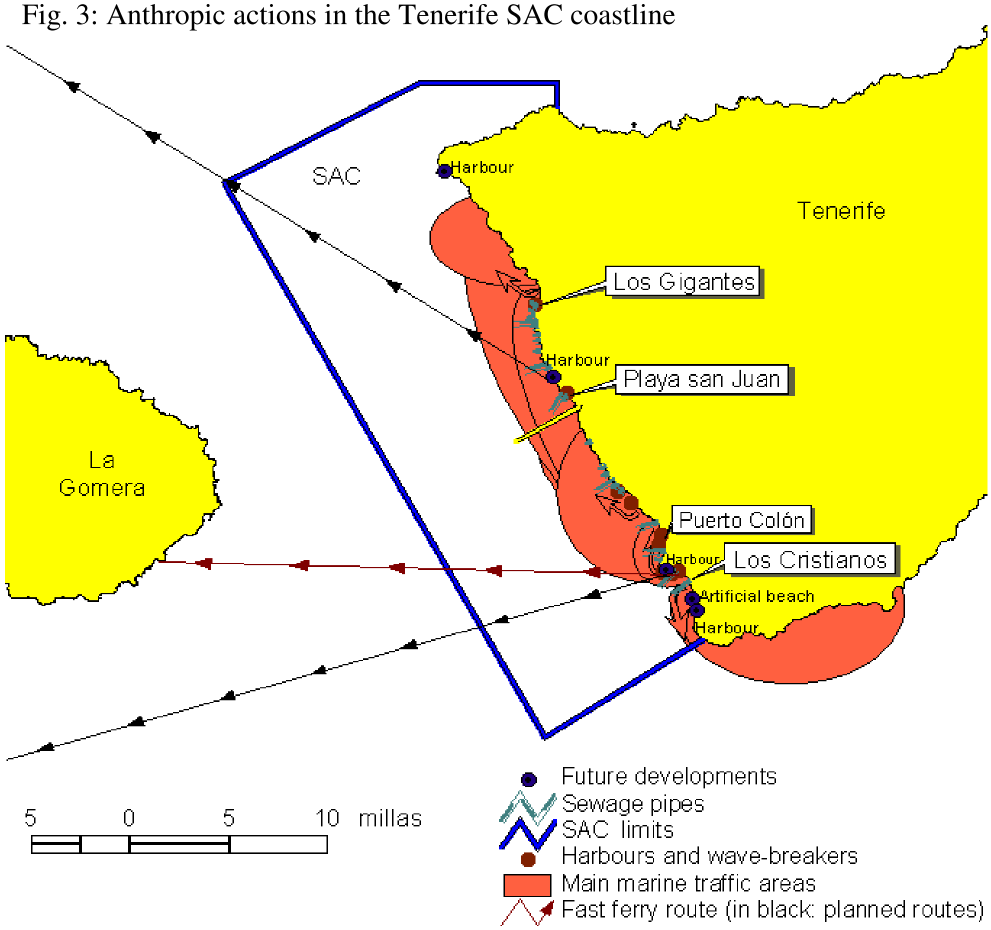
Fig. 2: Coastal benthic communities' distribution and their dominant specie.



The Tenerife SAC covers 6,648Ha, its perimeter is 98km maritime and 65km coastal, although the coastline itself has been left out of the protected area. Around 46km^2 have depths between 0-50m (1-1.5km from coastline). Inside them, sandy bottom holds 1.3km^2 of the community dominated by the garden eel *Nystactichthys halis* and 2.9km km^2 of that dominated by the seagrass *Cymodocea nodosa*, whose sensitive communities are also protected by the EU due to their importance for fish recruitment. The 14km^2 of rocky bottom are covered of brown algae (2,13km^2), other seaweeds (4km^2), and the majority (7.9 km^2) have been colonised by an invasive population of the introduced sea urchin *Diadema antillarum* that prevents seaweed settlement, creating what is termed "white areas". Its expansion is due to several factors, including over-fishing. (Aguilera, 1994). Alteration of shallow benthic communities as the seagrass *Cymodocea nodosa* has followed the starting of fast ferry operations, and booms of *clorophita* and *cianophyta* have been recorded after beach replenishments.

Two marine reserves with special fishing restrictions are proposed within the SAC in order to help the recovering of the ictic populations and further ecosystem balance (Bacallado, 1989), but still they haven't been implemented by the government.

Fig. 3: Anthropic actions in the Tenerife SAC coastline



The SAC coastline holds 4 harbours, 5 wave-breakers for artificial beach protection and 23 sewage pipes. In addition to these, planned developments include the expansion of the existing tourist resorts (receiving now around 1.25 million tourist/year), 5 new harbours (one with capacity for 360 boats and 3 ferries) and wave-breakers construction and sewage pipes as required by the growing urbanisation.

The traditional fishery activities constitute an important part of the marine traffic, but the main contribution is due to recreational vessels. They concentrate in the coastal area, thus interactions among high speed small boats, jet-skies and the bottlenose dolphins are common and out of control. Often the pilot's inexpertness results in dispersing the groups and increasing their diving periods. The construction of 5 new harbours would more than duplicate the number of boats, increasing the high pressure already existing on the dolphin's population.

DISCUSSION

Current studies of the impact of whale watching activities have focused on the responses of the animals in the presence of boats at a certain distance (Biassoni, 1999; Magalhaes *et al*, 1999). Very little has been done to identify what aspects of the boat approach have a greater effect on the whales. In Tenerife, the activity started in 1985 and has been steadily increasing since then, thus the resident cetacean populations in the area should reflect the existence of any possible habituation effect as suggested by Janik & Thompson (1996). Nevertheless, our results show significant trends in behavioural change of the animals in responding to the approaching boats that depends strongly on the approach strategy. This suggest that habituation to the presence of boats may happen only until the extent that they don't chase the animals. The disturbing effects are consistent with time since every day the populations receive around 70 visits. Results show an important influence of the social composition of the groups, which enhances the importance of taking into account the presence of calves when approaching cetaceans. Also, mature male pilot whales seem to play a major part in causing the group to react, which can be interpreted in the context of their defensive role in the social structure and to the fact that their movements aren't constrained by directly associated calves.

The number of cetacean strandings during the year 2000 has been unusually low, and only two are related to boat strikes.

The bottlenose dolphin's habitat is mainly coastal. In the Tenerife SAC the dolphins have been observed as near as 30m from the coast, which is favoured by the steep bottom profile. There is direct physical destruction of intertidal and infralitoral communities brought about by human activity and further indirect alteration due to the changes introduced within the ecosystem. Together with this, punctual alterations of natural conditions may influence cetacean population such as those produced by El Niño in 1997-98, which might be related to a recorded decrease in dolphin sightings following the reduction of the small epipelagic fishing stock in the archipelago (Aguilar, 1999). Bottlenose dolphins can be opportunistic with regard to food consumption (Bearzi *et al*, 1999), and some have been seen feeding around sewage pipes in the Tenerife SAC (Carrillo, *pers. comm.*), which increase their exposure to pollutants.

All these factors affect the species conservation, and can be considered important threats for the cetacean populations. The carrying capacity of the ecosystem within the SAC might be overwhelmed by their combined effect, which would be contrary to the objectives of conservation of the SAC's. Integral management programs of the coastal ecosystem should be implemented from a precautionary principle perspective, as we have little capacity to detect negative effects in time to prevent them (Hammond *et al*, 1999).

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