Effect of tourist vessels on the behaviour of the pantropical spotted dolphin, *Stenella attenuata*, in Drake Bay and Caño Island, Costa Rica

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ABSTRACT

Despite the exponential increase in whalewatching activities in Costa Rica, little is known about its biological impact on resident coastal populations of dolphins in the country. Globally, this activity has brought economic benefits to the communities where it is practiced and in some cases, has played an important role in conservation of these mammals. However, when intensively practiced, this activity may significantly affect the animals, since its success depends on following cetaceans for extended periods of time. This study was conducted during the 2004–2005 and 2005–2006 dry seasons, to examine the biological factors associated with this activity in two areas where it is intensively practiced: Drake Bay and Caño Island. Three strip transects were followed within a high (vessel) traffic area. The pantropical spotted dolphin was studied through instant sampling, every two minutes. Sighting density of dolphins accompanied by tourist boats was greater within 3km of the island compared to the average density in the whole study area. Dolphins reacted negatively to those boats that did not follow at least one of the rules of boat handling in the current existing national regulation for whalewatching guidelines. Furthermore, a logistic regression analysis showed that feeding and resting are less likely to occur in the presence of tourist boats. These two behaviours are extremely important and mishandled boats could cause the spotted dolphin to leave this area if these flaws continue. Due to the lack of economic resources and staff from state institutions in Costa Rica, the reinforcement of the Whalewatching Executive Decree 32495 (2005) may be more efficient with 'bottom up' control, where community representatives control their own resources in conjunction with government oversight.

KEYWORDS: WHALEWATCHING; MANAGEMENT; SPOTTED DOLPHIN; BEHAVIOUR; TOURISM; REGULATION

INTRODUCTION

Whalewatching can be defined as any commercial enterprise which provides for the public to see cetaceans in their natural habitat (IWC, 1994). Since about 70% of the global whalewatching activity is done from boats (e.g. Hoyt and Hvenegaard, 2002), an accelerated growth of a tourism activity such as this, is inevitably accompanied by an increase in boat traffic, which in turn is associated with a variety of economic impacts on communities as well as biological impacts on the animals involved (Luck, 2003). Whalewatching, although a non-lethal use of cetaceans (e.g. IWC, 1994), may have negative impacts on the behaviour and health of the populations of these mammals (e.g. Bejder *et al.*, 1999; Bejder *et al.*, 2006; Blane and Jaakson, 1994; Constantine, 2001; Constantine *et al.*, 2004; Corkeron, 1995).

In Costa Rica, commercial whalewatching began in 1990, and remained low until 1998 (Hoyt, 2001). It was not until after that date that an expansion of hotels and tourist activities (including whalewatching) occurred in Drake Bay or 'Bahía Drake' (Rasmussen *et al.*, 2002). However, the marked seasonal climate of this area has led to the intensification of this activity during the dry season (December to April), due to favourable weather conditions. Today, 11 different species of cetaceans are known to occur in Drake Bay (May-Collado *et al.*, 2005; Rasmussen *et al.*, 2002), some considered indisputable target species for whalewatching because of their predictable behaviour and proximity to the coast. These species include the most common dolphin in the area, the pantropical spotted dolphin (*Stenella attenuata*). The objective of this research was to determine if there is an impact of tourism vessels on the behaviour of the pantropical spotted dolphins found in Costa Rica's Southern Pacific.

METHODS

Field methods

Systematic surveys were conducted between Drake Bay and Caño Island, during the summer of 2004–2005 and 2005–2006 following three strip transects in a triangle (Fig. 1). Strip transects were of variable length (29, 25 and 23km) and 1000m wide (500m on each side of the trackline), and were followed for three or four consecutive days every month. Sampling of the area was performed continuously throughout the day, from 6:00hrs to 15:00hrs, alternating the start location each day.

The study area was selected based on its proximity to national protected areas and tourist attractions. Drake Bay is located in the South Pacific Region of Costa Rica. The total sampling area included approximately 160km^2 from Punta Sierpe (8º46'N, 83º39'W) to Punta Llorona (8º38'N, 83º44'W) in the Osa Peninsula, including the Caño Island (8º71'N, 83º89'W). The study area is adjacent to three major tourist destinations in the region: the Térraba-Sierpe Mangrove Wetland, Corcovado National Park and Caño Island Biological Reserve. The marine area within these sites represents rocky reefs and coral communities of high diversity (Guzmán and Cortes, 1989).

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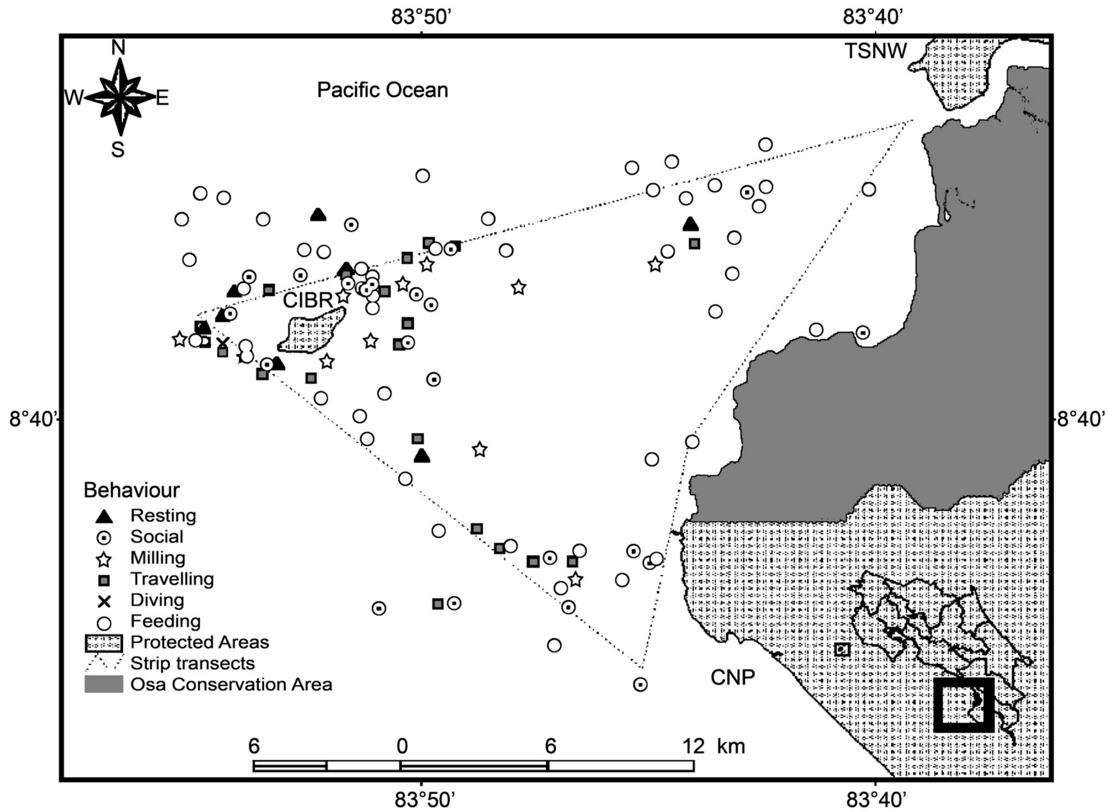

Fig. 1. Location of study site for spotted dolphins' behaviour (2004–2006). Averaged strip transects are joined by Terraba Sierpe National Wetland (TSNW), Caño Island Biological Reserve (CIBR) and Corcovado National Park (CNP) in Costa Rica. Locations of dolphin schools monitored are shown based on the dominant behaviour of each sighting.

An independent research boat (7m, outboard, 4 stroke engine) followed the transects during the two dry seasons between December 2004 and April 2006. The research boat was manoeuvred in order to minimise its potential effects on the dolphins' behaviour. Suggestions on appropriate boat manoeuvre were followed after Constantine *et al.* (2004) and the 32495 Executive Decree[1]. Despite these precautions, the presence of the research boat was also considered as a potential disturbance factor. Whenever a school of spotted dolphins was encountered, data on school size and age-class composition were collected. A focal-follow (see next section) observation was then initiated and data on the number of boats within 300m of the school and the dolphins' behavioural state were collected.

For analysis purposes, observations were divided into 'controlled observations' in presence of the research boat only and 'tourism observations' when one or more boats (besides the research boat) were present in a 300m radius watching the dolphins. Distance measurements were undertaken with the aid of a laser rangefinder (Bushnell Yardage Pro 500).

Behaviour

The dolphins' behavioural state was determined by using a 2-minute focal-school scan sampling methodology and assigning a predominant school activity (Altmann, 1974). An encounter was finalised when reaching a 40 minute limit or whenever the group was lost. A school consisted of any number of dolphins in apparent association, moving in a similar direction and often engaged in similar behaviours (Wells *et al.*, 1999).

The dolphins' behavioural states were assigned to one of the five categories detailed in Table 1, modelled on preliminary observations and adaptations from Shane (1990), Lusseau (2003) and May-Collado and Morales-Ramírez (2005).

Based on articles 13 and 16 of the 32495 Executive Decree (2005, Appendix I)[1], boat manoeuvring of sighted whalewatching vessels was categorised as 'Correct' when all regulations were followed and 'Incorrect' if the vessel: (1) was closer than 50m from the group with the engine running; (2) was closer than 100m when the dolphins were feeding or socialising; (3) remained more than 30 minutes with the same group; (4) interrupted the course of the group; (5) had passengers throwing food, liquid or waste into the sea; (6) generated excessive noise within 100m of the group; (7) approached animals from the front or perpendicular; (8) drove faster than the slowest-swimming dolphin; (9) remained in the place despite disturbance signs; (10) when it was the third vessel to arrive, did not respect the 200m distance from the first 2 boats; and/or (11) had passengers swimming with dolphins.

Furthermore, school reactions were assigned based on previously reported behaviours that were considered stress reactions signs for different cetaceans species in presence of vessels (Baker and Herman, 1989; Berggren, 2001; Blane and Jaakson, 1994; Constantine and Baker, 1997; Corkeron, 1995; Kruse, 1991; Nowacek *et al.*, 2001; Richter *et al.*, 2001; Williams *et al.*, 2002) as follows: avoidance; change of

[1] Decreto Ejecutivo Nº 32495-MINAE-MOPT-MSP-MAG. 2005. 'Reglamento para la Operación de Actividades Relacionadas con Cetáceos en Costa Rica'. Publicado en La Gaceta, Número 145 del 28 de julio del 2005. 6pp.

Table 1

Definitions of the behavioural states of the spotted dolphin schools during dry seasons (2004–06) in Drake Bay and Caño Island.

Feeding (FEED)
(1) Foraging: individuals dive synchronously for long intervals (2 mins). Steep dives finalising in fluke exposition are observed. Dives are often performed in a common concentric point. Group spacing and direction of movement varies.
(2) Hunting: individuals consuming prey by surface persecutions and circular fast swimming (not following another dolphin). This state involves encircling, aerial behaviour and direct prey catch.

Socialising (SO)
(1) Boat interaction: dolphins voluntarily approach a boat and show boat-riding or 'inspect' the vessel. Swim, get close.
(2) Interactions among individuals of the same group or between groups, manifested by persecutions, rubs, sexual contact, mother-calf interactions and aerial behaviour.

Travelling (TRAV)
Individuals moving faster than the idle speed of the research boat with constant direction, swimming with short, relatively constant dive intervals. Group spacing varies.

Resting (REST)
Individuals moving slower than the idle speed of the research boat with constant direction, swimming with short (<1 min.), relatively constant synchronous dive intervals. Animals are tightly grouped.

Milling (MILL)
Individuals surfacing facing different directions. No net movement. School often changes direction, dive intervals variable but short. Group spacing varies.

Diving (DIVE)
Individuals dive synchronously for longer intervals than previously observed within the observation. Often observed as a potential evasive reaction of the group. Direction of movement varies.

behaviour; increased dive intervals; leaps and tail slapping; change in direction; and increased swimming speed.

Analyses

Chi-squared (χ^2) approximations (PAST version 1.67b; Hammer *et al.*, 2001), were used to compare different behavioural categories and behavioural reactions to boats; in both cases, selected α was <0.05. To estimate tourism boats density in the study area, *Animal Movement* extension (Hooge and Eichenlaub, 1997) from *Arc*View GIS 3.3, (ESRI, 1998) was used within a sampling area of 350km^2. The specified search ratio for each circle was 2km.

Behavioural sampling units consisted of 2-minute scans. In order to compare the relationship between type of boats present (controlled or tourism) and behaviour observed in each school, a logistic regression of binomial response for each behaviour (SAS Institute, 2000, GENMOD procedure with repeated measures) was used. This generalised linear model (GLM) allows an evaluation of the probability of sighting a school in a certain behaviour based on the type of boat present. The *Link function* was a *Logit* function compatible for binomial responses.

The initial autocorrelation due to repeated measures throughout time (2 minute-observation periods within one sighting) was corrected by the repeated measures design. All scans belonging to the same sighting were specified as repeated measures within the model. Rejection criteria for each Ho was based on odds ratio estimates for each regression coefficient and 95% Wald Confidence Limits.

RESULTS

Forty eight hours were spent on dolphin observations. The average observation lasted 19 minutes (SD = 13.7min) and a total of 1,452 2-minute scans samples were collected. Dolphins were accompanied by boats in addition to the research boat in 8% of scans (n = 120). A total of 1,332 controlled scans and 120 tourism scans were collected. Comparisons of dolphin behaviour proportions within controlled observations vs tourism observations showed a significant difference ($\chi^2 = 32.93$, g.l. = 5, $p<0.001$). This suggests that the research boat could be considered as a suitable observation platform to contrast behaviour in the presence of boats other than a carefully driven research boat (Constantine *et al.*, 2004). This does not suggest that the research boat itself had no impact (Nowacek *et al.*, 2001) but that measured changes occurred above the effect of the research boat.

Tourism boats median closeness to dolphin groups was 50m, with any given behaviour the group showed at the time of getting closer to watch it. Almost 60% of the boats registered in whalewatching activities were observed between 8:30 and 9:30hrs. Tourism sightings density (boats/km²) was higher (= 0.17 ± 0.19) within 3km from Caño Island in comparison to average density (= 0.045 ± 0.1) in the whole surveyed area (Fig. 2). Groups showed more negative reactions in presence of vessels that showed an incorrect manoeuvring (Fig. 3; $\chi^2 = 4.96$, g.l. = 1, $p = 0.026$). Types of reactions presented by the dolphins were, in descending order, the following: behavioural change (29%); superficial tail slapping (19%); increased diving intervals (19%); evasiveness (18%); change of direction (11%); and increased speed (4%).

A negative effect of tourism boats was observed over feeding (FEED) and resting (REST) behaviour of spotted dolphins in Drake Bay and Caño Island. Feeding behaviour is 4.7 times more likely to occur in presence of the research boat than in presence of the tourism boat (Odds ratio = 4.7; Table 2). Resting behaviour was observed exclusively when tourism boat was not present (Fig. 4). On the other side, socialising (SO) behaviour is 4.7 times more likely to occur in presence of tourism boats than in presence of the research boat. There were no significant differences between control and tourist boats for presence of Traveling (TRAV), Milling (MILL) and Diving (DIVE) behaviours.

DISCUSSION

The median distance closeness of boats to dolphin groups within the Bay (50m) suggests the distance established in the

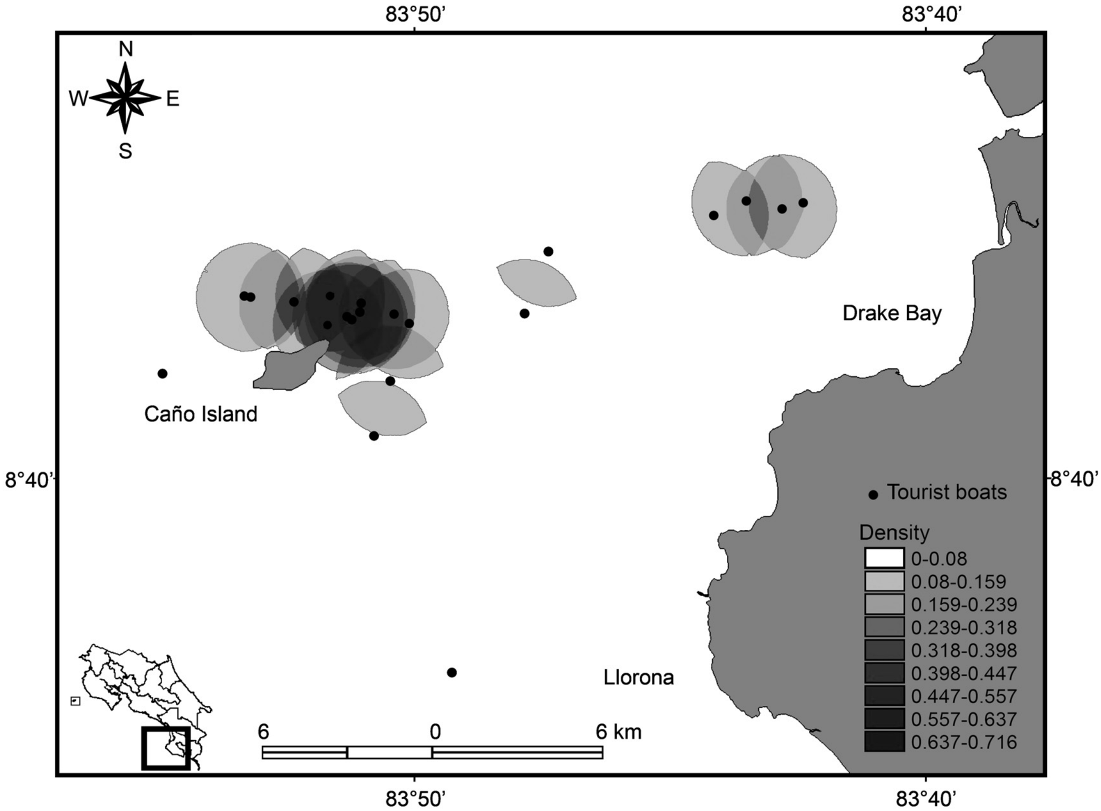

Fig. 2. Tourist boat density (boats/km^2) within study site during dry seasons of 2004–2005 and 2005–2006. Drake Bay and Caño Island, Costa Rica.

Decree ('50m as a minimum distance to the closest dolphin') is a viable instruction to be followed. Nevertheless, this distance measure was estimated including groups involved in feeding and socialising behaviours, in which case the vessels should remain at greater distances for being behaviours that directly affect cetacean group cohesion (Clark and Mangel, 1986; Emlen, 1991). Differentiating among behaviours requires training, so it is to be expected that most of the captains would not be able to identify the different behavioural categories for cetaceans.

Negative reactions from dolphins occurred mostly in the presence of those vessels with Incorrect manoeuvring (Fig. 3 and Appendix 1), which demonstrates the importance of following the regulations exposed in the national decree. The majority of these negative reactions are consistent with what has been cited by other researchers in different parts of the world and with different species of cetaceans (Baker and

Table 2

GLM results for pantropical spotted dolphin observed behaviours, as of present boat types during dry seasons 2004–06 in Drake Bay and Caño Island, Costa Rica.

Behaviour	Odds ratio*	Wald confidence limits 95%		Pr > |Z|
Feeding (FEED)	0.21	0.60	0.076	0.0035
Socializing (SO)	4.68	10.05	2.18	<.0001
Resting (REST)	2.9 E-11	–	–	0
Travelling (TRAV)	1.30	3.09	0.55	<.0001
Milling (MLLI)	0.88	3.15	0.24	0.015
Diving (DIVE)	2.42	8.29	0.71	<.0001

*Odds ratio<1 indicates a lower likelihood of a behaviour to occur in relation to the probability of this same behaviour without tourism boat(s).

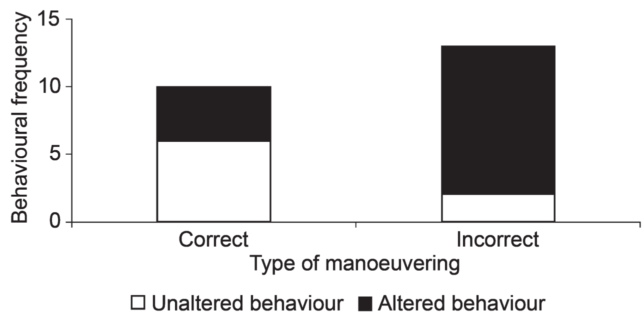

Fig. 3. Frequency of behavioural responses of the spotted dolphin depending on the type of tourist boat maneuvering within Drake Bay and Caño Island, Costa Rica (2004–2005 and 2005–2006). Altered behaviour = negative reaction.

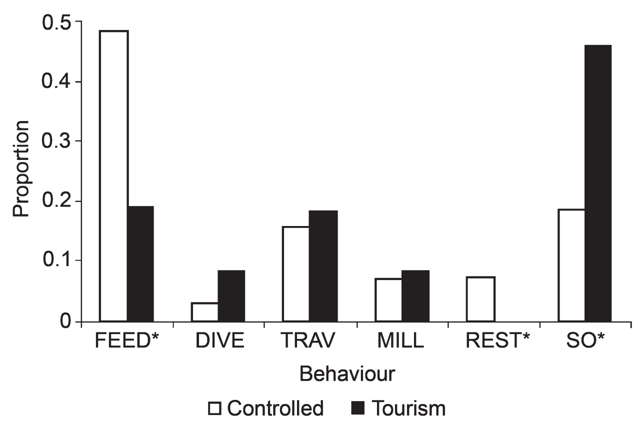

Fig. 4. Proportion of controlled and tourism observations in presence of distinct behaviours of the spotted dolphin in Drake Bay and Caño Island, Costa Rica (2004–2005 and 2005–2006). FEED = Feeding, DI = Diving, TR = Traveling, MI = Milling, RE = Resting and SO = Socialising, * = significant differences as reported by the GLM (95% confidence).

Herman, 1989; Blane and Jaakson, 1994; Constantine and Baker, 1997; Corkeron, 1995; Kruse, 1991; Nowacek *et al.*, 2001; Richter *et al.*, 2001; Williams *et al.*, 2002).

This study has shown that the presence of tourist boats had a negative effect on feeding and resting behaviour of spotted dolphins in Drake Bay and Caño Island. Feeding behaviour is more likely to occur in the presence of the research boat than in the presence of tourist boats. Similarly, Taubitz (2007) observed a trend in bottlenose dolphins to reduce foraging activities in the presence of boats. Few studies have addressed the effect of boats specifically with respect to foraging behaviour and feeding. Allen and Read (2000) found that bottlenose dolphin feeding use declined in primary habitat during high boat density periods and suggested that this may be due either to dolphins wanting to avoid high-traffic areas or in response to prey reaction to this high traffic (Engas *et al.*, 1995; Misund and Aglen, 1992; Mitson and Knudsen, 2003). Another possible explanation for this foraging decline is that the noise of the boat could be masking echolocation signs while dolphins hunt (Au, 2000). Montero-Cordero (2007) found no association between the behaviour of *S. attenuata* and time of day (study performed during the same period of time and within the same sampling area of this research). The latter discards any potential for time of day to be a factor responsible for some of the differences in dolphin behaviour.

It is a warning signal that resting behaviour in Drake Bay did not occur in any of the cases where tourist boats were present. Lusseau (2003) noted a decrease in the time occupied by bottlenose dolphins in resting behaviour in Fiordland, New Zealand. He reported 1% of this behaviour while tour boats were present, in contrast with 11% when only the research boat was present. In the case of Drake Bay, the daytime resting behaviour of spotted dolphins in the presence of exclusively the research boat, represent 8% of their daily activities (Montero-Cordero and Martinez-Fernandez unpublished data), compared to no resting at all in the presence of tourist boats. A decrease in this behaviour due to human disturbance was also observed by Constantine *et al.* (2004) for the bottlenose dolphin. Resting behaviour is fundamentally important for the health of various species of mammals (Bishop, 1999). The impact of reduced resting time for dolphins found in previous studies are still unknown, but other studies in other mammals have demonstrated physiological stress (Fowler, 1999; MacArthur *et al.*, 1979; Tietje and Ru, 1980). An overall reduction of resting will probably result in a reduction of energy reserves, which can affect foraging efficiency, alertness levels and parental care levels (Constantine *et al.*, 2004).

Socialising in dolphins implies visually conspicuous displays. This might partially explain the result of socialisation behaviour being 'more likely to occur in presence of tourist boats'. Tourist boats will probably spot a group where individuals are jumping or approaching for bow riding (Table 1). Ransom (1998) noted that Atlantic spotted dolphins frequently approached tourist boats without interrupting their socialising behaviour. Nevertheless, several studies have reported cetaceans to increase group cohesion in the presence of vessels (Bejder *et al.*, 1999; Bejder *et al.*, 2006; Nowacek *et al.*, 2001) and in contexts of presumed surprise or threat (Whitehead and Glass, 1985).

Coastal dolphins (e.g. spotted dolphins) tend to live in discrete-area societies with relatively small home ranges, thus tourist boats' disturbance becomes habitat degradation (Corkeron, 2004). Coastal spotted dolphins appear to maintain coastal populations in Golfo Dulce throughout the year and could be leaving and returning from this gulf with no substantial effort (Acevedo-Gutierrez and Burkhart, 1998; Cubero-Pardo, 1998)). The relative closeness of the Golfo Dulce with Drake Bay means that several of the dolphins found off the coast in Bahia Drake may be part of the resident population in the Gulf but this requires testing through dedicated photo-identification programmes. If it is the case, the same dolphins would be often exposed to repetitive harassment from boats in this area. This could reduce the biological adaptation of a stock when it occurs in the presence of critical behaviours such as diet, rest and play (Scheidat *et al.*, 2004). Moreover, Escorza-Treviño *et al.* (2002) clearly distinguished the genetic structure of spotted dolphins' population of the Pacific of Costa Rica, when compared with stocks in the rest of Latin America. This suggests a discrete displacement area for this population, within Costa Rican waters. Despite the fact that the 'tourism observations' were considerably less than 'controlled observations', statistical analysis detected significant negative effects on the behaviour of dolphins, which indicates that the impact of the tourist boats is a real problem in the Drake Bay and Caño Island areas.

Management implications

Good practices in tourism activities also make good business sense, as improved performance can enhance a tour operator's reputation and recognition in a tourism marketplace that is increasingly showing a preference for responsible products and suppliers (Sweeting, 2008). According to the IWC (2004), a number of options are available for managing the effects of whalewatching on cetaceans. These may be put into practice through regulations, permit conditions, codes of conduct, voluntary codes of practice or through targeted education programmes. Voluntary codes of conduct can be effective where there is good industry cooperation (International Whaling Commission, 2004). However, there are no whalewatching voluntary codes of conduct yet in Costa Rica, but a process has already been started (C. Molina, pers. comm.).

The limited success of regulations imposed by governments might be an indicator of resistance to 'top-down' controls on marine activities in rural areas. 'Bottom up' regulations, produced by local organisations and those actively involved in whalewatching, have been more accepted by operators in different countries (e.g. Parsons and Woods-Ballard, 2003) than top-down controls. In bottom-up management, operators are actively involved in monitoring and managing the ecotourism industry. By contrast, top-down systems control the anthropogenic use of natural resources through governmental laws or regulations. Environmental management studies in different parts of the world (e.g. Corbelli, 2007; Fraser *et al.*, 2006; Parsons and Woods-Ballard, 2003) have demonstrated a shift towards integrating participatory bottom-up approaches with conventional top-down systems. The latter integration resembles co-management, which implies the sharing of power and responsibility between the government and local resource users (Berkes, 2009).

For this specific case study, the duty of responsibility to monitor and control the responsible whalewatching, could be partially delegated to local tourism organisations or associations, for which scientific and proper legal advice should be provided. Nevertheless, beyond the local results presented here for Costa Rica (Central America), we recognise that the bottom-up approach has been effective in different socio-economic and environmental settings (Fraser *et al.*, 2006). Coastal communities around the world whose captains and guides possess a certain level of experience performing whalewatching activities, technical training and commitment to the environment, could be good candidates for a bottom-up approach.

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Appendix 1

Articles from Costa Rica Executive Decree Nº 32495 (2005).[1]

13.1	Do not get closer than 50 meters from the closest dolphin with the engine running and at least 30 meters with the engine off. Stay at least 100 meters apart from whales and cetaceans larger than 5 meters long.
13.2	Do not get closer than 100 meters from dolphins and 200 meters from whales and cetaceans larger than 5 meters long, when these show feeding or socialising behaviours.
13.4	Do not stay longer than 30 minutes with the same group of cetaceans, even when respecting indicated distances.
13.5	Do not stay longer than 15 minutes with mother-calf couples or solitary individuals and stay at least 100 meters apart from dolphins and 150 meters apart from whales and cetaceans larger than 5 meters long.
13.6	Do not interrupt cetaceans' routes by putting the boat in between animals or splitting a group.
13.7	Do not feed any cetacean species.
13.8	Do not generate excessive noise, like music, any kind of percussion, including noises generated by the engine, at less than 100 meters apart of any cetacean.
13.11	Do not throw any kind of waste, substance or material in watching or conservation areas, taking into account the other regulations about waste deposition in the ocean.
16.1	The dolphin or whale watching approach to moving animals should be from behind and slightly to one side coming from the same direction of the group. Vessels should advance by driving parallel to cetaceans´ traveling direction.
16.2	In presence of cetaceans, vessels should drive slower than the slowest-swimming animal from the group observed.
16.3	Leave the place at low speed if cetaceans show alteration signs.
16.4	A maximum number of 2 vessels around the same cetacean group are allowed. Any other vessel should keep a 200 meter distance apart from the first vessels.
16.5	In presence of solitary individuals or mother-calf couples, vessels should not approach to a closer distance than 100 meters.
16.6	Do not practice activities related to possession, fishing, diving or swimming, aquatic ski, 'jet-ski' or aquatic motorcycles, 'wind-surf', oars, canoes or kayaks in presence of cetaceans.

[1] Decreto Ejecutivo Nº 32495-MINAE-MOPT-MSP-MAG. 2005. 'Reglamento para la Operación de Actividades Relacionadas con Cetáceos en Costa Rica'. Publicado en La Gaceta, Número 145 del 28 de julio del 2005. 6pp.