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Boat operators in Bocas del Toro, Panama display low levels of compliance with national whale-watching regulations

A. Sitar [a], L.J, May-Collado [d], A.J. Wright [a], E. Peters-Burton [c], L. Rockwood [b], E.C.M. Parsons [a,*]

[a] Department of Environmental Science and Policy, George Mason University, Fairfax, VA, USA
[b] Department of Biology, George Mason University, Fairfax, VA, USA
[c] Educational Psychology Program, George Mason University, Fairfax, VA, USA
[d] University of Vermont, Department of Biology, 109 Carrigan Drive, Burlington, VT, USA

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ABSTRACT

In Bocas del Toro, Panama, unregulated dolphin-watching tourism has resulted in international concern. There are less than 100 resident bottlenose dolphins (*Tursiops* spp.) in Bocas del Toro that are genetically isolated from other populations in the Caribbean. Over just three years (2012–2014), at least 10 resident dolphins have died due to boat collisions. Panama does, however, have official whale-watching guidelines. This study conducted a boat-based survey from July to August 2013, to evaluate compliance with these guidelines. Indeed, the results show that dolphin-watching boats in Bocas were frequently violating Panama's whale-watching guidelines. During 817 min of direct observation, boats were closer than the regulated 100 m 71% of the time. Boat engines were only switched off or idle 31% of the time when vessels were 50 m or closer. Only 55% of all observed dolphin-watching interactions were following the whale-watching guideline of 1–2 boats concurrently. Forty-five percent of the time, 3–15 boats were watching the dolphins. Results from this study provide evidence of a high level of noncompliance with Panama's whale-watching guidelines. Thus, these results indicate that the resident dolphin population in Bocas del Toro, Panama will be threatened if this unmanaged whale-watching tourism continues.

1. Introduction

Whale-watching has become a highly profitable activity worldwide [19]. Well-managed whale-watching can bring benefits to human communities while potentially providing sustainable environment for cetaceans [13,16,18,30,42]. However, most whale-watching activities are boat-based and unregulated, this can cause negative effects on the target species [49]. The Archipelago of Bocas del Toro sustains the largest whale-watching industry in Panama. There are concerns that unsustainable tourism development in Bocas del Toro is starting to degrade the natural environment. Indications of this have become very apparent among locals, scientists, and even outside observers (e.g., [7,26,38–41]). Even the Lonely Planet guidebook expressed concern over this issue last decade [51]. Since then the sense of urgency has increased. In particular, dolphin-watching trips are a major tourist activity in Bocas del Toro, with these trips being advertised in most hotels and restaurants.

Boats in close proximity can disturb bottlenose dolphins' natural behavioral patterns (e.g. [4,5,15,25,32,33,35,45,48]). Continuous, chronic exposure to disturbance can increase energetic costs, prevent biologically important behaviors and possibly cause chronic stress responses, which can all be detrimental to the health of dolphin populations [27,34,44,46,47,58,66,69–71].

Preliminary analysis suggests that the resident population of bottlenose dolphins (*Tursiops truncatus*) in Bocas del Toro ranges from 72 to 87, with 37 inhabiting the main dolphin-watching location, "Dolphin Bay" [40]. These dolphins are genetically distinct from other bottlenose dolphin populations in the Caribbean [1,2] and over a three-year period (2012–2014), 10 resident dolphins are known to have died with wounds indicative of boat-based injury. This represents a large proportion of the local population [61].

Concern about the impact on the dolphins in Bocas del Toro has attracted international attention, including repeated mention of the problem by the International Whaling Commission (IWC) Scientific Committee [20,21,23,24]. When the status of the dolphin population was raised at the 2012 meeting of the International Whaling Commission (IWC) (which incidentally was held in Panama), the IWC Scientific Committee stated that:

"*The Committee … expressed concern regarding the intense and*

* Corresponding author.
E-mail address: ecm-parsons@earthlink.net (E.C.M. Parsons).

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uncontrolled dolphin watching in Bocas del Toro. The Committee strongly recommends that Panamanian authorities enforce the relevant whalewatching regulations (ADM/ARAP No.01) and in particular promote adherence to requirements regarding boat number and approach speed and distances… The Committee recommends continued research to monitor this dolphin population and the impacts of tourism on it." (p. 61, [20]). This concern has been expressed and reiterated every year due to an apparent lack of action by the Panamanian Government [20,21,23,24].

The IWC has established expertize in this area with discussions over the negative effects of whale-watching activities dating back to 1975 [6]. Since that time, the IWC became the global body for advocating and advising whale-watching impact research, education, and voluntary regulation development culminating in a set of "best practice" guidelines in 1996 [6]. Revised regularly, these guidelines are now used internationally as benchmark voluntary whale-watching guidelines [22]. Among other things, these guidelines require that: operators have a sound understanding of the behavior of the cetaceans, including indications that they are being disturbed; speeds are limited; appropriate approach angles and distances are used (especially around mother/calf pairs, solitary calves or juveniles); direct contact not be instigated nor pursuit of animals; as well as sudden changes in speed, direction or noise, be avoided.

In line with IWC guidance, the official Panamanian whale-watching[1] guidelines (Resolution ADM/ARAP NO. 01, 2007 [52]) require maximum approach distances of 100 m; speed restrictions (no faster than 4 knots or 7 kmph); a maximum observation time (<30 min); a minimum separation between observation events/encounters (also 30 min); and a maximum number of vessels in attendance (two - that must also remain 200 m from each other); restrictions on feeding the dolphins or making loud sounds; and prohibiting pursuit of animals. There are also special considerations for groups with calves that increase approach distances to 250 m and decrease observation times to just 15 min.

Despite the existence of these guidelines, they have been noted to be unclear to boat operators and unenforced in Bocas ([7,38–41]). Effectively, anyone who has a boat can take tourists out to watch the dolphins whenever and however they want. In Bocas del Toro at present, dolphin watching is becoming an example of Hardin's "tragedy of the commons" [14].

The situation in Bocas del Toro is unfortunately not unique. Many countries have legally binding whale-watching regulations that are violated by whale-watching operators [9,12,17,43,54,55]. In Victoria, Australia, where boat operators are licensed to whale-watch by the Department of Natural Resources and the Environment, one-third of all dolphin-watching boat approaches were determined to be illegal: operators were seen approaching very young calves (displaying the fetal-folds indicating a newly born animal), spending more than recommended time with animals, and approaching closer than proscribed distances [54].

Elsewhere, whale-watching trip operators have frequently been reported to be disregarding whale-watching guidelines and, more generally, the well-being of the target species by closely following, or chasing, animals so that their passengers are able to get a closer look and take better pictures (e.g., [60]). Such inappropriate vessel activity in close proximity to cetaceans may be resulting in animals being struck by whale-watching vessels, leading to serious injuries, or even mortalities [29,62,61]. Similar vessel behavior has also been observed in Bocas del Toro (e.g., [7,35,38–40]).

In Bocas del Toro, boat operators tend to leave port en masse, and as such, many boats frequently surround any given dolphin group. The majority of the boats head to "Dolphin Bay," which is regularly utilized by approximately 37 dolphins from a resident population consisting of less than 100 animals [40,41]. It is reportedly common to see dolphins being circled and chased by more than 10–15 boats all day long (e.g., [7,38,39]). Up to 19 boats simultaneously following dolphin groups have been reported with 39 boat interactions with a single group of dolphins in an hour - with all of these observations occurring during the low season for tourism [39]. However, more than 100 boats have been observed interacting with a single group of dolphins during "high" tourism season [39]. According to one senior boat captain, there are over 200 boat operators in Bocas del Toro, although this needs to be assessed and this does not include any boats owned by private residents. Taubitz [59] reported that approximately every 1.5 min a boat passed their study vessel in Bocas del Toro with the vast majority of these being whale-watching boats. Compounding the problem, boats were reported driving "aggressively" and provoking "negative responses" 78% of the time [59]. These negative responses are likely to have energetic consequences on these animals. For example, several studies have found that in Bocas dolphin-watching, boats elicit an increase in boat avoidance and a significant decrease in foraging time [27,39,56]. These studies demonstrate that the exposure to whale-watching in Bocas del Toro is substantial, and a cause for concern. Accordingly, this study sought to address the issue and respond to the recommendations of the IWC Scientific Committee [20] to monitor and assess tourism activities and their impacts on the resident dolphins. Specifically, this paper assesses the level of boat operator compliance with Panamanian whale-watching regulations in the Bocas del Toro region.

2. Methods

This study was conducted in the Bocas del Toro Archipelago from July to August 2013. Bocas del Toro is located at 9° 20′ 0″ N and 82° 15′ 0″ W, off the Caribbean coast of Panama, close to the border of Costa Rica [68] (Fig. 1).

A boat-based survey was conducted to measure levels of compliance with whale-watching guidelines. Research was

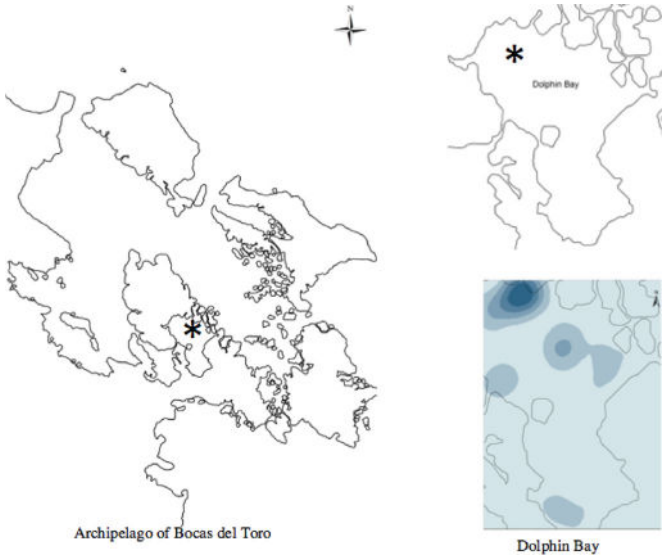

Fig. 1. Study site in the Archipelago of Bocas del Toro, highlighting Dolphin Bay where dolphin-watching activities concentrate. A Kernel density analysis highlights within the bay the areas where most dolphin-boat interactions occur.

[1] The term whale-watching is used throughout the rest of this paper, as the term refers to commercial activities that involve watching any wild cetacean, even though bottlenose dolphins are the primary target of the industry in Bocas del Toro.

Table 1
List of whale-watching boat operators' noncompliant maneuvers in this study.

Noncompliant maneuvers	
CIR	Circling dolphins
FD	Fast speed direct to dolphins
FL	Fast speed leaving
FOL	Following dolphins
HAR	Harassing dolphins
MD	Medium speed direct to dolphins
ML	Medium speed leaving
SCH	Searching for dolphins
SD	Slow speed direct to dolphins
THR	Moving through dolphin group
WTH	Within the dolphin group

conducted in small boats ranging from lengths of 19–30 ft (approximately 6–9 m) with a 75 hp or a 90 hp four-stroke outboard motor. If weather and accessibility permitted, data was collected from 0700 to 1600 h. To minimize impact of the research vessel on the study animals, the motor was turned off when dolphins were within a radius of 100 m. Survey efforts were concentrated within Dolphin Bay due to the high predictability of the dolphins and its proximity to other tourism attractions [38].

Boat activity observations began when whale-watching boats were sighted with dolphins in the study area. At the beginning of each sighting, GPS coordinates, location name, weather and sea state were recorded. Data was collected every minute due to the intensity of boat actions in Dolphin Bay. For every minute, the number of boats present, number of dolphins present, the type of boat maneuvers taking place (compliant and noncompliant) (see Tables 1 and 2), and the distance between the dolphins and the boats was collected. The distance between dolphins and boats was estimated by eye using known distances and lengths (e.g. boat length) to compare against and calibrate estimations (as is frequently done in cetacean line transect survey distance estimation (e.g. [67])). Additionally, if any notable events or activities were observed, they were also recorded at the time of the observation - such as physical interaction or serious harassment conducted by whale-watching operators. Sightings ended when dolphins left the area or when weather conditions deteriorated.

2.1. Categorizing boats

Observed boats were categorized as: whale-watching boats, canoes, sailboats, transport boats and canoes with motors. If more than one type of boat was recorded in that minute, the boat type that was assessed to have the greatest impact on dolphins (e.g., largest, loudest or closest) was the listed boat type for that minute. For instance, if a whale-watching boat (50 m away from dolphins) and transport boat (100 m away from dolphins) were documented together, the whale-watching boat would be the category recorded for that occurrence because it was presumed to have the greatest impact on dolphins. Any private boats were categorized by their activity, e.g. if a private boat was interacting with a dolphin group, it was categorized as whale-watching. For one incident, a sailing boat 100 m or more in length was categorized as "transport" because this vessel was transiting through the area.

Table 2
List of whale-watching boat operators' compliant maneuvers in this study.

Compliant maneuvers	
IDLE	Idle engine
OFF	Off engine
SL	Slow speed leaving
PAR	Parallel with dolphins

2.2. Assessing compliance with whale-watching guidelines

The level of whale-watching compliancy was analyzed by evaluating: 1) the distance of the boat to dolphins, 2) the number of boats with dolphins present at each 1-min interval, and 3) the maneuvering behaviors of the boats. All canoes or transport boats in proximity to dolphins were removed from the compliance analysis because they were not interacting with the dolphins, and were not whale-watching.

With regard to distance, boats that were at distances of 50 m or less were categorized as noncompliant (A) and boats at distances of 100 m or more were categorized as compliant (B). Because of the difficulty of judging distances at sea (e.g. [28,67]), boats at distances between 50 and 100 m, although technically being noncompliant, were excluded; there was a concern that accidental noncompliance because of misestimating distances might result in operators trying to be compliant being recorded as noncompliant, therefore a 50 m 'buffer' was incorporated. Thus vessels could be categorized as compliant (>100 m), or *definitely* noncompliant (<50 m). In terms of boat presence, if 3 or more boats were seen around a dolphin group at a given time, it was classified as noncompliant (A) but compliant (B) if there were just 1 or 2 boats seen at a given time.

Finally, boat maneuvers were evaluated according to whether they were following the Panamanian whale-watching guidelines. Maneuvers for boats at both compliant and noncompliant distances were assessed for the level of compliancy within each category. Further analysis of the maneuvers of boats was only conducted for vessels at noncompliant distances (i.e., distance of 50 m or less) (see Tables 1 and 2 above). This was done because noncompliant maneuvers are assumed to have more impact at close distances (Table 1), and conversely less impact at distances greater than 100 m from animals. Maneuvers that were categorized as compliant are ones that are required by the Panamanian whale-watching guidelines (Table 2).

A final maneuvering type, "travel," was recorded but omitted from analysis because boats that were transiting were neither directly interacting with the dolphins, nor were they a purely control situation.

From July to August 2013, over 13.5 h (817 min) of whale-watching "occurrences" were recorded (each "occurrence" was a 1-minute recording). Noncompliant boats with respect to distance (50 m or less distance from dolphins) accounted for 583-recorded minutes, and 234-recorded minutes involved distance compliant boats (100 m or more from dolphins).

A total of 62 dolphin survey sightings were recorded. Fifteen sightings were control sightings (no boat traffic). Twenty-six of the sightings had transiting boats or canoes in proximity to dolphins. Twenty-one sightings occurred where there were whale-watching boat interactions.

The Chi-square tests of independence were conducted with a subsample of 5 min via the statistics program, R (64-bit version 3.1.2.: R [50]) to examine this study's hypothesis (if dolphin-watching boat operators in Bocas del Toro are, or are not, following best whale-watching practices). When possible, subsampling of 5 min was used to offset autocorrelation and pseudoreplication because the sample size of this study is based on 1-min intervals and not the number of interactions observed.

3. Results

The degree of noncompliant approach distances (<50 m) was statistically significant when compared to compliant (>100 m)

approaches ($X^2 = 149.0832$, df = 1, p-value < 2.2e-16, $N = 817$). Fig. 2 illustrates that 71% of the time boats were approaching the animals with distances that were substantially closer (< 50 m) than the maximum distance established by the Panamanian regulations (> 100 m).

Evaluated more closely, both distance noncompliant (50 m or less from dolphins) and distance compliant (100 m or more from dolphins) boats were not following approved whale-watching maneuver techniques. Fig. 3 demonstrates that improper (noncompliant) maneuvers were seen more frequently than proper (compliant) whale-watching maneuvers, even for those boat operators that were at a compliant distance.

The top four violating maneuvers (for definitions of maneuvers see Tables 1 and 2) were "slow speed, direct approach towards dolphins" (SD; 106 occurrences, 18% of all maneuvers, 27% of noncompliant maneuvers only), "following dolphins" (FD; 81 occurrences, 14% of all maneuvers, 21% of noncompliant maneuvers only), "searching for dolphins" (SCH; 64 occurrences, 11% of all maneuvers, 17% of noncompliant maneuvering only), and "harassing dolphins" (HAR; 49 occurrences, 8% of all maneuvers, 13% of noncompliant maneuvers only). "Idle" was by far the most frequent compliant maneuver observed (139 occurrences, 24% of all maneuvers, 71% of compliant maneuvering only; Fig. 4).

Finally, for the number of boats interacting with a group of dolphins, we found that over 817 sightings, 45% of the time (446 sightings) boats were in compliance with whale-watching regulations (i.e., only 1 or 2 boats were simultaneously in proximity to a dolphin group). However, there were 371 occurrences (45% of the time) where whale-watching regulations were being violated with 3 or more boats present around dolphins simultaneously (Fig. 5a). The modal number of boats was 5 (64 total occurrences) to 6 (63 total occurrences) boats (Fig. 5b). There were 3 occurrences when as many as 15 boats were present around dolphins (Fig. 5b).

4. Discussion

This study was conducted one year following the initial recommendation by the International Whaling Commission (IWC) that whale-watching regulations in Bocas del Toro be urgently enforced [20]. The results demonstrate that despite this recommendation from the IWC, noncompliance levels with the regulations were still high and that the IWC recommendations had not been heeded, despite the recommendation given when the IWC was actually meeting in Panama.

For example, despite the study occurring during the low season for tourism and the requirement that whale-watching vessels stay 100 m from cetaceans and 200 m from each other, 71% of the time, boat operators were within 50 m or less of the dolphins (Fig. 2), and 45% of the time, there were 3 or more boats with dolphins, clearly placing the vessels within 200 m of each other (Fig. 5a). Maximum vessel numbers around a dolphin group reached 15, with 5 or 6 boats commonly seen with any single group (Fig. 5b). Just that result alone (the high number of whale-watching boats with a single group of dolphins) makes it quite likely that whale-watching in Bocas del Toro is having a negative impact on the local dolphins.

Increasing this likelihood is the number of inappropriate maneuvers that were also observed in this study. Closer vessels (< 50 m) were more likely to display inappropriate maneuvering than more distant ones (> 100 m), although rates of noncompliant maneuvering were relatively high regardless of distance (Figs. 3 and 4). The combination of aggressive vessel behavior with close proximity to the animals could exacerbate disturbance and pose greater risk, making this a particular concern. When noncompliant boat maneuvers for close boats (< 50 m; $n = 593$) were examined more closely (Fig. 4), 15.3% of maneuvers ($n = 91$) were boats chasing dolphins, 17.9% ($n = 106$) were boats moving slowly and directly towards dolphins, 8.3% ($n = 49$) were "harassing" incidents, and 10.8% ($n = 64$) consisted of boats searching around for dolphins. It is important to note that 14 events (2% of maneuvers) of vessels circling around dolphins were documented, while 14 events (2%) were boats driving through the dolphin pod, and 18 events (3%) were boats within the dolphin group.

Many of these inappropriate maneuvers involve sharp changes in speed and direction that can produce noise with rapidly changing intensity and frequency that have the potential to disturb cetaceans (e.g., [53,64,65]). If dolphins are close enough and the vessel is loud enough, it might be potentially possible for such invasive maneuvering to interfere with the dolphins' communication and impair the dolphins' hearing (temporary or permanent deafness or "threshold shifts") [11,53]. Previous acoustic work in Dolphin Bay, has shown that dolphins shift frequency and duration when interacting with dolphin-watching boats [35,37]. However, May-Collado and Wartzok [36] found that although a

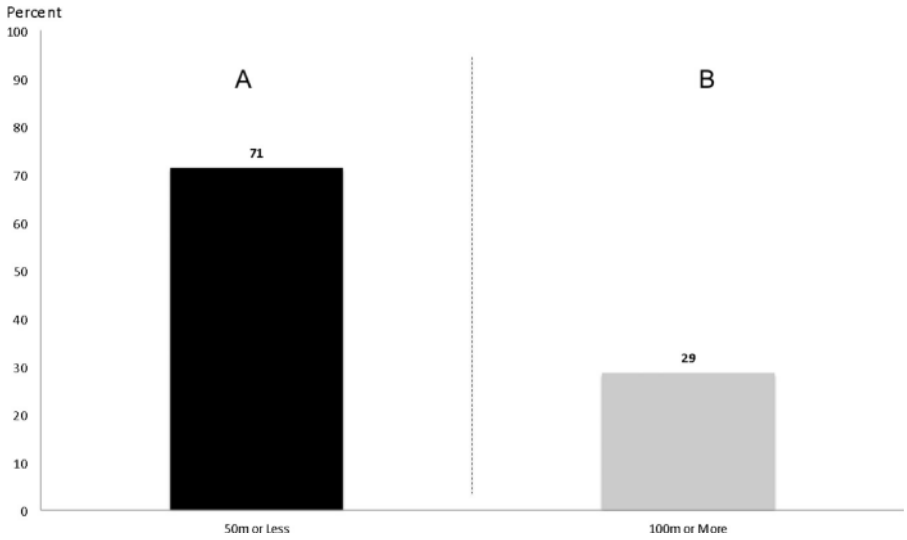

Fig. 2. Proportion of boat operators not following whale-watching regulations and following whale-watching regulations. A majority of 71% of boats were noncompliant with respect to approach distance (A) vs. 29% of boats that were compliant (B).

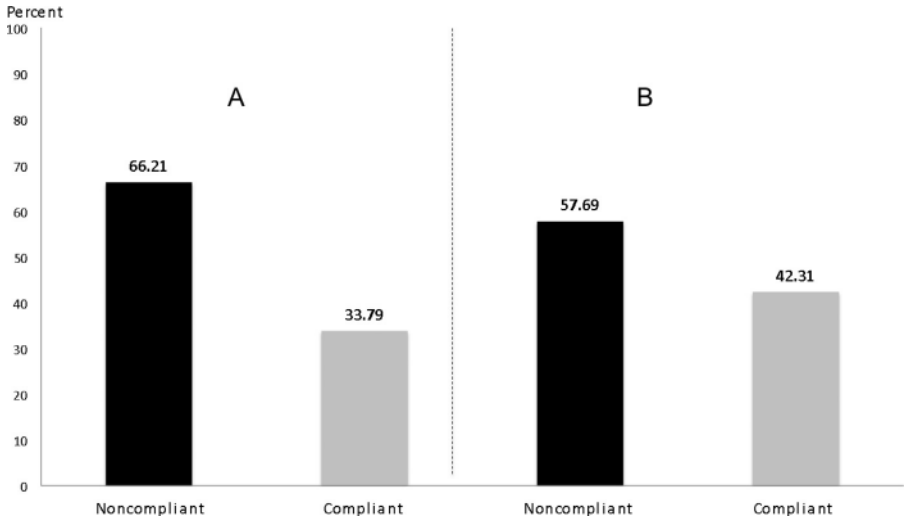

Fig. 3. Proportion of noncompliant and compliant boat maneuvering for both boats at noncompliant (A) boat distances (< 50 m) and compliant (B; > 100 m) distances. Within 817 occurrences, 66% percent of boats closer than 50 m were improperly maneuvering, and only 34% of these boats were maneuvering in a compliant fashion. Boats greater than 100 m away were in violation 58% of the time, while 42% of the time the boats were maneuvering in compliance with regulations.

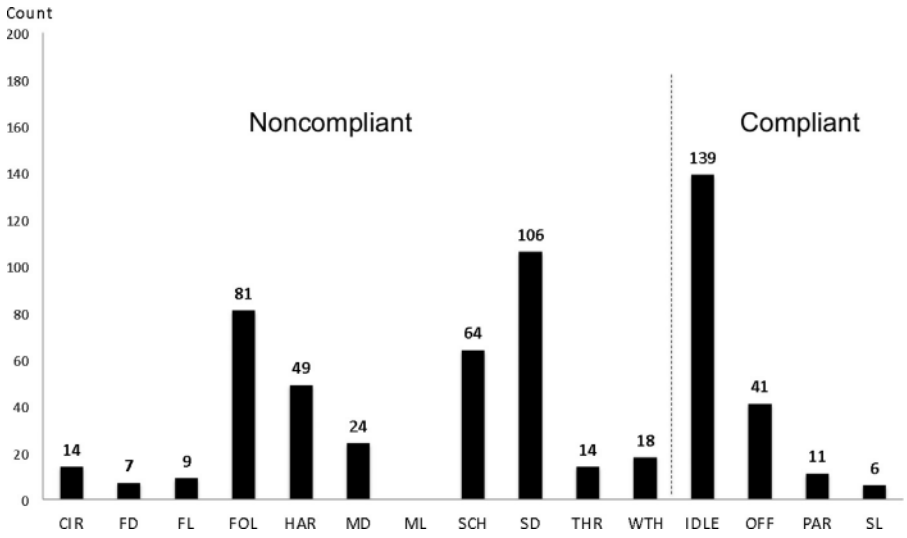

Fig. 4. Total count of whale-watching boat maneuvers in 583 observations at 50 m or less from dolphins. Maneuvers are listed from left to right: CIR=Circling; FD=Fast speed direct; FL=Fast speed leaving; FOL=Following dolphins; HAR=Harassing dolphins; MD=Medium speed direct; ML=Medium speed leaving; SCH=Searching for dolphins; THR=Driving through pod; WTH=With dolphins; IDLE=Idle engine; OFF=Engine Off; PAR=Driving parallel; and SL=Slowly leaving. For definitions of these maneuvers see Tables 1 and 2.

high number of dolphin-watching boats do correspond with higher noise levels, noise levels explained only a small percentage of the variation in Bocas dolphins' communicative signals. They suggest other cues (e.g., mode of approach of boats) may be important contributors to how dolphins respond to boat traffic.

Repeated noise exposure and disturbance may also be inducing repeated and/or chronic stress responses in the dolphin population in Bocas del Toro, with the associated potential for increased energetic costs due to physiological responses, immune function suppression and general increase in mortality rates [3,44,69–71]. Monitoring the long-term behavior, reproductive success and health of individual dolphins would be important future research in the area to detect if such impacts do, in fact, occur.

Finally, another potential concern is that of collisions between vessels and the dolphins. In Sarasota, Florida, higher recreational boat use was associated with increased rates of collisions with bottlenose dolphins in sheltered areas (shallow waters) actually at greater risk of collision due to higher recreational boat density [63]. Shallow waters are commonly used as shelter for dolphin calf rearing and feeding [45]. Mothers and calves are often slow-moving and mothers will typically remain very close to their offspring [63]. The resulting combination of vulnerable animals with increased risk is of particular concern and one that may be realized in Bocas del Toro. Much like Sarasota, Dolphin Bay (the area where most of the dolphin watching is being conducted) is a shallow area (approximately 20 m deep) with narrow mangrove channels [35]. However it is not yet known if this habitat represents a dolphin nursing area.

It is possible that such noncompliance is simply due to a lack of knowledge of Panama's whale-watching guidelines [57]. Misjudgment of the distance between the cetaceans and boats might also be a factor in noncompliance, as was suggested by Kessler and Harcourt [28] for Sydney, Australia. This study did, however, try to take such misjudgment into account in its methodology. Kessler and Harcourt [28] also suggested that intentional disregard for the regulations might be another cause for the noncompliance. Any such deliberate violations in Bocas and elsewhere might be due to a misconception among boat operators that close encounters with

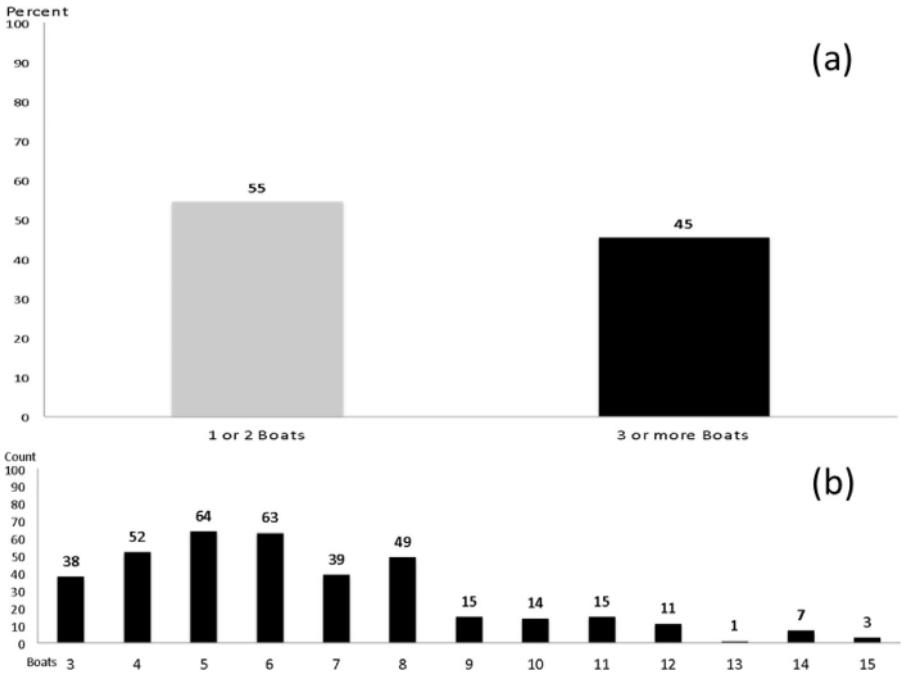

Fig. 5. Compliant (gray) and noncompliant (black) whale-watching boat numbers within 50 m of dolphins: (a) A comparison of the proportion of occurrences in the two categories ($n=817$); (b) Total number of occurrences of noncompliant whale-watching boat numbers ($n=583$).

dolphins enhance the customer experience. A survey conducted in Queensland, Australia, found that the distance between boat and cetacean had no actual effect on consumer satisfaction [46]. In fact, tourists were generally still satisfied with their whale-watching experience even when cetaceans were not seen [46]. In another study, Constantine [8] found that intrusive boat maneuvers resulted in more avoidance behavior and less dolphin-human interaction. Conversely more interaction was seen when boat maneuvering was less intrusive. Constantine [8] also found that human-dolphin interactions were more likely when dolphins had a "choice". Therefore the intrusive boat behavior in Bocas del Toro could actually be reducing the ability of tourists to view cetaceans and thus impeding customer satisfaction.

The findings from this study provide evidence to support previous comments by scientists about unsustainable whale-watching activity in Bocas del Toro (e.g. [39]). Boats are not following whale-watching regulations with regard to number of boats, their proximity to the dolphins nor their maneuvering. Regardless of whether these infractions are due to lack of awareness of the guidelines, honest mistakes, or willful misconduct, the end result is a probable increase in the chances of dolphin disturbance, injury and fatalities.

5. Recommendations

Other studies have ascertained that tourists in the Caribbean tend to prefer whale-watching operations that have sustainable practices [10,31], and thus it would be in the operators' benefit to adhere to whale-watching guidelines and best practices. As noted above, the Panamanian Government clearly has ignored the IWC recommendations [20,21,23,24] to monitor and enforce their whale-watching guidelines. Encouraging the local community to play a greater role in monitoring and enforcing (i.e. peer-to-peer) whale-watching guidelines may therefore be a better approach. This is to say, "bottom up" management of whale-watching guidelines, instead of relying on a "top down" approach. Current efforts are being focused on this bottom up approach. These efforts are requiring a greater level of outreach and engagement activity with the local community. Also, current efforts are involving scientists working closely with community leaders to provide feedback on the effectiveness of this approach. The local community in Bocas del Toro appears to be highly interested in marine conservation, especially dolphin protection (Sitar et al. in prep.), and thus, such a bottom up approach is probably feasible. However, it is equally important that responsible governmental agencies get involved in these ongoing efforts. Licensing dolphin-watching operators should limit the number of boats allowed to interact with dolphins and training should ensure that those boat operators with licenses have the appropriate knowledge to make good judgments in the field about distance, speed, and maneuvering. Furthermore, if the situation in Dolphin Bay were to be scientifically reviewed every year, with licenses similarly reviewed and evaluated annually, it should ensure that operators have a vested interest in ensuring the sustainability of dolphin-watching operations, and encouraging best whale-watching practices, if they wish to have their license renewed.

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