# THE STATUS OF THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) POPULATION OF BOCAS DEL TORO, PANAMA: PRELIMINARY RESULTS BASED ON A THREE YEAR ONGOING STUDY


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We allow the use of the information reported here <u>only</u> for NGO's seeking conservation and protection of these dolphins, and for govertmental agencies responsable to protect and manage these animals. However, the reader should be clear in that this is a preliminary and descriptive analyses of our data. More exhaustive and conclusive analyses are on the way and until them precaution is advice. Please cite this document as:

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## I. BACKGROUND

The Bottlenose dolphin (*Tursiops* spp.) among the best known dolphin species worldwide, largely for being the 'favorite' species to have in aquaria (Defran and Pryor 1980). Bottlenose dolphins are easily identified by their robust body, curved dorsal fin, gray coloration, and short rostrum. Adults range from 2-3.8 m (mean weight of 242 kg) (Culik 2004). Two species are recognized, *T. aduntus* known as the Indo-Pacific Bottlenose dolphin, found in waters of Australia, the Indian Ocean, China, and South Africa; and *T. truncatus* known as the Bottlenose dolphin found in temperate and tropical waters around the world (Culik 2004, Natoli 2006). In some areas several well-defined coastal communities have been described (resident dolphins inhabit a mosaic of overlapping home ranges). Two ecotypes of *T. truncatus* are recognized: coastal and oceanic, that appear to be distinct in terms of morphology, prey choice, (Mead and Potter 1995) and possibly social structure. Within these communities resident and non-resident animals can be found. Resident animals can show patterns of site fidelity of up to 17 years (Rogers et al. 2004).

Bottlenose dolphins live in social fission-fusion societies where individuals tend to associate in small groups and group composition varies throughout the day (Connor et al. 2000). The strongest social bonds are among adult males that tend to form complex hierarchical alliances which facilitate them to compete over estrus females (Connor et al. 1992, Connor et al. 2006). Females also form associations but they appear to be weaker and more variable. While some are solitary other can form associations of 'moderate strength' (Smolker et al. 1992).

A wide variety of sounds are produce by these dolphins which have been categorized into (1) broad-band echolocation clicks used to monitor their environment, prey and predator detection, (2) broad-band burst-pulsed sounds and (3) tonal sounds (often referred to as 'whistles') which are used for communication (Cook et al. 2004). Caldwell and Caldwell (1965) discovered a special type of tonal sound in captive bottlenose dolphins, so called 'signature whistles'. They noted that when captive bottlenose dolphins were separated during medical inspection, the animals emitted highly stereotyped whistles, unique for each individual. Based on these observations they proposed that signature whistles could serve for individual recognition and group cohesion. Since their work signature whistles have been documented in both wild and captive animals (Sayigh 2002, Janik and Slater 1997, Janik 2000). When all members of a group are together a variety of whistles are produced, but signature whistles are rarely used (Janik and Slater 1997).

Recognition patterns are strongest between mothers and calves (Sayigh *et al.* 1998). When the calf voluntarily gets separated from its mother, it will emit signature whistles to facilitate a reunion. Newborn calves are capable of whistling within days of birth, but the signature whistle is not developed until the first to third month of life. Once the signature whistle is developed it remains stable for the rest of the dolphin's life (Tyack 1999). Tyack and Sayigh (1997) proposed that the development of signature whistles had an important learning component. Several factors have been proposed to influence the acoustic structure of these signals: social structure (May-Collado et al. submitted, Podos et al. 2002), body size (May-Collado et al. in press, Matthews et al. 1999, Wang et al. 1995), the environment [ambient and anthropogenic noise] (Wang et al. 1995), and zoogeographical relationships (Steiner 1981).

Because coastal bottlenose populations are often in contact with humans, their populations tend to be more susceptible to human activities such as whale-watching, pollution, boat traffic, fisheries, etc. (Culik 2004). In several countries around the world, including Costa Rica, Guatemala, Mexico, and Venezuela bottlenose dolphins have been directly caught (Culik 2004), often for bait for shark fishing. Incidental mortality in gillnets and purse-seine fisheries occurs but the magnitude is unknown. According to Reyes (1991) Bottlenose dolphin annual mortality in the eastern tropical Pacific appears to be a small fraction (<5%) of the total small cetacean mortality.

Live catches also occur worldwide. Despite many international treaties and local protection through laws and regulations bottlenose dolphins are still caught from wild populations for aquaria exhibition. Many companies direct their efforts to Latin American countries where presumably there is little regulation (e.g. Guyana, Panama, Costa Rica), or limited enforcement of regulations.

Other human activities such as whale-watching, engine noise, pollution, and overall habitat destruction may be seen as indirect disturbances because they do not cause immediate mortality, but have accumulative that can nevertheless deteriorate the well being of dolphin populations.

Whale-watching has become the most popular eco-tourist attraction worldwide (Hoyt and Hvenegaard 2002, Hoyt 2001, 2002) exceeding US $1 billion worldwide in indirect expenditures (Hoyt 2001). As Hoyt (2000) pointed out, few sectors of the tourism industry have experienced the same levels of growth in such a short time as whale-watching operations. Latin America is one of the fastest growing tourism regions worldwide, in countries like Costa Rica and Panama, tourism represents a major source of income (LeMay 1998). The whale-watching industry in Central America (including the West Indies) is the second most rapidly growing worldwide with an average of 111.4% annual increase between 1991 and 1994, and 47.4% between 1994 and 1998. In 1991 the number of whale watchers was around 2,034 and 90,720 in 1998 (Hoyt 2001).

At first the International Whaling Commission (IWC, 1994) encouraged whale-watching as a sustainable use of cetacean resources. However, because most whale-watching is boat-based (72%) (Hoyt and Hvenegaard 2002) a rapid increase in this activity was inevitably associated with increase in boat traffic[3]. As a result, IWC (1995) and IFAW (1996) recognized whale-watching as potentially detrimental to cetaceans and organized a series of workshops to design guidelines for regulating whale-watching (Hoyt and Hvenegaard 2002). Early guidelines emphasized regulating approach distances, but with growing evidence that engine and propeller noise are the main cause of disturbance (e.g., Wartzok et al. 2004, Nowacek et al. 2001, Kruse 1991, Van Parijs and Corkron 2001), new regulations incorporate noise level limits (IWC 1995, IFAW 1996). At this pace there is a risk that noise levels from growing whale-watching and other recreational boat activities could reach critical limits. This is alarming, since many Latin American countries, including Panama are known for their efforts in conserving biodiversity, yet do not have whale-watching guidelines.

Motorized watercraft noise generally elicit avoidance behavior by cetaceans, like increasing swimming speed (Nowacek et al. 2001, Kruse 1991, Au and Perryman 1982, Urik 1983), longer dive duration heading changes (Nowacek et al. 2001, Au and Perryman 1982), decreased breathing synchrony (Hastie et al. 2003), and decrease inter-animal distances (Bedjer et al. 1999). Watercraft noise can also elicit changes in vocal rate (Van Parijs and Corkeron 2001, Buckstaff 2004, Scarpati et al. 2001), call duration (Foote et al. 2004), signal diversity, and frequency (Lesage et al. 1999) to avoid masking and to maintain group contact when boats are present. While some species show a greater vocal rate at the onset of approaches or after being disturbed by boats (Van Parijs and Corkeron 2001, Buckstaff 2004), others species produce longer calls when noise reaches critical levels (Foote et al. 2004) and shifting in frequency (3.6 kHz to 5.2-8.8 kHz) when vessels are to close.

Because of their worldwide distribution and plasticity to inhabit a variety of habitats, bottlenose dolphins are often used to establish water quality (Culik 2004). Concentrations of DDT, PCBs and heavy metals have been found in several bottlenose dolphin populations (Reyes 1991). High levels of these contaminants have been found in these dolphins, and theoretically could reduce reproductive ability and neonatal mortality (Wells and Scott 1999). Even low levels of DDT and PCBs can affect the immune system function (Culik 2004).

The goal of this report is to provide the first assessment on the status of this resident bottlenose dolphin population. The report is based on an ongoing research project by the principal investigator and collaborators that started in 2004. Here we provide preliminary information on the occurrence, distribution, group size, site fidelity, habitat use, population size estimations, bio-acoustics, and information on human-dolphin interactions. Our results can be used for future conservation and managing plans for the area. These should include guidelines for ‘dolphin-watching’ operators and other human activities that overlap with dolphin habitats. In addition, for organization such as Ocean Embassy with intentions of extracting individuals from this population, this is a small population of bottlenose dolphins with apparent restrict home ranges.

## II. Methods

### STUDY SITES

The Archipelago of Bocas del Toro is located on the Atlantic coast of Panama, about 35 km from Gandoca, Costa Rica. Bocas it is not protected by law, but it holds important marine ecosystems, including mangrove forest, sea grasses, and coral reefs. The area holds a resident population of bottlenose dolphins that are exposed to moderate-high whale watching, in addition to noisy traffic from the Almirante port. Figure 1 shows the surveyed area.

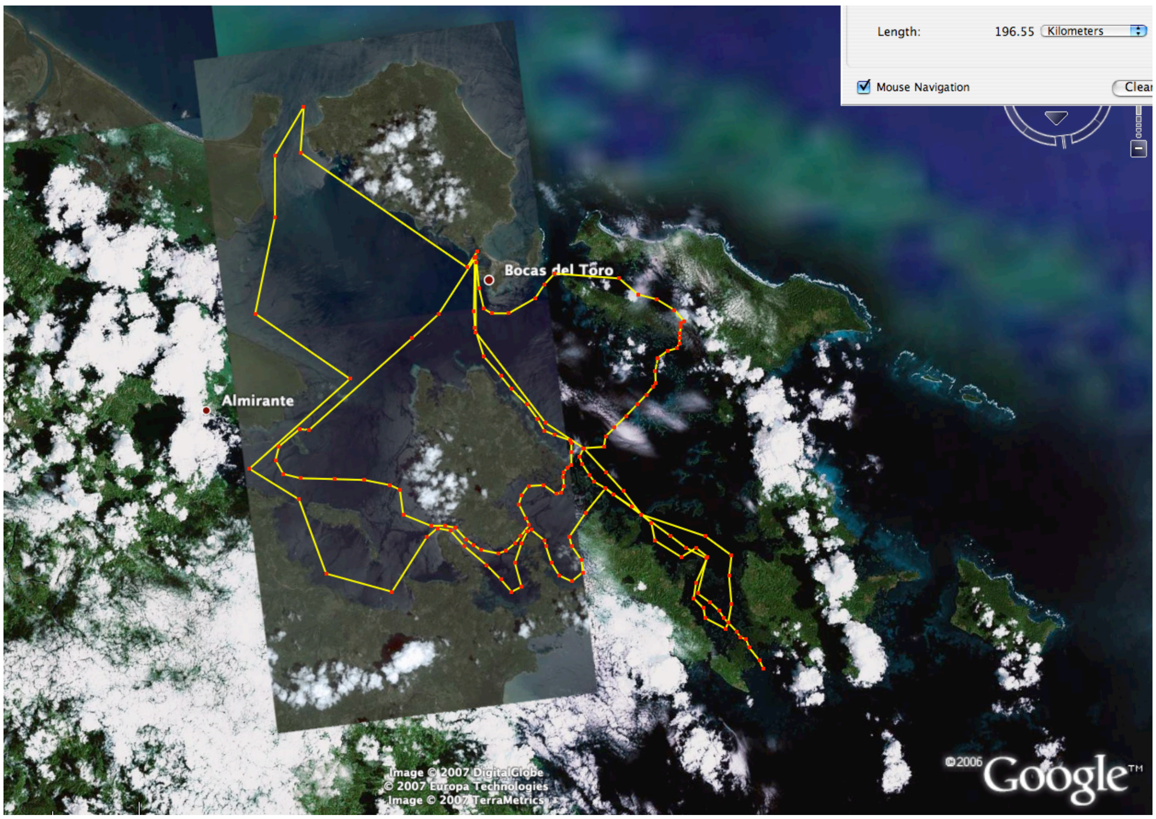



Figure 1. Surveyed area and respective predetermined routes followed each day.

**Surveys:** Study sites were boat-surveyed from 0630h to 1730h following several predetermined routes as shown in Figure 1. Once a group of dolphins was encountered the boat is approached slowly and in a parallel position to avoid dolphin disturbance (Wursig and Jefferson 1990). We generally maintained about 20-50 m distance to the group before turning the engine off to initiate data recording and photo-ID work. This type of approach is standard in cetacean studies because it minimizes behavioral impact on the group (e.g., Wursig and Jefferson 1990). A group is here defined as a "cohesive collection of conspecifics in a limited area, often engaged in similar activities and moving in the same general direction, maintained by social factors as a unit" (Wells *et al.* 1999). The following data was collected: group size (minimum, maximum, and best estimation), group composition (age and gender if possible) and geometry (see List I), photo-ID (unique marks in dolphin dorsal fin are photographed for later individual identification of group members), geographical position using a GARMIN GPS, behavioral state at the moment of the encounter and during acoustical recording sessions, and presence/absence of other boats. If boats were present the following data was collected, type of boat (see List I), the engine type (e.g., 25 hp, 50 hp etc), and type of approach (see List I).

**BEHAVIOR:** The occurrence of social activities, travel, resting, milling, foraging-feeding events, and diving based on May-Collado and Ramirez (2005*)* and Lusseau (2003) were measured using instantaneous scan sampling every 3 minutes to estimate the predominant behavior during acoustic recordings. The same method was used to determine changes in predominant behavior before, during, and after the encounter with dolphin-watching boats. Groups were followed between 20 min to 2h. Groups were followed until they were not seen anymore, or they were abandoned earlier if the animals showed signs of stress (tail slapping, loud blows, etc). Whale-watching boats approaching towards a group from a distance of 500 m were considered acoustically interacting with the group, since noise is within their audibility range at that distance.

**PHOTO-ID:** Photographs of the dorsal fin of the animals were taken to later use natural marks to identified individuals (Wursig and Jefferson 1990). This technique is a standard to determine site fidelity, estimate population size (by using capture and recapture analyses), movement patterns, and to control for re-sampling the same groups particularly in acoustic and behavioral studies. Photographs were taken (when possible) of each side of the dorsal fin. We used both 'random' and 'focal' techniques. A random technique is used when the group is larger than five individuals. Photos are taken in a random fashion no matter the side of the dorsal fin. When most of the group is photographed then we switch to a 'focal' technique by following individual animals in order to get both sides of their dorsal fin. A group with <40% of group composition similarity to previous sampled groups, was considered an independent group. We used digital cameras Canon EOS 10D, 6.3 Megapixel SLR and a digital Canon Rebel, with a 75-300 mm zoom lens.

Photos were later processed in Adobe Photoshop 7.0. Good quality pictures are selected based on contrast, focus, and coverage of the dorsal fin within the frame. These photos are printed, and then compared with previous photos. The matching process is done visually by two or three people independently, which need to be in agreement before a match is confirmed or a new individual is added to the catalogue. Photos below illustrate the type of naturals used to identify dolphins some are more permanent than others reason why the of continuous photo-Id work.


JACOME RACHEL-C


PLINIO LUNA


BLADES URANIA (female)

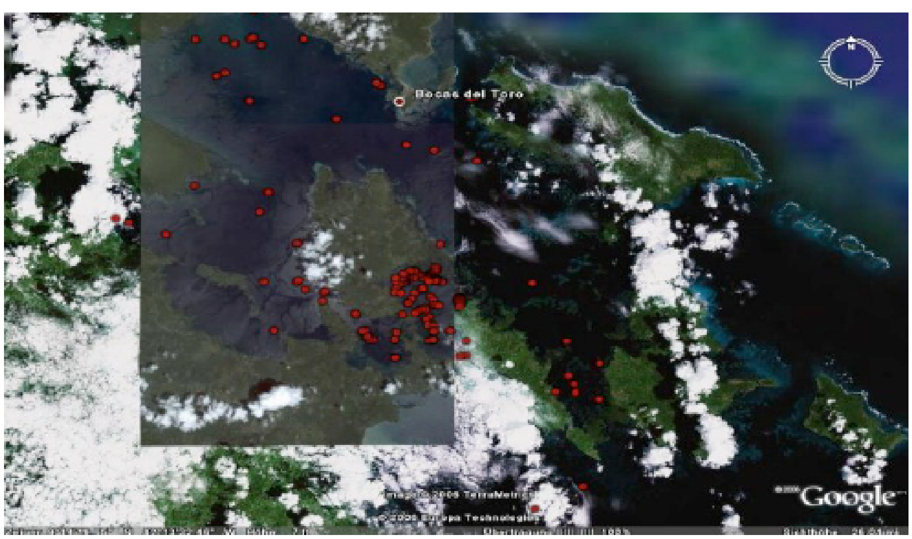
Figure 2. Examples of recently photo-identified animals (2007)

ACOUSTIC RECORDINGS: Dolphin acoustic signals, boat engines, and ambient noise were recorded using a broadband system: a RESON hydrophone (-203 dB re 1V/µPa, 1 Hz to 140 kHz) connected to AVISOFT recorder and Ultra Sound Gate 116 (sampling rate 500 kHz 16 bit) which sent the signals to a laptop (for details see May-Collado and Wartzok 2007). Sound files were later analyzed in the lab with the software Raven 1.1[R]. Dolphin signals were classified as *whistles*, pulsed sounds, and echolocation clicks (Richardson et al. 1995). For whistles a total of 14 parameters were measured following Barzua-Duran and Au 2003 and Azevedo and Sluys 2005. Complete and on axis *echolocation clicks* chains were analyzed following Rasmussen and Miller (2002) parameters. *Pulsed-sounds* (e.g.squawks, blats, cracks, snaps, bleats, barks, groans, and moans) will be analyzed following Lammers and Au (2003) parameters. Behavioral data will be collected from onboard.



## III. RESULTS AND DISCUSSION

OCCURRENCE AND GROUP SIZE: A total of 169 dolphin groups were sighted during the study period (2004, 2006, 2007). The total accumulative number of individuals in these groups was 1052, however, the same animals were seen multiple times, the total number of individuals in the Bocas population is only a fraction of this number (see below). The map below shows the distribution of group sightings from 2006. We are updating this map in ArcView with GPS data from 2004 and 2007.



Overall, sighting rate during the study period was 2.82 groups per day. Figure 3 shows the sighting rate for each year. Mean group size was 6.2 ± 5.2. Figure 4 shows the distribution of group sizes with 58.6% of the observed groups consisting of less than 6 individuals per group. Group size varied in relation to behavioral states. Groups engaged in traveling and social activities tend to be larger than those groups involved in foraging, milling, resting, and diving activities (Fig.5).

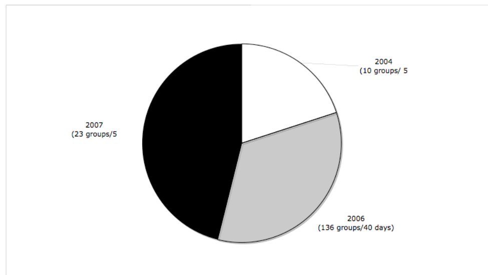



Figure 3. Group sighting rate based on numbered of days surveyed.

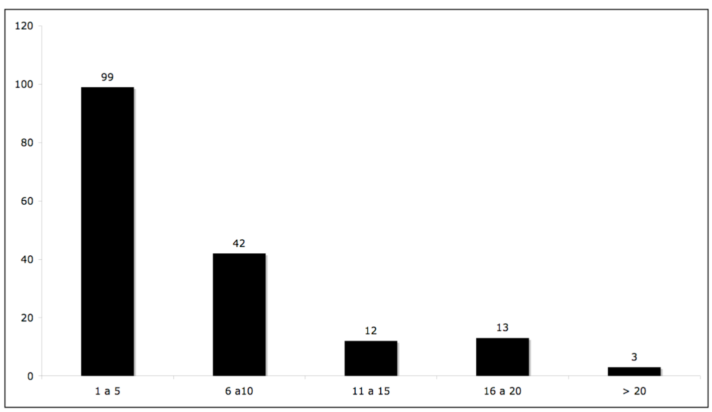



Figure 4. Group size distribution considering all groups observed.

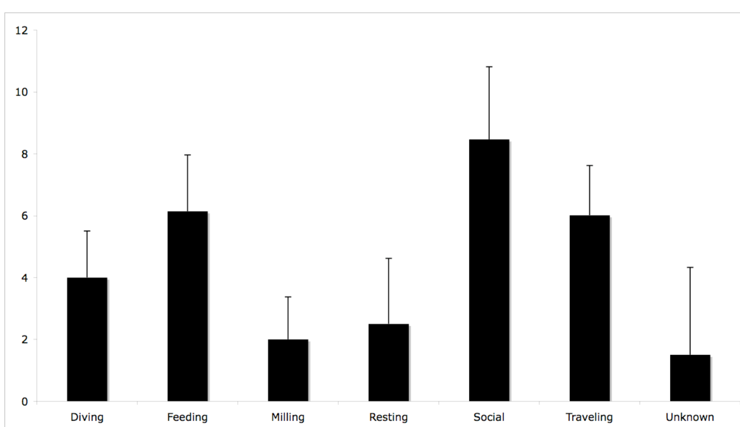



Figure 5. Mean group size in relation to group activity

**Population size estimates, and Site Fidelity:** We have not yet completed the photo and matching processing of 2006 and 2007. Thus this section is preliminary and with the only purpose of providing at first population size estimation based on the available information. We will be providing a more complete estimation once our 2007 field season is over.

We have photo-identified a total of 80 individuals within the limits of the study area. Figure 6 shows the discovery curve based on the accumulative number of new animals identified in each survey. About 48% of the animals have been re-sighted in the study area and the rest has been observed in only one occasion (Fig. 7). Using the software Simply Tagging (1999) we estimated population size using both, open (Jolly-Seber model) and close (Chao model) population models. We prefer to be conservative and report both estimations, given the preliminary nature of the data. Both models suggest the population is small. The open model estimates a population consisting of 43 (SD=4.8) to 65 (SD=6.9) animals with a 95% CI of 23 to 91 animals. The close model estimates a population of 102 (SD=9.60) animals and a 95% CI of 90 to 129 animals. It is important to note that coastal bottlenose dolphins show a variety of movement patterns, some move seasonally, other maintain year-round home ranges, others show periodic residency, and finally others show a combination of occasional long range movements and repeated local residency (Culik 2004). We do not know yet what animals show what pattern, but preliminary data suggest the Bocas community consist of residents (animals that have been observed during the three years, see Fig.8) and non-residents animals (some animals have been observed only in one occasion during these three years).

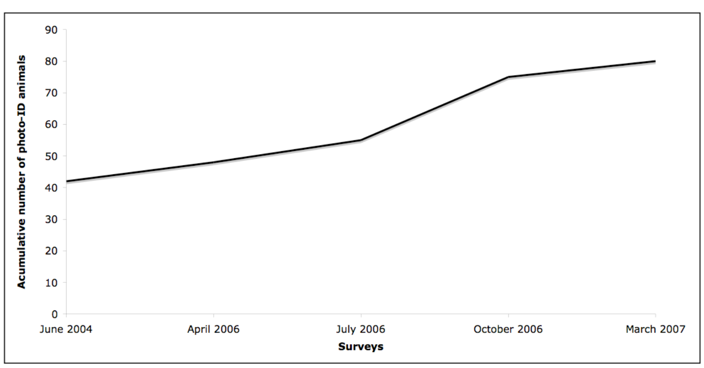



Figure 6. Accumulation curve of new ‘captures’ in five surveys.

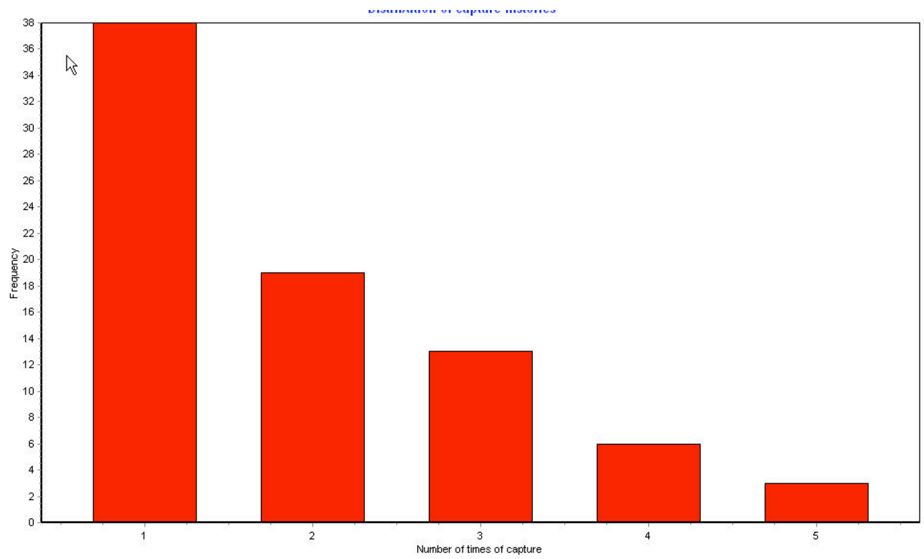


Figure 7. Distribution of photo-identified animals

Several animals appear to be year-round residents that tend to show site fidelity to specific areas within the Archipielago. For instance the following dolphins are typically encountered in Bocas Torito (see Fig. 8): Bity, Suppermessy, Halfin, Dolpho 3, Middlenotch2, Sawy, Scratchy, Zig-zag, among others. Figure 9, shows the expected home range of some of the most frequently encountered animals.

We have compared our photo-ID catalogues of bottlenose dolphins from Bocas del Toro with the one we have created for the Wildlife Refuge of Gandoca-Manzanillo, located only 35 km north Bocas. To date we have not found a single match between these two adjacent areas. Although preliminary, thus strongly suggest that despite the proximity, there may be little overlap between these populations. More work is underway to determine the degree of overlap (if any) of these populations.

BITY (female) HALFIN (male)

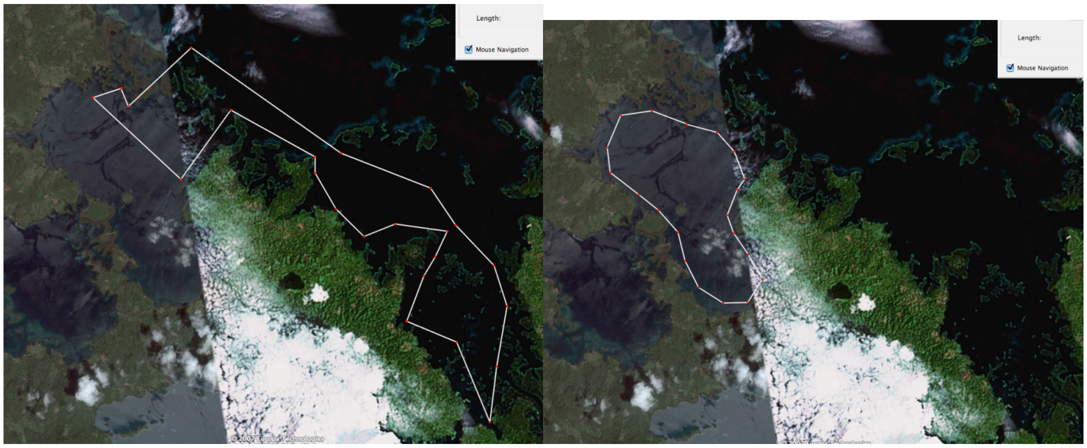
MESSY SUPERMESSY (female)

DOLPHO-3 SAWY

ZIG-ZAG



Figure 8. Examples of the most encountered dolphins in Bocas del Toro.



A. B.

Figure 9. Expected home ranges of Halfin and Bity (A) and Messy, Supermessy, Zig-zag, Dolpho 3, Middlenotch2, Sawy, and Scratchy (B) based on photo-ID data.

PRELIMINARY ASSESSMENT OF DOLPHIN HABITAT USE: Bocas is an important place for this bottlenose dolphin population. Bocas is use primarily for feeding and social activities, and animals tend to move considerably within the Archipelago (Fig.10). When considering time of the day, time of the encounter and group size, dolphins appear to invest more time foraging and diving in the morning and socializing in the afternoon (Taubitz 2007).

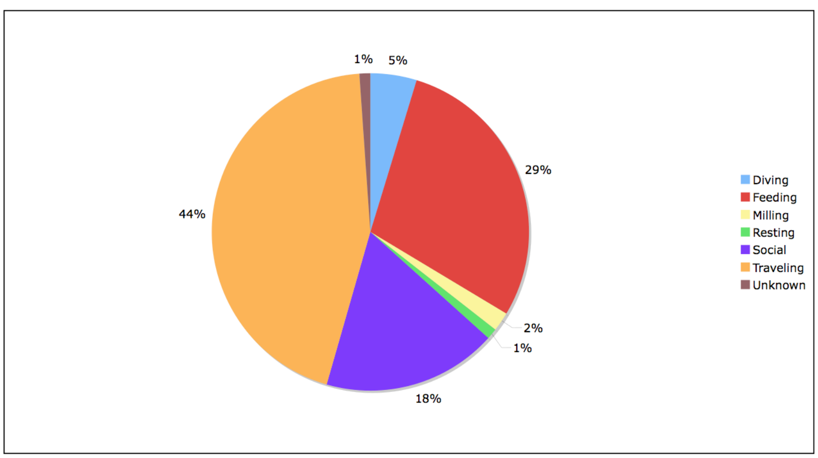



Figure 10. Percentage of groups encountered in a particular behavioral category.

BOAT TRAFFIC AND ITS EFFFECT ON DOLPHIN BEHAVIOR AND BIO-ACOUSTICS: In Bocas boat traffic rate during 2006 was 0.66, approximately every 1.5 minutes a boat passed by the research boat (Taubitz 2007). Table 1 shows a comparison of boat traffic and engine power between Bocas and the Wildlife Refuge of Gandoca-Manzanillo in Costa Rica (located 35 km north). The most common type of boat observed in Bocas, particularly within Bocas Torito are ‘dolphin-watching’ boats. The number of whale-watching boats directly interacting with a single group of dolphins ranged between 3 and 12.

**Table 1:** Quantity of boats per minute in the both study areas, subdivided into boat categories (Courtesy of Evelin Taubitz 2007).

| | Whale Watching | Fishing | Local Transport | Personal | Ferry | Jetski | Yacht | Others |
|---|---|---|---|---|---|---|---|---|
| **Bocas del Toro** | 0.4784 | 0.0008 | 0.0123 | 0.0716 | 0.0004 | 0.0031 | 0.0065 | 0.0913 |
| **Manzanillo** | 0.1952 | 0.0137 | 0.0000 | 0.0000 | 0.0000 | 0.0024 | 0.0000 | 0.0000 |

**Table 2:** Percentage of boats in different engine power classes observed in the two study sites. Boats with smaller engines are more common in Gandoca-Manzanillo than in Bocas del Toro (Courtesy of Evelin Taubitz 2007).

| | to 50 hp | 50-100 hp | 100-150 hp | 150-200 hp | >200 hp | others |
|---|---|---|---|---|---|---|
| **Bocas del Toro** | 23.69 | 65.54 | 3.45 | 3.18 | 1.40 | 2.75 |
| **Manzanillo** | 57.63 | 29.66 | 12.71 | 0.00 | 0.00 | 0.00 |

Taubitz (2007) found that in Bocas the approaching mode of the boats (see list below) played a major role in the reaction of the dolphins towards the whale-watching boats. Boats that were aggressive in their approach to the dolphins i.e., fast, driving directed toward the dolphins without changes of speed provoked the highest percentage of negative responses (78%). Because of the intense boat traffic dolphins may have become habituated to their present, but they are still being selective to whale-watching boats, which are the ones that spend more time following them. Taubitz (2007) found that during and after an encounter with whale-watching boats dolphins will spend more time traveling than in the presence of any other type of boat. In addition, to type of approach, the number of boats following a group of dolphins also had an effect on dolphin behavior. As shown figure 11 negative responses increased and neutral responses decreased with increasing number of boats.

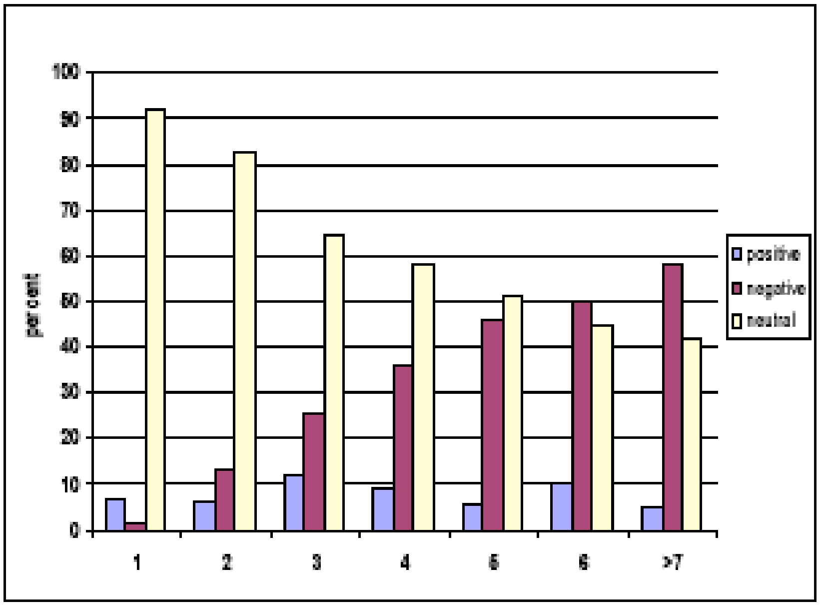



Figure 11. Responses of dolphins towards number of whale-watching boats present in an encounter.

In terms of acoustic responses we noted that there were no significant differences in sound production rate before, during, and after the encounter with a whale-watching boat. However, sound modulation (measured as whistle contour composition) did change. Figures below courtesy of Evelin Taubitz (2007) show the changes in whistle modulation before, during, and after an encounter with a dolphin-watching boat. In Bocas the predominant whistles counters (see Fig. 12) before an encounter with a boat were simple in modulation (45% 'upsweeps'), then during the encounter the dolphins shifted to emit highly modulated whistles ('sine whistles' 56%), and finally after the encounter they switched back to simple whistles (40% 'downsweeps').

Whistle acoustic structure also was affected by engine noise. In Bocas, during the encounter with whale-watching boats, dolphins tended to emit whistles with higher maximum and start frequency, after the encounter maximum frequency dropped back to similar values before the encounter (Taubitz 2007). In addition, there was a tendency to increase number of inflection points during these encounters. Number of inflection points is another measurement of whistle frequency modulation. When we compare dolphin/whale-watching interactions with the dolphin/research boat interactions we found that dolphins will produce more frequency modulated whistles in the presence of whale-watching boats.

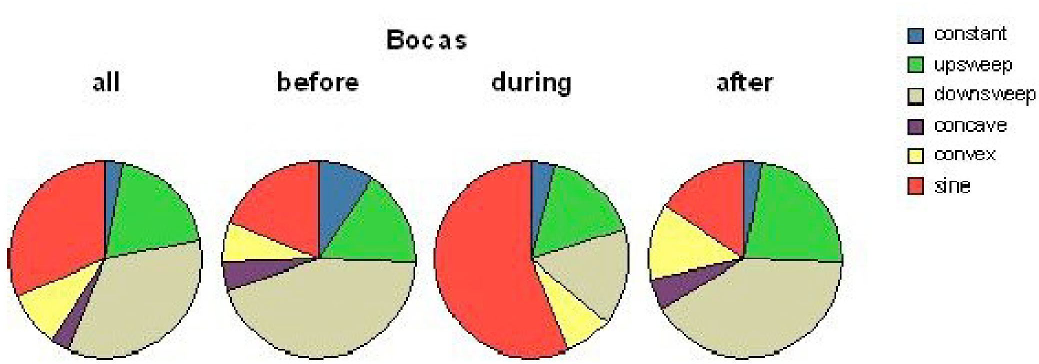



Figure 12. Changes in whistle contours (see attachment below that shows each type of whistles) before, during, and after an encounter with a whale-watching boat.

## IV. Conclusions and Recommendations

-The bottlenose dolphin population of Bocas del Toro is small and consists of year-round resident and non-resident animals. Resident animals appear to show high site fidelity and limited movement patterns. We do not recommend any dolphin extraction from this small population.

-Dolphins use the area for a range of activities feeding, traveling, socializing (mating, mother-calf, social interactions between group members, etc) and, resting and milling. Preliminary observations also suggest Bocas Torito may be an important habitat for mothers and calves as it is a particularly protected and closed area.

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-Although bottlenose dolphins appear to be habituated to human activities in Bocas, dolphins can react negatively particularly in the presence of intrusive and abundant whale-watching boats. As shown by Taubitz (2007) dolphins do not try to avoid all interactions with boats, unless the interactions become too lengthy and intrusive, or unpredictable. Leapfrogging (speeding to overtake whales or forcing them to play with the boat) is a technique used by many whale-watching operators in Bocas. This type of approach involves speeding, and speeding increases the intensity of cavitation noise and shifts engine noise to higher frequencies which are more likely to mask cetacean signals. Speeding thus tends to provoke more avoidance from the animals, than slower speeds with parallel approaches. Future 'dolphin-watching' guidelines should take into consideration the mode of approach and the speed o approach to the dolphins.

- When considering just the number of boats interacting with a particular of group, dolphins tend to increase their negative reactions with increasing number of boats. Taubitz (2007) showed the maximum negative reactions are reached when more than seven boats are present. This last field season we found that most whale-watching boats gathered with the same group of dolphins (up to 15 boats in the same location) forcing in many cases the animals to leave the area. We recommend no more than three boats following properly the same group of dolphins.

- With increasing whale-watching in Bocas, engine noise levels are also increasing. This augments the chances of masking important dolphin signals. Operators need to learn to recognize the different behavioral activities and be discrete in their approach particularly when the animals are feeding and relying in the echoes and fish sounds to detect prey, and when they are socializing, whistles are often used to promote and maintain group cohesion, maintain mother-calf contact, and promote male alliances which are important during the breeding time.

## V. Future Research

Population assessment: We are seeking for funds to do monthly surveys and in a larger area. The goal of the project is to photo-Id most of the animals in the population in order to get a more accurate population size estimation. In addition, we need to know what percent of the population is resident and which is not, as well as, the extend of their home ranges.

HABITAT ASSESSMENT: Furthermore we need to identify and characterize (prey availability, structure, etc.) which are the most important areas used by the resident dolphins. During the survey of March 2007, we hardly found dolphins in Bocas Torito, an area where they are commonly found. It is not clear yet this represented a change in distribution due to biotic or abiotic factors.

NOISE POLLUTION AND INTERACTIONS DOLPHIN-BOATS: Engine noise disturbances due to whale-watching and other recreational activities represent a real threat to Latin American cetaceans. Noise effect on dolphins depends on (1) the distance and depth between the animals and the source and (2) the intrinsic characteristics of noise sources. It is therefore a priority to (a) identify areas of dolphin/whale-watching overlap, (b) identify type and number of noise sources, (c) determine noise frequency of the sources, (d) determine the behavioral responses of the animals to the noise, and (e) assess habitat acoustic constraints that may facilitate negative interactions between animals and anthropogenic noise.

With the information this project is and will be generating we hope to help to propose several solutions to control approach distances and its associated noise. In the next year we will be testing different proposed models to identify and 'manage' noise levels. These are based on modeling zones of noise influence, defining critical areas, and areas of sensitivity or vulnerability.

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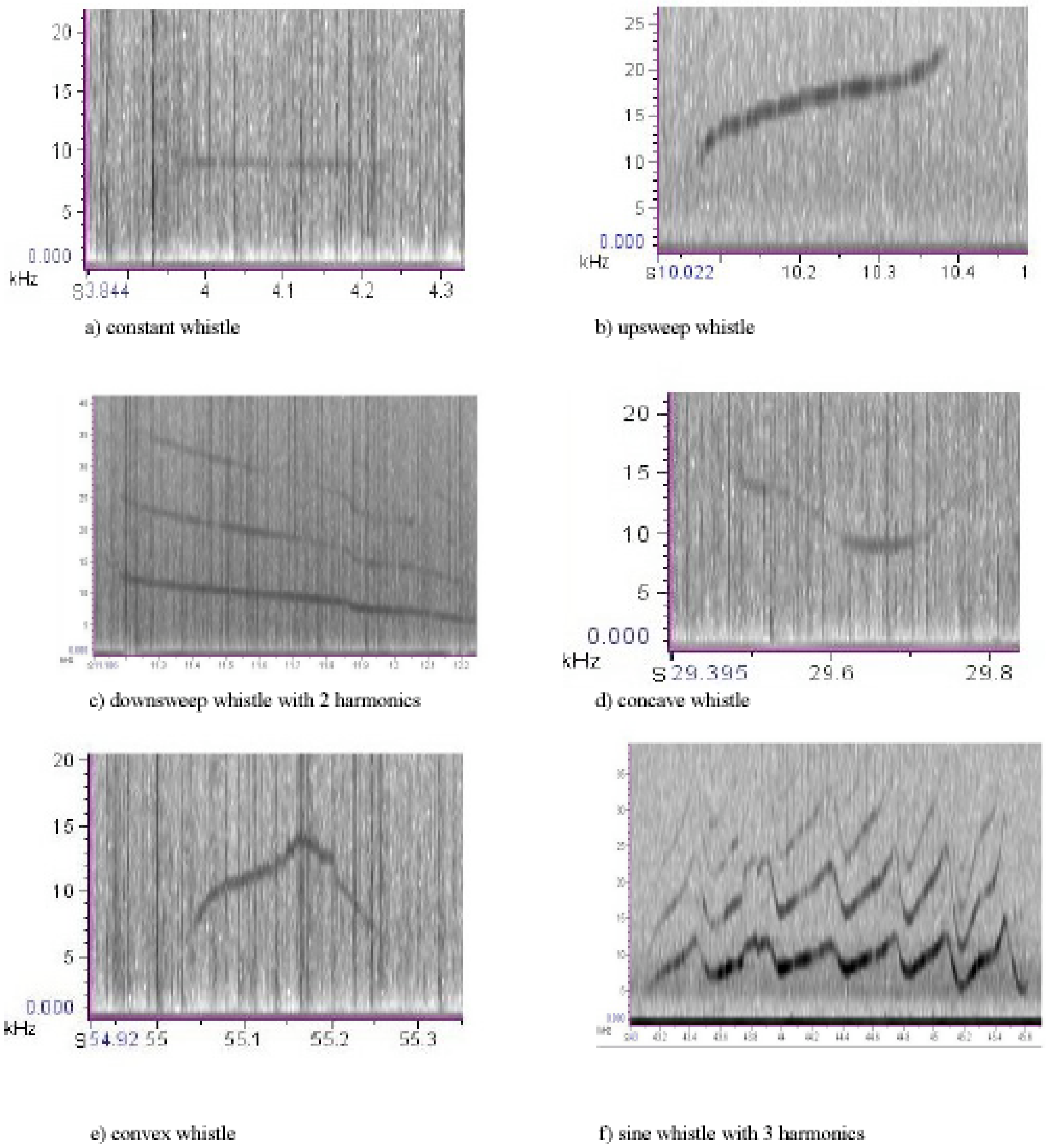
List of categories and definitions (Courtesy of Evelin Taubitz and Laura May-Collado).

| **Type** | **Description** |
|---|---|
| Research | Our boat used for investigation |
| Whale-Watching | Boats with tourists that stay and observe dolphins |
| Local Transport | Boats used for carrying passenger between islands or between mainland and islands, normally travelling at high speed |
| Personal | Boats primarily used for transporting workers and materials for work, as well as private vessels |
| Jetski | Fast motor-cycle like speed vehicles for one or two persons |
| Yacht | There was one private yacht in Bocas normally almost immobile doing whale-watching |
| Catamaran | Normally moving with inboard engine, doing whale-watching |
| Kayak | Without engine, often used from locals as fishing boats |
| Fishing boat | Small fishing boats with outboard engine |

| **Abbreviation** | **Description** |
|---|---|
| off | Engine off |
| 0 | Idle running |
| 1 | Fast, directed at the dolphin group, changes of speed |
| 2 | Fast, not directed at the dolphin group, changes of speed |
| 3 | Fast, directed at the dolphin group, no changes of speed |
| 4 | Slowly, parallel to the dolphin group, no changes of speed |
| 5 | Slowly, persecuting dolphin groups, changes of speed |
| 6 | Slowly, directed at the dolphin group, no changes of speed |
| 7 | Making circles |
| 8 | Fast, not directed at the dolphin group, no changes of speed |

| | |
|---|---|
| **positive** | Dolphin approach the boat, swim in the waves or follow it after it has passed by |
| **negative** | Dolphin flee or avoid the boat, radical behavioral changes, fast directional changes |
| **neutral** | No observable changes of behavior, continue to perform ongoing behavior |




Type of whistles contours defined for this study. Courtesy of Evelin Taubitz and Laura May-Collado.