Dolphins of the coastal Central Pacific of Costa Rica (from Matina to Puerto Limón)

Diversity and seasonal distribution

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Introduction

The Cetaceans are the most diverse group (order) of marine mammals, with 87 species currently recognized, gathered in 12 families and in 2 living suborders. They have colonized almost all ecosystems and habitats available from the coast to the open ocean, and from the surface to even great depths (+3000 m), countrary to other groups of marine mammals which have limited distributions around the world. It can even be found Cetacean species that are endemics of only one country. On the other hand, there are species that are year round residents of specific regions, while others are seasonal migratories. In general terms, Cetaceans play an important role in the marine ecosystems, particularly because their position in the marine food webs and because of this they have been called “ocean sentinels”, due to through their study, it can also be pictured different aspects of the ecosystem as a whole. From a conservation point of view, Cetacean species are also typical “umbrella species” (Leatherwood & Reeves 1983, Evans 1987, Katona & Whitehead 1988, Jefferson *et al.* 1994, NAFO 1997, McCafferty *et al.* 1999, Ross 2000).

This mammals are well represented in the Atlantic Ocean in both the Northern and Southern Hemispheres, where it can be found some species with wide distributions while others are more restricted to certain regions of this ocean. In this sense, there are at least 6 species that can only be found in the the Atlantic Ocean. In its oceanographic context, one of the most important inner regins of the Atlantic is the Caribbean Sea which boundaries are naturally defined by the Yucatán and Florida Peninsulas in the North, the Greater Antilles Ark to the East, the Ark of the Lesser Antilles from the Southeast-East and the Central American Isthmus and the Northeastern coast of South America to the West and Southwest. It has very variable depths that reach a maximus of 9,000 m in Puerto Rico's Sill. The temperature of the water is warm in general terms and this inner sea definitevely lies in the Tropical Region, being considered a marine region of high diversity and productivity, with extensive coastal areas covered by mangroves or coral reefs. The diversity of Cetaceans in the Caribbean is important (27 species, 31% of worldwide diverity) and have both coastal and oceanic species as well as resident and migratory species (Leatherwood & Reeves 1983, Evans 1987, Jefferson *et al.* 1994). It might be highligthed that there are three species of dolphins which are endemic to the Atlantic Ocean and that the three inhabit the Caribbean Sea: the Atlantic spotted dolphin (*Stenella frontalis*), the Clymene's dolphin (*Stenella clymene*) and the tucuxi dolphin (*Sotalia guianensis*). In the Caribbean Sea there is also a healthy whale watching industry that have been strongly developing through the years, being key species the spotted dolphins (both *Stenella frontalis* and *Stenella attenuata*) in Bahamas, thumpback whales in República Dominicana, Puerto Rico and Saint Kitts & Nevis and the orca (*Orcinus orca*) and cachalot (*Physeter macrocephalus*) in Puerto Rico and Saint Vincent & The Grenadines, respectively.

The Cetaceans of the Costa Rica's Caribbean

Up to know, in Costa Rica there has been much more research on Cetaceans in the Pacific Coast than in the Caribbean. In the first list of confirmed Cetaceans for the country, Rodríguez-Fonseca (2001) indicates the presence of 8 confirmed species of this mammals in the Caribbean of which, there are two that are not in the Pacific (endemics of the Atlantic, and another one that still is not reported in the Costa Rican Pacific Coast (Rodríguez-Fonseca 2001). Posteriorly, Palacios-Alfaro (2010) added a new species, the pygmy sperm

whale (*Kogia sima*). There are also several reports of strandings which round up a total of 10 cases that have involved at least 4 species (Rodríguez-Fonseca & Cubero-Pardo 2001, Fundación Keto 2011, D. Chacón *pers. com.* 2012). Historically, the first published reference was one about some behavioral observations of a bottlenose dolphin (*Tursiops truncatus*) in the coast of the Tortuguero National Park in the Northern Caribbean in the early eighties (Newcomer 1983). One of the most notable reserach events in the Caribbean of Costa Rica took place when it was first discovered the presence of the tucuxi dolphin in the Southern Caribbean (Cubero-Pardo & Rodríguez-Fonseca 1997, DiBerardinis *et al.* 1997). Although now known to be present also in Nicaragua, this dolphin is still only known in Costa Rica from the Southern Caribbean, mainly from Gandoca-Manzanillo Wildlife Refuge. According to Rodríguez-Fonseca & Fischel-Quirós (2007), this is the only relevant area in the Caribbean where a consistent whale watching activity is developing, mainly through dolphin watching. Some 7,000 watcher per year generates directly $200,000 to this community (6.7% and 3.7% of the national total, respectiveley). Even though there has been a general lack of systematic studies, there is a considerabel amount of data in the specific cases of bottlnose and tucuxi dolphins in the Southern Caribbean, mostly related to behavior, whistle patterns and ecology (Acevedo-Gutiérrez *et al.* 2005, Gamboa-Poveda & May-Collado 2006, May-Collado & Wartzok 2008, May-Collado & Wartzok 2009 and May-Collado 2010).

The different human activities that usually have negative impacts on Cetaceans, many of them lethal to the animals, significatevely affects their populations. The levels in which this impacts have been measured are variable but its difussion among decition makers and the general public tends to be low. Although there are no direct information on this issues for the Caribbean of costa Rica, several studies indicates the presence of chemical contaminants at least in the Bay of Moín and it is expected that such contaminants (organochlorines, PCB's, heavy metals and hydrocarbons) are potentially affecting the marine ecosystem and its species (Acuña-González *et al* 2004, Coll *et al.* 2004, García-Céspedes *et al.* 2004 y Sponberg 2004). About other well known impacts on Cetaceans on which there is no information at all in the Caribbean, collisions with ships and boats (marine traffic), marine debris, by-catch, hunting, oceanic noise and unmanaged whale watching activities, shuld be investigated in the short and medium term (Waring *et al*. 2000, Archer *et al.* 2001, Laist *et al*. 2001, Cubero-Pardo & Rodríguez-Fonseca 2002-2007, Wartzok *et al*. 2003-2004, Archer *et al.* 2004, Jensen & Silber. 2004, Gerrodette & Forcada 2005, de Lichtervelde 2006, Dolman *et al.* 2006, Panigada *et al*. 2006, Marine Mammal Center 2007, Wade *et al*. 2007, NOAA 2008, Williams & O'Hara 2009).

Objectives

1. Determine, the presence / absence of Cetaceans in the sampling area (from Matina River to the Port of Limón).

2. Determine the habitat use made by the species found in the study area (relative frequence, habitat use, residency, seasonality, etc.).

3. Identify possible environmental impacts which are affecting Cetaceans in the study area.

Methodology

1. There were made three field trips with three sampling days each (6 hours/day in the average), covering three different seasonal moments: a dry and rainy season transition (May), a rainy season peak (July) and a dry seaon peak (September).

2. Boats of 7 m in length were used, roofed or not, but that allow at least one observer at no less than 2.5 m over sea level, with 75 hp motors and no less than three observers.

3. Six transects of 6 Km each, were surveyed perpendicular to the coast, between the Mouth of the Matina River (Transect 1) and the Mouth of the Cieneguita River (Transect 6). Each transect began at approximately one kilometer from the coast. To go from one transect to another, it was ran a straight digonal between the end of one transect and the beginning of the following (Altmann 1974).

4. Aditionally, a daily "extra transect" was made sbetween the first and the last transects but parallel to the coast. On the other hand, observations were made during the runnings between one transect and another which were used to reinforce the data collected in the transects sampling (Krebs 1985).

5. During the transect sampling, it was taken a temperature measure (± 1 m underwater), it was qualitatively calcualted the lunminosity, the Beaufort Index and each species of Cetacean observed in an approximate range nof 100 m each side of the transect, positioning each sighting with a GPS. In each sighting point it was also measured the superficial temperature (Shane 1994).

6. In each sighting it was also determine the number of individuals per species (group size) and when possible, the sex and qualitative age stage of each individual. It also was gthered behavioral information of the animals sighted (Würzig & Würzig 1979, Shane 1994).

7. On each transect, usually when half of it has beeb sampled, it was made an average of 4 minutes of subaquatic recordings. This to reinforce the sighting effort and to determine the levels of oceanic noise.

8. For the identifidcation os species, besides the experience of the rsearchers, there were used field guides for the identification of Marine Mammals (jefferson *et al*. 1994, Shirihai & Barrett 2004).

9. Given the low number of sightings, no particular statistc test was used, other than average, percentages and frequencies.

Results and **Discussion**

Sampling effort

It was sampled 108 Km-transect on each seasonal moment, for a total of 324 Km-transect. Aditionally, a total of 382 Km between transects was made (8.5 Km between one transect and another) and a daily 26 Km from the first and the last transect, for a total of 234 Km. As a result, the absolut distance sampled was of 940 Km.

On the other hand, the observation effort was of 6 hours per day, that is, 18 hours per seasonal moment, for a final total of 54 hours. Finallythe area covered during each day of sampling was

estimated at 210 Km^2.

Variation of Temperature

The average surface temperature was of 28,8 ºC and was very similar in May and September, while it was lower in July, coinciding with the peak of the rainy season. It was also oberved a tendency of a temperature increasing between the first and the last transects in both, the partial and total averages, which is related that the first transects were sureveyed at the sunset, while in the three last the sun was higher in the sky (reaching or passing the midday in the last one).

Table 1. Temperature average (ºC) in the surface by month and by transect (T).

Month/Transect	T 1	T2	T 3	T 4	T 5	T 6	Month average
May	29	29,1	29,3	29,7	29,3	29,6	29,3
July	26,9	28	28,3	28,5	28,7	28,6	28,2
September	28,2	28,5	29,1	29,1	29,6	29,4	29
Total average/transect	28	28,5	28,9	29,1	29,2	29,2	**28,8ºC**

From such a point of view, the average temperature per transect for each seasonal moment, was always higher in May (transition) than in July (rain peak), while no differences were observed in respect to September (dry peak). The average of temperature difference for each transect between May and July was of 1.2 ºC, between May and September was of 0.36 ºC and between July and September it was of 0.82ºC, so the highest difference occured between the transition of the dry and the wet season and the peak of the rainy season. The monitoring of sea water temperature is important since it is the abiotic factor with more influence in Cetaceans prey distribution and can even directy influence de distribution of some dolphin and whale species (Würzig & Würzig 1979, Shane 1994). However, it is requieered a monitoring to know if this differences are, not only of significance but to nknow if it has a relationship with the dolphin distribution patterns in the area, since the sightings of both species were made in the transects with lower temperature in the average.

Cetacean's sightings

Only two species were sighted, the bottlenose (*Tursiops truncatus*) and the spotted (*Stenella frontalis*) dolphins, of the Family Delphinidae (Figura 1), for a total of 5 sightings, 3 of bottlenose (71.4% of the total) and one of spotted (14.3% of the total), plus one sighting of a mixed group involving the two aformentioned species (14.3% of the total), which accounted for the biggest group size observed at all. Even taken separately, for each species in the mixed group, the group size was bigger than any of the sightings made for this same species individually. This is is the usual pattern of mixed groups of dolphins since they look for proteccion when gatehering together, therefore resulting in much bigger groups. However, this is only a frequent behavior in oceanic conditions, so this mixed species sighting close to the coast is of interest.

Table 2. Sightings of dolphins and group size in the study area.

Species	**Nº of sightings**	**Group size**	**Minimum and maximum**	**Average**

T. truncatus	3(4*)	15(32*)	1 y 5 (17*)	3(10.7*)
S. frontalis	1 (2*)	2 (10*)	2 (8*)	2 (5*)
Mixto [1]	1	25	25 y 25	25
Total	**7**	**42**	**-**	**6**

*If the individuals of the mixed group are included.

1 *T. truncatus* and *S. frontalis*

Figure 1. The spotted dolphin (left) and the bottlenose dolphin (right) were the only two Cetacean species observed.

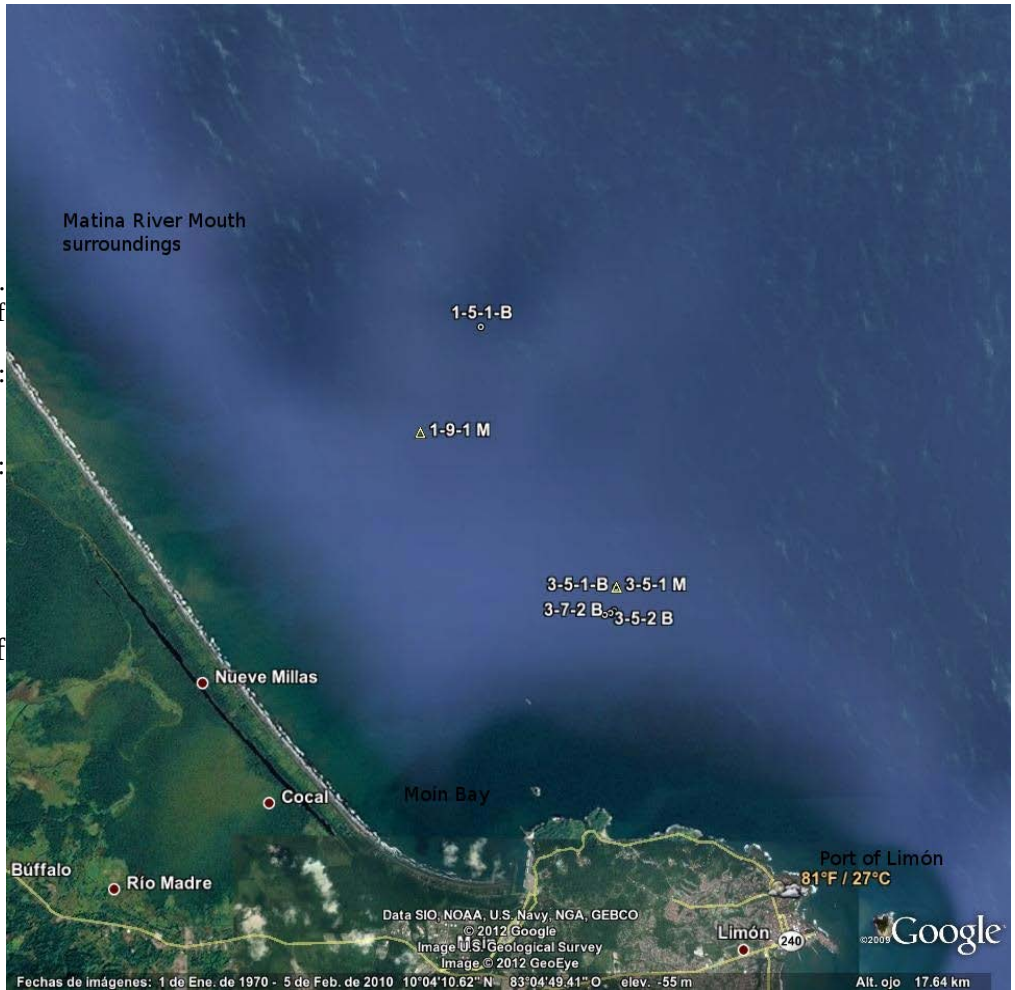


Figure 2. Sightings of dolphin species (B: *Tursiops truncatus* and M: *Stenella attenuata*

Since neither of both species observed were

found to be common, the bottlenose dolphin was more frequently observed than the spotted dolphin for both the total sightinggs and the group size (Table 2). All sightings were made in the more northern transects (T1 to T3), which cooincide with the lower temperature measured in the average, and there were no records at all in the transects of Moín Bay (and harbor) and in Port of Limón (T4 a T6). The bottlenose dolphin was observed in both during the transition dry/rainy season (May) and during the peak of the rainy season (July), but was not observed during the peak of the dry season (September). In some tropical areas it has been observed that bottlenose dolphins gather very near the coast to feed in river mouths (Cubero-Pardo 1998). The spotted dolphin was observed both, during the transition dry/rainy season (May) and during the peak of the peak of the dry season (Septemeber), while was not observed during the peak of the rainy season (July) (Table 3). In general terms, spotted dolphins tend to be more frequent in offshore-coastal situations. The prevailing behavior at the moment of sightings has been feeding, which accounts for the 75% of all sigthings, and traveling (25%). Both species are top predators (mostly fish and squid) in the marine food webs, with the difference that the average prey items size is significatively bigger in the bottlenose dolphin (usually > 50 cms for an adult bottlenose and between 20 to 40 cms for an adult spotted dolphin, A. Acevedo *com. pers.* 1998) due to its also significative bigger size (bottlenose 2.8 m lenght in the average, spotted 2.1 m in the average). There were no records of whistles or any other sound from neither of the two species. In Table 3 are indicated de low frequencies of sightings and that they were only in the first three transects, from north to south, that is, in the area of influnece of the Matina River mouth.

Table 3. Sightings average of dolphins/day/transect/ month.

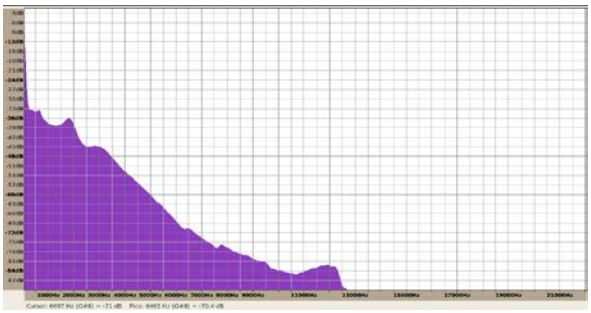
Species/month	T 1	T2	T 3	T 4	T 5	T 6	Average/ transect and total
*Stenella frontalis**[1]/May	0	0	0,33	0	0	0	0,06
*Stenella frontalis**/July	0	0	0	0	0	0	0
*Stenella frontalis**/September	0,33	0	0	0	0	0	0,06
Average/transect and total							**0,06**
*Tursiops truncatus***[1]/May	0,33	0	0,67	0	0	0	0,17
*Tursiops truncatus***/July	0	0	1	0	0	0	0,17
*Tursiops truncatus***/September	0	0	0	0	0	0	0
Average/transect and total							**0,11**

*Spotted dolphin **Bottlenose dolphin[1] Both species of the Famíly Delphinidae.

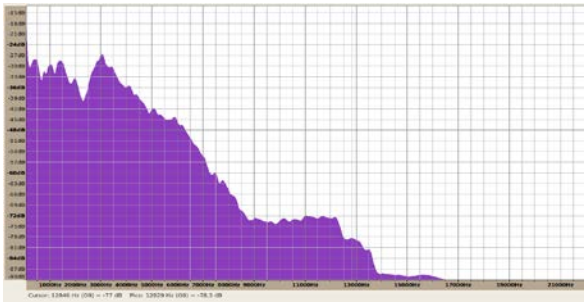
There were no recrods of any kind neither of manatees (*Trichechus manatus*, Sirenia:Trichechidae) nor of any species of Pinnipeds (Phocidae, Ottaridae. The Caribbean monk seal, *Monachus tropicalis*, with old records in Costa Rica and now considered extinct in all its range, and the California sea lion, *Zalophus californianus*, which has been accidentally introduced in the Western Caribbean).

Ocean noise measures (subaquatic noise).

At present, there is a main source of ocean noise and it is the marine traffic in the Moín Bay from its harbor and, in a lesser extent from the Port of Limón, some fifteen kilometers down south. The main activity of Moín harbor is related with cargo ships while in Limón Port is a mixture of cargos and turistic cruises. We observed 7 ships per sampling day in Moín and 4 in Limón harbor. But also it is have to add fishing boats, fast boats, Coast Guard patrols, etc.



Transect 1_In front of Matina River mouth (Mayo)



Transect 4 in the Bay of Moín (May)

Figure 6. A comparative example of the intensity (decibels, curve) and of the volume (Hertz, area under the curve) of ocean noise in a transect in the area of influnece of the Matina River (left) and in one in the area of influence of Bahía Moín (right).

Of a sample of 6 recordings (n = 6) per seasonal moment (N = 18), it was obtained a minimum averages in the frequency of 5086 Hz and in the intensity of 52 db, as well as a maximum averages in the frequency of 11,918 Hz and in the intensity of 73.1 db, these last in the Bay of Moín and surroundings. This magnitudes overlap with those of communication and echolocation of Cetaceans, mainly of Odontocetes, which can mask them and affect their communication and recognition of the environment. On the other hand, the frequencies are indicators of high persistence of ocean noise, and that could explain the absence of dolphin sightings in the Moin area. Though further research must be done, extending the periods of sampling. Also, the maximum values obtained were of 21,875 Hz and 105.5 db, in the T_4 which corresponds to punctual activities such as dragging, hydraulic hammering, high speed motors, among others, which reinforce the necesity to monitoring and regulate the oceanic noise in this important port area.

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