Ecology of Neritic Odontocetes Cetaceans in an Upwelling Ecosystem in the Northeastern Coast of Venezuela: *Delphinus* sp & *Sotalia guianensis.*

Final Technical Report 2010 - 2011 Term
To The Rufford Small Grants for Nature Conservation

Lenin E. Oviedo Correa MSc.
March 2012

The Rufford Small Grants Foundation

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INTRODUCTION

The entire Venezuelan marine territory is a potential habitat for cetaceans, being some particular regions especially suitable for dolphins and whales, due to physical and biological features (Acevedo, 2007). In this sense, the northeast coast of Venezuela host a great diversity of megafauna, including whales and dolphins, particularly related with high levels of water productivity, due to coastal upwelling processes. Additionally, the complex topography and bathymetry of this area offers a variety of marine and coastal habitat suitable to harbor cetaceans populations. Within the region bounded by the 100 m isobath inside the Cariaco Basin, the upwelling seasonal plume covered a surface area that ranked between 0 and $1x10^3$ Km^2 from August to October, and which then typically extended over an area greater than $12x10^3$ Km^2 in March (Muller Karger *et al.* 2004). This high productivity levels support the presence of mainly big sardine schools (*Sardinella aurita*) as well as other species (Mendoza *et al.* 2003, Guzman *et al.* 1999, Cardenas 1997), explaining the existence of a wide range of marine top predators in the area, including cetaceans. For commercially valuable species, knowledge about the degree of competition between fisheries and marine mammal predators is of vital importance (Oviedo, 2009), considering that cetacean distribution is generally related to the presence/absence of their prey (Forcada, 2008).

Acevedo (2007) detailed the distribution of the most frequently sighted species of marine cetaceans for the North Coast of Venezuela, of which *Delphinus sp.* and *Sotalia guianensis* are important species within shelf and coastal habitats on the Northeastern region. Here, the current status of these cetacean populations is uncertain, at least from a quantitative point of view, mainly because research efforts are novel, therefore, comparison with historical records or estimates are not possible. There are still many gaps of information in cetacean biology to establish a solid base-line useful for management of their populations (Oviedo, 2008).

In addition, the Northeastern region has a trend in coastal development that have resulted in an increased in boat traffic and corresponding noise pollution that is actually not regulated. Also, global climate change has had a strong influence in this habitat, where have been documented steady decreased in the wind force since 2004, resulting in a weak upwelling that has affected the larval energy intake of the cetacean' potential prey, sardines (Varela, 2008). Therefore, the sardine fishery has equally decrease since 2003, reaching a critical point on 2005.

As widely known, coastal species with a restricted home range, are exposed to pervasive threats as habitat degradation linked to coastal development and fishery over-exploitation. This, added to biological information scantly documented and the changes that are occurring in their habitat, makes an important issue the estimation of ecological and population parameters as distribution, abundance and habitat use of both species: guiana and common dolphins in the northeast coast of the country and their key areas for survival, as crucial base-line information for their management. In this sense, the keystone for proposing the designation of any special management status is the determination of their critical habitat, which includes feeding, nursery, resting areas as well as important migration routes. Hence, the ultimate goal of this project is to determine what portions of the shelf habitat in the northeast coast of Venezuela play these key roles in the well being of guiana and common dolphins' populations.

This report present the results obtained between 2010 and 2011, in the second period of intensive survey for this long term project, which includes both cetacean species, and will contribute to the available knowledge on their ecology, particularly, by exploring how dolphins are using the physical habitat and the possible determinants of their distribution within the northeastern coast of Venezuela.

AIMS AND OBJECTIVES

This project aims to produce biological information on four specific subjects: abundance, behavior, feeding habits and habitat use, of the two most representative species in the northeast coast of Venezuela mentioned before: *Delphinus sp* and *S. guianensis.*

All the scientific information generated, will be oriented towards to what we consider the ultimate goal of this project: integrate species-based information into an ecosystem level approach, which will widen the understanding of key processes in this primal marine habitat and foster development of more effective policy making and management.

In this sense, the **general objective** of this project is:

> To produce information on the ecology of two coastal odontocetes: common dolphin (*Delphinus sp*) and guiana (*Sotalia guianensis*) as baseline information to sustain ecosystem based management.

The **specific objectives** that will help to achieve the mentioned general objective, are the followings:

- To describe the main ethological characteristics of *Delphinus sp* and *S. guianensis* in the study area within the context of habitat use.

- To determine the relative abundance of the population of *Delphinus sp* in the study area.

- To establish the trophic impact of *Delphinus* sp predation and its effects on local fisheries.

MATERIALS AND METHODS.

Study area.

The entire study area was divided into two sub-areas, depending on which species was present, given our prior knowledge (Oviedo *et al.*, 2004; Esteves & Oviedo, 2007; Oviedo, 2009, 2010). Thereby, the study area for Guiana dolphins comprised the bays and coves from Guaca Bay (N 10°40' - W 63°24' / N 10°40' - W 63°25') to Guaraguao Bay (N 10°40' - W 63°28' / N 10°40' - W 63°29'), covering about 39 Km^2 of shallow marine areas and rocky - sandy coastline of the north coast of Paria Peninsula. The common dolphin relative abundance assessment was centered in the north coast of Araya Peninsula, including the southern and western coasts of Cubagua Island (N 10°39' - W 64°20' / N 10°51' - W 64°11'). This region has a complex submarine topography due to the presence of

Margarita, Coche and Cubagua Islands. Added to the complexity of the submarine physiography, an upwelling area is located north of Araya Peninsula and its intensity is highly influenced by the seasonal variations associated with the annual cycles of trade winds. The survey area in this region covers 576 Km^2 that comprises approximately 60% (>340 Km^2) of shelf habitat, and 40 % (>230 Km^2) of - transitional areas within the shelf break. Behavior sampling for common dolphin was focused in the northwestern portion of central Paria Peninsula towards the southeast tip of Margarita Island. Detectability conditions are much suitable around this area to engage dolphins encountered into group-follow protocol.

Dolphin surveys

Systematic surveys were made on two different platforms. On the case of common dolphins relative abundance, the route followed was that of a ferry boat, we were allowed to do surveys onboard the ferry, thanks to a working agreement with the regional office of MINAMB in Margarita Island. They allow us to start a trial program on February 19th, and finally signing the authorization after the second round of surveys on April 26th . This arrangement allows for the mitigations of most of the caveats we had experienced on the route Punta de Piedras – Margarita Island, heading Cubagua and Araya Peninsula, during surveys in 2007-2008, in term of detectability due to sea conditions and more important safety for equipment and personnel.

Surveys where sampling required a group-follow protocol were done through small boat. For Guiana dolphins, the surveys started from the west of Guaca Bay to Guaraguao Bay. Likewise, the behavior assessment of common dolphin also departed from our based adjacent to Guaca Bay heading to Margarita Island.

Data collection and analysis for *Delphinus sp*.

Regarding to this species, the data collection was focused on abundance estimation, ethological sampling and stomach contents analysis. Data for relative abundance analysis were obtained following the line transect protocol, but as the area is dominated by a sea state more than 3 in the Beaufort scale, the data collected is progressively increasing, but still not enough to be processed using the Distance software in order to obtain an estimate of the relative abundance. Alternatively, a relative abundance index per unit of efforts (APUE) was calculated using the total effort for this species and area surveyed.

The spatial analysis of relative densities and identification of frequently used areas for common dolphins was carried on estimating the near neighbor index and a kernel densities using ArcGIS 9.3. Kernel estimations was done by two alternative methods: a) by establishing two volumes-contours of utilization distribution; one containing 50% of all spatial records for core areas and another one for 95% of all spatial records indicating home range. b) using the APUE as a input parameters, to derive a general relative density gradient.

Ethological sampling was undertaken through group follow protocol and scan-sampling: every two minute, with a five minute interval (Altman, 1974; Mann, 1999). Behavioral states were described through a standardized behavioral key, following a modification on Schneider (1999) and García and Dawson (2003) approaches to suit the species pelagic ecology. Based on the preliminary observations of Oviedo *et al.* (2009), a behavioral budget was constructed with total percentages of each behavior.

Data collection and analysis for *S. guianensis*.

For Guiana dolphins, only ethological sampling was made, and it was centered in areas of significant presence, documented previously (Oviedo *et al.*, 2004; Esteves & Oviedo, 2007; Oviedo, 2008; Oviedo, 2009). The behavior sampling followed the same protocol and a method described before for common dolphins, but based on the preliminary observations of Oviedo *et al.* (2004; 2008), and the behaviors reported in Daura Jorge *et al*. (2005) which are more specific for *S. guianensis*, a behavioral budget was constructed with total percentages of each behavior.

Stomach content analysis for common dolphin

The trophic and spatial dimensions of the foraging niche are described through the integration of diet composition and prey biomass removal with spatial details on distribution. We were able to collect and analyze only three stranding events of common dolphin where stomach contents was entirely and analyzed *in situ***,** quantifying the number of identifiable prey items by remains (squid beaks, sagittal otoliths, vertebrae, poorly digested prey) containing diagnostic characters to be compare with either samples in collection or referenced in an atlas. Those remains were fixed and stored for proper comparison at later stage. The collection and analysis of stomach content required a license to be able to take samples during stranding events and carry on later analysis in laboratory facilities, only authorized personnel at government level are recipient of such permits, unfortunately to this date our license request (Nov 2009) is still pending evaluation, we were only able to attend as scientific support, the stranding events mentioned in figure 7, because the occurrence of such stranding cases where within/adjacent to the military facility that we use as research base (Hotel Naval Manzanillo:

http://hotelnavalmanzanillo.com/). The lack of permits for sampling prevents a more thorough analysis that quantifies prey in depths, in terms of volume and size rather than only describing prey items and the frequency of such prey.

The information obtained on prey occurrence and frequency was pooled together with non published records two stranding) from the late Prof. Jose Luis Naveira (1996) and summarized as a proportion of prey items according to the classification on Pauly *et al.* (1998): **BI:** Benthic Invertebrates, **LZ:** Large Zooplankton, **SS:** Small Squid, **LS:** Large Squid, **SP:** Small Pelagic, **MP:** Mesopelagic Prey, **MF:** Miscellaneous (mostly demersal) Fishes , **HV:** Higher Vertebrates.

Information on diet was integrated into a steady state mass balance trophic model (Ecopath 6.2) of the study area, once updated with the information on diet and proportions; we produced a graphic analysis of trophic impacts of *Delphinus* sp. on other functional groups as well as indices on Primary Production Required to illustrate and allow the comparison between the biomass removal by predation of common dolphin and catch of the artisanal sardine fleet.

RESULTS.

A total of 56 behavior surveys were carried out between February 2010 and August 2011, on board small boats. Of these, 30 surveys were made in the area that corresponds to the presence of common dolphins and 26 in the area of Guiana dolphin' presence. The field work usually started early in the morning around 7 am and finished between 2 and 3 pm, for both areas. Relative abundance of common dolphins was evaluated using line transects accounted for ten boat surveys.

Common dolphin *Delphinus* sp

Of the 30 surveys made for behavior assessment for common dolphins, fifteen of them were made in 2010 and the other additional 15 in 2011; in total, 22 times out of 30 surveys yielded encounters with groups of this species (13 in 2010 and 9 in 2011), which represents a 73% of sighting frequency for the entire study period (see Figure 1). The total time spent in the field was of 183.6 hours; of which 104.9 hours was the time spent searching for dolphins, with an average of 3.5 ± 1.8 hours.

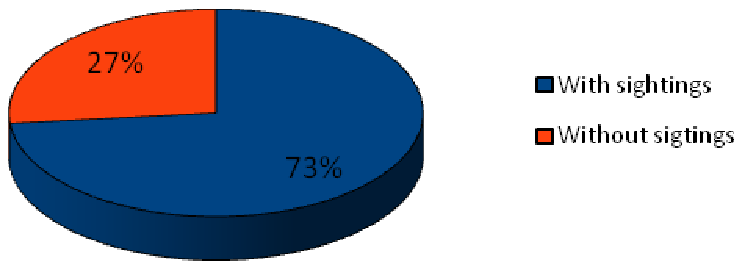

Figure 1. Sighting Frequency of *Delphinus* sp in the route central Paria Peninsula-South Margarita Island 2010-2011.

Observed group sizes varied usually between 20 and 100 individuals, with an average of 46 individuals per group. There were two opportunities in which the group sizes reached maximums of approximately 500 and 1000 individuals. In figure 2, it is possible to appreciate that the group sizes seemed to have low fluctuations between dry and rainy seasons and between years, with the two rare cases mentioned before each one for a different season.

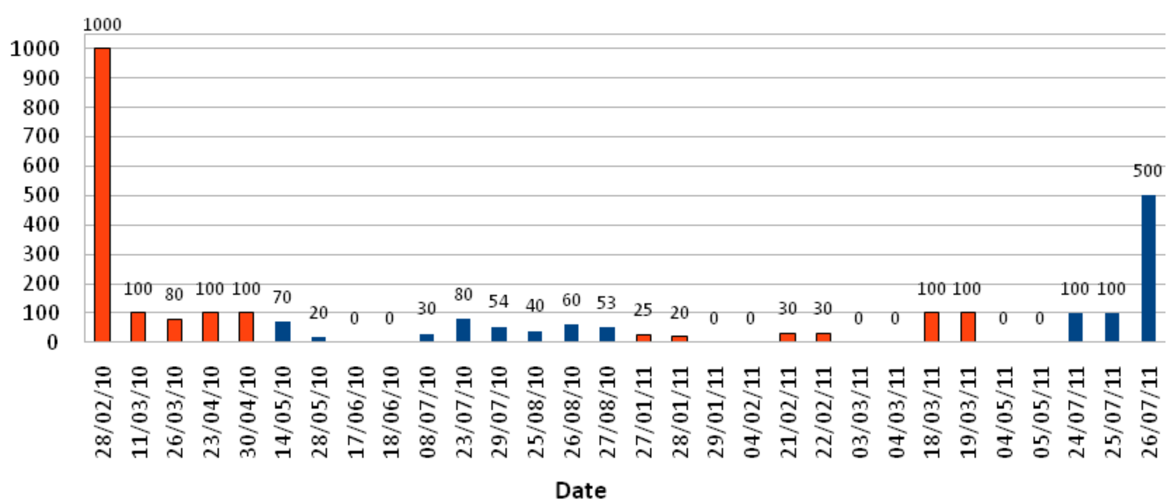

Figure 2. Estimated number of individuals per group sighted of *Delphinus sp* between 2010 and 2010, indicating the dry and rainy seasons.

whenever was possible, on good observation conditions, we kept track on group composition details, being the calves the most easily to distinguish in the field, by the obvious differences in body sizes between them and the juveniles-adults (this two classes where more difficult to differentiate). In total, for both years we found 55 calves (28 in 2010, and 27 in 2011) within the groups.

Common dolphin relative abundance per unit of effort (APUE) in the study area was 15.20 individuals per hour of total effort, with a relative density of 4.85 individuals/Km^2. Sightings of common dolphin during 2007- 2008 were mostly concentrated around the western tip of Araya Peninsula, while surveys and sightings in 2010-2011 were concentrated north on Central Paria Peninsula. Kernel estimates identifies spatially both location as important areas of distribution (Figure 3 and 4), even clearly delineating core areas of spatial aggregation, however the *near neighbor index* (*NNR*) for both areas differed considerably: for the Araya-Cubagua sub-area with sightings corresponding 2007-2008, there is a clumped aggregation of common dolphins that departs considerably from a random spatial arrangement (Z-score= -6,01, NNR= 0,63, p< 0.001), on the other hand, in the location for sightings in 2010-2011 at north of central Paria Peninsula, common dolphins evidenced a more disperse spatial pattern (Z-score= 3,48, NNR= 1,34, p< 0.001).

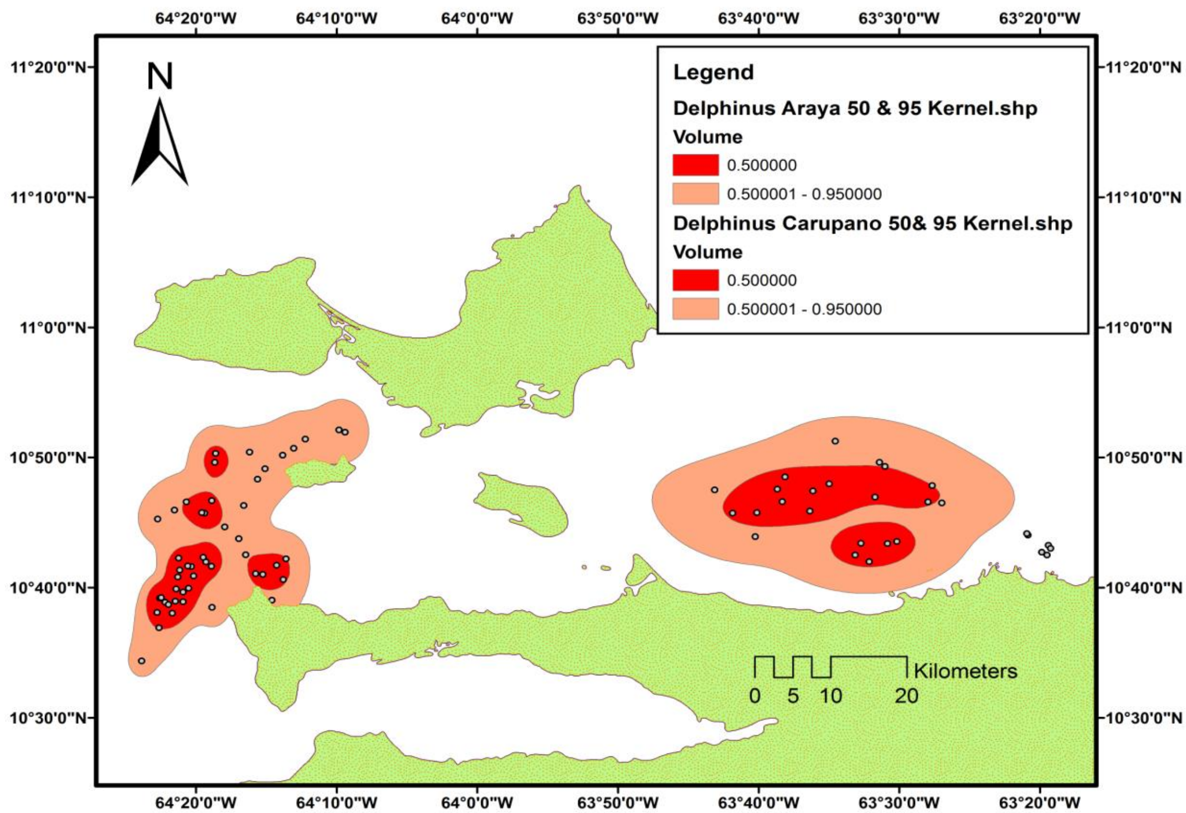

Figure 3. All sighting of common dolphin under The Rufford Small Grant supported project: Araya- Cubagua 2007-2008, Carupano 2010-2011. Kernel estimation with details on utilization distribution: 50% volume contours identifying core areas of spatial aggregation; 95% volume contour identifies potential home range.

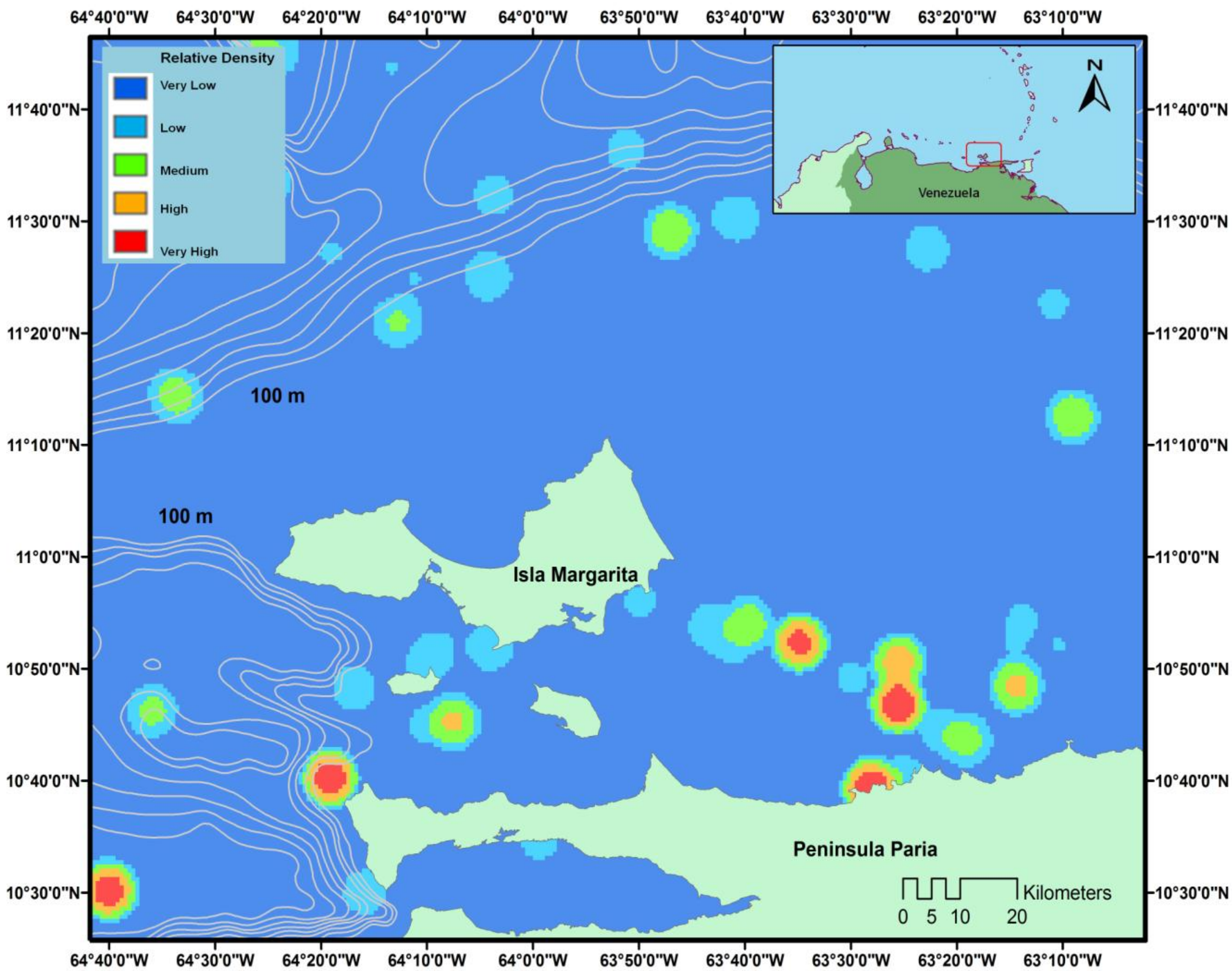

Figure 4. Kernel estimate portraiting the *relative abundance per unit of effort* (APUE) of all *Delphinus* sp.sightings in NE Venezuela, including the years under the support of Rufford Small Grant: 2007-2008 and 2010-2011 respectively.

The behavior of the majority of the group, specifically, the initial behavior most frequently observed was traveling, followed by foraging, There is a trend of increase in traveling as initial behavior in 2011 (89%) with respect to 2010 (62%; Figure 5). In total for the entire period, the dolphins were seen initially traveling on 73% of all the encounters, and just 27% of them were engaged in foraging at the beginning of the sightings (Figure 5). None of the others three categories (milling, resting, and socializing) were seen as initial behavior in common dolphins during the project. A behavioral budget was calculated with the data collected using the ethological sampling methodology explained before. For common dolphins we were able to collect this data in only 5 sightings, where detectability conditions were suitable with sea state of less than 3 in the Beaufort scale. We obtained that the common dolphins were foraging 49 percent of their time and traveling 43 percent (Figure 6), as the two dominant behaviors in the area. Only 8 percent of the time, groups were observed socializing. In the five occasions that this data was collected, we never saw them resting or milling.

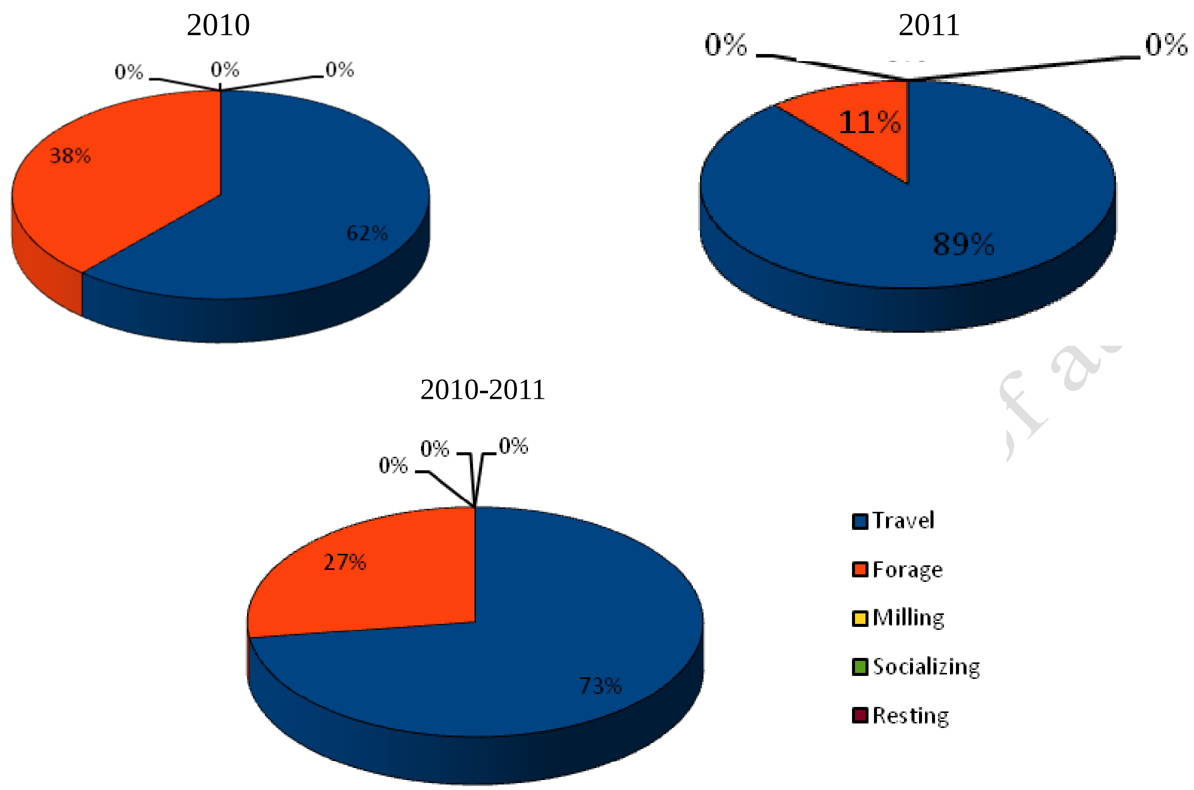

Figure 5. Initial behavior of common dolphin in the study area: during surveys in 2010, 2011 and overall term.

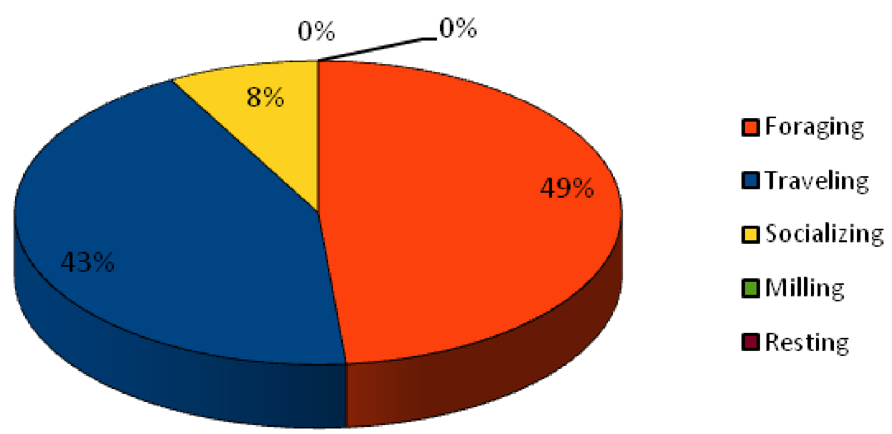

Figure 6. Behavioral budget for common dolphins with details on the three behavioral states where dolphins spend most of their time, during scan sampling observations.

Common dolphin diet is mostly dominated in occurrence by small pelagic (Table 1 and 2), as expected due to the location of stranding events at the meso-and local scale (Figure 7) at the north central Paria Peninsula.

Table 1. Prey item quantify in frequency of occurrence on three stranding of common dolphins (on 23/Jan, 22/Feb, and 04/Mar of 2010).

Group – Species	**Quantity**	**%**
Mollusk		
Loligo sp	21	0.05
Fish		
Engraulis sp	130	0.32
Engraulis eurystole	33	0.08
Sardinella aurita	186	0.45
Cetengraulis edentulous	10	0.02
Mugil curema	31	0.08

Table 2. Proportions of prey Items in the diet of common dolphin in the study area, pooled together with data from Naveira (1996), according to the classification on Pauly *et al.* (1998): **SS:** Small Squid, **SP:** Small Pelagic, **MF:** Miscellaneous (mostly demersal) Fish.

Item	**Dsp23Jan**	**Dsp22Feb**	**Dsp04Mar**	**Naveira1996**	**Total**	**Proportion**
SS	5	4	12	14	35	0.06
SP	122	79	158	124	483	0.86
MF	0	0	31	11	42	0.08

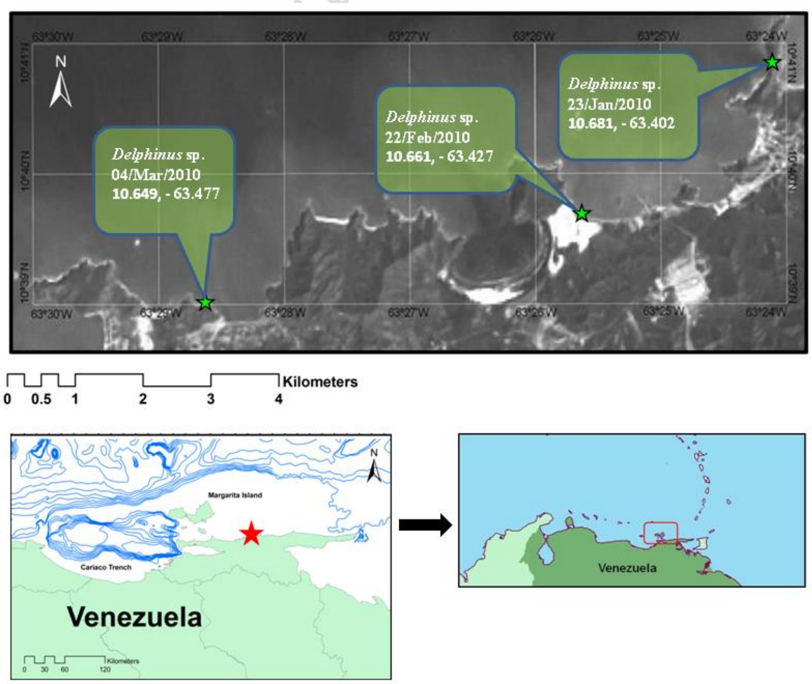

Figure 7. Location of stranding events of common dolphins where stomach contents were analyzed *in situ*

The model derived matrix of trophic impact portrayed in figure 8, illustrates graphically the impact of a functional group within the trophic web of the ecosystem assessed: in this case; the column of common dolphins as functional (predator) group contrasted with all other listed groups in rows. Common dolphins presence mostly derived in positive impacts on its own prey (squid, small pelagic) and groups part of the bottom up control, such as zoo and phytoplankton. In contrast and judging by the small, almost imperceptible size of the inverted bar, the negative impacts are localized within the common dolphin group itself and medium trophic level predator fish such as Carangids. Also there is an apparent small negative effect on heterotrophic benthonic organism.

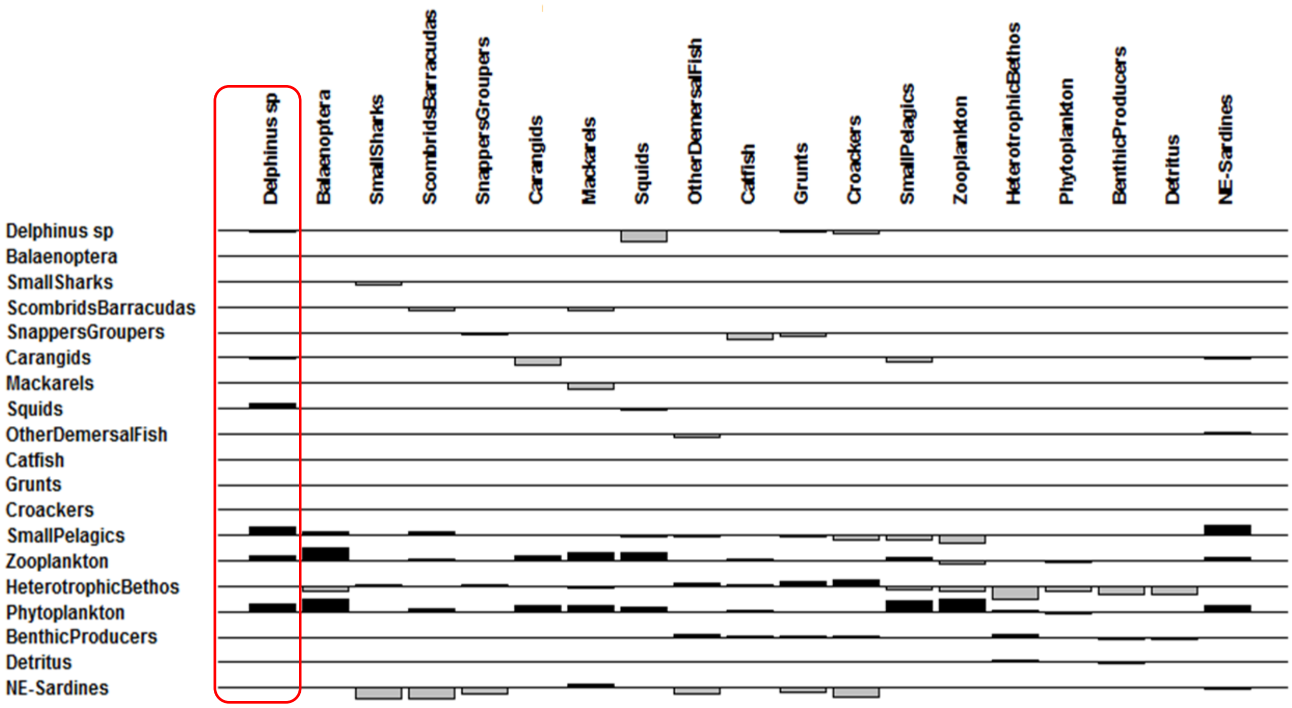

Figure 8. Matrix of trophic impact of functional groups within the trophic web of the shelf ecosystem in NE Venezuela, including common dolphins and the artisanal sardine fleet (NE-Sardines).

The indices corresponding to the *primary production required* for both, biomass removal by common dolphins and catch landing for the sardine fleet are reported in table 3. Common dolphin primary production required is by far more important that the one generated by sardine fishery.

Table 3. Primary Production Required, per unit of Biomass (PPR/B.Unit) and per unit of catch (PPR/C.Unit), reported in the Shelf ecosystem at the northeast coast of Venezuela' *ecopath* models for both scenarios.

	PPR/B.Unit (Pre)	PPR/C.Unit (Pre)	PPR/B.Unit (Post)	PPR/C.Unit (Post)
Delphinus sp	16.87	-.-	18.84	-.-
Sardine Fleet	-.-	0.47	-.-	0.57

Guiana Dolphin *Sotalia guianensis.*

In the evaluation regarding this coastal dolphin species, 26 surveys were carried out in the route Guaca Bay to Guaraguao Bay, between February 2010 and August 2011, of which 24 times we had encounters with groups of Guiana dolphins being the sighting frequency very high (94%).

The estimated group sizes (Figure 9) varied between 20 and 50 individuals in the entire period, with an average of 33 individuals/group and a minimum of 12 in February (mid dry season), being more constant between May and August 2011 (rainy season), when they ranked between 35 and 50 individuals per group.

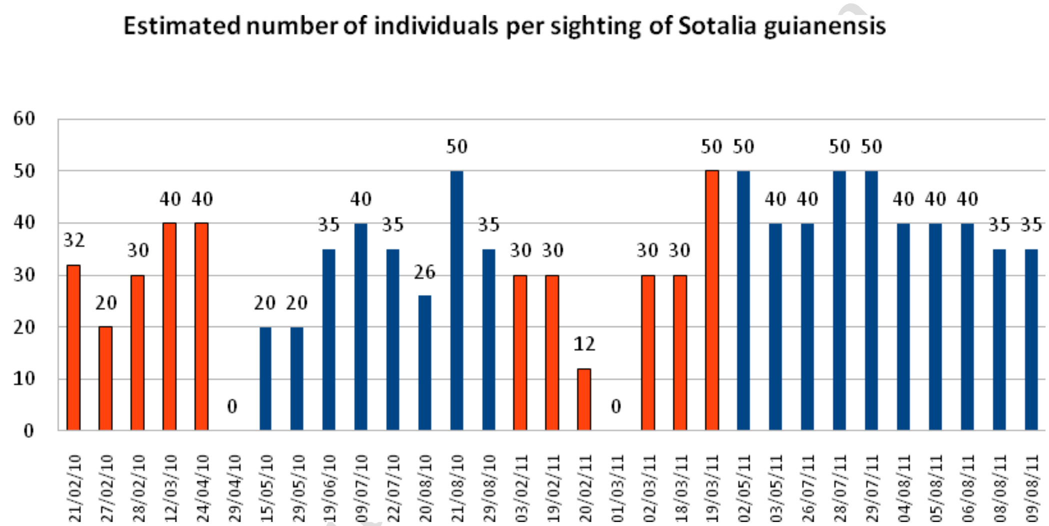

Figure 9. Estimated number of individuals per group sighted of *Sotalia guianensis* between 2010 and 2010, indicating the dry and rainy seasons.

The total effort was 162.85 hours; of which 54.75 hours was the total time spent searching for dolphins (prior to group encounter). In average the searching effort was of 1.7 ± 2.5 hours per day of survey. With this species, we also reported the group composition when possible, founding 86 calves for the whole period of which 27 were sighted on 2010 and 59 in 2011.

In the case of Guiana dolphins, the initial behavior most frequently observed was foraging. In 2010, this behavior had a frequency of 62% over traveling, which was only observed with a frequency of 38% (Figure 10). On the other hand, in 2011 there was an increase in foraging as initial behavior with a concomitant decrease in traveling frequencies, being the frequencies 94% and 6% respectively

(Figure 10). In general, it is possible to appreciate that for the entire period 2010 – 2011, the dominant behavior in terms of frequencies was foraging with a total of 80%, followed by traveling with 20% and the others three behaviors (milling, resting and socializing) were never observed at the beginning of the sightings for Guiana dolphins.

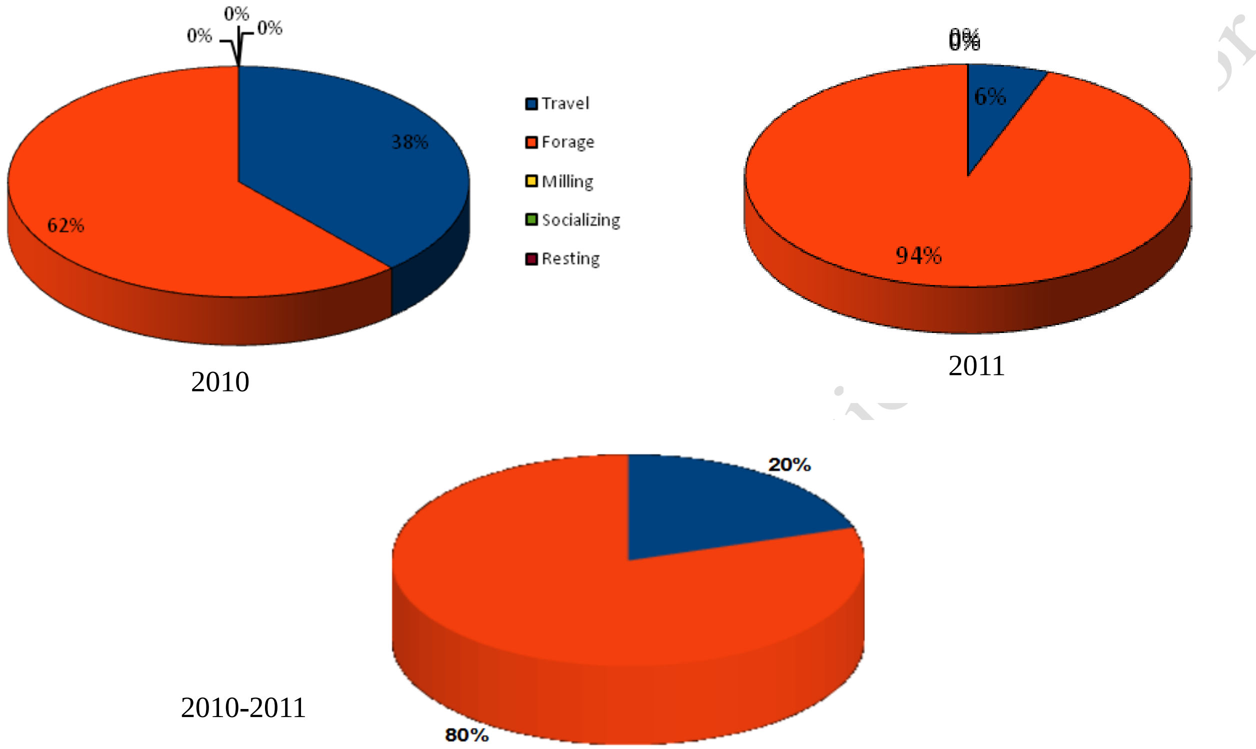

Figure XX. Comparison of the percentage of initial behavior for Guiana dolphins in 2010 and 2011 and overall assessment term

In the case of Guiana dolphins, we were able to complete the scan-sampling protocol in eight opportunities, founding that this species invest 77% of the time on foraging activities, 21% on traveling and only 2% of their time on socializing in this area, as it is possible to appreciate in the figure 11 below. Milling and resting were not observed in the area for none of the scan-sampling sightings.

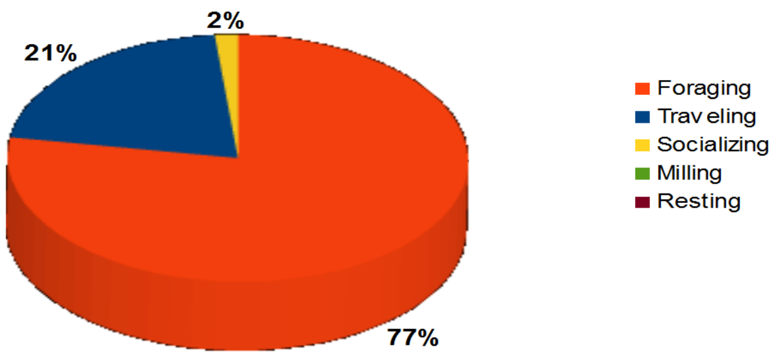

Figure 11. Behavioral budget for Guiana dolphins with details on the three behavioral states where dolphins spend most of their time, during scan sampling observations.

DISCUSSION

Common dolphins (*Delphinus* sp)

At a regional (meso) scale, major relative density areas for common dolphin are located within neritic domains, which is supported by a significant non random aggregation patterns, one disperse over a potential foraging area, and another clumped over the location with mayor topographic complexity, both independent of seasonal influence. The low fluctuations in the observed group sizes between dry and rainy seasons and between years, can suggest a local resident population, as well as the presence of calves year-round. Current effort on line transect protocol and more important the application of other techniques as photo-identification for mark recapture estimates of population size, will let us know if this population is actually resident in the area, as well as migration indexes.

The initial behavior most predominant in the northwestern of Paria Peninsula was traveling followed by foraging, and the behavioral budget shows that the dolphins invest almost all their time in this two activities with a small proportion on socializing, implying that this proportion of the area has an important role on the ecological fitness of common dolphin populations in the Northeastern coast of Venezuela, by providing them with the energetic sources necessaries for growth and reproduction even when they invest a considerable portion of energy in searching.

Key critical habitats identified by important density locations, overlap with equally localized coastal upwelling. Furthermore, the prey biomass removal within shelf habitat and particularly over those high relative density areas, would correspond with the close spatial relation between predator- preys, specifically with key commercial local prey for common dolphins: small pelagic, on the sectors referred by Freon *et al.* (1997) as key fishing grounds (areas numbered 2 and 6, in their figure 1). The critical habitats for common dolphin in the region which could be considered as areas of conservation importance are primarily associated with coastal upwelling areas and important small pelagic fishery grounds (Oviedo *et al.*2010).

The outputs of the *ecopath* model, based on the estimated relative abundance and diet composition, in terms of mixed trophic impact, suggest no affectation induced by the sardine biomass removal, associated with cetacean predatory habits onto the landing levels of the local sardine fleets. Common dolphins' negative trophic impact would include intra-specific competition and indirect effects on benthic organism due to the positive impact to potential competitors of this group such as small pelagic and even zooplancton, although the level of niche overlap with these organisms is low. The trophic impact of the sardine fleet would not establish a pressure on cetaceans, but in other important top predator of higher biomass density and trophic relationships such as small sharks, scombrids and barracudas.

Guiana dolphins (*Sotalia guianensis*)

Guiana dolphins showed a sighting frequency or encounter rate extremely high with lesser searching effort (in comparison with common dolphins), related to the reduced home range that the species has in the area observed in the maps: at local (micro) scale, the population of *S. guianensis* range in a stretch of coastline no longer than 15 Km, within the periphery of three human coastal settlements, where fishery is the major productive activity. Behavior sampling of this population indicates that overall the behavior budget is dominated by foraging. All along their range, in this specific stretch of coast, Guiana dolphin spend the majority of time in searching, capturing and consuming prey. However, the majority of foraging bouts are constrained not only to a very discrete location; a particular shallow bay (less than ten meters deep) with predominantly rocky shore, but to a very close distance to the coastline. Therefore, there would be a differential pattern of habitat use, where the intensity of foraging bouts at their discrete location demarcates the realized foraging niche for the local coastal dolphin population, a core critical area for energy acquisition. It is possible that other important activities, with key repercussion to the healthy growing of this population, such as resting and socializing (that might include reproduction), are taking part on the inside of the bay or near it.

Contextualizing dolphin's critical areas into the Venezuelan government's policies associated with fishery production.

Current strategic policies prioritized by the Venezuelan government, are address to promote and increase the national food production to achieve self sustainability. These strategies integrate along these policies the important local sector of artisanal fishery. A key step towards consolidating artisanal fishery has been the banning of industrial and semi industrial practices within territorial water, such as shrimp trawling, allegedly, responsible of affecting fish stocks recovery. The government agency administrating national fishery resources is even promoting the conversion from industrial and semi-industrial fishery operation to artisanal, allocating financial incentive to infrastructure (boats and engines) and gear acquisition. As a result for this policy, it is expected that coastal communities where artisanal fishery is the main productive sector might experience an expansion.

The identification of neritic/inshore dolphin's critical habitat in the northeastern coast of Venezuela is regionally associated with key eco-dynamic processes, such as coastal upwelling and locally identify bays and coves with specific value in term of species ecology and survival. The key elements considered before, highlight areas that would benefits from a protective status such as MPAs. The latter would promote healthy dolphin population growth and wider ecosystem benefits, considering that the scope of protection might include the base of the regional trophic relationships complex: upwelling and small pelagic aggregations. However, current government policies are promoting a major increase in fishery efforts for the artisanal fleet, which might not produce a conflict for resource utilization in the short and mid-term, but might increase other threats associated with coastal development, as byproduct of consolidating human settlements at close proximity of dolphin's critical habitats. For instance, recent interviews with local fishermen that operates all along the Paria Peninsula coast, seemed to show the potential absent of Guiana dolphins, 180 Km east and 90 Km west from their current localized range, that trend possibly indicate a *relictual distribution* along the study area, if so, the risk of dispensation would be additionally affected by an increase of traffic and coastal habitat degradation due to coastal communities expansion.

Based on the aspect highlighted above, we recommend the strengthening of baseline information, coupled with a communicational strategy addressed to government decision makers, which would emphasize the complementary aspects between current fishery policies (i.e. banned industrial practices) and the benefits of MPAs, along with the advantages of using predators such as dolphins as monitors of fish stock availability and sustainability. A pragmatic example would be the use of *Primary Production Required*, a similar index to the ecological foot print, when estimated for natural consumption of common dolphin and artisanal fishery catches, it has indicated a lower level of PPR for artisanal fishery when contrasted to natural predation by dolphins, hence the value of a healthy dolphin populations as monitor of a healthy fishery stock.

OUTCOMES OF THE PROJECT

This research effort has produced important baseline information to increase our ecological understanding of the interactions of neritic predators, in this specific case cetacean, with the structure and complexity of the habitat. This is an important component of a comprehensive management of marine habitats and resources. The information produced is intended to be available as references to stakeholders and decision makers; an emphasis is being made to encourage the integration of this baseline to the process of government management pertaining such key ecosystem as the shelf on Northeast Venezuela. We have produced to date the following outputs:

Scientific knowledge: With the information generated in this project we have produced 2 per review articles at Journal Marine Biological Association UK-JMBA and Revista de Ciencias Marinas-REVMAR, 5 presentation in scientific meetings (13th SOLAMAC - Montevideo 2008, 24th ECS-Stralsund 2010, 2nd ICOMMPA- Fort de France 2011). We project to produce two new peer review articles and forthcoming presentation for the 15th SOLAMAC in Puerto Madryn, Argentina.

Informing environmental management plans: We have provided with baseline information on common dolphins to the IUCN-CEG-SSC, in two occasions, the latest on February 6th 2012. We will produce management oriented technical reports to be directed to the regional office of MINAMB in Nueva Esparta state (Margarita Island). We have had already a fruitful association, since they as a government agency are in charge of all Issues related with Biodivercity. Additionally we partner in organizing management information workshops. We would continue in encouraging such interactions.

Conserving natural and socio-cultural capital: The Cariaco Basin in the Northeast Coast of Venezuela is a key natural heritage for the locals, nationwide and worldwide citizens. Our goal towards establishing strategies framed by Marine Spatial Planning - Ecosystem Based Management is directed to the preservation and sustainable use of important Ecosystem Services associated with mitigation through carbon offsetting and biodiversity conservation.

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Appendix 1

Encounters of Common Dolphins during surveys 2010-2011

Species	Day	Month	Year	T1	T2	Tenc	Behavior1
Dsp	28	Feb	2010	07:25:00	14:41:00	10:30:00	Travel
Dsp	11	Mar	2010	07:25:00	13:22:00	08:34:00	Forage
Dsp	26	Mar	2010	06:15:00	13:50:00	11:00:00	Travel
Dsp	23	Apr	2010	07:15:00	13:45:00	09:48:00	Travel
Dsp	30	Apr	2010	08:00:00	13:57:00	09:37:00	Travel
Dsp	14	May	2010	07:05:00	13:00:00	08:20:00	Forage
Dsp	28	May	2010	09:00:00	14:54:00	11:35:00	Forage
Dsp	08	Jul	2010	07:30:00	14:05:00	12:30:00	Travel
Dsp	23	Jul	2010	08:00:00	13:43:00	11:35:00	Travel
Dsp	29	Jul	2010	08:00:00	13:00:00	09:34:00	Forage
Dsp	25	Ago	2010	07:45:00	13:40:00	09:45:00	Forage
Dsp	26	Ago	2010	08:00:00	14:00:00	11:24:00	Travel
Dsp	27	Ago	2010	08:00:00	14:20:00	10:37:00	Travel
Dsp	27	Jan	2011	09:00:00	14:00:00	11:00:00	Travel
Dsp	28	Jan	2011	08:00:00	14:00:00	10:37:00	Travel
Dsp	21	Feb	2011	08:00:00	14:30:00	10:20:00	Travel
Dsp	22	Feb	2011	08:00:00	14:00:00	11:20:00	Forage
Dsp	18	Mar	2011	08:00:00	13:45:00	10:45:00	Travel
Dsp	19	Mar	2011	08:00:00	13:30:00	11:34:00	Travel
Dsp	24	Jul	2011	07:50:00	14:00:00	09:30:00	Travel
Dsp	25	Jul	2011	08:00:00	14:00:00	09:56:00	Travel
Dsp	26	Jul	2011	08:20:00	13:46:00	10:30:00	Travel

Appendix 2

Encounters of Common Dolphins during line transect surveys 2010-2011

Leg A#= Margarita-Araya
Leg B#= Araya-Margarita

Leg	Date	No Ind	<)	Dist R	Behavior
A1	19/02/10	2	72	200	Trav
A1	19/02/10	25	28	150	Trav
A1	19/02/10	15	38	220	Trav
B1	20/02/10	20	20	100	Trav
B1	20/02/10	6	15	78	Trav
A2	25/04/10	8	70	210	Trav
B2	26/04/10	12	45	300	Trav
A3	20/6/2010	20	70	200	Trav
A3	20/6/2010	8	22	125	Trav
A3	20/6/2010	10	30	100	Trav
A3	20/6/2010	6	70	100	Trav
B3	21/06/10	25	15	280	Trav
A4	22/08/10	10	50	250	Trav
A4	22/08/10	6	60	100	Trav
B4	23/08/10	20	30	200	Trav
A5	17/10/10	15	60	70	Trav
A5	17/10/10	20	35	100	Trav
B5	18/10/10	10	38	150	Trav

Appendix 3

Encounters of Guiana Dolphins during surveys 2010-2011

	Species	Day	Month	Year	T1	T2	Tenc	Behavior1
1	Sg	21	Feb	2010	07:45:00	12:41:00	08:03:00	Forage
2	Sg	27	Feb	2010	07:35:00	13:45:00	08:12:00	Forage
3	Sg	28	Feb	2010	07:25:00	14:41:00	08:25:00	Forage
4	Sg	12	Mar	2010	07:50:00	13:00:00	08:02:00	Forage
5	Sg	24	Apr	2010	08:15:00	12:45:00	08:38:00	Travel
6	Sg	29	Apr	2010	08:43:00	12:57:00	09:37:00	Travel
8	Sg	29	May	2010	09:20:00	13:54:00	10:35:00	Forage
9	Sg	19	Jun	2010	08:00:00	12:30:00	08:40:00	Travel/Forage
10	Sg	09	Jul	2010	07:00:00	12:03:00	20:30:00	Travel
11	Sg	22	Jul	2010	08:00:00	12:43:00	08:35:00	Forage
12	Sg	20	Ago	2010	07:55:00	14:40:00	08:45:00	Forage
13	Sg	21	Ago	2010	08:00:00	12:00:00	10:20:00	Travel
14	Sg	29	Ago	2010	08:20:00	12:20:00	08:57:00	Travel
15	Sg	03	Feb	2011	08:00:00	14:00:00	09:00:00	Forage
16	Sg	19	Feb	2011	08:00:00	12:30:00	08:20:00	Forage
17	Sg	20	Feb	2011	08:00:00	14:00:00	09:20:00	Forage
18	Sg	01	Mar	2011	08:00:00	12:00:00	09:00:00	Travel
20	Sg	18	Mar	2011	08:00:00	13:45:00	12:43:00	Forage
21	Sg	19	Mar	2011	08:00:00	13:30:00	12:54:00	Forage
22	Sg	02	May	2011	08:00:00	13:00:00	08:45:00	Forage
23	Sg	03	May	2011	08:00:00	14:00:00	08:57:00	Forage
24	Sg	26	Jul	2011	09:00:00	13:00:00	09:29:00	Forage
25	Sg	28	Jul	2011	08:00:00	14:00:00	09:50:00	Forage
26	Sg	29	Jul	2011	08:00:00	14:00:00	08:30:00	Forage
27	Sg	04	Ago	2011	08:00:00	13:00:00	08:30:00	Forage
28	Sg	05	Ago	2011	08:00:00	13:00:00	08:28:00	Forage
29	Sg	06	Ago	2011	08:00:00	12:00:00	09:00:00	Forage
30	Sg	08	Ago	2011	08:00:00	13:00:00	09:00:00	Forage
31	Sg	09	Ago	2011	08:00:00	13:30:00	09:35:00	Forage
32	Sg	10	Ago	2011	08:00:00	13:00:00	08:28:00	Forage