Habitat use of common dolphin (*Delphinus* sp.) in the Mochima National Park, Sucre, Venezuela

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ABSTRACT

The common dolphin (*Delphinus* sp.) is one of the most common cetaceans in Venezuela. This study aims to describe habitat use in the Mochima National Park, a protected area under high anthropogenic pressure. Opportunistic surveys were conducted following a pre-defined route from September 2009 to August 2010. Data such as the geographical position, group size, composition, behaviour were recorded at 5min intervals. A focal group-follow methodology was used. A grid of 500 × 500m was constructed and each cell was characterised by environmental features and a Coefficient of Area Use (CAU) was calculated. A logistic regression model was applied to identify factors that explain use pattern. Seventy opportunistic surveys were conducted during which 86 groups of dolphins were observed. Dolphins occupied an area of 36km^2, but Tigrillo inlet and to the northeast of the Caracas Islands were the areas most used. The common dolphins exhibited differential use, using shallow inshore waters most intensively and with probability of occurrence decreasing with increasing water depth and distance to the coast. They spent most of their time in feeding (40%) and socialising (24%) activities. Feeding and travelling behaviours were observed throughout the area studied, whereas socialising and resting activities were mainly concentrated in Tigrillo inlet, the Manare peninsula and the Caracas islands. Behaviour was mostly determined by season, depth, distance to the coast, group size and group composition. Throughout the year, the Park provided areas for refuge, feeding, and resting. It is therefore imperative to promote management and conservation policies that prevent any negative impacts from the increasing tourism and fishing activities we observed.

KEYWORDS: COMMON DOLPHIN; HABITAT; MONITORING; MODELLING; CARIBBEAN SEA; SOUTH AMERICA

INTRODUCTION

The term 'habitat use' refers to how an animal uses the physical and biological resources within a habitat (Krausman, 1999). A habitat can be used for feeding, refuge, mating and many other things. In some cases, an area that is used for foraging could also have the physical features required for refuge (Krausman, 1999). Differential use of habitat has been described in several taxonomic groups (Rivero *et al.*, 2005; Fischhoff *et al.*, 2007; Garaffo *et al.*, 2007; Kofoky *et al.*, 2007; Ryan *et al.*, 2008). Factors influencing habitat use vary according to species, but in general each species searches for environmental features that are directly or indirectly associated with the resources it would need for reproduction and survival (Krausman, 1999).

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To identify the factors that determine habitat preference, it is important to understand the ecological interactions between organisms and their environment (Beyer *et al.,* 2010). Understanding these interactions will help with identifying ecologically important areas (Johnson, 2000; Manly *et al*., 2002), which is fundamental for identifying areas that are suitable for environmental protection and mitigation from anthropogenic impacts (Dawson and Slooten, 1993; Hooker *et al*., 1999; Hastie *et al*., 2003). According to Wedekin *et al*. (2002), studies of habitat use and behaviour are important for conservation planning.

Common dolphins (genus *Delphinus*) are among the most widely distributed cetaceans, occurring across tropical, subtropical and temperate oceanic waters. They occupy a wide range of habitats, from nearshore areas to open ocean (Gaskin, 1968; Hui, 1979; Au and Perryman, 1985; Seltzer and Payne, 1988; Evans 1994; Ferrero and Walker, 1995; Bearzi, 2005; Acevedo, 2007; Filby *et al*., 2010; Tavares *et al*. 2010; Bilgman *et al*., 2018).

In Venezuela, common dolphins (*Delphinus* sp.) are distributed along the northeastern coast. They are the most frequently observed cetacean species in this area. To date, studies on this dolphin (Romero *et al*., 2001; Quevedo, 2004; Molero, 2005; Rangel *et al*., 2005; Acevedo, 2007; Bermúdez-Villapol and Sayegh, 2007; Esteves and Oviedo, 2007; Rangel and Cobarrubia, 2008; Oviedo *et al*., 2010) have reported that common dolphins often use shallow waters (< 100m) and spend a lot of time travelling. Recent abundance estimates for this species (Oviedo *et al*., 2010), indicate that common dolphins are abundant across the whole of the northeast coast. This information is of interest as this species of dolphin is the main target for dolphin watching (Bolaños-Jiménez *et al*., 2007) and whilst common dolphins are not classified as endangered, they do face a number of human threats.

The taxonomic identity of the Venezuelan stock of common dolphins remains controversial (Esteves and Oviedo 2007; Jefferson *et al*., 2009; Tavares *et al*., 2010; Committee on Taxonomy, 2019). Therefore, we refer to the common dolphin addressed in this research as *Delphinus* sp., under the premise that taxonomic identity will be resolved in the future.

The Mochima National Park is a natural area of abundant marine biodiversity which makes it ideal for tourism and commercial fishing (Suarez and Bethencourt, 1994; Miloslavich *et al*., 2003; Alvarez, 2015). In recent years, the Park has been under high anthropogenic pressure from such as fishing, vessel traffic, pollution and tourism (Rivero Blanco *et al*., 2001; Linares, 2016), which may be affecting its biodiversity. The aim of this study is to look at the habitat use of *Delphinus* sp., by identifying the environmental variables associated with their presence. It is also important to look at the habitat used in relation to group size and composition, as well as to the behaviour observed on the surface.

MATERIALS AND METHODS

Study area

The study area was located in the Mochima National Park on the northeastern coast of Venezuela, South America (10°10.31'N, 64°13.4'W and 10°25'N, 64°42.9'W) (see Fig. 1). Its edge is located at depths of 84m to 125m with slopes from 0 to 3° (Miró, 1974). It has a semi-arid climate with a dry season from January to May and a rainy season from June to December. The study area presents a cyclic variation related to the coastal upwelling phenomenon of the area. This can be seen by looking at the temperature, dissolved oxygen, salinity, pH and water clarity (Robaina, 1991).

Data collection

Opportunistic surveys were conducted in the morning from 07:00 to 12:00 hours (local time) from September 2009 to August 2010. The surveys followed a pre-defined route in the east of the Mochima National Park (Fig. 1). A 5m artisanal boat with a 40hp outboard motor was used to conduct the surveys. The average speed of the vessel was 15km/h and the mean duration of the surveys was 5 hours. Binoculars (*Look Mariner Series* LK750P, 7x50mm) were used to locate the animals.

For the purposes of the study, a group of dolphins was established as the sample unit (Shane, 1990). A group was defined as an ensemble of animals closely engaged in the same activity and moving in the same direction (Garaffo *et al*., 2007). When a group was found, the pre-defined route was abandoned and the group was followed for as long as possible, to a maximum of 30 minutes. Data such as geographic position, group size,
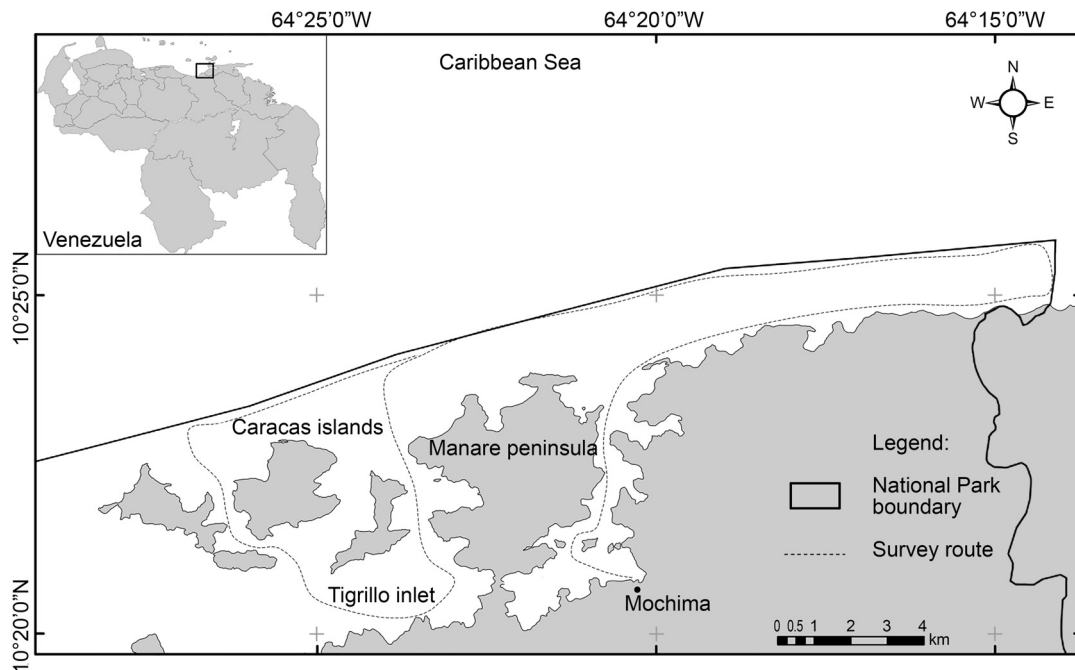
Fig. 1. Map of the study area which includes the park boundary and survey route. Surveys were done from Mochima town.

behaviour, and group composition were collected in blocks of five minutes when following a group of dolphins. When the 30 minute monitoring period ended, the survey was put on hold for two hours before the next recording to minimise the risk of auto-correlated data. This interval was chosen based on:

(1) the time necessary for an animal to transverse its home range (Swihart and Slade, 1985);

(2) data on *Delphinus delphis* swimming speeds; and

(3) he distance that can be travelled within that period (Hui, 1987; Rohr *et al*., 2002).

A photographic record of each group was made, using a digital reflex camera (*Nikon* D80) with an 18–200mm zoom lens, to identify group members individually (Wilson *et al*., 1999). Photo-ID focused mainly on capturing the dorsal fins of the dolphins. Individual identification prevented each group from being followed more than once during a day of sampling.

Behaviour

We recorded behaviour patterns using the focal group sampling criteria (Altmann, 1974; Mann, 1999). Each group was observed from left to right to include all individuals (Mann, 1999). A behaviour was considered 'predominant' if at least 50% of the animals were engaged in it at the time of observation. Each group's size and composition were also recorded.

Four behaviour states were considered:

(a) Feeding – short and unsynchronised dives, abundant surface events, multidirectional movements and, often, the presence of seabirds and schooling fish;

(b) Travelling – moving steadily in one direction, with synchronised dives;

(c) Socialising – Individual interactions within a group, frequent physical contact, often with vigorous movements and aerial behaviours such as leaping and breaching. This also included sexual and aggressive behaviours; and

(d) Resting – very slow movements or stationary at the surface (Norris and Dohl, 1980, Shane, 1990; Viddi and Lescrauwaet, 2005).

Group sizes were categorised at five size intervals (1–20, 21–40, 41–60, 61–80, and greater than 80 animals). According to their composition, groups were classified (Garaffo *et al.*, 2007) as (a) adult–juvenile, (b) juvenile, (c) mother with calves (more than 80% of the individuals were mothers with their calves) and (d) mixed (combination of mother with calves, juveniles and adults); the calves being dolphins less than half the length of an adult and in close association with an adult (Fertl, 1994); a juvenile being approximately two-thirds of the size of an adult who is frequently observed swimming in association with adults but not in the typical position of a calf (Mann *et al.*, 2000). Adults were defined as any animal not classified as a calf or juvenile. These latter were animals that appeared to be fully grown individuals (180–220cm in length), physically mature but not necessarily sexually mature (Collet and St Girons, 1984).

Environmental variables

Every time a group was sighted, we determined its geographical location using a GPS receiver and plotted on a nautical chart (DHN N 24433, 1:39.940). We drew a grid by using the Grids and Graticules extension of the ArcGIS 10.3 programme. The grid was composed of 30 rows and 58 columns with a cell size of 500 × 500m, the grid covered the entire study area. At each location, the depth, distance to the coast, and slope were measured. Depth was obtained by interpolation of points from the nautical chart. The distance to the coast was calculated by measuring from the centre point of each cell to the point closest to the coast. The slope was calculated in each cell using the following formula:

$$S = \frac{D_{max} = D_{min}}{DI}$$

where D_{max} is the maximum depth in the cell, D_{min} is the minimum depth in the cell, and DI is the distance in meters between the points of maximum and minimum depth of the cell, expressed in units of metres per kilometre (Cañadas *et al.,* 2002). All of the variables measured during the fieldwork were recorded on a digital voice recorder (*Olympus* VN-3100PC) and later transcribed to a database.

Data analysis

To determine habitat use, each cell was characterised by dolphin use intensity. The Coefficient of Area Use (CAU) both in total and per sampling season in each cell was calculated, using the following equation:

$$CAU = \frac{Di}{T}$$

where D_i is the cumulative time spent following dolphins in cell i and *T* is the total time spent following dolphins during the sampling period (Karczmarski *et al.*, 2000). Subsequently, the values of each cell per season were compared by means of a Wilcoxon test. Finally, with the purpose of spatially representing the habitat use, the values of the Coefficient of Use were grouped into three levels, low (0.002–0.006) medium (0.007–0.015) and high (0.016–0.025).

Univariate Chi-square analysis (χ^2) was applied to determine whether the groups used the area homogeneously with respect to the abiotic variables (depth, slope and distance to the coast) which were analysed in each cell (Zar, 1996). For this analysis, we started from the null hypothesis and the categories of environmental variables had an equal probability of occurrence. Additionally, a Multiple Correspondence Analysis (MCA) was used to determine if the habitat preferences (considering the variables depth, distance to the coast and slope) were related to group size and composition. For this analysis, the environmental variables were converted into categorical ordinal variables and, as a result of the test, a perceptual map was obtained for where the association between the set of categorical variables analysed were observed (Hair *et al.*, 1999).

Logistic Regression analysis was used to predict the relationship between the environmental variables (depth, distance to the coast, and slope) and the presence or absence of the species (Hair *et al.*, 1999). The method used during the logistic regression was 'stepwise backward', which included all the variables at the beginning and eliminated, in each step, those that contributed least to the significance of the model. The elimination of the

variables was based on the probability of the Wald test. This test allows a chi-square test to contrast the null hypothesis that the coefficient of each variable is independent of zero. Finally, the result was validated with the Hosmer-Lemeshow goodness of fit test.

The proportion of time that the groups spent displaying a particular behaviour within the areas were estimated. A χ^2 test was applied to determine if there was independence between behaviour and season, group size, and composition (Sokal and Rohlf, 1995). A Kruskal-Wallis test was applied to determine if there were differences between the behaviours in relation to the environmental variables. All statistical analyses were performed with SPSS software (version 19.0). Finally, maps were generated in order to visualise the areas used while displaying behaviour using a Geographic Information System.

RESULTS

Habitat use

From October 2009 to September 2010, 70 opportunistic surveys were conducted, and 86 groups of dolphins were observed. Total effort in the field was 310 hours, of which 44 hours were spent observing dolphins. Sampling effort in each season was equal to 155 hours. Out of the 250 cells analysed, dolphins were sighted in 140 (56%) equating to an area of 36km^2. Use by dolphins was not evenly distributed over the study area. Tigrillo inlet and the waters northeast of the Caracas islands were the areas most used by dolphins, exhibiting a high to medium CAU. Common dolphins were not observed to use Mochima Bay during the assessment period (Fig. 2).

During the rainy season, dolphins used 120 cells corresponding to 30km^2 (Fig. 3a). During this time, dolphins were observed more intensively in the northeast and southeast of the Caracas islands. On the other hand, in the dry season, dolphins used 85 cells equivalent to 21km^2 with a tendency to use Tigrillo inlet and the Manare peninsula more intensively (Fig. 3b). Even though during the dry season dolphins used fewer areas, a Wilcoxon test found no statistical significance in habitat use between seasons (z = 1.69, p = 0.09). The analysis of χ^2 revealed that common dolphins use their habitat differentially, showing increased usage in zones with depths between 10 and 100m (χ^2 = 188.52, gl = 5, p = 0.00) (Fig. 4a), near the coast (less than 2km, χ^2 = 208.74, gl = 3, p = 0.00) (Fig. 4b) and with low slope (< 0.09m/km, χ^2 = 204.35, gl = 2, p = 0.00) (Fig. 4c).
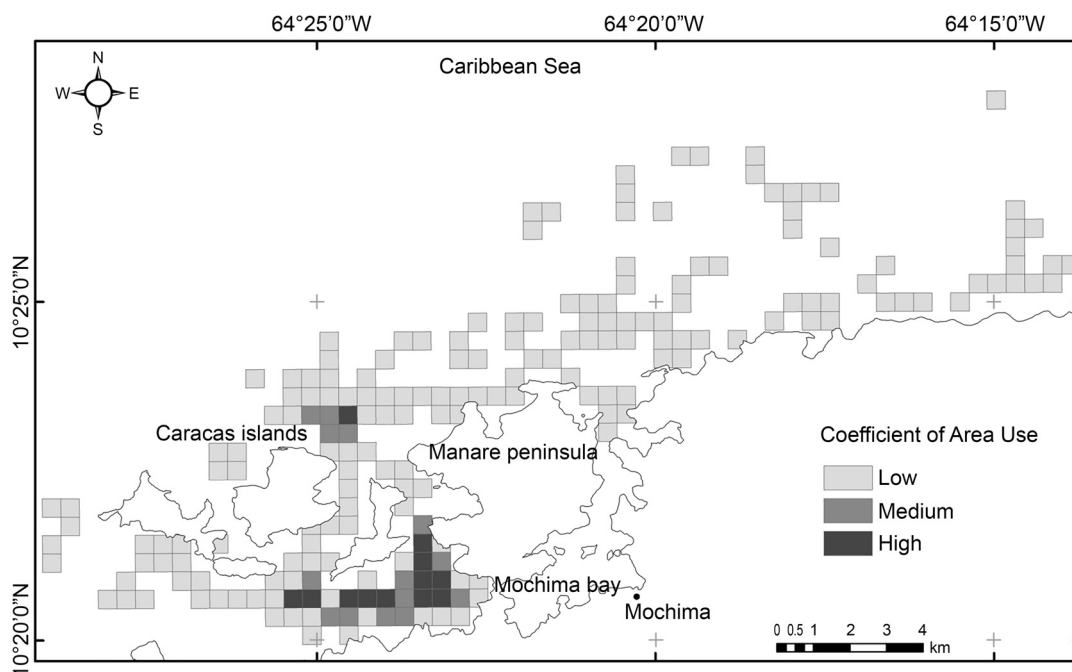

Fig. 2. Study area subdivided in cells of 500m × 500m. Each cell was characterised by a coefficient of area use (see text).
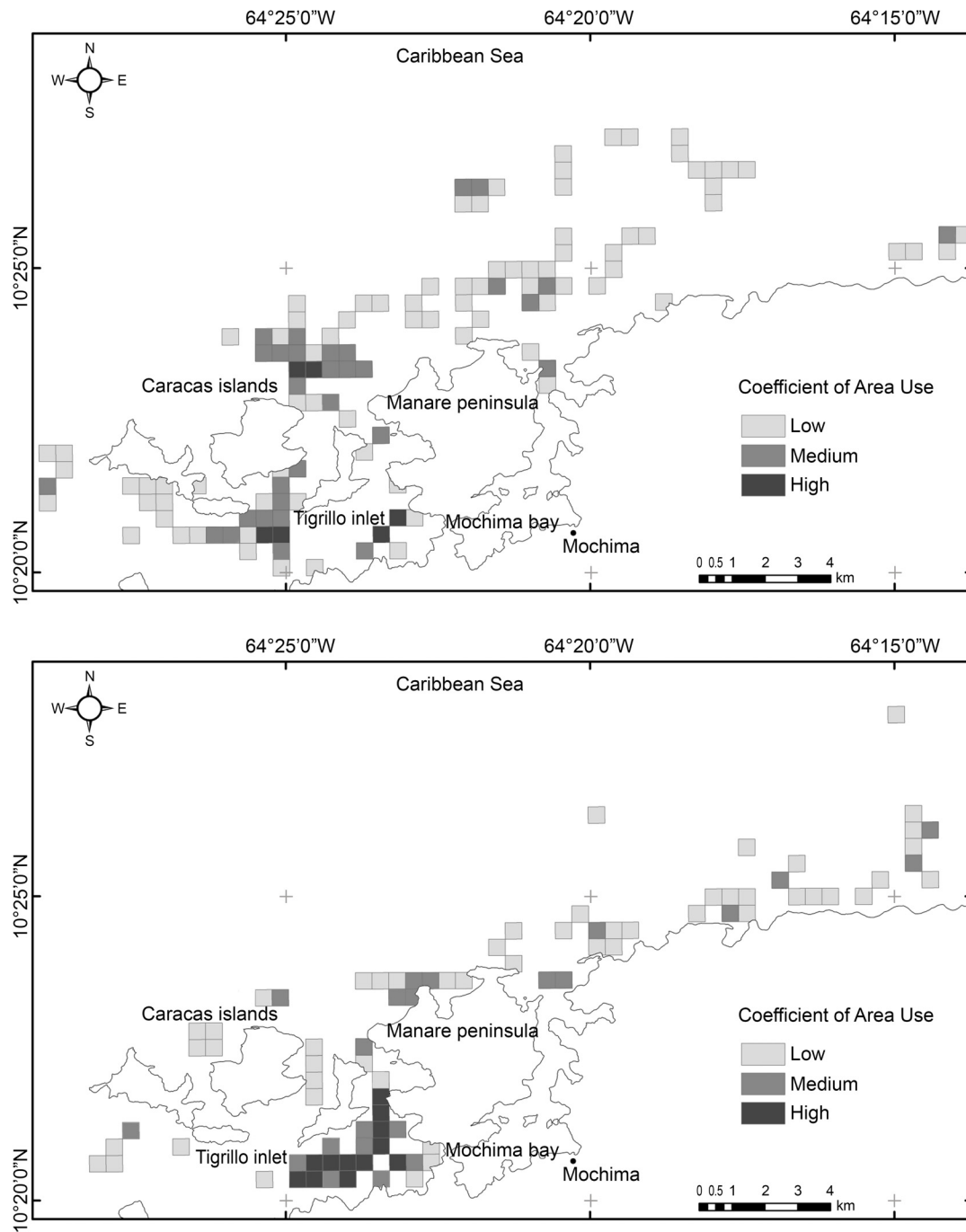
Fig. 3. Map of coefficient of area use by season, (a) rainy season (b) dry season.

Habitat use varied by group size and composition (Fig. 5). Groups of less than 20 individuals of adult–juvenile, mothers with calves and juveniles were observed using areas close to the coast (within 2km), with depths below 100m and a low slope (0.09m/km). Mixed groups larger than 20 individuals, in addition to using nearshore areas, also used offshore areas (up to 5km). The variance explained by this analysis was 69.75%.

Presence/absence analysis

The presence of common dolphins was analysed in relation to depth, slope and distance to the coast. Of the three variables analysed, depth and distance to the coast were significant with a negative beta coefficient, the probability of presence decreased with an increase in depth and distance to the coast. The correct classification rate of the model was 87.6%. The level of significance of the Hosmer-Lemeshow test indicated that the calculated model was effectively adjusted to the data used to estimate it (Table 1).
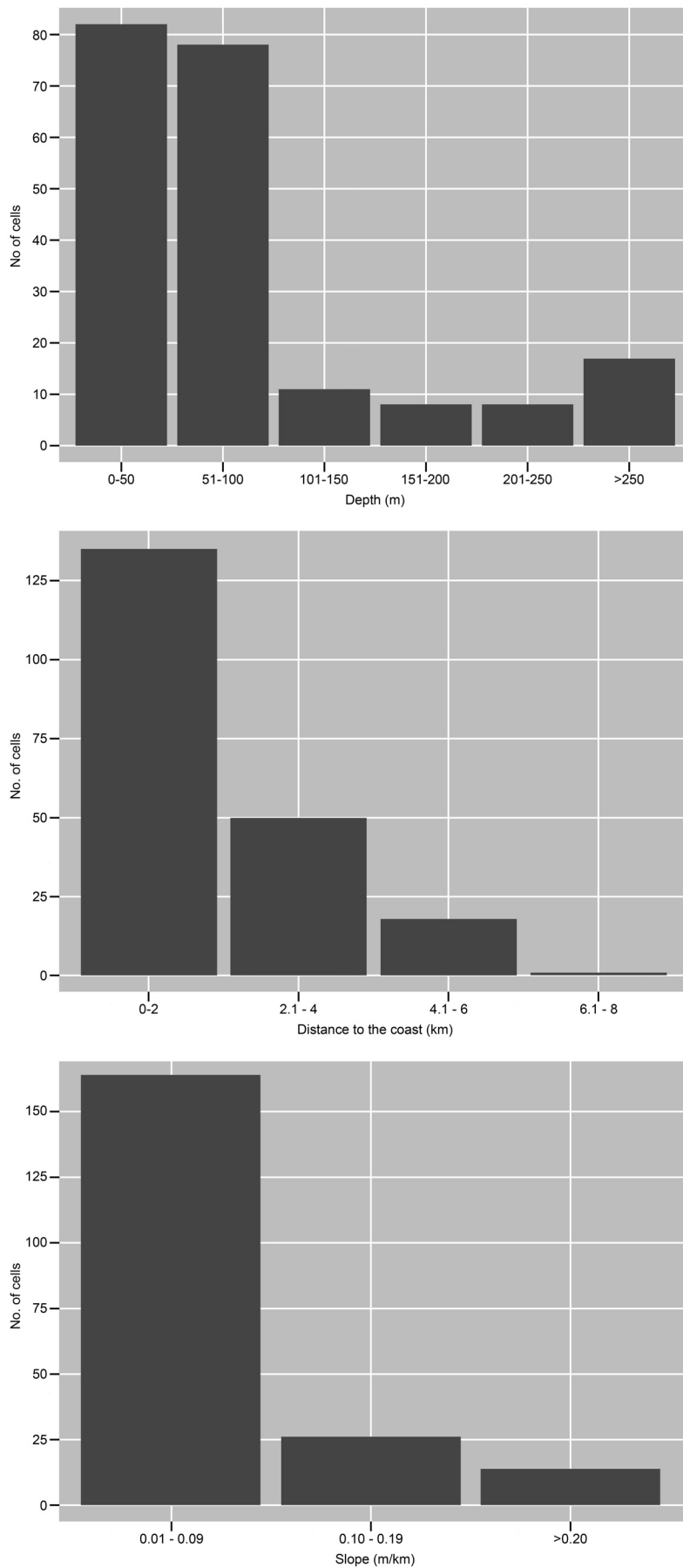
Fig. 4. Number of cells used by dolphins in each variable class, (a) depth (b) distance to the coast (c) slope.
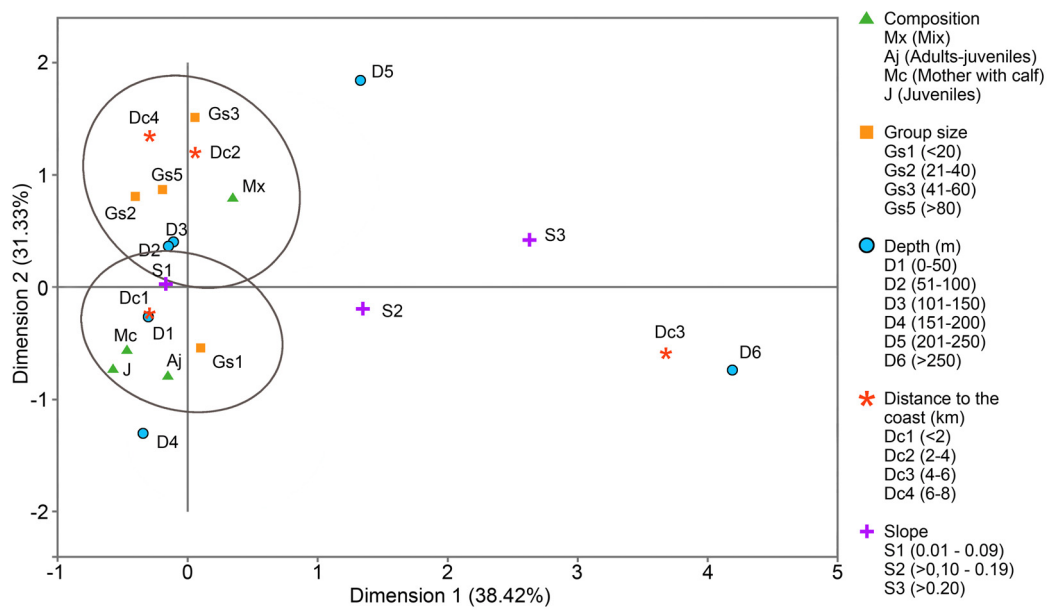
Fig. 5. Habitat use by group size and composition.

Table 1

Parameters for estimating the logistic regression model of the common dolphin as a function of the physical variables (depth, distance to the coast and slope) of the habitat.

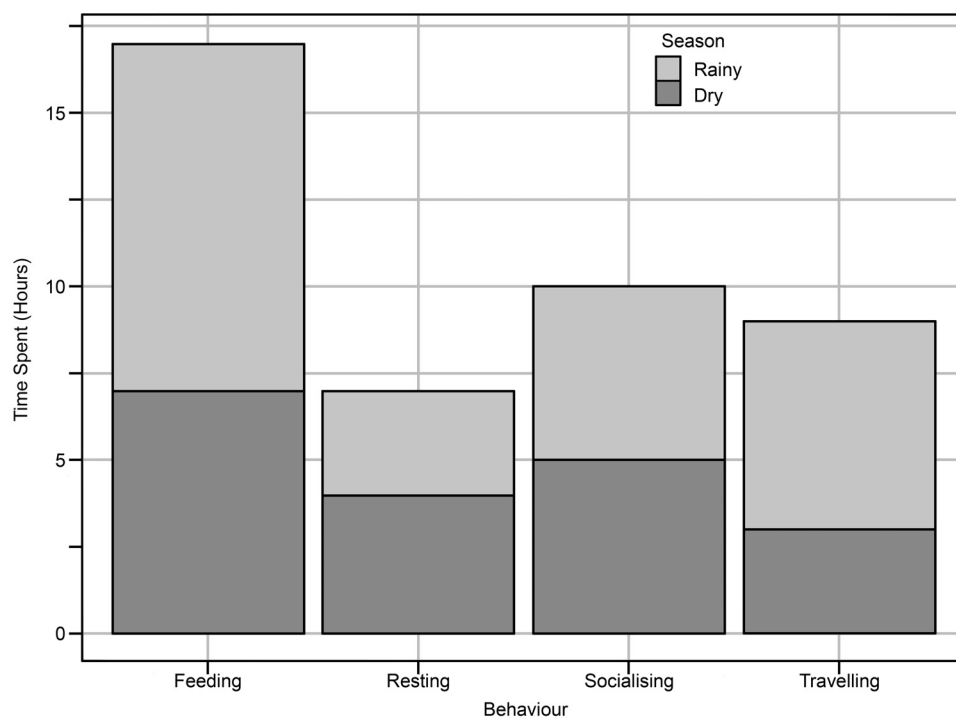|	Variables	B	S.E.	Wald	df	Sig.	Exp(B)	Hosmer-Lemeshow test
Step 1	Depth	−0.131	0.021	40.133	1	0.000	0.877	0.920
	Distance from the coast	−0.566	0.229	6.097	1	0.014	0.568	
	Slope	−4.684	6.732	0.484	1	0.487	0.009	
Step 2	Depth	−0.129	0.020	40.119	1	0.000	0.879	0.682
	Distance from the coast	−0.571	0.228	6.246	1	0.012	0.565	

Fig. 6. Time spent on each behaviour by seasons.

Behaviour

The behaviour most frequently observed was feeding (40%, n = 18 hours), followed by socialising (24%, n = 11 hours). Travelling was the third most frequent (19%, n = 8 hours) and resting was rarely seen (17%, n = 7 hours). Dolphins spent more time feeding and travelling in the rainy season, but more time in feeding and socialising during the dry season (Fig. 6). Differences in behaviours in relation to season were found to be significant (χ^2 = 30.44, df = 3, p = 0.001).

Feeding and travelling behaviours were observed throughout the study area, but more commonly to the northeast and southeast of the Caracas islands (Fig. 7a). Areas used included all categories of depth, distance to the coast and slope, nevertheless, dolphins spent more time in shallow areas near the coast (Fig. 8a–c).
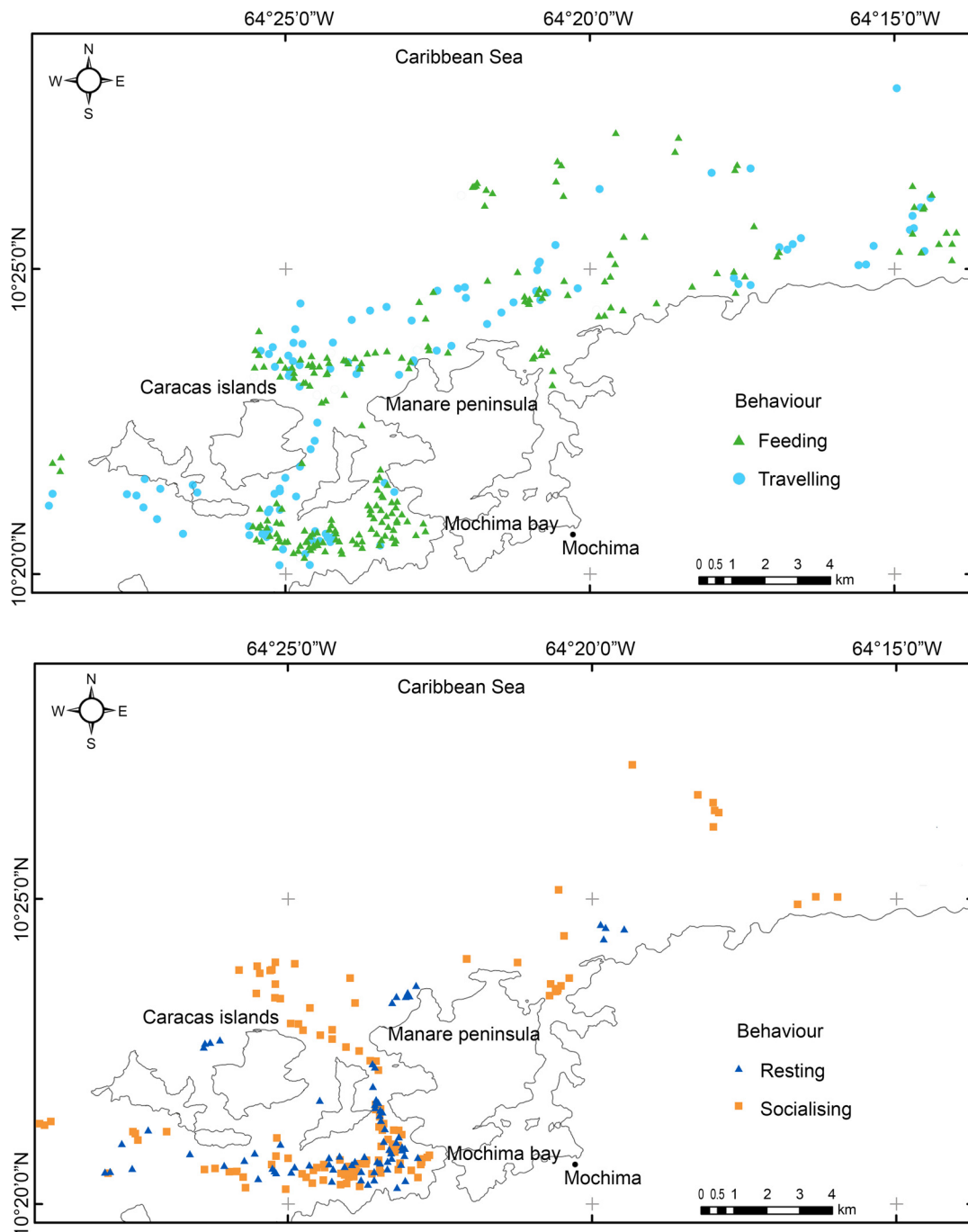

Fig. 7. Spatial distribution of behaviours observed in the common dolphin (*Delphinus* sp.) in the Mochima National Park, (a) feeding and travelling (b) resting and socialising.
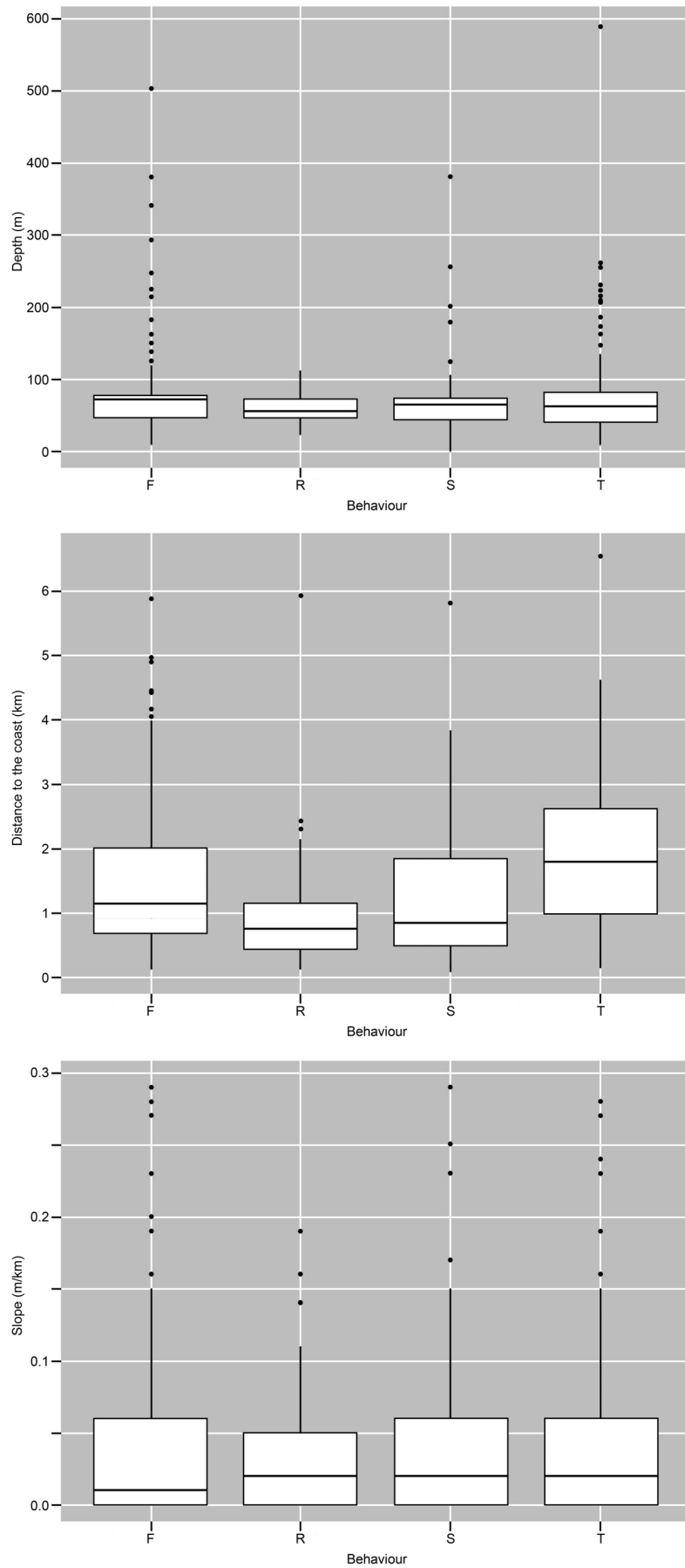
Fig. 8. Mean depth, distance to the coast and slope for common dolphins' behaviours, (a) depth (b) distance to the coast (c) slope.

The dolphins were found to socialise and rest mostly in shallow nearshore waters (Fig. 7b, 8a–c). These behaviours were mainly observed in Tigrillo inlet, the Manare peninsula and the Caracas islands. Behaviours varied significantly with the distance to the coast (H = 44.03, df = 3, p = 0.004) and depth (H = 8, df = 3, p = 0.03), however the slope was found to be not significant (H = 1.46, df = 3, p = 0.69).

The time that was spent displaying was found to vary significantly among group types (χ^2 = 37.09, df = 9, P = 0.001). Mixed and adults–juvenile groups spent a greater proportion of time feeding (Fig. 9a). Mothers with calves spent more time socialising and resting. Juveniles were more often feeding and travelling. All behaviours monitored also varied with group size (Fig. 9b), the smaller groups (1-20 individuals) spent more time feeding and socialising and larger groups (more than 80 individuals) spending more time feeding (χ^2 = 78.42, df = 9, p = 0.001).

DISCUSSION

This study provides new information on the ecology of the common dolphin (*Delphinus* sp.), one of the most commonly sighted cetaceans in the eastern region of Venezuela. Specifically, it reports new insights on habitat use, behaviour and occurrence of common dolphins for the Mochima National Park, a protected area that in recent years has had a high pressure by fisheries, chemical and acoustic pollution, commercial shipping traffic and unregulated dolphin watching activities (Bolaños-Jimenez, *et al*., 2007; Oviedo, 2008; Jefferson *et al*., 2009; Alvarez, 2015).

Common dolphins show differential use of the area. During the rainy season, dolphins were sighted to the northeast and southeast of Caracas islands while sightings were more common within Tigrillo inlet and Manare peninsula in the dry season. This result could be attributed to seasonal variations in the food resource (Wilson *et al*., 1997; Martinez-Serrano *et al*., 2011). The only known quantitative data on the diet of this population, determined by stomach contents, suggested that Venezuelan common dolphin feed mainly on Spanish sardine (*Sardinella aurita*; Naveira, 1996). These mesopelagic species have seasonal variations associated with coastal upwelling in the dry season (Mendoza *et al*., 1998; Gonzalez *et al*., 2007; Rueda *et al*., 2017,). During the dry season, sardines are abundant near the coast. Once the dry season is over, adult sardines move towards the northeast of our study area (Freón *et al*., 1997).

The sardine's movement towards the northeastern side of the study area coincides with the pattern of habitat use observed in this study. These results match those observed in an earlier study by Oviedo *et al*. (2010), which was conducted in the western area of the park, which also recorded seasonal and spatial variations in the habitat use by common dolphins. The authors suggested that variations were attributed to local movements of dolphin groups between feeding areas and this study supports their hypothesis.

The Tigrillo inlet and the waters northeast of the Caracas islands were the areas most frequently used by the observed dolphins. Dolphins were never observed in Mochima Bay where there is a significant amount of daily vessel traffic. In 2010, 90 boats were registered in this bay (INPARQUES, 2010) which may be a possible reason for the absence of dolphins. We detected changes in the behaviour of groups of mothers with calves and juveniles when two or more boats were close to them. Although these results were not the focus of this study, it is an important finding and could be considered a topic for future research. In coastal marine environments, vessel traffic is the anthropogenic activity with the greatest potential to disturb marine wildlife (Bejder, 2005; Bejder *et al*., 2006b; Lusseau *et al*., 2006; Lundquist, 2011). Previous research (Meissner *et al*., 2015) has indicated that commercial tourism and recreational vessels have a negative impact on the behaviour of common dolphins.

In general, common dolphins used shallow inshore waters more intensively, but this habitat use varied depending on group size and composition. Small groups composed of adult–juvenile, mothers with calves and juveniles mainly used shallow and nearshore areas. Larger groups of mixed composition were observed in both shallow and deep waters. Similar results have been shown elsewhere in common dolphins (Stockin *et al*., 2008; Filby, *et al*., 2010; Oviedo *et al*., 2010; Gaborit-Haverkort, 2012; Bilgmann *et al*., 2018) and other dolphin species (Sayman *et al*., 1973; Shane *et al*., 1986; Würsig, 1986; Garaffo *et al*., 2007; Gowans *et al*., 2008).

Some authors have speculated that using shallow nearshore areas would provide protection from predators (Würsig and Würsig, 1979; Norris and Dohl, 1980a), especially for mothers with calves and juvenile groups (Mann
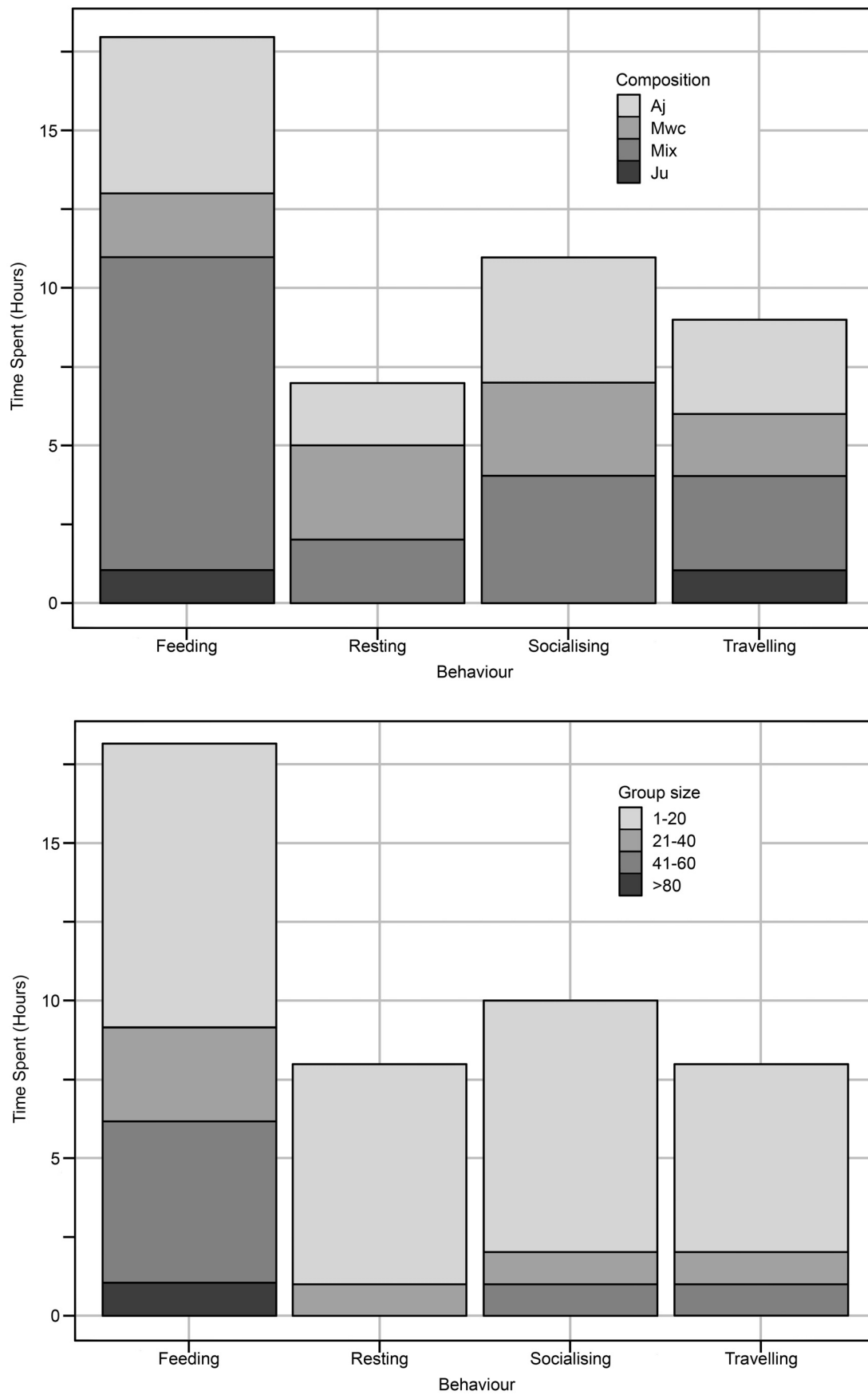
Fig. 9. Time spent on each behaviour by composition (a) and group size (b).

and Barnett, 1999). Likewise, being in a larger group reduces the risk of predation (Clutton-Brock *et al*., 1999; Hebblewhite and Pletscher, 2002). Saayman *et al*. (1972) pointed out that in deep waters the only defence against predators is the formation of large groups.

It is probable that predation risk may be another factor influencing observed habitat use in our study area (van Schaik and van Hoff, 1983; Lima and Dill, 1990; Heithaus and Dill, 2006; Stockin *et al*., 2008). During the study, we did not observe any predators in the area, although their presence was highlighted by local fishermen during informal interviews. Several authors (Jefferson *et al*., 1991; Visser, 1999; Maldini, 2003; Celona *et al*., 2006; Santos *et al*., 2006) have documented attacks on small odontocetes. In Venezuela, Sánchez-Criollo and Bermúdez-Villapol (2011), assessed shark attack rates on four species of cetaceans stranded in Margarita Island. Three species were identified as responsible for most cetacean attacks: cookiecutter sharks (Genus *Isistius*); tiger sharks (*Galeocerdo cuvieri*); and mako sharks (*Isurus* spp.). The results of that study indicated that shark attack rates were higher on common dolphins (*Delphinus* sp.) than on other species. This supports the hypothesis that mothers with calves and juveniles spend more time in shallower waters as a protection strategy (Degrati *et al*., 2008).

It was found that the behaviour of common dolphins in Mochima National Park was mostly influenced by season, depth, distance to the coast, group size, and group composition. The slope had no apparent influence on behaviour of common dolphins in this region. Feeding was the most frequent and widely observed behaviour over the entire study period. These results differ from Oviedo *et al*. (2010), Molero-Lizarraga *et al*. (2008) and Rangel and Cobarrubia (2008), who observed that travelling was the most frequent behaviour. Their studies were conducted in areas adjacent to the Mochima National Park. The results are however not directly comparable because the data collection methods were different. The differences observed among studies may be due to the daily and seasonal movements of prey. Food resources are rarely uniformly distributed throughout the environment, which requires travelling between foraging locations. According to Degrati *et al*. (2008) and Neumann and Orams (2005), there is a strong correlation between travelling and feeding. Travelling could therefore be directly related to the need to locate prey.

During our study travelling behaviour was generally preceded by feeding. Sequences of travelling and feeding have been observed previously (Degrati *et al*., 2008). Feeding was observed more frequently in larger groups than in smaller groups. These differences may occur because of the fission-fusion nature of common dolphin societies (Neumann, 2001), as groups merge to form larger groups for the purpose of foraging (Heithaus, 2001). Dolphins potentially feed in larger groups in the presence of large fish schools or when their prey are patchily distributed (Burgess, 2006).

Socialising was the second most observed behaviour. According to Neumann and Orams (2005) and Doenier *et al*. (1997) activities such as socialising should be more frequent, after satisfying nutritional needs. Socialising was recorded more frequently in both smaller groups, and groups of mothers with calves. Similar results have been described in other studies (Daura-Jorge *et al*., 2005; Garaffo *et al*., 2007; Stockin *et al*., 2009). The low frequency of resting behaviour observed in this study could be a sampling bias. When common dolphins rest, they show inconspicuous surface activity, making it very difficult to record this behaviour (Neumann and Orams, 2005). An alternative possibility is that the resting behaviour of the dolphins was disturbed by our boat. It was observed that while groups of mothers with calves spent more time in resting behaviours, these groups tended to be more sensitive to boat presence and noise (Guerra *et al*., 2014). Studies examining the effects of boats on cetaceans have quantified short-term changes in surface behaviour, frequently measured as changes in group activity (Lusseau 2003; Christiansen *et al*., 2010).

We identified priority habitats for feeding, refuge, and resting areas especially when observing mothers with calves and groups of juveniles. The use patterns presented here have important implications for park management. Current planning (especially zoning) may not be effective because it does not include dolphin protection areas. In recent years, human disturbances have affected Mochima National Park, so special legislation and control is needed. The purpose of this study was to provide data that would help the effective conservation of these dolphin populations and to present the evidence found.

Limitations

These results need to be interpreted with caution. We identified a few possible sources of bias that could influence results. Firstly, data for this study were collected using platforms of opportunity meaning the spatial coverage was strictly limited by the pre-determined route. Despite this limitation, it provided an inexpensive way to conduct surveys on cetaceans (Hupman *et al.*, 2015). Secondly, the dolphins were monitored for up to 30 minutes. This time limit was established to avoid the animals' habituation to the boat and for the continuity of the search for further groups. To mitigate these problems, sampling effort in each season was increased. Thirdly, the presence/absence data used in the logistic regression model could contain errors. It is possible that dolphins may have been present in an area but were not detected. According to Mackenzie (2005), observed absence may simply be the result of the survey method failing to detect the presence of the species that are resident at the location. While the presence of a target species can often be confirmed at a location, it is generally impossible to confirm species' absence. Finally, the sampling method was based on surface behaviours, this may have introduced bias because only more visible or conspicuous behaviours are recorded, and this would affect the observation of more subtle behaviours such as resting.

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