HABITAT USE AND PREFERENCE BY *SOTALIA GUIANENSIS*: A PARTIAL REVIEW OF AVAILABLE KNOWLEDGE AND RESEARCH FRAMEWORK

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Introduction

The two main questions in ecology are, according to Krebs (2001), "where" a species occur and "why". The first question is, *a priori*, the easiest to answer because it deals with a *pattern*, more objective, considerably less complex, and involving a smaller number of variables, essentially biological in nature. The second question deals with a *process* and generally a great number of variables, biological and physical in nature, and how these variables influence one another. When we ask how the environment where a species live (or its habitat) affect its presence and abundance, we are focusing on questions of habitat use and preferences by this species.

The studies about the habitat use and preferences of the estuarine dolphin (*Sotalia guianensis*) are still scarce. Inferences about preferred areas of use and key habitats for the species were made based on empirical knowledge and without proper hypothesis testing directed to answer these specific questions.

In the present article, we aim to clarify some basic and important concepts generally used in studies about wildlife-habitat relationships. After this first and necessary step, we reviewed scientific literature about habitat use and preference of the estuarine dolphin, offering a summary of information about the subject. At the end, we suggested a research framework for better assessment of habitat use and preference for future studies on the species.

Conceptual review

Some basic and important concepts are listed and discussed below:

Spatial use: the basic information necessary for every study about habitat use and preference is how the specie uses the space, or the *pattern* of spatial use. This information corresponds to the dependent variable in studies about wildlife-habitat relationship. It can be described for a species as its distribution, home-range, presence/absence, density, abundance index in quadrats or transects and other descriptive methods. All methods assume an adequate research design close to an ideal sampling effort equally distributed on space and time. If a study deviates significantly from this ideal condition, it may be necessary to correct the heterogeneity of research effort. The chosen method to describe the spatial use of a species will be better if it brings some information about intensity of use, separating areas of higher usage to areas of occasional use by the dolphins.

Habitat: it corresponds to an "area with a combination of resources and environmental conditions that promotes occupancy by individuals of a given species (or population) and allow those individuals to survive and reproduce" (Morrison *et al.*, 1998). Thus, a particular habitat includes a

species and its environment, or, according to Garshelis (2000), habitat is organism specific. Space and/or area, *per se*, are not the same as habitat. The habitat of a species should be described by a group of variables that distinguish it from other habitats. Space is habitat, but habitat is more than the simple space. The choice of these variables is an important initial step for studies involving wildlife-habitat relationship.

Habitat variables: the variables that describe a habitat may be quantitative or qualitative, and correspond to the independent variables in studies of habitat use and preference. In the terrestrial environment, vegetation type is often regarded as the best existing habitat variable, and also the most used by researchers. In the aquatic environment other variables are used, and these variables can de divided roughly on physiographic (e.g., depth, distance from the coast), physical-chemical (e.g. temperature, salinity, water transparency), or biotic (e.g., presence of mangrove forests, presence of prey and predators). It is important to point out that the chosen variables should have biological meaning for the species being studied, influencing its presence or absence, and should not be correlated with each other.

Habitat use: may be regarded as the description of the characteristics of the habitats (defined by a group of habitat variables) that an individual, group, population or species use in a defined period. A description of habitat use by a species should include de maximum and minimum values of each variable used by the species, as well as the most used values, such as a central tendency parameter (mean or median). Na example for the marine environment is the range of depth which a given species may be observed, including the depths that this particular species is observed more often, and the depths where it is rarely found. It is common in the scientific literature the confusion between habitat use and spatial use (or distribution). The spatial use, as described above, deals with the simple description of where the species is present, while the habitat characteristics are not measured and related to this presence.

Habitat preference: it involves differential use of habitat types by a species, and the method most used to study this matter is to compare the available habitats to the habitats effectively used by a species in a given area (use-availability design - Garshelis, 2000). It is possible to test the null hypothesis that a particular habitat variable is used by a species in the same proportion of its availability in the area sampled by the researcher. When the null hypothesis is accepted, it means that the species did not prefer any type of habitat described by the variable. If the null hypothesis is rejected, the disproportional use of a habitat type in relation to its availability suggests that the species preferred certain habitat types while avoiding others. Thus, “an animal spends more time in a given habitat type than expected by chance alone” (Bjørge, 2002). After this procedure, the researcher may apply confidence intervals to know specifically what habitat types were “preferred” or “avoided” by the animal (Neu *et al.*, 1974). We strongly recommend the chapter by Garshelis (2000), who reviewed concepts, methods and problems associated with each method to evaluate wildlife-habitat relationship.

Partial review of existing knowledge about habitat use and preference by *Sotalia guianensis*

For the present review we used seven scientific works about habitat use and preference by the estuarine dolphins (Table 1). Only three of these works were published in peer-reviewed scientific magazines. Other works used the term “habitat use” in their title but did not addressed the issue as it was conceptually reviewed above, limiting to describe spatial use patterns by the species. Some

other works brought some sparse information about habitat use and were not included in the present review.

The habitat variables and the number of works that used them (when more than one work, in parenthesis) were: depth (n = 6), distance from the coast (n = 4), sea floor relief (n = 3), transparency (n = 2), temperature, distance from sand banks, presence of rocks on the bottom, presence of islands, presence of submerse sand banks, presence of rivers, type of shore, type of substrate, intensity of currents, and variability in the direction of currents.

Shallow waters (< 15 m) and close to the coast (< 12 km) were used more intensively or preferred by the estuarine dolphin. In spite of the probable correlation between these two variables, the reviewed works suggest that areas with small depths and close to the coast represent invariably the typical habitats for the species. The range of habitats used by the estuarine dolphin, however, is wider. The estuarine dolphin may use deeper areas and farther from the coast, as well as steep or flat bottoms.

The habitat use and preference by the species was not coincident among the different studies reviewed. This lack of agreement is due to, among other reasons, the distinct habitat variables used, the differences of analytical procedures and, possibly, to differences in the behavior of the animals.

The environmental heterogeneity and the higher abundance of prey were the most used explanations to justify the habitat preferences observed. The local spatial scale was the only approached in the studies.

It was common in these studies the confusion or lack of definition of terms, concepts, habitat variables and spatial scale used. Sampling sufficiency was not mentioned by any work. The analytical methods applied were not always appropriate to infer about habitat preference by the species, while hypothesis testing were absent in some works.

Research framework

Below, based on our conceptual and knowledge review, we will suggest some important points to be considered in future studies about habitat use and preference by the species:

- Test habitat preference across different spatial scales, including the regional and local scales (micro and macrohabitat);
- Homogeneous research effort, both in the spatial and temporal axis, in the study areas;
- Sufficient number of samples (e.g., sightings), independent of each other;
- Use of the largest possible variety of habitat variables, not correlated with each other;
- Complete description of spatial use, habitat use and preference by the species;
- Use of adequate statistical analyses to infer about habitat preferences (see Neu *et al.*, 1974; Morrison *et al.*, 1998; Garshelis, 2000).

Table 1: Studies and respective information about habitat use and preferences by *Sotalia guianensis*.

Source	Habitat variables	Habitat use	Habitat preference	Statistical test
Cremer, 2000	Depth, bottom relief, presence of rocks on the bottom, islands, submerse sand banks and rivers, and type of margin	Depth: 0 to 10 m	Depth: 6 to 10 m High sea floor relief Close to mangrove forests	
Bonin, 2001	Distance from the coast, depth	Depth: 0 to >12 m Dist. coast: 0 to 2 km	Depth: 0 to 8 m Dist. coast: 0 to 0,3 km High sea floor relief	
Edwards & Schnell, 2001	Distance from the coast	Dist. coast: 0 to 300 m	Depth: 0 to 5 m Dist. coast: 0 to 100 m	G test (only for distance from the coast)
Flores, 2003	Depth, temperature, transparency	Depth: 2 to 7 m Transp.: 0.3 to 1,75 m Temp.: 13 to 28°C	Not tested	
Lodi, 2003	Temperature, depth, transparency, distance from the coast, type of substrate	Depth: 2 to 15 m Dist. coast: 0,2 to 10 km	Depth: 2 to 6 m Dist. coast: 1 to 3 km mud bottoms	Spearman Correlation
Wedekin *et al.*, 2004	Depth, sea floor relief, intensity and variability in the direction of currents	Not stated	Depth: 0 to 6 m High sea floor relief Moderate to low intensity of currents Moderate variability in the direction of currents	Chi-square
Rossi-Santos *et al.*, 2005	Depth, sea floor relief, distance from the coast, distance from sand banks	Depth: 0 to 15 m Dist. sand banks: 0 to 12 km Dist. coast: 0 to 12 km	Depth: 0 to 6 m Dist. sand banks: 0 to 6 km Dist. coast: 0 to 5 km Low sea floor relief	Chi-square

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