HABITAT ASSESSMENT OF NATURAL AND ARTIFICIAL AQUATIC ENVIRONMENTS IN SEMI-ARID BRAZIL*

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INTRODUCTION

Defined as the living space for instream biota, the physical habitat is spatially and temporally dynamic as a result of the hydrological regime and interactions with structural features, such as slope gradient, bank structure and substrate. The physical habitat of rivers and streams in semi-arid Brazil has been degraded by human activities since colonization. This is likely to have led to modification of biotic communities and the ecological functioning of these aquatic ecosystems.

The knowledge of species diversity and their biology alone, or the preservation of geographical areas based solely on their fauna, does not necessarily provide the means for long-term species survival or recovery. In addition to such measures, the preservation of the physical processes that create habitat and maintain aquatic diversity in semi-arid streams will ensure that the aquatic biota is able to colonize the available habitat and, therefore, improve the probability of long-term persistence (Maltchik & Medeiros 2006). Knowledge of the condition of the physical habitat is therefore a critical component, as the nature of the local habitat has a profound influence on the structure and organization of biological communities. Fundamental to this, is the development of methods for assessing the ecological condition or "health" of rivers. Information on habitat would also be useful for predicting or assessing the potential distribution of key aquatic organisms, such as fish and macroinvertebrates, based on their habitat requirements (Mugodo *et al.* 2006).

This paper evaluates habitat diversity, substrate composition and general morphological characteristics in a range of environment types across semi-arid streams and rivers in northeastern Brazil. It aims at understanding the overall differences between natural and modified aquatic systems, as well as spatial and temporal variability in the physical habitat.

MATERIAL AND METHODS

This study was performed in two different areas of the Brazilian semi-arid: Seridó/Borborema (PB/RN) and Buique/Vale do Ipojuca (PE) (MMA 2004). In each area three sites were selected to represent typical artificial and natural semi-permanent environments. Sites consisted of stream reaches, usually 100 to 500 m long, and artificial reservoirs created from stream impoundment. Sampling was conducted during one year on four occasions (April, June, September and December 2006). Catchment- and local-scale variables were selected based on Mugodo *et al.* (2006) and local characteristics, and classified according to three sets of variables: (1) substrate composition, estimated for one square meter in each survey point and allocated to substrate classes; (2) habitat characteristics, representing the abundance of marginal microhabitat structures, estimated in each survey point; and (3) site morphology, representing morphometrical and physico-chemical characteristics, measured at each study site, as three replicates.

Usually 3 to 12 random survey points were evaluated within each river reach or reservoir. Substrate composition and habitat elements were estimated as their proportional contribution to site wetted perimeter. For the evaluation of site morphology, width was measured using a measuring tape for distances of up to 100 m and GPS satellite receiver for distances greater than 100 m in larger sites. Depth was measured with a staff at approximately equivalent distances along a transect. Flow was measured using the float method (Maitland 1990). Bank slope was estimated visually and allocated into slope categories. The elevation was estimated from GPS receiver readings. Water temperature (°C) and dissolved oxygen (mg/l) were measured with a digital oxygen meter (Lutron DO 5510), and turbidity (cm) was measured with a Secchi disk.

Detrended Correspondence Analysis and Principal Component Analysis, followed by the Multi-Response Permutation Procedures (MRPP) (McCune and Mefford 1999), were performed to understand patterns in the data and test for significance of differences. The Indicator Value (IV) showed important elements that separated significantly different *a-priori* groups.

RESULTS AND DISCUSSION

Substrate composition consisted generally of mud (53.9%) and sand (38.2%), with cobbles and rocks encompassing 6.1% of the substrate. The structure of the habitat was composed of submerged grass (10.3 %), macrophyte cover (8.8%), filamentous (5.5%) and attached (6.5%) algae, overhanging vegetation (4.9%), submerged vegetation (4.5%), small (3.5%) and large (1.9%) woody debris, leaf litter (1.8%) and roots (0.4%). Overall, the average diversity and richness of habitat elements was higher in Seridó (Shannon´s diversity S=1.5 ±0.3; R=9.1 ±2.6) than in Buique (S=1.1 ±0.3; R=7.1 ±1.3). However, MRPP showed that habitat and substrate composition were not significantly different between these two areas (A=0.02; p=0.24). Alternatively, differences in habitat structure and substrate composition were significant between river and reservoir sites (A=0.07; p=0.03) and dry and wet seasons (A=0.09; p=0.01). Important habitat elements that discriminated river and reservoir sites were macrophyte cover for reservoirs (IV=53.3%; p=0.02) and cobbles for river sites (IV=81.3%; p<0.01). Submerged (IV=48.8%; p=0.01) and overhanging (IV=48.9%; p=0.01) vegetation were significant elements in separating the dry and wet seasons.

With regard to site morphology, MRPP showed significant differences between both study areas (A=0.38; p<0.01) and river/reservoir sites (A=0.29; p<0.01). However, site morphology was not significantly different between the dry and wet seasons (A=-0.03; p=0.85). Because the study sites are semi-permanent (retaining water for the entire hydrological cycle), changes in some characteristics, such as depth, width, turbidity and temperature were small, whereas others did not change throughout the study period, such as altitude and bank slope. Important features separating both study areas were site width (IV=84.3%; p<0.01) and elevation (IV=74.1%; p<0.01) for Buique, and temperature (IV=52.9%; p<0.01) for Seridó. Besides turbidity (IV=60.7%; p<0.01), site width (IV=92.8%; p<0.01) and elevation (IV=69.2%; p<0.01) were also significant features separating rivers from reservoir sites. Elevation was a good descriptor of the study sites as, sites in Buique were considerably higher than sites in Seridó. However, because the sampling design is not balanced (two reservoirs in the Buique area and only one in the Seridó area), site width was a biased element discriminating the study areas. Site width was greater in Buique because of the predominance of large reservoirs as study sites in this area. Nevertheless, site width was an appropriate descriptor of environment type, because rivers were consistently narrower than reservoirs. Results indicate that substrate, habitat and morphological elements are accurate descriptors of environment types and some of the spatio-temporal variation in aquatic environments in the semi-arid region of Brazil.

* This work was funded by CNPq/UEPB/FAPESQ (350082/2006-5) and PPBio Semi-Árido

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