SEASONAL AND SPATIAL VARIATION IN WATERBIRD COMMUNITY ALONG MONJOLINHO RIVER, SÃO CARLOS (SP, BRAZIL)

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INTRODUCTION

The wetlands arround the world are under threat due to the human land use. These areas have been altered, degraded and/or lost. The cities and agriculture exert on rivers extreme pressures. The progressive loss of humid areas is caused by drainage, high abstraction of water, pollution, and other factors (Wetlands International, 2005). All these sources of impact are considerable and many are increasing. Unfortunately, anthropic disturbance can greatly alter the structure of animal and plant communities.
The habitat heterogeneity along water flows can influence both bird assemblage composition and abundance (Rushton *et al.,* ., 1994). Aquatic environments are often mosaics in which waterbirds are not uniformly distributed. The patterns of distribution of birds through habitats reflect decisions made by individuals selecting places in which to establish a foraging or breeding territory.
As areas are cleared due to agriculture, industry, or urbanization, the vegetative structure of the habitat often undergoes major change, followed by water quality and soil erosion. Many studies showed that the diversity of aquatic birds is influenced more by the nature and conditions of habitats surrounding water than by the water quality itself. Despite their relatively tolerance for water conditions, the waterbirds are at risk in Neotropics (Stotz *et al.,* ., 1996). Monitoring of bird communities provides data, which are valuable to biodiversity conservation.

OBJECTIVES

This paper aims to describe for the first time the aquatic bird communities along six points through Monjolinho River, what provides information about the local waterbird populations during a year - long.
We describe richness and abundance of waterbirds, seasonal patterns, and habitat use related to the quality of habitat surrounding water in selected points.

MATERIAL AND METHODS

Study area. Monjolinho River is an affluent of Jacaré - Guaçu River, drained by Tietê River, which is included in the upper Paraná River Basin. It is located in municipality of São Carlos, São Paulo State. Our research incorporated a measurement of the degree of disturbance. We selected three different habitat conditions: (site 1, 21^{0}59'11"S - 47^{0}52'31"W, 833m elevation) human made lakes, with stablished vegetation-considered mid - low level of disturbance; (site 2, 21^{0}59'48"S - 47^{0}53'47"W, 819m elevation) river pathway with low - density vegetation-intermediate - high level of disturbance; and (site 3, 22^{0}00'42"S - 47^{0}54'26"W, 806m elevation) stretch without vegetation-highest levels of disturbance. We settled two points in which site, 400m one from another, totaling six points. The site 2 are located 2.4 km downstream the river from site 1. Site 3 is about 4.8 km from site 1.
Data collect. Species richness and abundance was estimate from November 2007 to December 2008. We surveyed four times each of the six points, twice a season (breeding and non - breeding period). Each count lasted about 1 hour. We evaluated whether bird assemblage and abundance counts were different among three levels of disturbance along the land - water interface of Monjolinho River. We used PAST software (Hammer *et al.,* ., 2001) to estimate and compare diversity index of Shannon - Winner (H', with bootstrap 95% of confidence) and BioEstat (Ayres *et al.,* ., 2007) to run the tests. Wilcoxon rank - sum test (Mann - Whitney test) were done for seasonal data, Kruskall - Wallis test for equality of the medians among the three sites looking for differences, and cluster analyses (multivariate statistics) to measure Euclidean distance between the six points.

RESULTS AND DISCUSSION

A total of 39 water - dependent birds were recorded during the study. Most of them are piscivores and omnivores (36%

each). Ardeidae family contributed to 21% of all species, Rallidae 13%, and Anatidae 10%. 806 individuals were counted. The mean relative abundance of species ranged from 0.0012 to 0.0893. *Amazonetta brasiliensis*, *Ardea alba*, *Vanellus chilensis* and *Phalacrocorax brasilianus* were the most common species; and *Gubernetes yetapa*, *Mycteria americana*, *Pardirallus nigricans* and *Podilymbus podiceps* were the less frequent ones. The total diversity index (H') calculated was 3.301, and evenness 0.69.

The richness, the individual encounters, and index of diversity were different for each site. In site 1, 39 species were detected in 572 encounters and H' = 3.29. The site 2, 27 species, 160 individuals observed, and H' = 2.96. In site 3, only 17 species and 74 individual encounters were registered, and H' = 2.42. The degree of disturbance measured out of bird data surveys indicated that site 1 has the low indices of disturbance, site 2 with intermediate levels and site 3 is the most depredated one, with the highest levels of disturbance. This may corroborate our hypothesis of more degraded and disturbed the area is, less environmental quality it sustains. However, more data are needed to strongly prove this. Considering the six points (two in each site), the cluster analyses using Euclidean distance indicates the minimal distance is between point 5 and 6 (distance = 2.59), both in site 3 (the more degraded one) and the maximal distance is between point 2 (in site 1) and point 6 (in site 3, distance = 14.74). There was always more distance between sites, and points in different sites, than between points inside these sites, as we expected.

We tested if the structure of waterfowl community depends on the sites (with different degrees of disturbance and degradation) or does not depend on the area where it is. We used the abundance data of all species. The Kruskal - Wallis test indicates that the community depends on the sites (H=47.71, $p < 0.0001$). The Dunn test comparing medians showed differences between sites 1 and 2, and between sites 1 and 3, both $p < 0.05$; but was not statistically significant (p) between sites 2 and 3. Therefore, the presence and abundance of species depend on the sites.

Comparing seasonal variations (breeding and non - breeding periods), there were differences between H' (p=0.003, using bootstrap), but not between evenness (p=0.33), nor equitability (p=0.14). The seasonal variation was tested by Wilcoxon - rank - sum test (or Mann - Whitney) by comparing abundances in aquatic bird populations. There were variations between the two seasons (U=327.5, $p < 0.0001$). Hence, the waterbird community structure changes between the breeding and non - breeding periods.

CONCLUSION

For the most part, aquatic birds reflect the quality of the vegetation that surrounds the water flow, the degree of disturbance and the coverage area of water. The differences of abundance and species composition between the sampling sites along Monjolinho River could be associated to human impacts. Waterbirds in this study may act as indicators for riparian habitat quality and the presence of lakes, despite being non - natural ones. Besides, the breeding and non - breeding periods can alter the waterfowl communities, indicating seasonality.

We emphasized the importance of maintenance and protection of small and mid - size rivers and lakes. These environments can hold significant waterbird communities. The majority of sampling sites are very relevant to local avifauna, indicating the high biological value of this river. Moreover, this study is also a contribution to ecological Monjolinho River database for its conservation.

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