



Species inventory of aquatic macrophytes in the last undammed stretch of the Upper Paraná River, Brazil

Inventário de espécies de macrófitas aquáticas no último trecho sem barragens do Alto Rio Paraná, Brasil

Douglas Costa Souza^{1*}, Eduardo Ribeiro Cunha¹, Raytha de Assis Murillo¹,
Márcio José Silveira¹, Mikaela Marques Pulzatto¹, Mario Sérgio Dainez-Filho¹,
Lucas Assumpção Lolis¹ and Sidinei Magela Thomaz¹

¹Programa de Pós-graduação em Ecologia de Ambientes Aquáticos Continentais – PEA, Universidade Estadual de Maringá – UEM, Av. Colombo, 5790, Bloco G90, Jardim Universitário, CEP 87020-900, Maringá, PR, Brazil

*e-mail: douglascosouza@gmail.com

Cite as: Souza, D.C. et al. Species inventory of aquatic macrophytes in the last undammed stretch of the Upper Paraná River, Brazil. *Acta Limnologica Brasiliensia*, 2017, vol. 29, e115.

Abstract: The last undammed stretch of the Upper Paraná River in the Brazilian territory is, to date, not completely inventoried, which rises concerns given the rapid rates of species extinctions. **Aim:** Here, we provide an inventory of macrophyte taxa recorded in the last undammed 230 km stretch of the Upper Paraná River. **Methods:** We inventoried macrophyte taxa in 27 sampling stations including lakes, the main channel of the river, and the tributary confluences in November 2013 and in May and November 2014. Macrophyte were sampled in littoral zones. We explored taxonomic and life form aspects of the recorded species. We used species accumulation curves and ordination techniques to summarize the variation in richness and composition of macrophyte species. **Results:** We recorded 71 macrophyte taxa in 35 families. Most species were emergent, amphibian, free-floating, and rooted submerged. At the main channel of the Upper Paraná River, *Eichhornia azurea*, *E. crassipes*, and *Paspalum repens* represented the most frequent species. The most frequent species in the tributary confluences were *Ludwigia* sp., *E. azurea*, and *Polygonum ferrugineum*, while in lakes, *Ludwigia* sp., *Oxycaryum cubense*, and *E. azurea* were the most representative taxa. In regard to macrophyte composition, the invasive *Hydrilla verticillata* mostly influenced sites in the Upper Paraná River, in the ordination space, while floodplain lakes were mostly characterized by the presence of species such as *Scleria melaleuca*, *Panicum maximum*, and *Thelypteris* sp., among others. **Conclusions:** Our study indicates that the last undammed stretch of the Upper Paraná River contains a large number of macrophyte species, suggesting that this stretch is an important area for the conservation of macrophyte species. In addition, the occurrence of invasive species (e.g., *Hydrilla verticillata*) within the investigated stretch deserves attention in terms of potential impacts for which management action may be necessary.

Keywords: reservoir; conservation; aquatic plants; undammed river; floodplain.

Resumo: Até o presente momento, o último trecho livre de barramentos no Alto Rio Paraná não foi completamente investigado e essa realidade é preocupante frente às taxas atuais de extinção de espécies. **Objetivo:** Nesse trabalho, foi realizado um inventário dos taxa de macrófitas aquáticas nos



últimos 230 km livres de barramento do Alto Rio Paraná. **Métodos:** As macrófitas foram inventariadas na zona litorânea de 27 estações amostrais em novembro de 2013 e maio e novembro de 2014. Descrições gerais sobre aspectos taxonômicos de macrófitas e sobre as formas de vida foram explorados. Complementarmente, foram utilizadas curvas de acumulação de espécies e técnicas de ordenação para sumarizar a variação na composição das espécies de macrófitas. **Resultados:** Foram registrados 71 taxa de macrófitas pertencentes a 35 famílias. A maioria das espécies foi classificada nas seguintes categorias: emergentes, flutuantes livres, anfíbias e submersas enraizadas. No canal principal do rio, as espécies mais frequentes foram *Eichhornia azurea*, *E. crassipes* e *Paspalum repens*. Nas confluências dos tributários, *Ludwigia* sp., *E. azurea* e *Polygonum ferrugineum* foram as mais representativas, enquanto nas lagoas, *Ludwigia* sp., *Oxycaryum cubense* e *E. azurea* se destacaram. Em relação à composição de espécies, os locais de amostragem no Alto Rio Paraná foram mais influenciados pela invasora *Hydrilla verticillata*, enquanto as lagoas foram mais caracterizadas por espécies como *Scleria melaleuca*, *Panicum maximum*, *Thelypteris* sp., entre outras. **Conclusões:** Em geral, esse estudo apontou que a área do Alto Rio Paraná apresenta um grande número de espécies de macrófitas. Ademais, a ocorrência de espécies invasoras dentro do trecho investigado chama atenção para cuidados quanto a potenciais impactos, para os quais, ações de manejo podem ser necessárias.

Palavras-chave: reservatório; conservação; plantas aquáticas; rio não barrado; planície de inundação.

1. Introduction

Species inventories represent a consistent and efficient method for obtaining basic information on species distributions. This kind of data has been continuously claimed as a basis for prioritizing conservation areas and directing conservation actions (Prance & Campbell, 1988; Raven & Wilson, 1992; Balmford & Gaston, 1999; Brooks et al., 2004). Information on species distribution provides valuable inputs for habitat relationship modeling and biodiversity monitoring, which serves many conservational purposes, such as sustaining native populations and regulating invasive species (Thomaz et al., 2004; Elith & Leathwick, 2009). Despite the importance of such species inventories, this type of information still lacks for many areas or has been poorly implemented with incomplete surveys.

Similar to many other groups, information on species distribution of aquatic macrophytes shows large geographical gaps (Chambers et al., 2008). This group of aquatic plants include 2,610 species, with great species richness and endemism rates in the Neotropics (Chambers et al., 2008), which coincides with scarce inventories and intense threats for aquatic biodiversity such as habitat degradation, invasive species, flow modification, water pollution, and others (Dudgeon et al., 2006).

Within the Neotropical region, macrophytes colonize large wetland areas such as floodplains, and dam constructions represent major threats to their diversity. Dams drastically change environmental conditions (Ward & Stanford, 1995), causing habitat loss and displacement of macrophyte species (e.g., Benítez-Mora & Camargo, 2014). These features increase concerns about conservation,

since a large number of reservoirs has been built in the tropics.

Among the severely dammed rivers in the Neotropical region, many macrophyte species have been recorded in the Upper Paraná River and in its associated habitats (Ferreira et al., 2011). Considering the importance of its remaining stretch that flows free near the line of the Southern Tropic, a large group of experts in the diversity of many aquatic taxa, including macrophytes, conducted a collaborative project aiming to increase the knowledge on many aquatic organisms along this stretch (see this special issue of *Acta Limnologica Brasiliensia*).

Here, we present an inventory of macrophyte taxa recorded in the last undammed 230 km stretch of the Upper Paraná River. We surveyed macrophytes in 12 sites located in the main channel of the Upper Paraná River, confluences of seven tributaries with this river and eight associated floodplain lakes. We present and discuss the occurrence of taxa recorded, the composition of the macrophyte community, and we infer about the commonness and rarity of such taxa across sampling sites in this stretch.

2. Material and Methods

2.1. Sampling

The sampling area comprised the entire undammed stretch of the Upper Paraná River. This stretch is mainly characterized by a gradient that extends from oligotrophic conditions close to the Porto Primavera dam to more pristine conditions farther away from the dam, but closer to the lower border of the Ilha Grande National Park (Figure 1). Ecosystems connected directly to the Upper Paraná

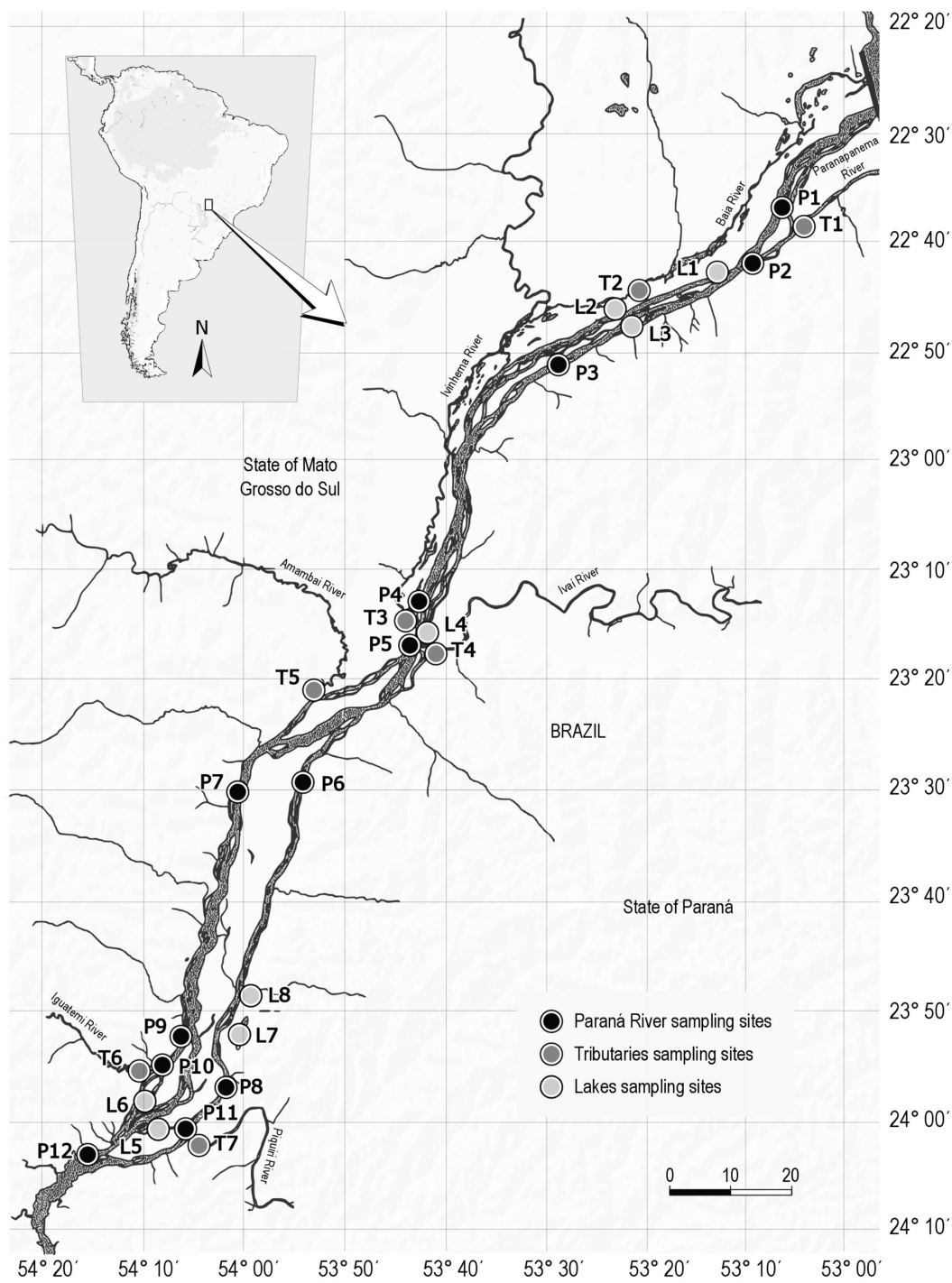


Figure 1. Sites of macrophyte sampling at the main channel of the Upper Paraná River (P1-P12; black circles), confluences of tributaries with the main channel (T1-T7; dark grey circles) and floodplain lakes (L1-L8; light grey circles). The tributaries sampled were the rivers Paranapanema (T1), Baía (T2), Ivinheima (T3), Ivaí (T4), Amanbai (T5), Iguatemi (T6), and Piquiri (T7). The floodplain lakes sampled were lakes Garças (L1), Xirica (L2), Pombas (L3), Ivaí (L4), Saraiva (L5), Pavão (L6), Xambrê (L7), and São João (L8).

River commonly present high water transparency, low P concentrations, and intermediate N concentrations (Rocha & Thomaz, 2004; Thomaz et al., 2004). More details on the abiotic aspects for the area can be found in Santana et al. (2017).

Macrophyte taxa were inventoried in 27 sampling stations, coinciding with the sampling sites presented for other taxonomic groups (see other publications in this special issue). The sampling stations were distributed among three categories

of habitats: the main channel of the Upper Paraná River, tributary confluences (areas in the mouth of tributary rivers that reach the Upper Paraná River), and the floodplain lakes. Among the sample sites, 12 were established in the main channel of the Upper Paraná River and distributed along the study area. Along the same stretch, seven sampling stations were in tributary confluence areas of the rivers Paranapanema, Baía, Ivinheima, Ivaí, Amanbaí, Iguatemi, and Piquiri. The other eight sampling sites were the floodplain lakes Garças, Xirica, Pombas, Ivaí, Saraiva, Pavão, Xambrê, and São João (Figure 1).

Field surveys were conducted in November 2013 and in May and November 2014. At each sampling site, we used a boat and recorded all macrophyte species that were visualized by one observer in a transect at the littoral zone (50-100 meters surveyed for 15-30 minutes). Submerged species were sampled with rakes. Over the whole sampling period, samples were taken by five different researchers with similar training. Taxa identification was supported by specialized literature (e.g., Kissman, 1997; Kissman & Groth, 1999; Kissman & Groth, 2000; Lorenzi, 2000; Pott & Pott, 2000). We also used specialized literature for classifying macrophytes according to their life form: amphibian (AN), emergent (EM), rooted floating-stemmed (RFS), rooted floating-leaved (RFL), free floating (FF), free submerged (FS), rooted submerged (RS), and epiphytic (EP) species (Pott & Pott, 2000).

2.2. Analyses

Species records on different sampling dates were combined for each sampling site. General descriptions for macrophyte taxonomic aspects and life forms were explored by frequency of species occurrence, number of species per taxonomic family, and number of species per life form.

To describe the pattern of species accumulation with increasing sampling effort, we used a species accumulation curve. The sample-based protocol was employed and the accumulation curve was constructed in the R environment, using the iNEXT package (Hsieh et al., 2016).

To summarize the variation in the composition of the macrophyte species, we used non-metric dimensional scaling (nMDS). We used presence and absence data to perform the ordination, and the configuration of sites in the multivariate space was obtained using the Sørensen index. The nMDS was

performed in the R environment, using the vegan package (Oksanen et al., 2017).

3. Results

Most species recorded belonged to the families Poaceae, Cyperaceae, Polygonaceae, Pontederiaceae, and Salviniaceae (Figure 2A). Emergent, amphibian, free-floating, and rooted submerged were the life forms with the greatest species numbers (Figure 2B). In terms of frequency, the most common taxa were *Ludwigia* sp., *Eichhornia azurea* (Sw.) Kunth, *E. crassipes* (Mart.) Solms, *Polygonum ferrugineum* Wedd., and *Salvinia auriculata* Aubl. (Figure 3A).

In the main channel of the Upper Paraná River, *E. azurea*, *E. crassipes*, and *Paspalum repens* were the most frequent species (Figure 3B; Appendix 1). Among the rare species, we recorded the emergent species *P. hydropiperoides*, *Pontederia cordata*, and *Rhynchospora corimbosa* (Appendix 1). These species were considered rare since they showed lower frequencies of occurrence in relation to the other sampled species.

In terms of the macrophyte species sampled in the tributary confluences, the most frequent ones were *Ludwigia* sp., *E. azurea*, and *P. ferrugineum*, while the rare species were *Pistia stratiotes*, *P. cordata*, and *Urochloa mutica* (Figure 3C; Appendix 1). In the floodplain lakes, the most frequent species were *Ludwigia* sp., followed by *Oxycaryum cubense* and *E. azurea* (Figure 3D; Appendix 1). The rarest species recorded in these ecosystems were *P. mesneirianum*, *Scleria melaleuca*, and *Thelypteris* sp. (Figure 3C; Appendix 1).

A total of 71 macrophyte taxa, belonging to 35 families, were recorded (Appendix 1; Figure 4). The number of macrophyte species recorded increased rapidly with increasing sampling effort (solid line; Figure 4), but did not reach an asymptote (Figure 4). Extrapolations of species richness provided by the species accumulation curves (dashed line) indicated that additional macrophyte taxa could still be recorded with increasing sampling effort (Figure 4).

The composition of the macrophyte species community was summarized by the nMDS (ordination stress = 0.12; Figure 5). Species composition in sites of the Upper Paraná River was mostly influenced by the presence of *Hydrilla verticillata* (Figure 5A and B), while the floodplain lakes were mostly characterized by the presence of *S. melaleuca*, *Panicum maximum*, *Thelypteris* sp., *Eleocharis geniculata*, *Cissus erosa*, *Caperonia castaneifolia*, and *P. punctatum*

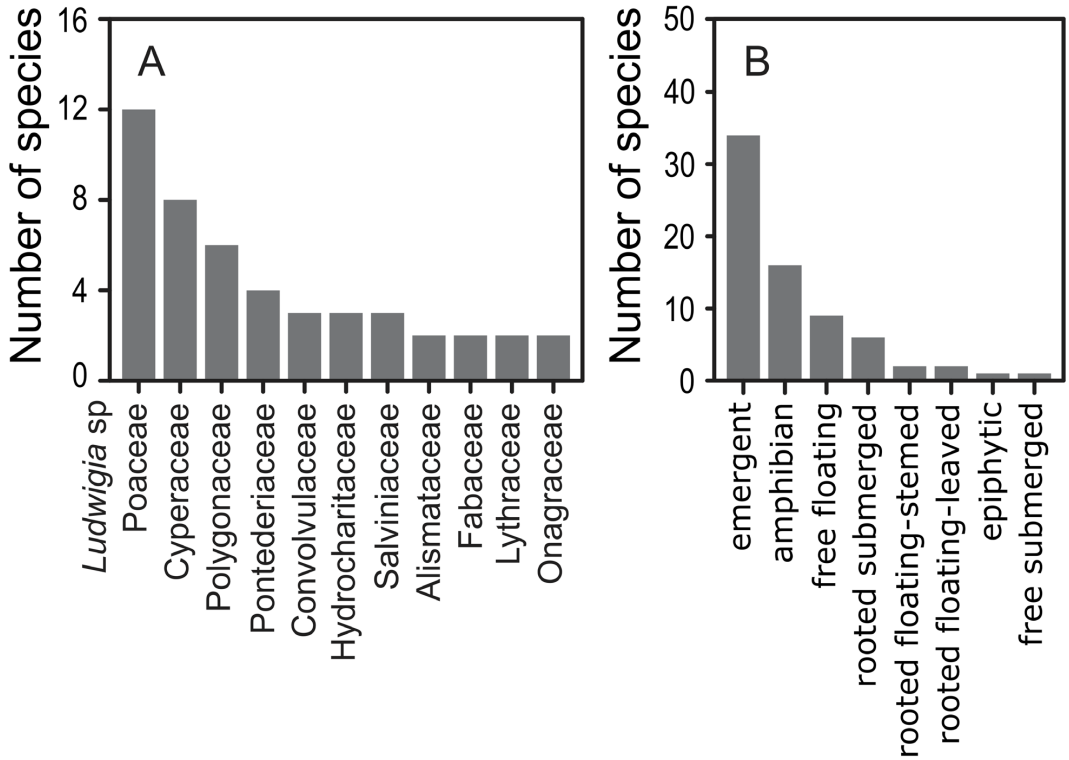


Figure 2. Number of species per family for families with the largest number of recorded species (A) and number of species per life form (B) across all sampling sites.

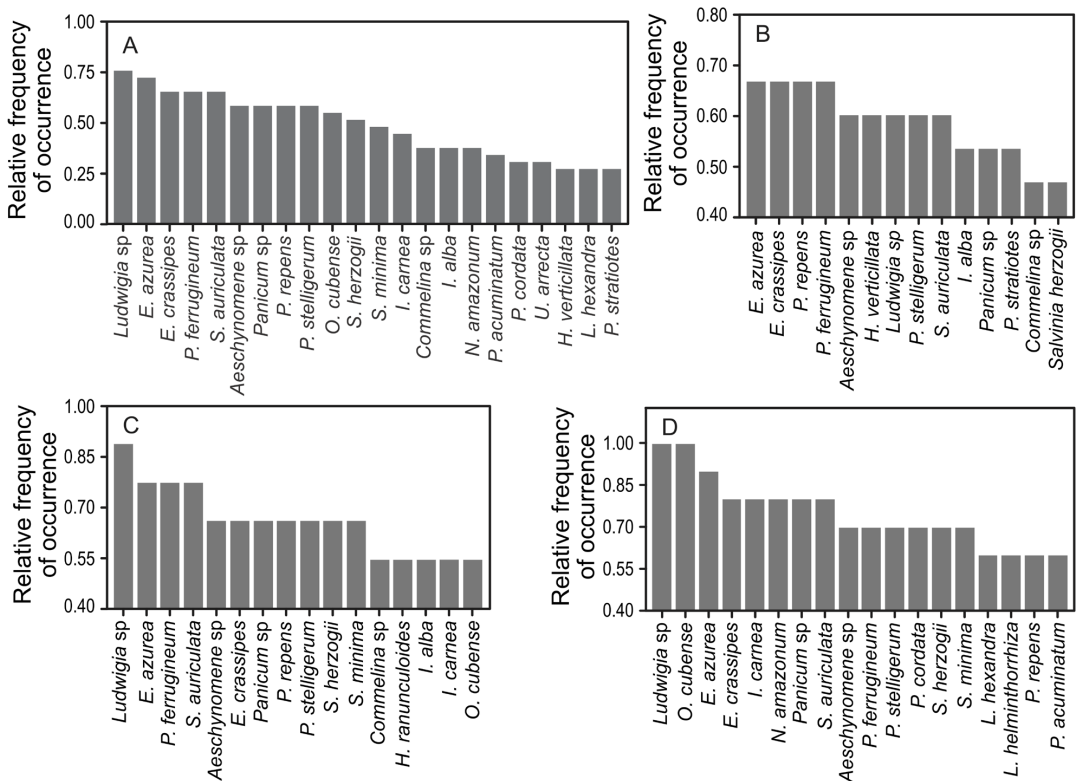


Figure 3. Most frequent species found in all sampling sites (A) and in the different types of habitats sampled, including the main channel of the Upper Paraná River (B), the tributary confluences (C), and the floodplain lakes (D).

(Figure 5A and B). The tributaries shared species with both the Upper Paraná River and the floodplain lakes and were slightly influenced by the presence of *U. mutica* (Figure 5A and B).

4. Discussion

The taxa recorded in the different habitats of the last undammed stretch of the Upper Paraná River represent about 7% of the total species registered in the entire Neotropical region (about 984 species) (Chambers et al., 2008). However, although this is seemingly a low percentage of species, this number becomes more significant considering the relative small area where our study took place and the low taxonomic resolution of many taxa we recorded (22 out of 71 taxa were recorded at the genus level). In our survey, we recorded several species also found in other floodplains and wetlands in the Neotropical

region (Pott & Pott, 2000; Bove & Paz, 2003; Catian et al., 2012). Compared to previous studies in the same area, we recorded more macrophyte taxa than, for example, Murphy et al. (2003) (28 taxa), Bini et al. (2001), and Thomaz et al. (2009) (50 taxa each). However, we recorded fewer macrophyte taxa than Ferreira et al. (2011), which may be related to the differences in the sampling approaches of the two studies. Our surveys were conducted in the littoral zones by boat to minimize survey costs and to maximize the inventoried geographical range, while the surveys performed by Ferreira et al. (2011) were more limited in terms of geographical range, but included additional microhabitats, such as marshes and intermittently flooded areas. Our study, however, provides a contribution in terms of expanding the geographical information on macrophyte distribution in the area.

Considering our findings in terms of taxonomy, the families with the greatest number of species were Poaceae, Cyperaceae, and Polygonaceae (Figure 3A). Both Poaceae and Cyperaceae are families with a cosmopolitan distribution, showing a great number of species. These species are most commonly associated with vegetation in poorly drained conditions such as swamps, marshes, bogs, and waterbody shores (Judd et al., 2009), but can also grow prolifically in areas with a shallow water column, such as littoral zones (e.g., *Panicum pernambucensis*). Species of these families usually have fast growth rates with propagule dispersion by water and wind, which enables them to achieve broader geographical distributions (Kissman, 1997; Matias et al., 2003). In addition, Poaceae and Cyperaceae hold species that are stoloniferous, a trait that makes them much more likely to expand their

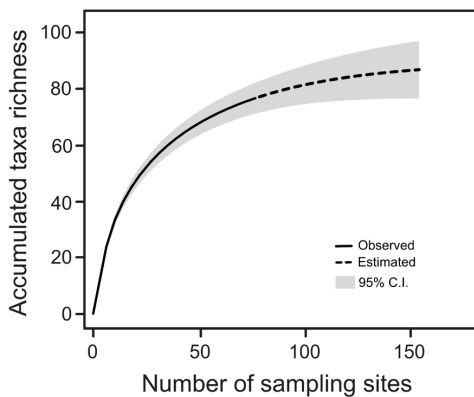


Figure 4. Species accumulation curve for macrophyte samples conducted at the last undammed stretch of the Upper Paraná River.

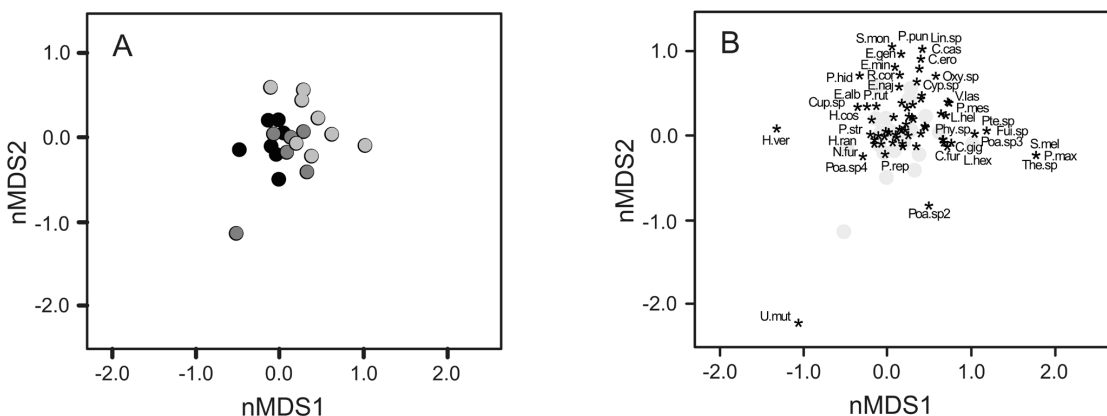


Figure 5. Non-metric dimensional scale (nMDS) for macrophyte species sampled at sites in the main channel (black), tributaries (dark gray), and floodplain lakes (light gray) of the Upper Paraná River. Both sites (A) and species scores (B) are shown.

distribution and to show dominant distribution in contrast to species from other taxonomic families.

Interestingly, within families with the greatest number of species, we recorded *U. arrecta*, which is a highly invasive Poaceae species native to Africa. This species has been recorded in several habitats of the Upper Paraná River basin (Michelan et al., 2010, 2013), and records of its occurrence in the floodplain rise concerns. Even though the frequency of occurrence of this species was not remarkable, we believe that monitoring and management actions should be implemented as safety measures to avoid its potential spread and establishment in new sites.

Regarding the macrophyte life forms, emergent species attained the highest number of species recorded and were mostly represented by species of the Cyperaceae, Fabaceae, and Onagraceae families. These families are also present in other important wetlands similar to the one investigated here, such as the Pantanal (Pott & Pott, 2000). Emergent species usually have a higher tolerance to water stress and may easily adapt to intermittent conditions of flood and drought found in floodplain ecosystems. In our study, these species were recorded in all three habitat types (Upper Paraná River, tributary confluences, and floodplain lakes), which corroborates the findings from previous studies (Murphy et al., 2003; Santos & Thomaz, 2007; Pott et al., 2011; Tabosa et al., 2012). Most frequent among species with this life form was *Ludwigia* sp., which was recorded in all sampled ecosystems, but had a remarkable occurrence in lakes (Figure 5). Such findings were expected, given the great adaptability of this genus to different conditions.

The second most frequent life form was that of amphibian plants. This group has a stronger water stress tolerance than emergent plants and can occur in both drier and humid substrates (Matias et al., 2003). However, emergent life forms tend to be better competitors than amphibian ones due to their faster growth rates and opportunistic behavior (Lycarião & Dantas, 2017), which might explain the pattern found here.

The other two representative life forms were free-floating and rooted submerged macrophytes. These groups have, compared to the other life forms, a low diversity in floodplains (e.g., Junk & Piedade, 1997; Pott & Pott, 2000). In the sampled region, free-floating macrophytes were mainly represented by *E. crassipes* and *S. auriculata*, demonstrating a high frequency in all studied environments (Figure 5). These plants are highly spread in Neotropics and may achieve high abundances.

In the Amazon floodplains, for example, *E. crassipes* may build up 40 to 50% of total plants biomass (Piedade et al., 2010). Among the submerged macrophytes, the native *Egeria najas* and the exotic invasive *H. verticillata* were the most important in terms of frequency of occurrence, which corroborate the surveys performed by Sousa et al. (2009, 2010). Our results show that *Egeria najas* and *H. verticillata* differ in terms of colonizing habitats, with greater occurrence of *Egeria najas* in lentic habitats and greater occurrence of *H. verticillata* in the main channel of Upper Paraná River (also similar to Sousa et al. 2009, 2010). Such aspect was also important for distinguishing species composition between types of habitat. For example, the nMDS identified *H. verticillata* as one of the main determinants of the community composition found in habitats in the main channel of the Upper Paraná River (see Figure 5).

Considering the occurrences of species, regardless of their family or life form, the most frequent ones were *Ludwigia* sp., *E. azurea*, *E. crassipes*, *P. ferrugineum*, and *S. auriculata* (Figure 3), and this pattern was consistent across all types of studied ecosystems. All five species were found in at least half of the sampled Upper Paraná River areas. All of them are widely distributed in South American floodplains (Pott & Pott, 2000; Bove & Paz, 2003; Catian et al., 2012), and some of them are even found invading other continents and causing economic and ecological losses (Téllez et al., 2008). In accordance to their large geographical distribution and successful invasion of ecosystems in other continents, the great frequencies of occurrence of these species in our samples are most likely related to the great phenotypic plasticity they present (Wells & Pigliucci, 2000).

Contrasting the patterns for frequent species, many species recorded in our study can be considered rare due to their low frequency of occurrence (Figure 3). Among them, for example, are *Hymenachne amplexicaulis*, *U. mutica*, and *Panicum maximum* (Appendix 1), which were restricted to only one of the types of ecosystems investigated. Along with limiting environmental conditions, another possible explanation for the low occurrence of these macrophyte species is the presence of stronger competitors, hampering their establishment.

Here, we recorded occurrence of macrophytes species within the whole last undammed stretch of the Upper Paraná River. Such information mainly contributes to expand the recorded distribution

of macrophyte species within this area, which may be particularly useful for conservation and management purposes. The relatively high diversity of macrophytes we found rises attention to the need of strengthening conservation measures in order to protect macrophyte diversity. In addition, our samples revealed broad spatial distribution of invasive species, such as *H. verticillata* and *U. arrecta*, which alarm for urgent monitoring of potential impacts. Lastly, we recommend future investigations to explore the relationships between distribution of macrophyte species with environmental factors in order to provide even more solid basis for macrophyte conservation measures.

Acknowledgements

We thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES/Proex) for financial support. The authors DCS, MMP, and MSDF thank CAPES for providing scholarships. The authors RAM and LAL thank CNPq for scholarships. ERC thanks the Fundação Araucária (an organization of the Government of Paraná state, Brazil) and the Itaipu Binacional for providing a scholarship. MJS thanks the Brazilian Council of Research (CNPq) for a post-doctoral scholarship. SMT thanks the CNPq for continuous funding through a Research Productivity Grant. We also thank Sebastião Rodrigues, Thamís Meurer, and Thaisa Michelan for their support during surveys.

References

- BALMFORD, A. and GASTON, K.J. Why biodiversity surveys are good value. *Nature*, 1999, 398(6724), 204-205. <http://dx.doi.org/10.1038/18339>.
- BENÍTEZ-MORA, A. and CAMARGO, J.A. Ecological responses of aquatic macrophytes and benthic macroinvertebrates to dams in the Henates River Basin (Central Spain). *Hydrobiologia*, 2014, 728(1), 167-178. <http://dx.doi.org/10.1007/s10750-014-1816-6>.
- BINI, L.M., THOMAZ, S.M. and SOUZA, D.C. Species richness and B-diversity of aquatic macrophytes in the upper Paraná River floodplain. *Archiv für Hydrobiologie*, 2001, 151(3), 511-525. <http://dx.doi.org/10.1127/archiv-hydrobiol/151/2001/511>.
- BOVE, C.P. and PAZ, J. *Guia de campo das plantas aquáticas do Parque Nacional da Restinga de Jurubatiba*. Rio de Janeiro: Museu Nacional, 2003.
- BROOKS, T., DA FONSECA, G.A.B. and RODRIGUES, A.S.L. Species, data, and conservation planning. *Conservation Biology*, 2004, 18(6), 1682-1688. <http://dx.doi.org/10.1111/j.1523-1739.2004.00457.x>.
- CATIAN, G., LEME, F.M., FRANCENER, A., CARVALHO, F.S., GALLETTI, V.S., POTT, A., POTT, V.J., SCREMIN-DIAS, E. and DAMASCENO-JUNIOR, G.A. Macrophyte structure in lotic-lentic habitats from Brazilian Pantanal. *Oecologia Australis*, 2012, 16(04), 782-796. <http://dx.doi.org/10.4257/oeco.2012.1604.05>.
- CHAMBERS, P.A., LACOUL, P., MURPHY, K.J. and THOMAZ, S.M. Global diversity of aquatic macrophytes in freshwater. *Hydrobiologia*, 2008, 595(1), 9-26. <http://dx.doi.org/10.1007/s10750-007-9154-6>.
- DUDGEON, D., ARTHINGTON, A.H., GESSNER, M.O., KAWABATA, Z.I., KNOWLER, D.J., LÉVÊQUE, C., NAIMAN, R.J., PRIEUR-RICHARD, A.H., SOTO, D., STIASSNY, M.L.J. and SULLIVAN, C.A. Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews of the Cambridge Philosophical Society*, 2006, 81(2), 163-182. PMID:16336747. <http://dx.doi.org/10.1017/S1464793105006950>.
- ELLITH, J. and LEATHWICK, J.R. Species distribution models: ecological explanation and prediction across space and time. *Annual Review of Ecology Evolution and Systematics*, 2009, 40(1), 677-697. <http://dx.doi.org/10.1146/annurev.ecolsys.110308.120159>.
- FERREIRA, F.A., MORMUL, R.P., THOMAZ, S.M., POTT, A. and POTT, V.J. Macrophytes in the upper Paraná river floodplain: checklist and comparison with other large South American wetlands. *Revista de Biología Tropical*, 2011, 59(2), 541-556. PMID:21717850.
- HSIEH, T.C., MA, K.H. and CHAO, A. iNEXT: an R package for rarefaction and extrapolation of species diversity (Hill numbers). *Methods in Ecology and Evolution*, 2016, 7(12), 1451-1456. <http://dx.doi.org/10.1111/2041-210X.12613>.
- JUDD, W.S., CAMPBELL, C.S., KELLOGG, E.A., STEVENS, P.F. and DONOGHUE, M.J. *Sistemática vegetal: um enfoque filogenético*. 3. ed. Porto Alegre: Artmed, 2009.
- JUNK, W.J. and PIEDADE, M.T.F. Plant life in the floodplain with special reference to herbaceous plants. In: W.J. JUNK. *The central Amazon floodplain: ecology of a pulsing system*. Berlin: Springer-Verlag, 1997, pp. 147-181. http://dx.doi.org/10.1007/978-3-662-03416-3_8.
- KISSMAN, K.G. and GROTH, D. *Plantas infestantes e nocivas*. 2. ed. São Paulo: BASF Brasileira S.A., 1999. Tomo II.
- KISSMAN, K.G. and GROTH, D. *Plantas infestantes e nocivas*. 2. ed. São Paulo: BASF Brasileira S.A., 2000. Tomo III.

- LORENZI, H. *Plantas daninhas do Brasil: terrestres, aquáticas, parasitas e tóxicas*. 3. ed. Nova Odessa: Instituto Plantarum, 2000.
- LYCARIÃO, T.A. and DANTAS, Ê.W. Interactions between different biological forms of aquatic macrophytes in a eutrophic tropical reservoir in Northeastern Brazil. *Revista de Biologia Tropical*, 2017, 65(3), 1095-1104. <http://dx.doi.org/10.15517/rbt.v65i3.29441>.
- MATIAS, L.G., AMADO, E.R. and NUNES, E.P. Macrófitas aquáticas da lagoa de Jijoca de Jericoacoara, Ceará, Brasil. *Acta Botanica Brasílica*, 2003, 17(4), 623-631. <http://dx.doi.org/10.1590/S0102-33062003000400015>.
- MICHELAN, T.S., THOMAZ, S.M. and BINI, L.M. Native macrophyte density and richness affect the invasiveness of a tropical Poaceae species. *PLoS One*, 2013, 8(3), 1-8. PMID:23536902. <http://dx.doi.org/10.1371/journal.pone.0060004>.
- MICHELAN, T.S., THOMAZ, S.M., MORMUL, R.P. and CARVALHO, P. Effects of an exotic-invasive macrophyte (tropical signalgrass) on native plant community composition, species richness and functional diversity. *Freshwater Biology*, 2010, 55(6), 1315-1326. <http://dx.doi.org/10.1111/j.1365-2427.2009.02355.x>.
- MURPHY, K.J., DICKINSON, G., THOMAZ, S.M., BINI, L.M., DICK, K., GREAVES, K., KENNEDY, M.P., LIVINGSTONE, S., MCFERRAN, H., MILNE, J.M., OLDROYD, J. and WINGFIELD, R.A. Aquatic plant communities and predictors of diversity in a sub-tropical river floodplain: the upper Rio Paraná, Brazil. *Aquatic Botany*, 2003, 77(4), 257-276. [http://dx.doi.org/10.1016/S0304-3770\(03\)00108-6](http://dx.doi.org/10.1016/S0304-3770(03)00108-6).
- OKSANEN, J., BLANCHET, F.G., FRIENDLY, M., KINDT, R., LEGENDRE, P., MCGLIN, D., MINCHIN, P. R., O'HARA, R. B., SIMPSON, G. L., SOLYMONS, P., STEVENS, M. H. H., SZOECs, E. and WAGNER, H. *Vegan package – R*. Oulu: CRAN, 2017.
- PIECADE, M.T.F., JUNK, W., D'ÂNGELO, S.A., WITTMANN, E., SCHÖNGART, J., BARBOSA, K.M.N. and LOPES, A. Aquatic herbaceous plants of the Amazon floodplains: state of the art and research needed. *Acta Limnologica Brasiliensia*, 2010, 22(2), 165-178. <http://dx.doi.org/10.4322/actalb.02202006>.
- POTT, V.J. and POTT, A. *Plantas aquáticas do Pantanal*. Brasília: EMBRAPA, 2000.
- POTT, V.J., POTT, A., LIMA, L.C.P., MOREIRA, S.N. and OLIVEIRA, A.K.M. Aquatic macrophyte diversity of the Pantanal wetland and upper basin. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, 2011, 71(1), 255-263. Supplement 1. PMID:21537598. <http://dx.doi.org/10.1590/S1519-69842011000200004>.
- PRANCE, G.T. and CAMPBELL, D.G. The present state of tropical floristics. *Taxon*, 1988, 37(3), 519-548. <http://dx.doi.org/10.2307/1221097>.
- RAVEN, P.H. and WILSON, E.O. A fifty-year plan for biodiversity surveys. *Science*, 1992, 258(5085), 1099-1100. PMID:17789079. <http://dx.doi.org/10.1126/science.258.5085.1099>.
- ROCHA, R.R.A. and THOMAZ, S.M. Temporal variation of limnological factors in the upper Paraná River floodplain habitats. *Acta Scientiarum*, 2004, 26, 261-271.
- SANTANA, N.F., PEREIRA, L.S., ROBERTO, M.C., GOMES, S.E.A. and MORMUL, R.P. Longitudinal gradient in limnological variables in the Upper Paraná River: a brief description and the importance of undammed tributaries. *Acta Limnologica Brasiliensia*, forthcoming 2017, 29.
- SANTOS, A.M. and THOMAZ, S.M. Aquatic macrophytes diversity in lagoons of a tropical floodplain: the role of connectivity and water level. *Austral Ecology*, 2007, 32(2), 177-190. <http://dx.doi.org/10.1111/j.1442-9993.2007.01665.x>.
- SOUSA, W.T.Z., THOMAZ, S.M. and MURPHY, K.J. Response of native *Egeria najas* Planch. and invasive *Hydrilla verticillata* (L.f.) Royle to altered hydroecological regime in a subtropical river. *Aquatic Botany*, 2010, 92(1), 40-48. <http://dx.doi.org/10.1016/j.aquabot.2009.10.002>.
- SOUSA, W.T.Z., THOMAZ, S.M., MURPHY, K.J., SILVEIRA, M.J. and MORMUL, R.P. Environmental predictors of the occurrence of exotic *Hydrilla verticillata* (L.f.) Royle and native *Egeria najas* Planch. in a sub-tropical river floodplain: The Upper River Paraná, Brazil. *Hydrobiologia*, 2009, 632(1), 65-78. <http://dx.doi.org/10.1007/s10750-009-9828-3>.
- TABOSA, A.B., MATIAS, L.Q. and MARTINS, F.R. Live fast and die young: the aquatic macrophyte dynamics in a temporary pool in the Brazilian semiarid region. *Aquatic Botany*, 2012, 102, 71-78. <http://dx.doi.org/10.1016/j.aquabot.2012.05.004>.
- TÉLLEZ, T.R., LÓPEZ, E.M.R., GRANADO, G.L., PÉREZ, E.A., LÓPEZ, R.M. and GUZMÁN, J.M.S. The Water Hyacinth, *Eichhornia crassipes*: an invasive plant in the Guadiana River Basin (Spain). *Aquatic Invasions*, 2008, 3(1), 42-53. <http://dx.doi.org/10.3391/ai.2008.3.1.8>.
- THOMAZ, S.M., CARVALHO, P., PADIAL, A.A. and KOBAYASHI, J.T. Temporal and spatial patterns of aquatic macrophyte diversity in the Upper Paraná River floodplain. *Brazilian Journal of Biology = Revista Brasileira de Biologia*, 2009, 69(2), 617-625. Supplement. PMID:19738968. <http://dx.doi.org/10.1590/S1519-69842009000300016>.
- THOMAZ, S.M., PAGIORO, T.A., BINI, L.M., ROBERTO, M.C. and ROCHA, R.R.A. Limnology

- of the upper Paraná floodplain habitats: patterns of spatio-temporal variations and influence of the water levels. In: A.A. AGOSTINHO, L. RODRIGUES, L.C. GOMES, S.M. THOMAZ and L.E. MIRANDA, eds. *Structure and Functioning of the Paraná River and its Floodplain (Peld-site6)*. Maringá: Eduem, 2004, pp. 37-42.
- WARD, J.V. and STANFORD, J.A. The serial discontinuity concept: extending the model to floodplain rivers. *River Research and Applications*, 1995, 10, 159-168. <http://dx.doi.org/10.1002/rrr.3450100211>.
- WELLS, C.L. and PIGLIUCCI, M. Adaptive phenotypic plasticity: the case of heterophylly in aquatic plants. *Perspectives in Plant Ecology, Evolution and Systematics*, 2000, 3(1), 1-18. <http://dx.doi.org/10.1078/1433-8319-00001>.

Received: 26 May 2017

Accepted: 08 November 2017

Appendix 1. List of species sampled in the main channel of the Upper Paraná River, confluences of tributaries with the main channel, and floodplain lakes. Black squares denote species occurrence. Tributaries sampled were the rivers Paranapanema (T1), Baía (T2), Ivinheima (T3), Ivaí (T4), Amanbai (T5), Iguatemi (T6), and Piquiri (T7). Floodplain lakes sampled were Garças (L1), Xirica (L2), Pombas (L3), Ivaí (L4), Saraiva (L5), Pavão (L6), and Xambê (L7). Life forms were amphibian (AM), emergent (EM), rooted floating-stemmed (RFS), rooted floating-leaved (RFL), free floating (FF), free submerged (FS), rooted submerged (RS), and epiphytic (EP).

SPECIES	LIFE FORMS	SAMPLING SITES																										
		PARANÁ RIVER						TRIBUTARIES						FLOODPLAIN LAKES														
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	T1	T2	T3	T4	T5	T6	T7	L1	L2	L3	L4	L5	L6	L7	L8
Acanthaceae																												
<i>Hygrophila costata</i> Nees & T. Nees	EM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alismataceae																												
<i>Echinodorus grandiflorus</i> (Cham. & Schitdl.) Michell	EM	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1
<i>Sagittaria montevidensis</i> Cham. & Schitdl.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
Amaranthaceae																												
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	AM	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Apiaceae																												
<i>Centella asiática</i> (L.) Urb.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
<i>Hydrocotyle ranunculoides</i> L. f.	RFS	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Araceae																												
<i>Pistia stratiotes</i> L.	FF	-	-	-	-	1	1	-	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asteraceae																												
<i>Eclipta alba</i> (L.) Hassk.	AM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Azollaceae																												
<i>Azolla</i> sp.	FF	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Continued...

SPECIES	LIFE FORMS	SAMPLING SITES																																
		PARANÁ RIVER								TRIBUTARIES				FLOODPLAIN LAKES																				
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	T1	T2	T3	T4	T5	T6	T7	L1	L2	L3	L4	L5	L6	L7	L8						
Cabombaceae																																		
<i>Cabomba furcata</i> Schult. & Schult. f.	RS	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1		
Cactaceae																																		
<i>Oxypetalum</i> sp.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-		
Characeae																																		
<i>Nitella</i> sp.	RS	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Commelinaceae																																		
<i>Commelina</i> sp.	EM	-	-	-	-	1	1	-	-	-	1	1	-	1	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-		
Convolvulaceae																																		
<i>Ipomoea alba</i> L.	AM	-	-	-	1	1	1	-	-	-	1	1	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-		
<i>Ipomoea cairica</i> (L.) Sweet	AM	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Ipomoea carnea</i> Jacq.	AM	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	
Cucurbitaceae																																		
<i>Cyclanthera</i> sp.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Cyperaceae																																		
<i>Cyperus giganteus</i> Vahl	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Cyperus</i> sp.	AM	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Eleocharis geniculata</i> (L.) Roem. & Schult.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Eleocharis minima</i> Kunth	EM	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Fuirena</i> sp.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oxycaryum cubense</i> (Poepp. & Kunth) Palla	EP	-	-	-	-	1	-	-	-	-	1	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Rhynchospora</i> <i>corymbosa</i> (L.) Britton	AM	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Scleria melaleuca</i> Rchb. ex Schtdl. & Cham.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Continued...

SPECIES	LIFE FORMS	SAMPLING SITES																											
		PARANÁ RIVER									TRIBUTARIES									FLOODPLAIN LAKES									
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	T1	T2	T3	T4	T5	T6	T7	L1	L2	L3	L4	L5	L6	L7	L8	
Euphorbiaceae																													
<i>Caperonia castaneifolia</i> (L.) A. St.-Hil.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Fabaceae																													
<i>Aeschynomene</i> sp.	EM	-	-	-	1	1	1	-	-	-	1	1	1	-	1	-	-	1	1	1	1	1	1	-	-	1	-	-	1
<i>Vigna lasiocarpa</i> (Mart. ex Benth.) Verdc.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Hydrocharitaceae																													
<i>Egeria najas</i> Planch.	RS	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
<i>Hydrilla verticillata</i> (L. f.) Royle	RS	1	-	-	1	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Limnobiium laevigatum</i> (Humb. & Bonpl. ex Willd.) Heine	FF	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lentibulariaceae																													
<i>Utricularia foliosa</i> L.	FS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Lythraceae																													
<i>Cuphea melvilla</i> Lindl.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Cuphea</i> sp.	AM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malvaceae																													
<i>Hibiscus</i> sp.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Nymphaeaceae																													
<i>Nymphaea amazonum</i> Mart. & Zucc.	RFL	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	1	1	1	-
Onagraceae																													
<i>Ludwigia helminthorrhiza</i> (Mart.) H. Hara	FF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Ludwigia</i> sp.	EM	-	-	-	-	1	1	1	-	-	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Phyllanthaceae																													
<i>Phyllanthus</i> sp.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Appendix 1. Continued...

SPECIES	LIFE FORMS	SAMPLING SITES																											
		PARANÁ RIVER							TRIBUTARIES							FLOODPLAIN LAKES													
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	T1	T2	T3	T4	T5	T6	T7	L1	L2	L3	L4	L5	L6	L7	L8	
Poaceae																													
<i>Hymenachne amplexicaulis</i> (Rudge) Nees	EM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Leersia hexandra</i> Sw.	EM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	1	-	1
<i>Panicum maximum</i> Jacq.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Panicum perambucense</i> (Spreng.) Mez ex Pilg.	EM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-
<i>Panicum</i> sp.	EM	-	-	-	-	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Paspalum repens</i> P.J. Bergius	EM	-	-	-	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Poaceae</i> sp1	EM	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Poaceae</i> sp2	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
<i>Poaceae</i> sp3	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Poaceae</i> sp4	EM	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Urochloa arrecta</i> (Hack. ex T. Durand & Schinz) Morrone & Zuloaga	RFS	-	-	-	-	1	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Urochloa mutica</i> (Forsk.) T.Q. Nguyen	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Podostemaceae																													
<i>Podostemum rutifolium</i> Warm.	RS	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonaceae																													
<i>Polygonum acuminatum</i> Kunth	EM	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1
<i>Polygonum ferrugineum</i> Wedd.	EM	-	-	-	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Polygonum hydroperoides</i> Michx.	EM	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 1. Continued...

SPECIES	LIFE FORMS	SAMPLING SITES																												
		PARANÁ RIVER						TRIBUTARIES						FLOODPLAIN LAKES																
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	T1	T2	T3	T4	T5	T6	T7	L1	L2	L3	L4	L5	L6	L7	L8		
<i>Polygonum meiserianum</i> Cham. & Schtidl.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Polygonum punctatum</i> Elliott	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-		
<i>Polygonum stelligerum</i> Cham.	EM	-	-	-	1	1	1	1	-	1	-	1	-	1	-	1	-	1	1	1	1	1	-	-	1	1	-	1		
Pontederiaceae																														
<i>Eichornia azurea</i> (Sw.) Kunth	RFS	-	-	-	1	1	1	1	-	1	1	-	1	1	-	1	1	-	1	1	1	1	1	1	1	1	1	-	1	
<i>Eichornia crassipes</i> (Mart.) Solms	FF	-	-	-	1	1	1	1	-	1	1	-	1	1	-	1	-	1	1	-	1	-	1	-	1	1	1	1	1	
<i>Eichornia diversifolia</i> (Vahl) Urb.	FF	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Pontederia cordata</i> L.	EM	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	1	1		
Pteridaceae																														
<i>Pteridophyta</i> sp	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	
Rubiaceae																														
<i>Diodia brasiliensis</i> Spreng.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Salviniaceae																														
<i>Salvinia auriculata</i> Aubl.	FF	-	-	-	1	1	1	-	-	1	1	-	1	1	1	-	1	1	1	-	1	1	1	1	1	1	1	1	-	
<i>Salvinia herzogii</i> de la Sota	FF	-	-	-	1	1	-	-	-	1	1	-	1	1	-	1	-	1	-	1	-	1	-	1	1	1	1	1	-	
<i>Salvinia minima</i> Baker	FF	-	-	-	1	-	-	-	-	1	1	-	1	1	-	1	-	1	-	1	-	1	-	1	1	1	1	1	-	
Scrophulariaceae																														
<i>Lindernia</i> sp	RS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
Thelypteridaceae																														
<i>Thelypteris</i> sp.	EM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Verbenaceae																														
<i>Lippia</i> sp.	EM	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Vitaceae																														
<i>Cissus erosa</i> Rich.	AM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-