Online Resources for

**Assessing the legacy of land use trajectories on stream fish communities of southern Brazil**

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Table S1. Summary table of physical and landscape characteristics of sampling sites in the two aquatic ecoregions, Laguna dos Patos (n = 15) and Lower Uruguay (n = 32 sites). Data are shown only for sample sites that were effectively included in the study after sample completeness and autocorrelation analyses (see Methods).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Laguna dos Patos | | | | Lower Uruguay | | | |
| Sampling Site Characteristics | Minimum | Maximum | Mean | Standard Deviation | Minimum | Maximum | Mean | Standard Deviation |
| Depth (cm) | 4.1 | 45.0 | 18.1 | 12.7 | 15.1 | 65.2 | 32.4 | 11.8 |
| Width (m) | 1.7 | 7.7 | 4.9 | 1.6 | 3.0 | 9.2 | 6.0 | 1.6 |
| Order (Strahler) | 2 | 4 | 2.5 | 0.6 | 2 | 4 | 2.7 | 0.6 |
| Watershed Area (km²) | 1.5 | 39.2 | 16.3 | 10.8 | 3.0 | 48.7 | 17.8 | 11.8 |
| Altitude (m) | 36 | 346 | 166 | 100 | 91 | 372 | 199 | 75 |

Table S2. Proportion (%) of each original land use class in the sampled watersheds of two aquatic ecoregions (Laguna dos Patos, n = 15; Lower Uruguay, n = 32). Data for 2013 as reference year. In the analyses, we regrouped each class into either of two classes, “natural vegetation” or “other cover” (see Methods).

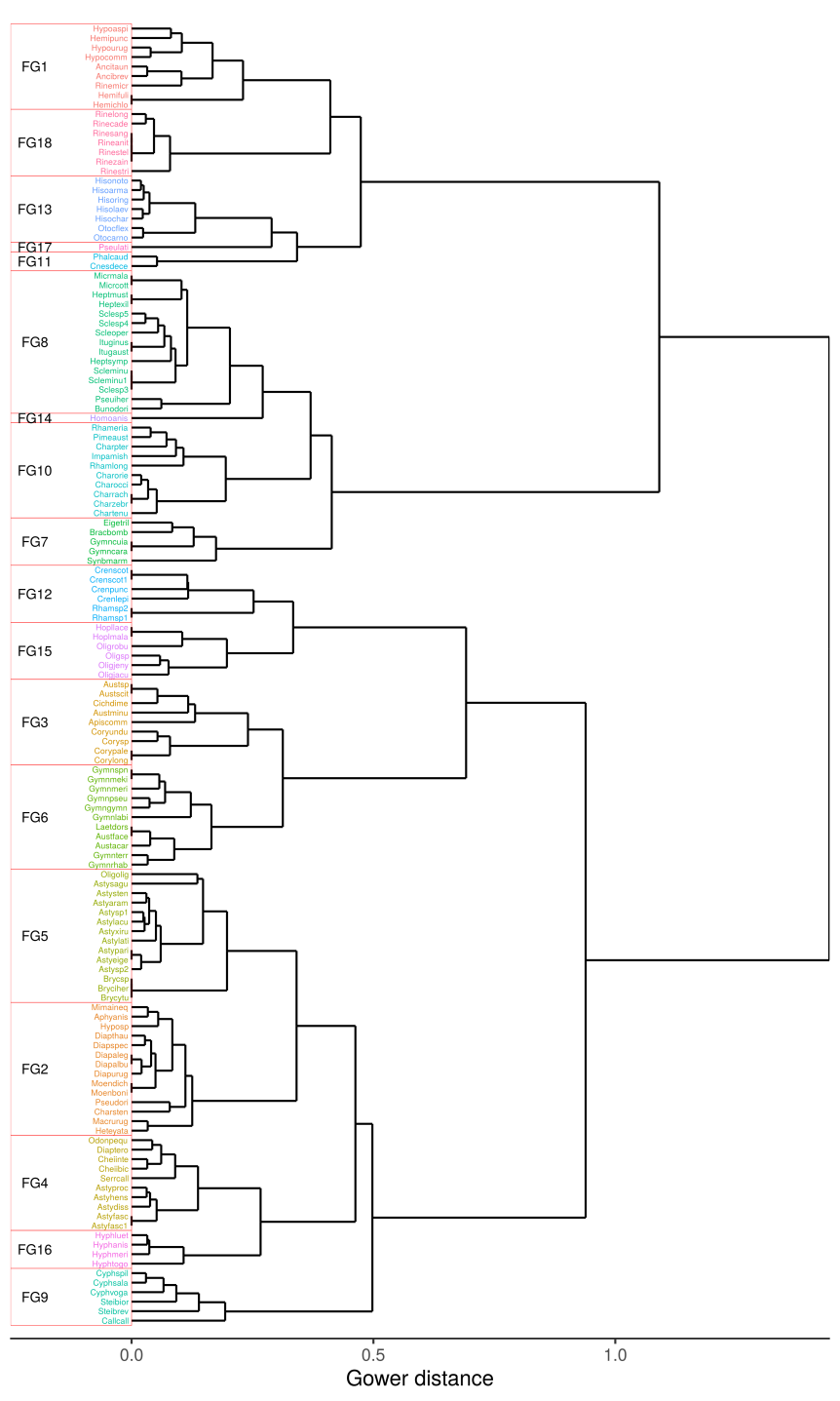
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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Laguna dos Patos | | | | Lower Uruguay | | | |
| Land use class | Minimum | Maximum | Mean | Standard Deviation | Minimum | Maximum | Mean | Standard Deviation |
| Annual and perennial crop | <1.0 | 48.5 | 5.0 | 11.8 | <1.0 | 74.9 | 16.3 | 19.7 |
| Forest formation | 1.3 | 26.4 | 16.2 | 7.5 | <1.0 | 50.3 | 10.6 | 13.9 |
| Forest plantation | <1.0 | 10.1 | 3.1 | 3.2 | <1.0 | 6.4 | 1.0 | 2.2 |
| Grassland formation | 44.6 | 84.1 | 71.2 | 13.2 | 2.0 | 98.7 | 66.3 | 27.9 |
| Pasture-agriculture mosaic | <1.0 | 32.4 | 5.4 | 7.9 | <1.0 | 14.4 | 5.1 | 4.4 |
| Other non-vegetated areas | - | - | - | - | <1.0 | 2.6 | <1.0 | <1.0 |
| Pasture | - | - | - | - | 1.4 | 20.7 | 7.90 | 6.5 |
| River, lake and ocean | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 10.4 | 1.1 | 2.4 |
| Rocky outcrop | <1.0 | 1.5 | <1.0 | <1.0 | - | - | - | - |
| Wetlands | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |

**Table S3**. Summary table for land use trajectory attributes in the 47 sampled watersheds.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trajectory Attribute | Minimum | Maximum | Mean | Standard Deviation |
| Native vegetation loss 1993 (%) | 0.1 | 73.1 | 13.1 | 15.2 |
| Native vegetation loss 2013 (%) | 0.3 | 79.6 | 21.2 | 21.6 |
| Magnitude (accumulated%) | 9.9 | 242.5 | 53.5 | 38.6 |
| Frequency (years) | 6 | 13 | 8.9 | 1.3 |
| Duration T20 (years) | 0 | 34 | 11.3 | 12.4 |
| Duration T40 (years) | 0 | 33 | 5.6 | 10.2 |

**Table S4**. List of fish species, name abbreviation, functional group (see cluster analysis in Fig. S1) and the frequency of occurrence for each species across 60 sampled streams.

| Species | Abbreviation | Functional Group | Frequency | |
| --- | --- | --- | --- | --- |
| *Acestrorhynchus pantaneiro* Menezes, 1992 | Acespant | - | 1 |
| *Ancistrus brevipinnis* (Regan, 1904) | Ancibrev | FG1 | 7 |
| *Ancistrus taunayi* Miranda Ribeiro, 1918 | Ancitaun | FG1 | 31 |
| *Apareiodon affinis* (Steindachner, 1879) | Aparaffi | - | 1 |
| *Aphyocharax anisitsi* Eigenmann & Kennedy, 1903 | Aphyanis | FG2 | 6 |
| *Apistogramma commbrae* (Regan, 1906) | Apiscomm | FG3 | 1 |
| *Astyanax* aff *fasciatus* Cuvier, 1819 | Astyfasc1 | FG4 | 3 |
| *Astyanax aramburui* Protogino, Miquelarena & López, 2006 | Astyaram | FG5 | 5 |
| *Astyanax dissensus* Lucena & Thofehrn, 2013 | Astydiss | FG4 | 15 |
| *Astyanax eigenmanniorum* (Cope, 1894) | Astyeige | FG5 | 24 |
| *Astyanax fasciatus* (Cuvier, 1819) | Astyfasc | FG4 | 2 |
| *Astyanax henseli* de Melo & Buckup, 2006 | Astyhens | FG4 | 24 |
| *Astyanax lacustris* (Lütken, 1875) | Astylacu | FG5 | 32 |
| *Astyanax laticeps* (Cope, 1894) | Astylati | FG5 | 28 |
| *Astyanax paris* Azpelicueta, Almirón & Casciotta, 2002 | Astypari | FG5 | 2 |
| *Astyanax procerus* Lucena, Castro & Bertaco, 2013 | Astyproc | FG4 | 6 |
| *Astyanax saguazu* Casciotta, Almirón & Azpelicueta, 2003 | Astysagu | FG5 | 3 |
| *Astyanax* sp. 1 | Astysp1 | FG5 | 2 |
| *Astyanax* sp. 2 | Astysp2 | FG5 | 3 |
| *Astyanax stenohalinus* Messner, 1962 | Astysten | FG5 | 5 |
| *Astyanax xiru* Lucena, Castro & Bertaco, 2013 | Astyxiru | FG5 | 11 |
| *Australoheros acaroides* (Hensel, 1870) | Austacar | FG6 | 4 |
| *Australoheros facetus* (Jenyns, 1842) | Austface | FG6 | 2 |
| *Australoheros minuano* Říčan & Kullander, 2008 | Austminu | FG3 | 14 |
| *Australoheros scitulus*(Říčan & Kullander, 2003) | Austscit | FG3 | 6 |
| *Australoheros* sp. | Austsp | FG3 | 1 |
| *Brachyhypopomus bombilla* Loureiro & Silva, 2006 | Bracbomb | FG7 | 5 |
| *Bryconamericus iheringii* (Boulenger, 1887) | Bryciher | FG5 | 55 |
| *Bryconamericus* sp. | Brycsp | FG5 | 1 |
| *Bryconamericus ytu* Almirón, Azpelicueta & Casciotta, 2004 | Brycytu | FG5 | 2 |
| *Bunocephalus doriae* Boulenger, 1902 | Bunodori | FG8 | 4 |
| *Callichthys callichthys* (Linnaeus, 1758) | Callcall | FG9 | 3 |
| *Characidium* aff *zebra* Eigenmann, 1909 | Charzebr | FG10 | 15 |
| *Characidium occidentale* Buckup & Reis, 1997 | Charocci | FG10 | 18 |
| *Characidium orientale* Buckup & Reis, 1997 | Charorie | FG10 | 5 |
| *Characidium pterostictum* Gomes, 1947 | Charpter | FG10 | 38 |
| *Characidium rachovii* Regan, 1913 | Charrach | FG10 | 4 |
| *Characidium tenue* (Cope, 1894) | Chartenu | FG10 | 12 |
| *Charax stenopterus* (Cope, 1894) | Charsten | FG2 | 12 |
| *Cheirodon ibicuhiensis* Eigenmann, 1915 | Cheiibic | FG4 | 2 |
| *Cheirodon interruptus* (Jenyns, 1842) | Cheiinte | FG4 | 31 |
| *Cichlasoma dimerus* (Heckel, 1840) | Cichdime | FG3 | 3 |
| *Cnesterodon decemmaculatus* (Jenyns, 1842) | Cnesdece | FG11 | 6 |
| *Corydoras longipinnis* Knaack, 2007 | Corylong | FG3 | 10 |
| *Corydoras paleatus* (Jenyns, 1842) | Corypale | FG3 | 13 |
| *Corydoras* sp. | Corysp | FG3 | 1 |
| *Corydoras undulatus* Regan, 1912 | Coryundu | FG3 | 3 |
| *Crenicichla* cf *scottii* (Eigenmann, 1907) | Crenscot1 | FG12 | 2 |
| *Crenicichla lepidota* Heckel, 1840 | Crenlepi | FG12 | 35 |
| *Crenicichla punctata* Hensel, 1870 | Crenpunc | FG12 | 3 |
| *Crenicichla scottii* (Eigenmann, 1907) | Crenscot | FG12 | 20 |
| *Cyphocharax saladensis* (Meinken, 1933) | Cyphsala | FG9 | 3 |
| *Cyphocharax spilotus* (Vari, 1987) | Cyphspil | FG9 | 13 |
| *Cyphocharax voga* (Hensel, 1870) | Cyphvoga | FG9 | 14 |
| *Diapoma alburnum* (Hensel, 1870) | Diapalbu | FG2 | 1 |
| *Diapoma alegretensis* Malabarba & Weitzman, 2003 | Diapaleg | FG2 | 19 |
| *Diapoma speculiferum* Cope, 1894 | Diapspec | FG2 | 2 |
| *Diapoma terofali* (Géry, 1964) | Diaptero | FG4 | 14 |
| *Diapoma thauma* Menezes & Weitzman, 2011 | Diapthau | FG2 | 3 |
| *Diapoma uruguayensis* (Messner, 1962) | Diapurug | FG2 | 9 |
| *Eigenmannia trilineata* López & Castello, 1966 | Eigetril | FG7 | 4 |
| *Gymnogeophagus gymnogenys* (Hensel, 1870) | Gymngymn | FG6 | 6 |
| *Gymnogeophagus labiatus* (Hensel, 1870) | Gymnlabi | FG6 | 1 |
| *Gymnogeophagus mekinos* Malabarba, Malabarba & Reis, 2015 | Gymnmeki | FG6 | 20 |
| *Gymnogeophagus meridionalis* Reis & Malabarba, 1988 | Gymnmeri | FG6 | 5 |
| *Gymnogeophagus pseudolabiatus* Malabarba, Malabarba & Reis, 2015 | Gymnpseu | FG6 | 1 |
| *Gymnogeophagus rhabdotus* (Hensel, 1870) | Gymnrhab | FG6 | 12 |
| *Gymnogeophagus* sp. n | Gymnspn | FG6 | 6 |
| *Gymnogeophagus terrapurpura* Loureiro, Zarucki, Malabarba & González-Bergonzoni, 2016 | Gymnterr | FG6 | 1 |
| *Gymnotus carapo* Linnaeus, 1758 | Gymncara | FG7 | 2 |
| *Gymnotus cuia* Craig, Malabarba, Crampton & Albert, 2018 | Gymncuia | FG7 | 3 |
| *Hemiancistrus chlorostictus* Cardoso & Malabarba, 1999 | Hemichlo | FG1 | 4 |
| *Hemiancistrus fuliginosus* Cardoso & Malabarba, 1999 | Hemifuli | FG1 | 5 |
| *Hemiancistrus punctulatus* Cardoso & Malabarba, 1999 | Hemipunc | FG1 | 1 |
| *Heptapterus exilis* Faustino‐Fuster, Bockmann & Malabarba, 2019 | Heptexil | FG8 | 4 |
| *Heptapterus mustelinus* (Valenciennes, 1835) | Heptmust | FG8 | 56 |
| *Heptapterus sympterygium* Buckup, 1988 | Heptsymp | FG8 | 1 |
| *Heterocheirodon yatai* (Casciotta, Miquelarena & Protogino, 1992) | Heteyata | FG2 | 8 |
| *Hisonotus armatus* Carvalho, Lehmann A., Pereira & Reis, 2008 | Hisoarma | FG13 | 1 |
| *Hisonotus charrua* Almirón, Azpelicueta, Casciotta & Litz, 2006 | Hisochar | FG13 | 10 |
| *Hisonotus laevior* Cope, 1894 | Hisolaev | FG13 | 8 |
| *Hisonotus notopagos* Carvalho & Reis, 2011 | Hisonoto | FG13 | 3 |
| *Hisonotus ringueleti* Aquino, Schaefer & Miquelarena, 2001 | Hisoring | FG13 | 3 |
| *Homodiaetus anisitsi* Eigenmann & Ward, 1907 | Homoanis | FG14 | 1 |
| *Hoplias* aff *malabaricus* (Bloch, 1794) | Hoplmala | FG15 | 19 |
| *Hoplias lacerdae* Miranda Ribeiro, 1908 | Hopllace | FG15 | 5 |
| *Hyphessobrycon anisitsi* (Eigenmann, 1907) | Hyphanis | FG16 | 6 |
| *Hyphessobrycon luetkenii* (Boulenger, 1887) | Hyphluet | FG16 | 24 |
| *Hyphessobrycon meridionalis* Ringuelet, Miquelarena & Menni, 1978 | Hyphmeri | FG16 | 9 |
| *Hyphessobrycon togoi* Miquelarena & López, 2006 | Hyphtogo | FG16 | 2 |
| *Hypobrycon* sp. | Hyposp | FG2 | 2 |
| *Hypostomus aspilogaster* (Cope, 1894) | Hypoaspi | FG1 | 6 |
| *Hypostomus commersonii* Valenciennes, 1836 | Hypocomm | FG1 | 8 |
| *Hypostomus uruguayensis* Reis, Weber & Malabarba, 1990 | Hypourug | FG1 | 1 |
| *Imparfinis mishky* Almirón, Casciotta, Bechara, Ruíz Díaz, Bruno, D’Ambrosio, Solimano & Soneira, 2007 | Impamish | FG10 | 3 |
| *Ituglanis australis* Datovo & de Pinna, 2014 | Itugaust | FG8 | 1 |
| *Ituglanis inusitatus*  Ferrer & Donin, 2017 | Ituginus | FG8 | 2 |
| *Laetacara dorsigera* (Heckel, 1840) | Laetdors | FG6 | 1 |
| *Loricariichthys melanocheilus* Reis & Pereira, 2000 | Lorimela | - | 1 |
| *Macropsobrycon uruguayanae* Eigenmann, 1915 | Macrurug | FG2 | 1 |
| *Microglanis cottoides* (Boulenger, 1891) | Micrcott | FG8 | 11 |
| *Microglanis malabarbai* Bertaco & Cardoso, 2005 | Micrmala | FG8 | 3 |
| *Mimagoniates inequalis* (Eigenmann, 1911) | Mimaineq | FG2 | 5 |
| *Moenkhausia bonita* Benine, Castro & Sabino, 2004 | Moenboni | FG2 | 2 |
| *Moenkhausia dichroura* (Kner, 1858) | Moendich | FG2 | 1 |
| *Odontostilbe pequira* (Steindachner, 1882) | Odonpequ | FG4 | 1 |
| *Oligosarcus jacuiensis* Menezes & Ribeiro, 2010 | Oligjacu | FG15 | 1 |
| *Oligosarcus jenynsii* (Günther, 1864) | Oligjeny | FG15 | 21 |
| *Oligosarcus oligolepis* (Steindachner, 1867) | Oligolig | FG5 | 5 |
| *Oligosarcus robustus* Menezes, 1969 | Oligrobu | FG15 | 1 |
| *Oligosarcus* sp. | Oligsp | FG15 | 1 |
| *Otocinclus arnoldi* Regan, 1909 | Otocarno | FG13 | 2 |
| *Otocinclus flexilis* Cope, 1894 | Otocflex | FG13 | 2 |
| *Phalloceros caudimaculatus* (Hensel, 1868) | Phalcaud | FG11 | 25 |
| *Pimelodella australis* Eigenmann, 1917 | Pimeaust | FG10 | 25 |
| *Pseudobunocephalus iheringii* (Boulenger, 1891) | Pseuiher | FG8 | 3 |
| *Pseudocorynopoma doriae* Perugia, 1891 | Pseudori | FG2 | 33 |
| *Pseudohemiodon laticeps* (Regan, 1904) | Pseulati | FG17 | 1 |
| *Rhamdella eriarcha* (Eigenmann & Eigenmann, 1888) | Rhameria | FG10 | 4 |
| *Rhamdella longiuscula* Lucena & da Silva, 1991 | Rhamlong | FG10 | 7 |
| *Rhamdia* sp. 1 | Rhamsp1 | FG12 | 9 |
| *Rhamdia* sp. 2 | Rhamsp2 | FG12 | 19 |
| *Rineloricaria anitae* Ghazzi, 2008 | Rineanit | FG18 | 2 |
| *Rineloricaria cadeae* (Hensel, 1868) | Rinecade | FG18 | 11 |
| *Rineloricaria longicauda* Reis, 1983 | Rinelong | FG18 | 1 |
| *Rineloricaria microlepidogaster* (Regan, 1904) | Rinemicr | FG1 | 6 |
| *Rineloricaria sanga* Ghazzi, 2008 | Rinesang | FG18 | 1 |
| *Rineloricaria stellata* Ghazzi, 2008 | Rinestel | FG18 | 38 |
| *Rineloricaria strigilata* (Hensel, 1868) | Rinestri | FG18 | 2 |
| *Rineloricaria zaina* Ghazzi, 2008 | Rinezain | FG18 | 1 |
| *Scleronema* cf *minutum* (Boulenger, 1891) | Scleminu1 | FG8 | 2 |
| *Scleronema minutum* (Boulenger, 1891) | Scleminu | FG8 | 13 |
| *Scleronema operculatum* Eigenmann, 1917 | Scleoper | FG8 | 3 |
| *Scleronema guapa Ferrer & Malabarba 2020* | Sclesguap | FG8 | 2 |
| *Scleronema macanuda Ferrer & Malabarba 2020* | Sclespmaca | FG8 | 6 |
| *Scleronema teiniagua* Ferrer & Malabarba 2020 | Sclesptein | FG8 | 2 |
| *Serrapinnus calliurus* (Boulenger, 1900) | Serrcall | FG4 | 2 |
| *Steindachnerina biornata* (Braga & Azpelicueta, 1987) | Steibior | FG9 | 11 |
| *Steindachnerina brevipinna* (Eigenmann & Eigenmann, 1889) | Steibrev | FG9 | 2 |
| *Synbranchus marmoratus* Bloch, 1795 | Synbmarm | FG7 | 30 |



**Figure S1**. Cluster analysis generated using Ward’s method based on Gower distance of fish functional traits (see Online Resource II).

Table S5. Ecological thresholds for each significant stream fish indicator (Species and Functional Group, FG). Thresholds were identified in TITAN analysis for six different attributes of vegetation loss trajectories.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Indicator | +/- | Native vegetation loss 1993 (%) | Native vegetation loss 2013 (%) | Frequency (years) | Magnitude (accumulated%) | Duration T20 (years) | Duration T40 (years) |
| Species | Astyhens | z- | - | 1.40 | - | - | - | - |
| Cheiint | z- | 12.90 | 8.01 | - | - | - | - |
| Crensco | z- | - | - | - | 31.73 | - | - |
| Gymnrhab | z- | 8.26 | - | - | - | - | - |
| Phalcaud | z- | 1.77 | - | - | - | - | - |
| Pseudori | z- | 12.91 | 3.54 | - | - | - | - |
| Scleminu | z- | 0.95 | - | - | - | - | - |
| Symbmarm | z- | 1.49 | - | - | - | - | - |
| Rhamsp2 | z+ | 26.30 | 53.16 | - | - | 16.50 | 4.50 |
| Functional | FG2 | z- | 4.15 | 3.47 | - | - | - | - |
| FG4 | z- | 4.02 | 3.68 | - | - | - | - |
| FG6 | z- | 6.22 | 5.93 | - | 3.28 | 4.53 |  |
| FG7 | z- | 3.99 | - | - | - | - | - |
| FG11 | z- | 4.85 | - | - | - | - | - |

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