

This file has been cleaned of potential threats.

If you confirm that the file is coming from a trusted source, you can send the following SHA-256 hash value to your admin for the original file.

745624b5a4c749a3f47f1b86d26c62ad6618ba006502a2e07252d6e9f53feafc

To view the reconstructed contents, please SCROLL DOWN to next page.

**The text that follows is a PREPRINT.
O texto que segue é um PREPRINT.**

Please cite as:

Favor citar como:

Azevedo-Santos, Valter M.; Jorge Luiz
Rodrigues Filho, Philip M. Fearnside,
Thomas E. Lovejoy & Marcelo F. G. Brito.
2021. **Conservation of Brazilian
freshwater biodiversity: Thinking
about the next 10 years and
beyond.** *Biodiversity and Conservation*
30: 235–241. <https://doi.org/10.1007/s10531-020-02076-5>

DOI: 10.1007/s10531-020-02076-5

ISSN: 0960-3115 (Print) 1572-9710 (Online)

Copyright: Springer Netherlands

The original publication is available at:

O trabalho original está disponível em:

<https://doi.org/10.1007/s10531-020-02076-5>

<http://link.springer.com/>

Conservation of Brazilian freshwater biodiversity: Thinking about the next 10 years and beyond

Valter M. Azevedo-Santos¹, Jorge Luiz Rodrigues Filho², Philip M. Fearnside³, Thomas E. Lovejoy⁴ & Marcelo F. G. Brito⁵

¹ Department of Zoology, São Paulo State University, Botucatu, São Paulo, Brazil.

² Laboratory of Ecology – Department of Fisheries Engineering and Biology, UDESC, 88790-000, Laguna, Santa Catarina, Brazil.

³ Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, 69067-375, Brazil

⁴ Department of Environmental Science and Policy, George Mason University, Fairfax, VA, 22030, USA

⁵ Department of Biology, Federal University of Sergipe, Av. Marechal Rondon s/n, Rosa Elze, São Cristóvão, Sergipe, Brazil

*Corresponding author (E-mail: valter.ecologia@gmail.com)

Abstract

In 2021 the countries of the world will discuss a framework under the Convention on Biological Diversity (CBD) for a new environmental agenda for the next 10 years (the “post-2020”). Parties should consider Brazil to be a central nation in these discussions. The country holds a large freshwater biodiversity that needs to be protected, but current policies imperil species and ecosystems. Here we present topics to guide other CBD parties in discussing with Brazil a better agenda to conserve freshwater biodiversity in the “post-2020”. These initiatives include: (i) a national plan to reduce threats, (ii) restoration of freshwater ecosystems, (iii) protected areas, (iv) more investment in research, and (v) science communication. Brazil’s participation in these CBD negotiations is fundamental for a new agreement, but the country is under a presidential administration with little concern for the environment. While our suggestions are intended for participants in the CBD negotiations, they will also be relevant to other international actors in the coming years. Nations, international investors, private companies and NGOs around the world must therefore use their influence to press the current administration to protect the country’s environment, including its enormous freshwater biodiversity

Keywords: Freshwater protected areas; laws; mining; post-2020; restoration; biological invasions

Declarations

Funding

PMF and MFGB received CNPq research grants;

Conflicts of interest

None

Since February 2020, the 196 Parties to the Convention on Biological Diversity (CBD) have been discussing the challenges of conserving biodiversity in a world that is undergoing climate change and increasing human population and consumption (CBD 2020). The parties will formulate a new global framework, scheduled to be agreed in 2021. These decisions will provide a global environmental agenda for the next 10 years (the “post-2020”).

49 The parties should consider Brazil to be central to the discussion of the post-2020 period
50 due to its vast biodiversity, especially those in inland waters. The country contains a large
51 percentage of the planet's freshwater species (Agostinho et al. 2005). For example, the country
52 holds 3148 freshwater fish species (ICMBio 2018), a larger richness than North America,
53 Central America, Europe, and Oceania combined (Dagosta and de Pinna 2019). Another example
54 is freshwater Cladocera, with more than 140 species (Brito et al. 2020), a number that
55 corresponds to ~ 23 % of the world's total for this group (Forró et al. 2008).

56 Brazil's high freshwater biodiversity is in constant peril (ICMBio 2018; Pelicice et al.
57 2017). An assessment of the state of conservation of Brazilian freshwater species organized by
58 the Chico Mendes Institute for Biodiversity Conservation (ICMBio) is being done through
59 voluntary collaboration of national and international researchers. These evaluations have shown
60 that many Brazilian fish species are extinct at the regional level (ICMBio 2018); this is alarming
61 because the extinction of local or regional populations eliminates genetic variability. Brazilian
62 diversity is being imperiled as dams, agricultural expansion, pollution, and other impacts take
63 their toll on Brazil's aquatic ecosystems. Other threats include invasive species, a danger that is
64 augmented by planned inter-basin water transfer projects and by unsustainable aquaculture and
65 sport fishing (e.g., Daga et al. 2020; Garcia et al. 2018; Nobile et al. 2020; Ribeiro et al. 2017).

66 Although threats to Brazil's flora and fauna have been increasing for years (e.g., Ferreira
67 et al. 2014; Azevedo-Santos et al. 2017; Fernandes et al. 2017), Brazil's current president (Jair
68 Bolsonaro), who took office in January 2019, has greatly worsened the situation (e.g.,
69 Supplementary Material A). For example, the president has submitted a proposed law to the
70 National Congress (PL 191/2020) that would legalize mining and dam construction in
71 indigenous areas (Congresso Nacional 2020). The collapse of the Brumadinho and Mariana
72 mine-tailings dams (Cionek et al. 2019; Fernandes et al. 2016) made it very clear that Brazil is
73 not able to monitor and ensure proper functioning of its mines (Ferreira et al. 2014; Nazareno
74 and Vitule 2016). Impacts of mining in indigenous areas are likely to disrupt biodiversity in both
75 terrestrial and freshwater ecosystems.

76 The Ministry of Environment was not abolished altogether, as had been promised by the
77 president during his electoral campaign (Supplementary Material B). However, the person
78 President Bolsonaro appointed to head the ministry (Ricardo Salles) has acted to set the
79 environment back on many fronts. For example, Salles recently repealed important resolutions of
80 the National Environment Council (CONAMA), including revoking resolution on licensing for
81 irrigation projects (284/2001; see Supplementary Material C), thus imperiling many waterbodies
82 and their biodiversity. This further reinforces the conclusion that Brazil must be placed at the
83 center of the negotiations for a new agreement for the next decade and beyond. In view of this
84 possibility, we present suggestions for the CBD signatory nations outlining the main actions that
85 are necessary to conserve Brazilian freshwater biodiversity.

86

87 **Post-2020: Examples of needed actions**

88

89 *A national plan to reduce threats*

90 We believe that Brazil needs a national plan to reduce threats to biodiversity. Here we
91 will provide examples of threats that should be considered in a discussion by the parties to the
92 CBD.

93 Mining is an activity that has disrupted Brazilian aquatic ecosystems, especially gold, that
94 releases a lot of mercury (Malm et al. 1998), and those associated with tailings dam associated
95 (Fernandes et al. 2016). More inspections and restrictions on mining near waterbodies are needed
96 (Pelicice et al. 2017); the same applies to tailings dams because they have a gigantic potential for
97 biodiversity destruction (Cionek et al. 2019; Fernandes et al. 2016). Also needed is improved
98 inspection to prevent illegal mining, including better control at the country's borders to avoid
99 entry of mercury and other illegal inputs used in this activity.

100 Hydroelectric dams have fragmented major rivers for years (Agostinho et al. 2008;
101 Fearnside 2016a), and Brazil has ambitious plans for new Amazon dams. Brazil must consider
102 investing more in alternatives with less impact than Amazon dams, such as halting export of
103 electro-intensive commodities (especially aluminum), improved transmission and use efficiency,
104 and generation from the country's abundant wind and solar sources (Fearnside 2016a; Pelicice et
105 al. 2017).

106 Agriculture must respect the limits of ecosystems so that it is promoted with
107 sustainability. For example, numerous agricultural chemicals are currently allowed, hundreds of
108 them approved during the current presidential administration (Supplementary Material D). Many
109 of these poisons are banned in more-developed nations (Thomaz et al. 2020). The sale of these
110 chemicals for agriculture, and their irregular use, can cause disturbances in freshwater
111 ecosystems, since pesticides can reach waterbodies in the runoff of rainwater. When these
112 chemicals reach aquatic ecosystems, they can cause serious harm to the freshwater biota
113 (Miranda et al. 2008).

114 Many decisions, especially through new laws, have the capacity to expose Brazilian
115 freshwaters to introduced species from the most varied locations of the planet (Coelho and Henry
116 2017; Pelicice et al. 2014). The Aichi Targets have been ignored in this regard in various ways
117 (Lima Junior et al. 2018), with harmful consequences for ecosystems (Vitule et al. 2009).
118 Invasive species should be treated more seriously by authorities and by society in general.

119 Pollution of the country's ecosystems has been taking place for a long time. Hundreds of
120 cities in the country still throw domestic effluents into urban streams without any prior treatment.
121 In addition, many Brazilian ecosystems (and the species within them) have received
122 unprecedented amounts plastic waste (e.g., Andrade et al. 2019; Giarrizzo et al. 2019). The full
123 extent of the impacts of this on Brazilian freshwater biota is unknown. Brazil has failed to adopt
124 rigid measures to prevent the input of polymers and other types of waste in the country's
125 ecosystems.

126

127 *Restoration of freshwater ecosystems*

128 Restoration of freshwater ecosystems has barely been discussed in the country and is still
129 a topic largely restricted to the academic community. Brazilian authorities need to rethink
130 opportunities for depollution, following trends in a number of other countries.

131

132 *Protected areas*

133 Most Brazilian protected areas have limited value for protection of freshwater
134 biodiversity (e.g., Frederico et al. 2018). More-efficient protected areas therefore need to be
135 implemented to protect this diversity (Azevedo-Santos et al. 2019). However, this depends on
136 the good will of political agents.

137

138 *More investment in research*

139 Brazil is far from knowing the entirety of its freshwater biodiversity. For example, even
140 at this point in the 21st century, scientists described a large aquatic mammal (Hrbek et al. 2014).
141 In addition to the country's outstanding diversity of fish and other freshwater vertebrates, aquatic
142 invertebrate diversity is enormous over a wide range of taxonomic groups (Hamada et al. 2018,
143 2019). We are likely to lose species before we even know of their existence. Thus, basic studies
144 (e.g., surveys) on biodiversity should receive adequate investment in Brazil. In addition,
145 bureaucratic barriers that hinder this type of research need be removed (Bockmann et al. 2018);
146 in this regard, we recommend a revision of the biodiversity law (Law 13,123, May 20, 2015).

147 More investments are needed in biological collections, as these are essential for
148 taxonomic revisions and discoveries of new species. The September 2018 fire that destroyed
149 Brazil's National Museum in Rio de Janeiro (Supplementary Material E) suggests the extent to
150 which important collections have been neglected by the country's political authorities.

151

152 *Science communication*

153 Many of Brazil's public policies promote development without regard for impacts on
154 biodiversity (Fearnside 2016b; Pelicice et al. 2017). Environmental policies, including those
155 involving freshwater ecosystems, must be guided by scientific knowledge, which also requires
156 the participation of scientists in the policy-elaboration process (Azevedo-Santos et al. 2017).

157 Only a small fraction of the country's scientific knowledge of biodiversity is provided to
158 society at large. Although important examples of science outreach exist (see França et al. 2018),
159 these are still relatively few. Providing scientific knowledge to society at large (and government
160 investments for this purpose) is essential to conserving freshwater biodiversity.

161
162 **Final Remarks**

163 Parties to the CBD need to consider our suggestions for conserving Brazilian freshwater
164 biodiversity in discussions on the new treaty for the “post-2020” period. While our suggestions
165 are directed to the CBD parties, they also apply to other international actors, including
166 governments, businesses and non-governmental organizations (NGOs). Brazil's environmental
167 setbacks under the current presidential administration have reached a magnitude suggesting that
168 measures needed to protect the country's biodiversity will not be taken in the absence of
169 influence from international actors (Ferrante and Fearnside 2019). Countries importing Brazilian
170 soy, beef and timber must condition their purchases on adequate safeguards, among other
171 economic inducements to change the Brazilian government's behavior (Kehoe et al. 2019).
172 Private companies and NGOs, both national and international, among other actors such as
173 international investors, must also exert influence on environmental conservation in Brazil.

174 Parties to the CBD also need to consider creating an international fund for countries with
175 megadiversity, such as Brazil. Such a fund must not only focus on conservation of forests, but
176 also on freshwater biodiversity. Decisions for the next ten years are crucial for biodiversity and
177 future generations in Brazil.

178
179 **Acknowledgements**

180 We are grateful to Francisco Diogo R. Sousa, for sending literature on Cladocera, and Paula N.
181 Coelho and Vanessa S. Daga, for critical revision of the final version of this manuscript. We
182 would like to thank the four anonymous reviews, who significantly improved this paper.

183
184 **References**

- 185 Agostinho AA, Thomaz SM, Gomes LC (2005) Conservation of the Biodiversity of Brazil's
186 inland waters. *Conserv Biol* 19: 646–652. <https://doi.org/10.1111/j.1523-1739.2005.00701.x>
- 188 Agostinho AA, Pelicice FM, Gomes LC (2008) Dams and the fish fauna of the Neotropical
189 region: Impacts and management related to diversity and fisheries. *Braz. J. Biol.* 68(4,
190 Suppl.), 1119-1132. <https://dx.doi.org/10.1590/S1519-69842008000500019>
- 191 Andrade MC, Winemiller KO, Barbosa PS, Fortunati A, Chelazzi D, Cincinelli A, Giarrizzo T
192 (2019) First account of plastic pollution impacting freshwater fishes in the Amazon:
193 Ingestion of plastic debris by piranhas and other serrasalmids with diverse feeding habits.
194 *Environ Pollut* 244: 766–773. <https://doi.org/10.1016/j.envpol.2018.10.088>
- 195 Azevedo-Santos VM, Fearnside PM, Oliveira CS, Padial AA, Pelicice FM, Lima Jr DP,
196 Simberloff D, Lovejoy TE, Magalhães ALB, Orsi ML, Agostinho AA, Esteves FA,
197 Pompeu PS, Laurance WF, Petreire Jr M, Mormul RP, Vitule JRS (2017) Removing the
198 abyss between conservation science and policy decisions in Brazil. *Biodivers Conserv* 26:
199 1745–1752. <https://doi.org/10.1007/s10531-017-1316-x>
- 200 Azevedo-Santos VM, Frederico RG, Fagundes CK, Pompeu PS, Pelicice FM, Padial AA,
201 Nogueira MG, Fearnside PM, Lima LB, Daga VS, Oliveira FJM, Vitule JRS, Callisto M,

- 202 Agostinho AA, Esteves FA, Lima-Junior DP, Magalhães ALB, Sabino J, Mormul RP,
203 Grasel D, Zuanon J, Vilella FS, Henry R (2019) Protected areas: A focus on Brazilian
204 freshwater biodiversity. *Divers Distrib* 25: 442–448. <https://doi.org/10.1111/ddi.12871>
- 205 Bockmann FA, Rodrigues MT, Kohsldorf T, Straker LC, Grant T, de Pinna MCC, Mantelatto
206 FLM, Datovo A, Pombal Jr. JP, McNamara JC, Almeida EAB, Klein W, Hsiou AS,
207 Groppo M, Castro RMC, Amorim DS (2018) Brazil's government attacks biodiversity.
208 *Science* 360: 865. <https://doi.org/10.1126/science.aat7540>
- 209 Brito MTS, Diniz LP, Pozzobom UM, Landeiro VL, Sousa FDR. (2020) Cladocera (Crustacea:
210 Branchiopoda) from the state of Mato Grosso, Brazil. *Ann Limnol* 56: 7.
211 <https://doi.org/10.1051/limn/2020005>
- 212 CBD (Convention on Biological Diversity) (2020) Discussions open in Rome towards a
213 landmark new UN biodiversity framework. CBD. [https://www.cbd.int/doc/press/2020/pr-](https://www.cbd.int/doc/press/2020/pr-2020-02-24-post2020-en.pdf)
214 [2020-02-24-post2020-en.pdf](https://www.cbd.int/doc/press/2020/pr-2020-02-24-post2020-en.pdf)
- 215 Cioneck VM, Alves GHZ, Tófoli RM, Rodrigues-Filho JL, Dias RM (2019) Brazil in the mud
216 again: Lessons not learned from Mariana dam collapse. *Biodivers Conserv* 28: 1935–
217 1938. <https://doi.org/10.1007/s10531-019-01762-3>
- 218 Coelho PN, Henry R (2017) The small foreigner: New laws will promote the introduction of
219 non-native zooplankton in Brazilian aquatic environments. *Acta Limnol Bras* 29: e7.
220 <https://doi.org/10.1590/s2179-975x0717>
- 221 Congresso Nacional (2020) PL 191/2020. Câmara dos Deputados. Brasília, DF, Brazil.
222 <https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2236765>
- 223 Daga VS, Azevedo-Santos VM, Pelicice FM, Fearnside PM, Perbiche-Neves G, Paschoal LRP,
224 Cavallari DC, Erickson J, Ruocco AMC, Oliveira I, Padial AA, Vitule JRS (2020) Water
225 diversion in Brazil threatens biodiversity. *Ambio* 49: 165–172.
226 <https://doi.org/10.1007/s13280-019-01189-8>
- 227 Dagosta FCP, de Pinna M (2019) The fishes of the Amazon: Distribution and biogeographical
228 patterns, with a comprehensive list of species. *Bull Am Mus Nat Hist* 2019: 1–163.
229 <https://doi.org/10.1206/0003-0090.431>
- 230 Fearnside PM (2016a) Environmental and social impacts of hydroelectric dams in Brazilian
231 Amazonia: Implications for the aluminum industry. *World Devel* 77: 48-65.
232 <https://doi.org/10.1016/j.worlddev.2015.08.015>
- 233 Fearnside PM (2016b) Brazilian politics threaten environmental policies. *Science* 353: 746–748.
234 <https://doi.org/10.1126/science.aag0254>
- 235 Fernandes GW, Goulart FF, Ranieri BD, Coelho MS, Dales K, Boesche N, Bustamante M,
236 Carvalho FA, Carvalho DC, Dirzo R, Fernandes S, Galetti Jr. PM, Millan VEG, Mielke
237 C, Ramirez JL, Neves A, Rogass C, Ribeiro SP, Scariot A, Soares-Filho B. (2016) Deep
238 into the mud: Ecological and socio-economic impacts of the dam breach in Mariana,
239 Brazil. *Nat Conserv* 14(2): 35-45. <https://doi.org/10.1016/j.ncon.2016.10.003>
- 240 Fernandes, GW, Vale MM, Overbeck GE, Bustamante MM, Grelle CE, Bergallo HG, ... &
241 Araújo J. (2017). Dismantling Brazil's science threatens global biodiversity heritage.
242 *Perspect Ecol Conser* 15(3): 239-243. <https://doi.org/10.1016/j.pecon.2017.07.004>
- 243 Ferrante L, Fearnside FM (2019) Brazil's new president and 'ruralists' threaten Amazonia's
244 environment, traditional peoples and the global climate. *Environ Conserv* 46: 261–663.
245 <https://doi.org/10.1017/S0376892919000213>

- 246 Ferreira J, Aragão LEOC, Barlow J, Barreto P, Berenguer E, Bustamante M, ... & Pardini R,
 247 (2014) Brazil's environmental leadership at risk. *Science* 346: 706-707.
 248 <https://doi.org/10.1126/science.1260194>
- 249 Forró L, Korovchinsky NM, Kotov AA, & Petrusek A (2008) Global diversity of cladocerans
 250 (Cladocera; Crustacea) in freshwater. *Hydrobiologia* 595: 177–184.
 251 https://doi.org/10.1007/978-1-4020-8259-7_19
- 252 França JS, Solar R, Hughes RM, Callisto M (2019) Student monitoring of the ecological quality
 253 of neotropical urban streams. *Ambio* 48: 867–878. [https://doi.org/10.1007/s13280-018-](https://doi.org/10.1007/s13280-018-1122-z)
 254 [1122-z](https://doi.org/10.1007/s13280-018-1122-z)
- 255 Frederico RG, Zuanon J, Marco Jr PM (2018) Amazon protected areas and its ability to protect
 256 stream-dwelling fish fauna. *Biol Conserv* 219: 12–19.
 257 <https://doi.org/10.1016/j.biocon.2017.12.032>
- 258 Garcia DAZ, Magalhães ALB, Vitule JRS, Casimiro ACR, Lima-Junior DP, Cunico AM, Brito
 259 MFG, Petrere-Junior M, Agostinho AA, Orsi ML (2018) The same old mistakes in
 260 aquaculture: The newly-available striped catfish *Pangasianodon hypophthalmus* is on its
 261 way to putting Brazilian freshwater ecosystems at risk. *Biodivers Conserv* 27: 3545–
 262 3558. <https://doi.org/10.1007/s10531-018-1603-1>
- 263 Giarrizzo T, Andrade MC, Schmid K, Winemiller KO, Ferreira M, Pegado T, Chelazzi D,
 264 Cincinelli A, Fearnside PM (2019) Amazonia: The new frontier for plastic pollution.
 265 *Frontiers Ecol Environ* 17: 309-310. <https://doi.org/10.1002/fee.2071>
- 266 Hamada N, Thorp JH, Rogers DC (2018) *Keys to Neotropical Hexapoda. Thorp and Covich's*
 267 *Freshwater Invertebrates*. Volume III. 4 ed. Elsevier.
- 268 Hamada N, Nessimian JL, Querino RB (2019) *Insetos Aquáticos na Amazônia Brasileira:*
 269 *Taxonomia, Biologia e Ecologia*. Instituto Nacional de Pesquisas da Amazônia (INPA).
- 270 Hrbek T, Silva VMF, Dutra N, Gravena W, Martin AR, Farias IP (2014) A new species of river
 271 dolphin from Brazil or: How little do we know our biodiversity. *PLoS ONE* 9: e83623
 272 <https://doi.org/10.1371/journal.pone.0083623>
- 273 ICMBio (Instituto Chico Mendes de Conservação da Biodiversidade) (2018) *Livro Vermelho da*
 274 *Fauna Brasileira Ameaçada de Extinção: Volume VI - Peixes*. ICMBio, Brasília, DF,
 275 Brazil.
- 276 Kehoe L, Reis T, Virah-Sawmy M, Balmford A, Kuemmerle T, and 604 signatories (2019) Make
 277 EU trade with Brazil sustainable. *Science* 364: 341.
 278 <https://doi.org/10.1126/science.aaw8276>
- 279 Lima Junior DP, Magalhães ALB, Pelicice FM, Vitule JRS, Azevedo-Santos VM, Orsi ML,
 280 Simberloff D, Agostinho AA (2018) Aquaculture expansion in Brazilian freshwaters
 281 against the Aichi Biodiversity Targets. *Ambio* 47: 427–440.
 282 <https://doi.org/10.1007/s13280-017-1001-z>
- 283 Malm O (1998) Gold mining as a source of mercury exposure in the Brazilian Amazon. *Environ*
 284 *Res*; 77(2): 73-78
- 285 Miranda AL, Roche H, Randi MAF, Menezes ML, & Ribeiro CAO (2008) Bioaccumulation of
 286 chlorinated pesticides and PCBs in the tropical freshwater fish *Hoplias malabaricus*:
 287 Histopathological, physiological, and immunological findings. *Environ Int* 34(7), 939–
 288 949. <https://doi.org/10.1016/j.envint.2008.02.004>
- 289 Nazareno A, Vitule J (2016) Too many mining disasters in Brazil. *Nature* 531: 580.
 290 <https://doi.org/10.1038/531580e>

- 291 Nobile AB, Cunico AM, Vitule JRS, Queiroz J, Vidotto-Magnoni AP, Garcia DAZ, Orsi ML,
292 Lima FP, Acosta AA, Silva RJ, Prado FD, Porto-Foresti F, Brandão H, Foresti F, Oliveira
293 C, Ramos IP (2020) Status and recommendations for sustainable freshwater aquaculture
294 in Brazil. *Aquaculture* 12: 1495-1517. <https://doi.org/10.1111/raq.12393>
- 295 Pelicice FM, Azevedo-Santos VM, Vitule JRS, Orsi ML, Lima Junior DP, Magalhães ALB,
296 Pompeu PS, Petreire Jr M, Agostinho AA (2017) Neotropical freshwater fishes imperiled
297 by unsustainable policies. *Fish Fish* 18: 1119–1133. <https://doi.org/10.1111/faf.12228>
- 298 Pelicice FM, Vitule JRS, Lima Junior DP, Orsi ML, Agostinho AA (2014) A serious new threat
299 to Brazilian freshwater ecosystems: The naturalization of nonnative fish by decree.
300 *Conserv Lett* 7: 55–60. <https://doi.org/10.1111/conl.12029>
- 301 Ribeiro VR, Silva PRL, Gubiani EA, Faria L, Daga VS, Vitule JRS (2017) Imminent threat of
302 the predator fish invasion *Salminus brasiliensis* in a Neotropical ecoregion: Eco-
303 vandalism masked as an environmental project. *Perspect Ecol Conser* 15: 132–135.
304 <https://doi.org/10.1016/j.pecon.2017.03.004>
- 305 Thomaz SM, Gomes Barbosa L, de Souza Duarte MC, Panosso R (2020) The future of nature
306 conservation in Brazil. *Inland Waters* 10: 295-303.
307 <https://doi.org/10.1080/20442041.2020.1750255>
- 308 Vitule JRS, Freire CA, Simberloff D (2009) Introduction of non-native freshwater fish can
309 certainly be bad. *Fish Fish* 10: 98–108. <https://doi.org/10.1111/j.1467-2979.2008.00312.x>
- 310

SUPPLEMENTARY MATERIAL

A - Bolsonaro administration policies on biodiversity

Campos-Silva JV, Peres CA (2019) Brazil's policies stuck in the mud. *Science* 363: 1046.

<https://doi.org/10.1126/science.aaw8293>

Coelho FEA, Lopes LC, Cavalcante RMS, Corrêa GC, Leduc AOHC (2019) Brazil unwisely gives pesticides a free pass. *Science* 365: 552–553.

<https://doi.org/10.1126/science.aay3150>

Fearnside PM (2019) Setbacks under President Bolsonaro: A Challenge to Sustainability in the Amazon. *Sustentabilidade International Science Journal* 1(1): 38–52.

[http://cca.ufam.edu.br/pdf/Revista_Sustentabilidade_28-06-](http://cca.ufam.edu.br/pdf/Revista_Sustentabilidade_28-06-2019%20(1%C2%AA%20Edicao).pdf)

[2019%20\(1%C2%AA%20Edicao\).pdf](http://cca.ufam.edu.br/pdf/Revista_Sustentabilidade_28-06-2019%20(1%C2%AA%20Edicao).pdf)

Carvalho WD, Mustin K, Hilário RR, Vasconcelos IM, Eilers V, Fearnside PM (2019) Deforestation control in the Brazilian Amazon: A conservation struggle being lost as agreements and regulations are subverted and bypassed. *Perspectives in Ecology and Conservation* 17(3): 122-130. <https://doi.org/10.1016/j.pecon.2019.06.002>

Fearnside PM (2019) Desmonte da legislação ambiental brasileira. In: *Movimentos Socioambientais: Lutas - Avanços - Conquistas - Retrocessos - Esperanças*. (ed Weiss JS) Xapuri Socioambiental. pp. 317–381. <https://doi.org/10.37682/xapbk.msoc-ed1-010>

B - Ministry of the Environment (promise of extinction)

Stachewski AL (2019) Bolsonaro mantém Ministério do Meio Ambiente, mas esvazia pasta.

Negócios, 29 January 2019.

<https://epocanegocios.globo.com/Brasil/noticia/2019/01/bolsonaro-mantem-ministerio-do-meio-ambiente-mas-esvazia-pasta.html>

Bragança D (2018) Bolsonaro confirma promessa: Ministério do Meio Ambiente deixará de existir. Oeco, 30 October 2018. <https://www.oeco.org.br/noticias/bolsonaro-confirma-promessa-ministerio-do-meio-ambiente-deixara-de-existir/>

C - CONAMA

G1 (2020) Resoluções revogadas no Conama: entenda ponto a ponto o que muda e os prejuízos ao meio ambiente. G1, 28 September 2020
<https://g1.globo.com/natureza/noticia/2020/09/28/resolucoes-revogadas-no-conama-entenda-ponto-a-ponto-o-que-muda-e-os-prejuizos-ao-meio-ambiente.ghtml>

Grilli M (2020) Entidades e ONGs ambientais criticam Conama e avaliam ir à Justiça para anular revogações. Globo Rural, 28 September 2020.
<https://revistagloborural.globo.com/Noticias/Sustentabilidade/noticia/2020/09/entidades-e-ongs-ambientais-criticam-conama-e-avaliam-ir-justica-para-anular-revogacoes.html>

D - Poison

Carijo A (2019) Bolsonaro administration approves 197 pesticides in five months. Brasil de Fato, 22 May 2019 <https://www.brasildefato.com.br/2019/05/22/bolsonaro-administration-approves-169-pesticides-in-five-months/>

Grigori P (2020) Em meio à pandemia, governo Bolsonaro aprova 118 agrotóxicos em dois meses. A Pública, 13 May 2020. <https://apublica.org/2020/05/em-meio-a-pandemia-governo-bolsonaro-aprova-96-agrotoxicos-em-dois-meses/>

E - National Museum fire

Phillips D (2018) Brazil museum fire: ‘incalculable’ loss as 200-year-old Rio institution gutted. The Guardian, 3 September 2018. <https://www.theguardian.com/world/2018/sep/03/fire-engulfs-brazil-national-museum-rio>

Andreoni M, Londoño E (2018) Loss of indigenous works in Brazil museum fire felt 'like a new genocide'. New York Times, 13 September 2018.

<https://www.nytimes.com/2018/09/13/world/americas/brazil-museum-fire-indigenous.html>

Escobar H (2018) In a 'foretold tragedy,' fire consumes Brazil museum. *Science* 361: 960.

<https://doi.org/10.1126/science.361.6406.960>