



Invasive
sun corals
threaten
Brazil's native
reefs.

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Brazil policy invites marine invasive species

Invasive species threaten biodiversity and ecosystem function and can affect human well-being and services (1). In November 2019, Brazil's Tourism Ministry launched a plan to sink 1200 scrapped ships, trains, and airplanes, most of them inside marine protected areas (MPAs) (2), supposedly to promote diving tourism business. Artificial reefs, such as those that would be created by sinking these vehicles, are used by invading species as stepping-stones to natural reefs, causing ecological, social, and economic deterioration (3). This plan, if implemented, would undermine efforts to attain Convention on Biological Diversity (4) and National Environmental Policy Act targets (5).

Among the most likely invaders are sun corals (*Tubastraea* spp.), which were first reported in Brazil on oil platforms in the 1980s (6). These noxious corals spread along 3000 km of coastline, aided by transfer on the oil industry's platforms and drill ships as well as shipwrecks (3). On natural reefs, sun corals kill native corals, change reef communities and processes (3, 7), and modify seascapes (8), causing loss of income and requiring management (9).

In February 2020, ships sunk by the government between 2009 and 2017 were found to be covered in sun corals near the largest coastal reefs in Brazil, the Costa dos Corais MPA (10). The government plans to sink scrap in other sensitive

areas, such as the World Heritage-listed Fernando de Noronha Marine National Park (11). Brazil has a National Plan for the prevention of sun corals that highlights suppression of pathways of dispersion to protect native species and ecosystems (5), so the Tourism Ministry appears to be both ignoring its own government's advice and violating international conservation principles. The plan is controversial given that natural reefs and wrecks in Brazil are not overused by divers, and SCUBA is an expensive sport available to few people (12). Instead of moving forward with the plan to sink more ships, Brazil should encourage better use of natural reefs and historical shipwrecks and support monitoring and management of reefs.

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REFERENCES AND NOTES

1. L. Pejchar, H. A. Mooney, *Trends Ecol. Evol.* **24**, 497 (2009).
2. Ministério do Turismo, "Embratur anuncia programa de afundamento de navios para fomentar o turismo náutico," *Embratur* (2019) [in Portuguese].
3. J. C. Creed *et al.*, *Biol. Invasions* **19**, 283 (2017).
4. U.N. Convention on Biological Diversity, "Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets" (2010).
5. Ministério do Meio Ambiente/Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, "Plano Nacional de Prevenção, Controle e Monitoramento do coral-sol (*Tubastraea* spp.) no Brasil" (2018) [in Portuguese].
6. C. B. Castro, D. O. Pires, *Bull. Mar. Sci.* **69**, 357 (2001).
7. R. J. Miranda *et al.*, *Mar. Environ. Res.* **138**, 19 (2018).
8. K. C. C. Capel *et al.*, *Bull. Mar. Sci.* **96**, 217 (2020).
9. S. Rodrigues, "Empresas terão que adotar medidas contra coral-sol," *O Eco* (2017) [in Portuguese].
10. L. Markman, "Espécie de coral vira praga no litoral de Pernambuco e ameaça biodiversidade" *TV Globo* (2020) [in Portuguese].
11. A. Borges, "Sem regra ambiental, plano de Bolsonaro é fazer 73 naufrágios artificiais no litoral" *O Estado de S. Paulo* (2020) [in Portuguese].
12. R. Y. G. Rowe, G. E. O. Santos, *Cad. Virtual Tur.* **16**, 61 (2016).

COMPETING INTERESTS

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Brazil threatens Indigenous lands

Brazil's President Jair Bolsonaro has adopted anti-environmental measures for the Amazon since taking office in January 2019 (1), and deforestation pressures are increasing with plans for expanding plantations of soy and other

export crops (including biofuels) and for building new roads, dams, and mines (1, 2). On 6 February, Bolsonaro submitted a bill to Brazil's National Congress that would open Indigenous lands for mining, extraction of oil and gas, and construction of hydroelectric dams, cattle ranches, and mechanized monocultures such as soy (3). Indigenous leaders would be allowed to rent tribal land to non-Indigenous agribusiness entrepreneurs (3). The bill would allow mining in Indigenous lands without authorization from their Indigenous inhabitants (3). This bill, if passed, would violate the rights of Indigenous peoples and threaten the environment.

The Brazilian Society for the Progress of Science (SBPC) organized a public seminar at the National Institute of Amazonian Research (INPA) to discuss the risks the bill poses to Amazonia (4), and the organizers drafted an open letter alerting civil society and decision makers to the bill's violation of Brazilian legislation and ILO Convention 169, which require free, prior, and informed consultation of Indigenous peoples affected by actions such as this (5). The right to consultation has been routinely ignored by large enterprises in the Amazon, putting many traditional peoples at risk (6).

Bolsonaro's desire to open Indigenous lands to agribusiness and mining has often been expressed in his extemporaneous remarks and social media posts. Early in his term of office, a visit by his ministers of agriculture and environment to an illegal soy plantation in an Indigenous land signaled impunity for violations of current legal restrictions (1). The proposed law now makes the threat imminent. The administration's discourse is credited with invasions of Indigenous lands and killings of Indigenous leaders reaching record levels in 2019 (7). The impact of illegal gold miners (garimpeiros)—a constant threat

to Indigenous lands—will now be even greater thanks to the proposed law and to the risk of spreading coronavirus disease 2019 (COVID-19). Bolsonaro has repeatedly expressed support for these invaders (1). On 14 April, his environment minister dismissed one of the directors of the environmental agency as punishment for having ordered the removal of garimpeiros from an Indigenous land (8).

Demarcated Indigenous lands represent 24% of Brazil's Amazon biome, thus protecting more than the 14% that is in federal "conservation units" (protected areas for biodiversity) (9). Indigenous lands act as shields protecting traditional peoples, biodiversity, carbon stocks, and ecosystem services. Destruction of these forested areas poses a risk to the entire planet, as it affects one of the world's largest carbon stocks (10). We urge the president of Brazil's Chamber of Deputies not to put this bill to a vote, and we encourage Brazil's Supreme Court to act quickly to protect the country's Indigenous peoples.

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REFERENCES AND NOTES

1. L. Ferrante, P. M. Fearnside, *Environ. Conserv.* **46**, 261 (2019).
2. E. J. A. L. Pereira et al., *Land Use Pol.*, 10.1016/j.landusepol.2020.104491 (2020).
3. Senado Notícias, "Chega ao Congresso projeto que permite mineração em terras indígenas" (2020); <https://www12.senado.leg.br/noticias/materias/2020/02/06/chega-ao-congresso-projeto-que-permite-mineracao-em-terras-indigenas> [in Portuguese].
4. SBPC, "SBPC-AM promove evento para discutir a Mineração na Amazônia" (2020); <http://portal.sbpnet.org.br/noticias/sbpc-am-promove-evento-para-discutir-a-mineracao-na-amazonia/> [in Portuguese].
5. SBPC, INPA, "Nota contra o Projeto de Lei 191/2020 e em defesa da Amazônia" (2020); www.jornaldaciencia.org.br/wp-content/uploads/2020/03/Nota_Oficial_SBPC_INPA.pdf [in Portuguese].

6. L. Ferrante, M. Gomes, P. M. Fearnside, *Land Use Pol.*, 10.1016/j.landusepol.2020.104548 (2020).
7. Human Rights Watch (HRW), *Rainforest Mafias: How Violence and Impunity Fuel Deforestation in Brazil's Amazon* (HRW, 2019); www.hrw.org/sites/default/files/report_pdf/brazil0919_web.pdf.
8. Jornal Nacional, "Ministro do Meio Ambiente exonera o diretor de Proteção Ambiental do Ibama" (2020); <https://g1.globo.com/jornal-nacional/noticia/2020/04/14/ministro-do-meio-ambiente-exonera-o-diretor-de-protecao-ambiental-do-ibama.ghml> [in Portuguese].
9. E. M. Nogueira et al., *Reg. Environ. Chang.* **18**, 261 (2018).
10. S. S. Saatchi et al., *Proc. Natl. Acad. Sci. U.S.A.* **108**, 9899 (2011).

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Call for transparency of COVID-19 models

A hallmark of science is the open exchange of knowledge. At this time of crisis, it is more important than ever for scientists around the world to openly share their knowledge, expertise, tools, and technology. Scientific models are critical tools for anticipating, predicting, and responding to complex biological, social, and environmental crises, including pandemics. They are essential for guiding regional and national governments in designing health, social, and economic policies to manage the spread of disease and lessen its impacts. However, presenting modeling results alone is not enough. Scientists must also openly share their model code so that the results can be replicated and evaluated.

Given the necessity for rapid response to the coronavirus pandemic, we need many eyes to review and collectively vet model assumptions, parameterizations, and algorithms to ensure the most accurate modeling possible. Transparency engenders public trust and is the best defense against misunderstanding, misuse, and deliberate misinformation about models and their results. We need to engage as many experts as possible for improving the ability of models to represent epidemiological, social, and economic dynamics so that we can best respond to the crisis and plan effectively to mitigate its wider impacts.

We strongly urge all scientists modeling the coronavirus disease 2019 (COVID-19) pandemic and its consequences for health and society to rapidly and openly publish their code (along with specifying the type of data required, model parameterizations, and any available documentation) so that it is accessible to all scientists around the world. We offer sincere thanks to the many teams that are already sharing their models openly. Proprietary black boxes and code withheld for competitive motivations have no place in the global crisis we face today. As soon as possible,

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Add your voice to *Science*! Our new NextGen Voices survey is now open:

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To submit, go to www.sciencemag.org/nextgen-voices

Deadline for submissions is 15 May. A selection of the best responses will be published in the 3 July issue of *Science*. Submissions should be 200 words or less. Anonymous submissions will not be considered.

please place your code in a trusted digital repository (1) so that it is findable, accessible, interoperable, and reusable (2).

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REFERENCES AND NOTES

1. CoMSES Network, Trusted Digital Repositories (www.comses.net/resources/trusted-digital-repositories/).
2. M. D. Wilkinson *et al.*, *Sci. Data* **3**, 160018 (2016).

COMPETING INTERESTS

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ERRATA

Erratum for the Report "Design of an in vitro biocatalytic cascade for the manufacture of islatravir" by M. A. Huffman *et al.*, *Science* **368, eabc1954 (2020).** Published online 17 April 2020; 10.1126/science.abc1954

Erratum for the Report "Mutual control of coherent spin waves and magnetic domain walls in a magnonic device" by J. Han *et al.*, *Science* **368, eabc1767 (2020).** Published online 17 April 2020; 10.1126/science.abc1767

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