



Thematic assessment report on invasive alien species in Brazil: summary for policymakers

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Abstract: Biological invasions are one of the major threats to biodiversity and good quality of life, resulting from the translocation of species by human action. There are more than 500 alien species currently invading ecosystems in Brazil, particularly plants and fishes, while little is known about invasive microorganisms. Although invasive alien species are present in all ecosystems in the country, most have been recorded in habitats with greater human interference, such as urban and peri-urban areas, farmland, dams, reservoirs, ports, and canals. Historically, the southern and southeastern regions of Brazil have had more invasive alien species, but there has been an increase in the number of invasive alien species in the central-western and northern regions in recent decades. The ornamental trade of plants and fishes as well as the illegal pet trade of wild mammals and reptiles are some of the main pathways for invasive species introduction and spread in Brazil. Breeding and cultivation systems that allow escape to natural areas are a relevant route of species introductions in freshwater ecosystems, while unintentional introductions from shipping and infrastructure are of extreme concern in marine ecosystems. The negative impacts of invasive alien species on the biota mainly include changes in community structure and local decrease in native species richness, mediated by predation, competition, and ecosystem changes. Most negative impacts are recorded for

intentionally introduced species, such as fishes and plants, but unintentional introductions have led to impacts on good quality of life, with associated costs and impacts on human health. The management of biological invasions faces challenges that need to be overcome, such as the lack of public knowledge about the impact of invasive alien species, the popular appeal of charismatic invasive species or those used by humans, and the use of controversial control techniques. However, successful experiences of eradication and control in terrestrial and marine ecosystems have been recorded, some of them involving public engagement in management actions. Recognizing the issue as a cross-cutting public policy and developing ongoing governance experiences are fundamental goals for the management of invasive alien species in Brazil.

Keywords: *Convention on Biological Diversity; biological invasions; biodiversity loss; ecosystem services; impacts; management.*

Relatório temático sobre espécies exóticas invasoras no Brasil: sumário para tomadores de decisão

Resumo: Invasões biológicas são uma das maiores ameaças à biodiversidade e à boa qualidade de vida, ocorrendo a partir da translocação de espécies por ação humana. Existem mais de 500 espécies exóticas invadindo ecossistemas atualmente no Brasil, com destaque para plantas e peixes. Pouco se sabe sobre microrganismos invasores. Apesar de existirem espécies exóticas invasoras em todos os ecossistemas no país, a maior parte dos registros foi feita em habitats com maior interferência humana, como áreas urbanas, periurbanas, terras cultivadas, represas, reservatórios, portos e canais. Historicamente, as regiões sul e sudeste do Brasil apresentam mais espécies exóticas invasoras, mas nas últimas décadas se tem observado um aumento no número de espécies exóticas invasoras nas regiões centro-oeste e norte. O comércio de plantas e peixes ornamentais, assim como o comércio ilegal de mamíferos e répteis silvestres como animais de estimação são algumas das principais vias de introdução e disseminação de espécies exóticas invasoras no Brasil. Sistemas de criação e cultivo que possibilitam o escape para áreas naturais são uma relevante via de introdução em ecossistemas de águas continentais, enquanto introduções não intencionais a partir de navegação e de infraestrutura são de extrema preocupação em ecossistemas marinhos. Os impactos negativos de espécies exóticas invasoras sobre a biota incluem principalmente alterações na estrutura de comunidades e diminuição local da riqueza de espécies nativas, mediados por predação, competição e modificações ecossistêmicas. A maior parte dos impactos negativos registrados ocorreram para espécies introduzidas intencionalmente, como peixes e plantas, mas introduções não intencionais têm levado a impactos na boa qualidade de vida, com custos associados e impactos sobre a saúde humana. A gestão de invasões biológicas esbarra em desafios a serem superados, tais como a falta de conhecimento do público sobre o impacto de espécies exóticas invasoras, o apelo popular de espécies invasoras carismáticas ou utilizadas por humanos e o emprego de técnicas controversas de controle. Entretanto, experiências bem-sucedidas de erradicação e controle em ecossistemas terrestres e marinhos têm sido registrados, alguns deles envolvendo engajamento público nas ações de manejo. Reconhecer o tema como uma política pública transversal e desenvolver experiências continuadas de governança são metas fundamentais para a gestão e o manejo de espécies exóticas invasoras no Brasil.

Palavras-chave: *Convenção de Diversidade Biológica; manejo; impactos; invasões biológicas; perda de biodiversidade; serviços ecossistêmicos.*

About the Summary for Policymakers

The summary for policymakers presents the key messages of the thematic assessment report on invasive alien species in Brazil (Dechoum, Junqueira & Orsi 2024), prepared under the scope of the Brazilian Platform for Biodiversity and Ecosystem Services. This report was developed by 73 lead authors, 12 collaborating authors, and 15 reviewers from different research institutions and government bodies, representatives of the third sector and independent professionals from all regions in Brazil. A balance of gender, race, and expertise was sought. The report is a synthesis of the available scientific knowledge on invasive alien species in Brazil. The main objectives of the report were (1) to describe the state of knowledge on invasive alien species

in Brazil, as well as the trends and determining factors for biological invasions in terrestrial, marine and freshwater ecosystems; (2) to compile impacts caused by invasive alien species; and (3) to identify current and future management opportunities and governance options for mitigating negative impacts, conserving biodiversity, and ensuring the provision of ecosystem services.

The BPBES report (Dechoum et al. 2024) is divided in six chapters, as described below:

- Chapter 1 – Introduction – concepts and structure of the Report
- Chapter 2 – Status and trends of invasive alien species in Brazil
- Chapter 3 – Direct and indirect drivers of introduction and spread of invasive alien species

Chapter 4 – Impacts of invasive alien species on biodiversity, Nature's contributions to people, and good quality of life in Brazil

Chapter 5 – Management of invasive alien species: lessons learnt in Brazil

Chapter 6 – Options for the management and governance of invasive alien species in Brazil

This summary for policymakers contains four key messages that express the main findings of the BPBES report. Each of them is supported by complementary information that show the evidence referenced in different sections of the chapters. The source of all information contained in the summary for policymakers is referenced - i.e., the number of the chapter and subtitle to which it refers - and one of four possible degrees of confidence is assigned, depending on the quality/quantity of the evidence and the level of consensus. The four levels are: 'inconclusive' (based on suggestions, speculation, or very limited evidence); 'unresolved' (several independent pieces of evidence available, but conclusions diverge); 'established but incomplete' (a consensus is supported by few studies or studies that do not address the issue precisely) and 'well-established' (supported by several independent synthesis studies with convergent conclusions).

Key Messages

1. *Biological invasions cause serious negative impacts on biodiversity and ecosystem services, affecting the economy, health, and sociocultural activities*

Evidence of negative impacts caused by biological invasions in natural areas are 30 times more frequent than of positive impacts (*well established*) {4.3}. There are indications of negative impacts for more than half of the non-native invasive plants and animals registered in Brazil (*well established*) {2.2, 4.3}. Negative impacts are most likely worse than scientific evidence has been able to prove (*established, but incomplete*) {4.3}. A total of 476 non-native invasive species have been registered in Brazil, of which 268 are animals and 208 are plants or algae (*well established*) {2.2.1, 2.2.2, 4.3}. There are 1,004 evidences of negative impacts for 239 of these species in natural areas in the country (*well established*) {4.3.1, 4.3.2}. Impact records are available for all large taxonomic groups, covering all geopolitical regions, biomes, and ecosystems (*well established*) {4.3.1, 4.3.2}. Although obtaining proof of negative impact is rather complex, this does not mean that impacts do not occur, as potential impact is inherent to the process of biological invasion. On the other hand, only 33 punctual, short-term positive impacts were found in the literature for natural areas. These were related to plants providing food for indigenous animals and to bioengineer species, such as worms (*well established*) {4.3.1}. An estimate of economic losses in Brazil varied between 77 and 105 billion US dollars from 1984 to 2019, based on negative impacts by only 16 invasive non-native species, mainly agricultural and silvicultural pests (28 billion US dollars) and vectors of diseases (11 billion US dollars). These costs include losses in production, working hours, hospitalization, and interference in the tourism industry, among others {4.3.3, 4.4.3}. Biological invasions by mosquitos, as in the genus *Aedes*, often associated with arboviruses, have led to grave consequences in

public health due to outbreaks of diseases such as dengue fever, zika, chikungunya, and urban yellow fever. Furthermore, the golden mussel has impacted hydropower plants, water treatment facilities, and cage aquaculture in fish farms, producing severe economic losses. The cleaning of biofouling may cost over US\$ 8,000 per day in a small hydropower plant, and up to US\$ 1,000,000/day in large plants such as Itaipu, as the functioning of turbines has to be interrupted. Sun corals are among the most studied marine invasive non-native species, with well-known impacts described for the Brazilian coastline. While these invasive species are known to change the structure and diversity of indigenous communities wherever they invade, studies on economic and social losses are scarce {4.4.3}. Assessments are also missing on non-native invasive species known to cause large-scale impacts in other countries, as well as on the economic costs of such impacts. Another gap of high complexity refers to the quantification of impacts caused by microorganisms and fungi with potential for causing serious damage to human health or agricultural systems (*well established*) {4.3.3, 4.4}.

Concerted, decentralized actions in a broad biosecurity context can expedite compliance to international agreements and norms of which Brazil is a signatory, while preventing and mitigating negative impacts of biological invasions. Target 6 of the 2030 Global Biodiversity Framework of the Convention on Biological Diversity (CBD), of which Brazil is a signatory since 1992, requests countries to eliminate, minimize, reduce and/or mitigate the impacts of invasive non-native species on biodiversity and ecosystem services. Additionally, the target refers to the identification and management of pathways of introduction of non-native species in order to prevent and reduce the rate of introduction and establishment of other known or potentially invasive non-native species by at least 50 percent by 2030. The eradication or control of invasive non-native species in priority sites such as islands is also a priority {1.1, 6.1, 6.2}. In order to achieve this target, Brazil counts on at least 30 federal and subnational regulations relevant to the topic (*well established*) {6.1, 6.2}. These regulations transcend the environmental area and are fragmented in a profusion of federal, state, and municipal laws on the environment, agriculture, health, and certification standards (*well established*) {6.2.2}. Despite existing regulations, however, actions are most often disconnected and punctual (*well established*) {6.2, 6.3}. Consolidating existing legislation into a national policy would facilitate the achievement of Target 6 of the 2030 GBF/CBD. The national policy must cover prevention, control, and mitigation of negative impacts of biological invasions in the environmental, agricultural, health, and sociocultural areas (*established, but incomplete*) {1.1, 1.5.3}.

2. *Biological invasions cannot be dissociated from human activities*

Records of occurrence of invasive non-native species are more frequent in degraded areas or in places with intense human transit. However, no ecosystem is immune to biological invasions, even when in a good state of conservation. Records of invasive non-native species have been compiled for all ecosystems in Brazil {2.3.1, 2.3.2, 2.3.3}, including protected areas. Information is scarce for indigenous, quilombo, and traditional territories {2.4}. Urban areas are vulnerable to invasive non-native species due to the intense transit of humans, commodities, and merchandise coming through ports and airports {3.3.2}. The pet, ornamental plant, and horticulture trades are the main

pathways of introduction of invasive non-native species in terrestrial ecosystems (*well established*) {1.2.2, 2.3.4.1, 3.3.1, 4.4}. Agriculture, forestry and agroforestry use non-native species that often escape and become invasive if not managed properly {2.3.4.2}. Dams are characterized by modified habitats of low diversity easily invaded by fishes and aquatic plants {2.3.4.3}. Terrestrial and aquatic cultivation/breeding systems are also relevant pathways of introduction, with frequent escapes difficult to prevent {2.3.4.4}. Records of biological invasions are abundant in degraded areas along the Brazilian coast {2.3.4.5}.

If the current socioeconomic scenario is maintained, an increase of 20 to 30% in biological invasions by the end of the century is predicted due to intensified trade and transport of commodities and transit of people. The invasive non-native species with the highest evidence of negative impacts were introduced intentionally for economic use. An increase in records of negative impacts by invasive non-native species is expected in coming decades not only due to increased research but to the intensification of human activities (*well established*) {2.6, 4.5}. The introduction of species for sport fishing in continental waters increased exponentially since the year 2000 in the Amazon region {2.6.2.1}. Invasive non-native species records increased by 25% between 2009 and 2019 in marine environments, at a rate of 3 new species per year. If this rate is maintained, 45 to 67 new invasive non-native species can be expected by 2050 (*well established*) {2.6.2.2, 3.2.1, 3.2.2, 3.2.3, 4.5}. Secondary forests in the Amazon, Cerrado, and Caatinga regions are also expected to be more invaded due to an increase in deforestation, linear infrastructure, and climate change (*well established*) {2.6.2.3, 3.2.1, 3.2.2, 3.2.3, 4.5}. Invasive non-native plants widely used in economic activities such as grazing and forestry are highlighted among those impacting terrestrial ecosystems. The economic use of species increases the likelihood of establishment, which explains the large number of invasion records of useful plants (*well established*) {4.3.2}.

Recognition of the problem by society, as well as individual and collective actions, reduce biological invasions. The inclusion of criteria that consider invasion in environmental licensing and permits, as well as regulations for species used by economic sectors create opportunities for qualification and added value in production systems aligned with the objectives of sustainable development. Social participation in management activities and collaborator networks can contribute to reduce the impact of biological invasions more quickly with higher efficiency at lower cost (*established, but incomplete*) {5.2.3.2}. Mainstreaming information on the origin of invasive non-native species and their impacts to society may help reduce public opposition to management actions, especially when involving pets, food plants, and the so-called charismatic species (*well established*) {5.4}. Existing federal and state legal measures define criteria for the use of invasive non-native species in production systems and for environmental licensing processes. The National Environment Policy defines activities that involve the introduction of non-native species as potentially pollutant, therefore requiring environmental permits and licensing. The dispersal of invasive non-native species can be interpreted as a form of pollution, and is also characterized as an environmental crime (Federal Law 9605/1998) (*well established*) (6.2.2.1). Other examples are Resolution MEPC (Marine Environmental Protection Committee) nº 378(80), which establishes guidelines for the control and management of biofouling in ships and other vessels, decrees and regulations of the

Federal Environmental Agency (IBAMA) and the National Council for the Environment (CONAMA), which establish regulations for licensing aquaculture and sport fishing activities {6.1.1} (*well established*).

3. *Swiftness in decision-making on invasive species management increases the chances of success in preventing and mitigating negative impacts of biological invasions*

Biological invasions are processes of low predictive capacity and high risk. Inaction, as well as delayed action, allow invasions to become worse and cause negative impacts over time. The low predictability and high risk of biological invasions {2.2} require the adoption of different management strategies in accordance with stages of invasion (*well established*) {2.3.3.2}. While eradication is advocated for early stages of invasion, control must be used to reduce the size of invasions or contain spread when eradication is no longer feasible (*well established*). For example, South African lovegrass (*Eragrostis plana*) was introduced in Rio Grande do Sul, in southern Brazil, in the 1950s as a seed contaminant. The species was disseminated as a forage grass, then later forbidden by the Ministry of Agriculture in 1979. This period of inaction sufficed for lovegrass to become the most widely spread invasive non-native species in the Pampa Biome, currently covering more than two million hectares of grassland. It has eliminated indigenous species by competition and reduced local biodiversity and the quality of indigenous pastures (*well established*) {4.3.3}.

Prevention is the best cost-benefit alternative for managing invasive non-native species, followed by early detection and rapid response, as management becomes costlier and more labor intensive over time. Tools such as risk assessment {5.2.1} and pathways management {5.2.2} are designed to help prevent species introductions and spread (*well established*), as recommended in national and international guidelines and regulations such as the National Invasive Non-native Species Strategy and the Convention on Biological Diversity {5.2.3}. Early detection and rapid response must involve monitoring and surveillance strategies, social participation, and the development of collaborator networks for actions on invasive species to be more efficient and strengthen public engagement (*well established*) {5.3.2}.

4. *Immediate strategic actions can be executed to prevent and control biological invasions*

A legal and institutional framework is available in Brazil, as well as enough technical capacity to broaden the scope of prevention and control of biological invasions. The Federal Constitution and international conventions are the base of the legal framework {1.1.2, 6.2.1}. Additionally, legal regulations are published at the federal, state, and municipal levels, including official invasive non-native species lists, to guide overall management and practical actions (*well established*) {6.2.1.3, 6.4.1}. Management experiences can be replicated to other areas, ecosystems, and species by applying prevention, early detection and rapid response, eradication, and control measures (*well established, but incomplete*) {5.2, 5.3, 6.4.3, 6.4.4, 6.4.5}.

Mainstreaming information to the public and mediating conflicts of interest are strategic approaches to overcome public resistance and gather support for management actions and the development of regulations for the private sector. Educational activities that value native biodiversity can create new opportunities in use and trade based on

local species, especially in the case of ornamental plants (*not resolved*) {6.3, 6.3.1}. Complementarily, public policies in support of production using native or non-native but not invasive species can contribute to create sustainable alternatives such as breeding native fish species in aquaculture (*inconclusive*) {6.4.9}. The engagement of civil society has been shown to be a successful alternative in invasive non-native species management (*established, but incomplete*) {5.3.4}. Among successful cases of community engagement in management actions is the Volunteering Program for pine (*Pinus elliottii*) control in Dunas da Lagoa da Conceição Natural Municipal Park, in Florianópolis (Santa Catarina), and the Cipó Vivo project for the control of braquiaria grass (*Urochloa eminii*) in Serra do Cipó National Park, in Minas Gerais. While the benefits of intentional introductions may be restricted to specific economic sectors, companies, or social groups, the costs derived from the losses and management of invasive species are shared by society {1.5.2}. Conflict management on invasive non-native species that offer benefits to individuals or particular groups is key for decision-makers and managers to reduce long-term rivalry and benefit society (*established, but incomplete*) {1.5.2, 5.5.4, 6.4.2}.

Investing more widely on capacity building and action for invasive non-native species management is helpful in confronting the problem. A gain in scale can be attained in biological invasion management by offering capacity building opportunities to a diverse public (*inconclusive*) {6.4.12}. For example, when the Santa Catarina state environmental agency began dealing with invasive species issues in 2008, staff from several sectors were involved, from environmental education, protected area management, and environmental licensing and permits, to managers from some municipalities. As a result, a state program for invasive non-native species management was established, an official list was published (Resolução Consemma n° 08/2012), and action plans for invasive species management were developed for all state protected areas and a few municipal ones {6.1.1}.

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Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Data Availability

Supporting data are available at <https://www.bpb.es.net.br/wpcontent/uploads/2024/02/Relatorio-Tematico-Sobre-Especies-ExoticasInvasoras.pdf>.

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