A peer-reviewed open-access journal
NeoBiota
Advancing research on alien species and biological invasions

NeoBiota 93: 293–319 (2024)
DOI: 10.3897/neobiota.93.121386

Research Article

# Stakeholder mapping to support invasive non-native species management in South America

Manuela Erazo[1], Pablo García-Díaz[2,3,4], Bárbara Langdon[5,6], Karen Mustin[7,8], Mário Cava[9,10], Gabriella Damasceno[9,11,12], Magdalena F. Huerta[13, 14], Eirini Linardaki[2], Jaime Moyano[15], Lía Montti[16,17], Priscila A. Powell[4,18], Thomas W. Bodey[2], David F. R. P. Burslem[2], Laura Fasola[3,19], Alessandra Fidelis[9], Xavier Lambin[2], Sofía Marinaro[4,20], Aníbal Pauchard[5,6], Euan Phimister[21,22], Eduardo Raffo[23], Ignacio Rodríguez-Jorquera[13], Ignacio Roesler[3,19], Jorge A. Tomasevic[13], J. Cristóbal Pizarro[6,24]

1 Food and Agriculture Organization of the United Nations, Regional Office for Latin America and the Caribbean, Santiago, Chile
2 School of Biological Sciences, University of Aberdeen, Aberdeen, UK
3 Aves Argentinas/Asociación Ornitológica del Plata, CABA, Argentina
4 Instituto de Ecología Regional (UNT-CONICET), Tucumán, Argentina
5 Laboratorio de Invasiones Biológicas (LIB), Facultad de Ciencias Forestales, Universidad de Concepción, Concepción, Chile
6 Institute of Ecology and Biodiversity (IEB), Santiago, Chile
7 Instituto de Investigación en Recursos Cinegéticos (IREC, CSIC-ULM-JCCM), Ronda de Toledo 12, Ciudad Real, Spain
8 Department of Biodiversity, Ecology and Evolution, Complutense University of Madrid, Ciudad Universitaria, 28040, Madrid, Spain
9 Lab of Vegetation Ecology, Instituto de Biociências, Universidade Estadual Paulista (UNESP), Rio Claro, Brazil
10 Programa de Pós-graduação em Conservação de Recursos Naturais do Cerrado, Instituto Federal Goiano, Urutaí, Brazil
11 German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Puschstrasse 4, 04103, Leipzig, Germany
12 Institute of Biology, Martin Luther University Halle Wittenberg, Am Kirchtor 1, 06108 Halle (Saale), Germany
13 Centro de Humedales Río Cruces, Universidad Austral de Chile, Valdivia, Chile
14 Fundación Legado Chile, Puerto Varas, Chile
15 Grupo de Ecología de Invasiones, INIBIOMA, CONICET, Universidad Nacional del Comahue, Quintral 1250, San Carlos de Bariloche, CP, 8400, Argentina
16 Instituto de Investigaciones Marinas y Costeras, Universidad Nacional de Mar del Plata-CONICET, CC 1260, 7600, Mar del Plata, Argentina
17 Instituto de Geología de Costas y del Cuaternario, Universidad Nacional de Mar del Plata-CIC. Fúnes 3350, 7600 Mar del Plata, Argentina
18 Facultad de Ciencias Naturales e IML, Universidad Nacional de Tucumán, Tucumán, Argentina
19 Consejo Nacional de Investigaciones Científicas y Técnicas-Fundación Bariloche, San Carlos de Bariloche, Argentina
20 Biogeography Conservation Lab, Humboldt University of Berlin, Berlin, Germany
21 Business School, University of Aberdeen, Aberdeen AB24 3QY, UK
22 Business School, University of Stellenbosch, PO Box 610, Bellville 7535, South Africa
23 Servicio Agrícola y Ganadero, Gobierno de Chile, Valdivia, Chile
24 Laboratorio de Estudios del Antropoceno. Facultad de Ciencias Forestales. Universidad de Concepción, Concepción, Chile

Corresponding author: Xavier Lambin (x.lambin@abdn.ac.uk)

OPEN ACCESS

Academic editor: Ramiro Bustamante
Received: 21 February 2024
Accepted: 14 May 2024
Published: 8 July 2024



## Abstract

Effective long-term management of invasive non-native species (INNS) in South America is a pressing yet complex task. Critically, the environmental, historical, cultural, and economic idiosyncrasies of the region call for the inclusion of a plurality of views from those sectors of society receiving the negative and positive impacts of INNS. This is a multifaceted, and often daunting, task that can be aided by an early identification of stakeholders – those affected by or with an interest in INNS and their management – accompanied by targeted stakeholder engagement. Here, we report the procedures and results of a stakeholder mapping activity aimed at identifying stakeholders and designing engagement strategies. Using expert knowledge procedures, we compiled comprehensive lists of stakeholders for six case-studies in South America: (i) invasive grasses (*Urochloa* spp.) in Brazil; (ii) glossy privet (*Ligustrum lucidum*) in Argentina; (iii) lodgepole and Monterey pines (*Pinus contorta* and *P. radiata*) in

**Citation:** Erazo M, García-Díaz P, Langdon B, Mustin K, Cava M, Damasceno G, Huerta MF, Linardaki E, Moyano J, Montti L, Powell PA, Bodey TW, Burslem DFRP, Fasola L, Fidelis A, Lambin X, Marinaro S, Pauchard A, Phimister E, Raffo E, Rodríguez-Jorquera I, Roesler I, Tomasevic JA, Pizarro JC (2024) Stakeholder mapping to support invasive non-native species management in South America. NeoBiota 93: 293–319. https://doi.org/10.3897/neobiota.93.121386

Argentina; (iv) American mink (*Neogale vison*) in Argentina and Chile; (v) lodgepole and Monterey pines in Chile; and (vi) German yellow-jacket (*Vespula germanica*) in Chile. Overall, we identified 250 stakeholders, which, based on their interest and influence, were classified into "context settlers" (2%), "key players" (47%), "crowd" (5%), and "subjects" (49%). We outlined strategies to engage with each of these four groups and for each of our six case-studies. Across case studies, communication with stakeholders was the most common engagement strategy proposed (27%; 19 of 70 strategies), followed by active involvement of stakeholders in INNS research and management (23%). Our results highlight the importance of considering power imbalances, as those stakeholders more likely to benefit from INNS were assessed to have more influence over INNS management relative to local and indigenous communities. Our work illustrates how to identify stakeholders in a rigorous and rapid manner, which should be complemented with the involvement of the stakeholders themselves.

**Keywords:** Argentina, Brazil, Chile, expert knowledge, long-term management, participatory environmental management science-normative strategies, social actors

## Introduction

Invasive non-native species (INNS, hereafter), those non-native species that have established multiple self-sustaining populations outside their native range, and have spread from their point of introduction (Blackburn et al. 2011), are a leading cause of biodiversity loss and damage to ecosystem services and economic assets globally (Pyšek et al. 2020; Diagne et al. 2021). Consequently, effectively managing the severe impacts of INNS has become a priority for policy-makers and environmental managers worldwide (Early et al. 2016; Turbelin et al. 2016; Robertson et al. 2020). Unfortunately, many of these INNS are too widespread and abundant to be eradicated, and therefore need to be actively managed over the long term to mitigate their negative impacts and restore affected native communities (Dunham et al. 2020; Robertson et al. 2020; Sapsford et al. 2020). As the impacts of INNS on biodiversity, ecosystems, and human well-being vary regionally and locally, management practices must adapt and match these idiosyncrasies to be effective (Núñez and Pauchard 2010; Dunham et al. 2020; García-Díaz et al. 2022).

South America is no exception to these global INNS trends. The number and distribution of INNS have increased in the region since the 1800s (Seebens et al. 2021), leading to impacts on natural ecosystems and local societies and their economies (Speziale et al. 2012; Early et al. 2016; Essl et al. 2020). This is particularly troubling given that South American countries harbour highly diverse natural ecosystems of global significance (Mittermeier et al. 2011). In Argentina alone, there are more than 772 INNS, of which 102 are known to cause negative ecological impacts (GEKKO, Grupo de Estudios en Conservación y Manejo, Departamento de Biología, Bioquímica y Farmacia 2023). In continental Chile and Brazil, existing datasets have reported well over 1,100 non-native species in each country, with hundreds of them classified as INNS (PNUD 2017, Ziller et al. 2020). INNS pose a serious challenge to ecological integrity and livelihoods in South America, and these problems are forecast to increase in the near future (Speziale et al. 2012; Essl et al. 2020; Seebens et al. 2021).

A range of national and multi-national policies have been formulated and, at least, partially implemented to deal with INNS in South America (Speziale et al. 2012; Turbelin et al. 2016; Faria et al. 2023). These include the Chilean "Estrategia Nacional Integrada para la Prevención, el Control y/o Erradicación de las Especies Exóticas

Invasoras " (Comité Operativo para la Prevención, el Control y la Erradicación de las Especies Exóticas Invasoras 2014), the "Estrategia Nacional sobre Especies Exóticas Invasoras " in Argentina (Ministerio de Ambiente y Desarrollo Sostenible 2022) , and a wide variety of policies in Brazil (reviewed recently by Faria et al. 2023). Additionally, trans-national organisations such as MERCOSUR (Southern Common Market) have produced guidelines for member countries, including Argentina and Brazil with Chile as an associated country, to tackle the INNS problem ("Lineamientos para la Elaboración de un Plan para la Prevención, Monitoreo, Control y Mitigación de las Especies Exóticas Invasoras"; MERCOSUR, 2019). These are relatively recent initiatives that still need to be adopted widely, and assessing their efficacy in addressing INNS will require continued monitoring and research (Núñez and Pauchard 2010; Speziale et al. 2012; Faria et al. 2023). Counter to these initiatives, past and ongoing policies that promote the use of INNS in South America continue to create a misalignments in objectives that hampers progress in INNS management in the region (Reyes and Nelson 2014; Baggio et al. 2021; Faria et al. 2023).

The potential success of these INNS management policies hinges on accounting for the constraints imposed by a low availability of context-specific ecological information, high socio-cultural diversity, policy mismatches, strong dependence on natural resources, and limited funds for addressing the challenges posed by INNS (Núñez and Pauchard 2010; Speziale et al. 2012; Faria et al. 2023). In particular, there is potential for conflicts of interest and identity over INNS use and management due to the diversity of actors involved and how they perceive and receive INNS impacts depending on their economic activities, interest, income levels, and asymmetries in power and access to resources (Beever et al. 2019, Shackleton et al. 2019a; Sax et al. 2022). For example, some INNS are used for wood and cellulose production (e.g., pines, *Pinus* spp., and gum trees, *Eucalyptus* spp.) and recreation and tourism (e.g., trout, *Salmo trutta* and *Oncorhynchus mykiis*, wild pigs, *Sus scrofa*, and red deer, *Cervus elaphus*), providing important economic and cultural benefits for certain societal sectors (Defossé 2015; Ballari and Barrios-García 2022; Sax et al. 2022). Additionally, many INNS are highly dispersive, requiring large-scale temporal and spatial management over large tracts of land with different uses and tenures to overcome their capacity to rebound and reinvade following population suppression (Oliver et al. 2016; Glen et al. 2017; Banks et al. 2018).

Many South American countries have economies based on natural resource use and extraction. They generally include extensive areas that have been converted to monocultures of non-native species, often owned by trans- or multi-national companies that usually hold very different views of nature, natural resource use, and sustainable development than do indigenous and traditional peoples and local communities (hereafter ITPLCs), and which usually wield much more power in decision-making processes (De Castro et al. 2016; Oberlack et al. 2016; De la Mora 2023). This leads to a situation in which those most dependent on land tend to be those most excluded from environmental governance structures, further fuelling inequity in natural resources use and management (Bateman and Mace 2020; Löfqvist et al. 2023; Tedesco et al. 2023). This inequality is a matter of general concern for global agencies and South American countries when formulating environmental and economic policies (De Castro et al. 2016; Löfqvist et al. 2023).

Considering the complexity of environmental governance in South America, effective INNS management will benefit from a more inclusive approach to ensure that the interests and needs of all stake- and right-holders are met (Crowley et al. 2017; Kapitza et al. 2019; García-Díaz et al. 2022). Inclusive approaches to environmental management aim to recognise the values, preferences, and needs of the diversity of actors involved via transparent, accountable, and participatory decision-making processes, the equitable sharing of costs and benefits across societal sectors, and respect for different rights, identities, and ecosystem management practices (Martin et al. 2016; Raymond et al. 2022; Löfqvist et al. 2023; Tedesco et al. 2023). Inclusive environmental management incorporates the idea of supporting or empowering community-based initiatives and recognises that ITPLCs have the right to decide how to manage their territories and should be involved in decisions (Martin et al. 2016). This is both a reflection of a moral stance on how environmental management should be approached, and of the recognition that a broad engagement with society is necessary to gain the social legitimacy to operate and implement environmental management actions (Bridger et al. 2019; Raymond et al. 2022; Mason et al. 2023). As a consequence, inclusivity has been shown to lead to improved social and ecological outcomes and long-term viability in environmental management, although a certain level of disagreement on objectives and interventions is always expected (Bryce et al. 2011; Alter et al. 2019; Chambers et al. 2021; Newig et al. 2023). In turn, this entails engaging stakeholders, understanding their attitudes and local perspectives, and anticipating and navigating social conflict (Novoa et al. 2018; Kapitza et al. 2019; Shackleton et al. 2019b; Newig et al. 2023). Stakeholder engagement is critical for fostering collective action in formulating and implementing INNS management under complex socio-ecological conditions (e.g., Stokes et al. 2006; Bayliss et al. 2013; Omondiagbe et al. 2017). A vital first step involves identifying stakeholders and analysing their interests and how they relate to INNS to develop engagement strategies that foster stakeholder participation (Reed 2008; Conroy and Peterson 2013; Bridger et al. 2019).

Here, our aim was to design collaborative management actions for INNS across three countries in South America. We show how the application of a structured methodology to systematically identify and map stakeholders can be used to plan engagement strategies. In this sense, we align our work with frameworks that consider the plurality of stakeholders' views to define and formulate INNS management projects to deliver the most favoured outcome(s) for all (Bridger et al. 2019; García-Díaz et al. 2022; Newig et al. 2023). We included both stakeholders with an interest and influence on INNS themselves (e.g., companies planting INNS trees) and stakeholders with an interest and influence on INNS management (e.g., NGOs controlling an INNS). Some stakeholders may have an interest and influence on both INNS and their management. We focussed on six case studies of INNS plants and animals in Argentina, Brazil, and Chile to showcase the applicability of our methods across a range of geographical, ecological, and social conditions. The ultimate output is a series of lists of essential stakeholders linked to strategies that engage them in the process of defining INNS management plans. Our stakeholder mapping tools applied to South America have the potential to become an instrumental method for promoting inclusive INNS management.

## Methods

The process described here was part of a multi-country, multi-species research project funded under the Latin American Biodiversity Programme as part of the Newton Fund (Lambin et al. 2020), with contributions from the UK Natural

Environment Research Council (NERC), the Argentine National Scientific & Technical Research Council (CONICET), the Brazilian São Paulo Research Foundation (FAPESP), and the Chilean National Commission for Scientific & Technological Research (CONICYT), which later became the National Agency for Research and Development (ANID). The project took place between 2019 and 2023, and represented a collaboration among universities, research institutes, and non-governmental organisations in Argentina, Brazil, Chile, and the UK aiming to improve the management of INNS based on six detailed case-studies. Based on researchers' and practitioners' opinions and perceptions, our objective was to identify the stakeholders relevant to our case-studies in our study areas (see map in Fig. 1) and propose engagement strategies for the participatory socio-ecological management of INNS.

Early in the project, partners identified that a barrier to effective engagement of stakeholders in the case-study countries was a lack of clarity surrounding the different stakeholders involved and their levels of interest and potential influence on the different study species and their management. It was in this context that we conducted an iterative exercise over the course of six months (April-September 2021), including individual expert activities and two virtual workshops with researchers and practitioners that aimed to: 1) list the stakeholders expected to

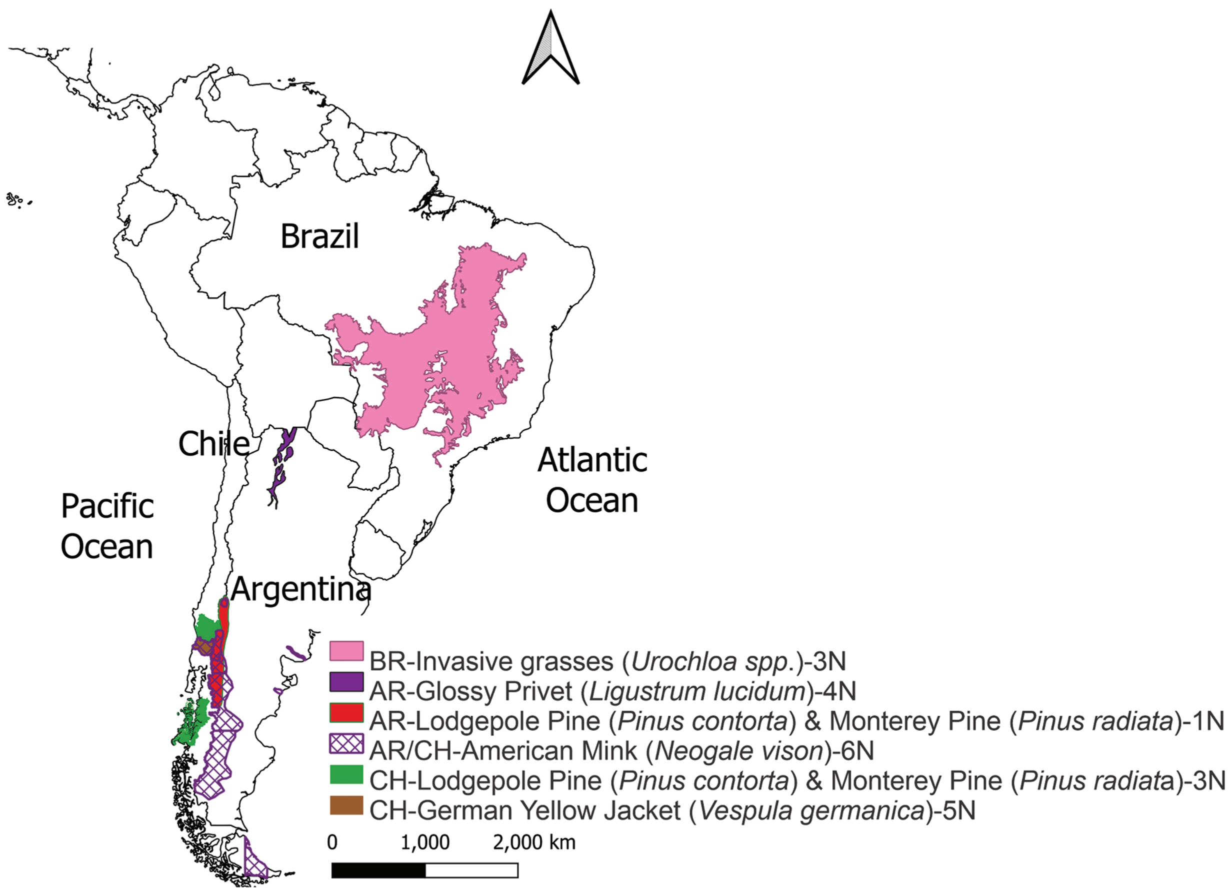


**Figure 1.** Geographical location of our six case-studies (AR: Argentina; CH: Chile; BR: Brazil), the target INNS (common and scientific names), and the number of participants per case-study who completed individual stakeholder spreadsheets containing information on the stakeholders relevant to their system (denoted by the letter *N* in the legend). The final products were a consensus stakeholder spreadsheet and a consensus engagement strategy for each of the six case-studies.

be impacted by, or have influence on, INNS and their management; 2) map the distribution of different stakeholders in the different study systems along axes of interest and influence, with a view to 3) defining engagement strategies for different stakeholder groups.

Our central instrument was a stakeholder spreadsheet that each participant had to complete independently. Participants then discussed their completed personal spreadsheets with both other members of their same case-study group and the broader group of participants during facilitated virtual workshops. The ultimate goal was to produce a final single stakeholder spreadsheet for each case-study (6 final stakeholder spreadsheets in total). We invited 2–6 participants and experts per case-study, all of them project partners, to participate in this activity. In the case of pines in Argentina, two were invited, but only one participated. We were unable to recruit substitute experts for this case-study since we only invited on-project partners and close collaborators. The stakeholders for *Pinus radiata* and *Pinus contorta* were assessed to be the same for both species in both Argentina and Chile and, therefore, the stakeholder spreadsheets were independent for each country but included both pine species together (pines, hereafter). In addition, two participants were involved in two case-studies and, therefore, completed a stakeholder spreadsheet for each. The final number of participants per case-study varied between one and six, all of them co-authors in this paper. Overall, we obtained 21 individual stakeholder spreadsheets and six unique consensus stakeholder spreadsheets. An exemplar spreadsheet and the instructions provided to each participant can be found in the Suppl. materials 1, 2, respectively (see also Table 1), and in a data package archived at the UK Environmental Information Data Centre (EIDC) which is publicly available (Erazo et al. 2024). In the following sections we describe our methodology in detail.

## Identifying stakeholders

Our first step involved collecting an initial list of stakeholders expected to be impacted by, or have an influence on, INNS and their management. For each case-study, we emailed the respective participants to complete our stakeholder spreadsheet individually and independently. Participants were given two weeks to list all the stakeholders, including all the organisations and actors they considered to be relevant to their case-study, guided by the following questions (based on Reed and Oughton 2017): 1) Who would be affected by your target INNS or by your control or management project? 2) Who has the power to influence the outcomes of your project? 3) Who are your potential allies and opponents? 4) Are there people whose voices or interests in the issue may not be heard? 5) Who could facilitate or impede the success of the project through their participation, non-participation or opposition? And, 6) who could contribute to the success of the INNS target species management or control with financial, technical or other resources?

Participants were provided with background information and instructions, and were encouraged to be comprehensive and to list as many stakeholders as possible at this stage. Where appropriate, participants could also search for papers, institutional publications, websites, social media platforms, and historical records, as well as consult other experts and key informants, and news sites to identify stakeholders. However, they were instructed to avoid contacting any of the other participants involved in this activity. Additionally, while the circulated stakehold-

**Table 1.** Description and stakeholder mapping dimensions of the 17 elements of our stakeholder spreadsheet, each one corresponding to a column in our spreadsheet.

| Dimension | Variable | Description |
|---|---|---|
| Stakeholders Identification | 1. Name of the organisation | Basic data about each stakeholder. |
| | 2. Target INNS | |
| | 3. Country | |
| | 4. Ecoregion | |
| Stakeholders' area of interest | 5. Stakeholders' area of interest | Variables that help to identify stakeholders' key areas of interests. Categories:<br>– Environmental sustainability & biological conservation<br>– Social & community development<br>– Natural resource management<br>– Governance & policy<br>– Academic and research<br>– Agriculture, livestock and forestry production (including landowners, traders and associations).<br>– Tourism sector<br>– Other (describe) |
| Stakeholders' attitudes and values towards nature | 6. Conception of nature | A proxy to understand and categorise stakeholder pre-disposition towards INNS. Categories:<br>– Naturalism: Nature is a venue for exploration and first-hand discovery<br>– Humanism: Nature provides emotional satisfaction<br>– Moralism: Nature is inherently valuable and should be preserved<br>– Dominionism: Nature is meant for humans to control<br>– Utilitarianism: Nature is a reservoir of material resources for humans<br>– Negativism: Nature is dirty, dangerous, and/or scary<br>– Ecologism: Nature is a fascinating system of interrelated processes<br>– Scientism: Nature is an object worthy of empirical study about its structures and functioning |
| Management experience | 7. Previous experience in IAS management | Stakeholders' prior experience in INNS management:<br>Yes = 1<br>No = 0<br>NA = No Answer or Not Applicable |
| Level of influence | 8. Land ownership | A proxy for the level of influence. Categories of land ownership measured on a 5-point scale:<br>– Large landowners and companies (≥ 30,000 ha) = 5<br>– Large landowners (< 30,000–5,000 ha) = 4<br>– Medium-sized landowners (< 5,000–200 ha) = 3<br>– Smallholders (< 200–5 ha) = 2<br>– No land = 1 |
| | 9. Perceived level of influence of stakeholders | Perceived level of influence of stakeholders on the decision-making process regarding INNS and their management (e.g., if they have the capacity to influence decisions, to make decisions, or to implement actions regarding INNS and their management). The variable is measured by a 5-point scale:<br>– Extremely influential = 5<br>– Moderately influential = 4<br>– Somewhat influential = 3<br>– Slightly influential = 2<br>– Not at all influential = 1 |
| INNS Impacts | 10. Negative INNS ecological impacts | Set of variables on the perceived INNS impacts will help to measure the level of interest of the stakeholder, measured on a 5-point scale:<br>– Extreme = 5<br>– Major = 4<br>– Moderate = 3<br>– Minor = 2<br>– None = 1 |
| | 11. Negative INNS economic impacts | |
| | 12. Negative INNS socio-cultural impacts | |
| | 13. Positive INNS ecological impacts | |
| | 14. Positive INNS economic impacts | |
| | 15. Negative INNS socio-cultural impacts | |
| Level of interest | 16. Perceived level of interest on INNS and their management | Perceived stakeholders' level of interest, measured on a 5-point scale:<br>– Very interested = 5<br>– Interested = 4<br>– Moderately interested = 3<br>– Slightly interested = 2<br>– Not interested = 1 |
| Relationships among stakeholders | 17. Relationships with other stakeholders | Variable providing relevant information on the multiple relationships among stakeholders. |

er spreadsheet included many columns to add information on each stakeholder (Table 1), in this initial step the participants were told to focus on identifying stakeholders rather than characterising them. In total, we built 21 independent stakeholder spreadsheets in this step.

Once the initial listing of stakeholders was complete, we held a facilitated online workshop on 15 April 2021 aimed at further developing the participants' understanding of the social dimensions of INNS, the use of the stakeholder spreadsheet, the next steps, and the overarching goal of the stakeholder mapping activity. This three-hour workshop included two presentations and a practical group activity. For the group activity, which served to demonstrate the methods and the use of the stakeholder spreadsheet, the participants were grouped by study species – with pines in Argentina and Chile grouped together. Each of the 3–6 participants in each group was asked to choose three exemplary stakeholders from their lists and classify them depending on the stakeholder type (e.g., NGOs, ITPLCs, or government agencies) and their level of interest in INNS and their management. We used the online software MURAL (https://www.mural.co/) to support this exercise, and we invited four external experts not involved in the stakeholder listing to join to provide an external perspective and potentially challenge the results and evidence being presented (García-Díaz et al. 2022). After the group discussions, all participants joined a general meeting where a representative of each group presented the results of the exercise to all participants, and we ran a Q&A session.

After this first workshop, we provided additional instructions and participants were given 30 days to individually and independently revise their stakeholder lists and add the remaining information to each stakeholder listed (see Table 1). The final lists of stakeholders and associated information can be found in Suppl. material 3 and in the data package archived at the EIDC (Erazo et al. 2024).

### Mapping INNS impacts and stakeholder influence to design engagement strategies

Based on the information collected in the revised stakeholder spreadsheets, our next step was to construct influence/interest matrices (see Reed et al. 2009 for details), according to the researchers' and practitioners' perceptions of the stakeholders' levels of interest in, and influence on INNS management. This type of analytical categorisation is commonly applied in environmental management and can be carried out with or without direct stakeholder involvement in the analysis (Reed et al. 2009). Here, the analysis was conducted by the participating researchers and practitioners without direct involvement of ITPLCs and other stakeholders. The implications of this for the interpretation of the results are fully considered in the discussion of this paper.

To derive interest from impact, the overall level of interest was assumed to be the maximum across all six impact types (positive or negative ecological, economic, and socio-cultural) where 1 represents not at all interested in INNS and their management, and 5 represents highly interested in INNS and their management. We used the maximum instead of the mean or other summary statistics because the scales are not directly comparable across impact types and, consequently, not readily amenable to mathematical operations (Canessa et al. 2021). Moreover, we expect that any stakeholder with a high negative or positive impact in any of the impact dimensions will be highly interested regardless of the scores in the other dimensions.

We held a second facilitated online workshop on 18 May 2021 with the same participants and external experts, in which experts were again divided into groups according to their study species. In this workshop, experts within the same group discussed their individual stakeholder spreadsheets and obtained a single consensus stakeholder spreadsheet for each of the six case-studies. Finally, we built an influence/interest matrix based on the information stored in those consensus stakeholder spreadsheets. The consensus stakeholder lists can be found in the Suppl. material 3 and in the data package archived with the EIDC (Erazo et al. 2024).

According to their level of interest and influence on both INNS and their potential management, stakeholders were classified into four categories (Reed et al. 2009):

1. ***Context settlers:*** Highly influential but with low interest.
2. ***Key players:*** Highly influential and high interest.
3. ***Crowd:*** Little influence and little interest.
4. ***Subjects:*** Low influence but high interest.

Within each group, experts also identified potential engagement strategies for each of the four stakeholder categories described above. After that, all participants joined a general meeting where they discussed their final stakeholder spreadsheets, the corresponding influence/interest matrices, and their engagement strategies. After this second workshop, participants were given one month to produce a final list of engagement strategies tailored to each stakeholder category. Unlike in previous steps, members of the same case-study group were allowed to meet to debate and discuss their consensus engagement strategies. Exemplar consensus engagement strategies and the final lists of consensus engagement strategies are provided in Suppl. materials 4, 5, respectively, and in the EIDC data package (Erazo et al. 2024).

We summarised the outputs of our stakeholder mapping exercise by qualitatively describing the consensus stakeholder spreadsheets and consensus engagement strategies across and between case-studies, countries, and stakeholder types. We did not conduct more detailed analyses and comparisons due to concerns about the validity of the data gathered, as stakeholders were not directly consulted (so the information remains the opinions and perceptions of our participants) and the different settings covered by our case-studies meant that some of them generated detailed stakeholder lists whilst others were broader categories (e.g., detailed lists of the government organisations involved in the Argentine privet case vs. broad categories of government levels in the case of the Brazilian Cerrado). This also reflects the complexity associated with mapping stakeholders at large scales, which we elaborate on below. We anonymised the spreadsheets, and engagement strategies, removing the names of the participants and any named organisation and institution, prior to analysis.

## Results

### Stakeholder identification and description

We identified a total of 250 potential stakeholders in three countries (99 in Argentina, 18 in Brazil, and 133 in Chile), across all target species (97 for pines considered together, 49 for German yellow-jacket, 47 for the American mink, 18 for the

African grasses, and 39 for privet). The lower number of stakeholders identified in Brazil is explained by the large extent of the study area and the use of high-level stakeholder categories instead of detailed lists of each stakeholder within each category. Main stakeholder categories across all target species were: government agencies (30.8%), followed by local communities (17.2%), landowners, producers, rural workers organisations, and companies (14.4%), and public, private, and non-governmental educational, research and extension organisations (14.4%). Other categories each account for less than 10% of the total.

Our participants classified each stakeholder into one of nine primary areas of interest (Table 1): 20.8% of them relate to governance and policy, 20.4% to agriculture, livestock and forestry production, 17.6% to social and community development, 16.4% to environmental sustainability and biological conservation, 11.2% to academic and research, 6% to natural resources management, another 6% to the tourism sector, and 1.6% to other interests.

### Stakeholder interest in and influence on INNS and their management

The vast majority of the stakeholders listed (232; 93%) were expected to be highly interested in INNS and their management. Of these, 109 (47% of 232) were expected to have high influence and thus were classified as "key players", while 123 (53%) were expected to have little influence and were considered to be "subjects". Government agencies (56), landowners, producers, rural workers and companies (22), and public, private, and non-governmental educational, research and extension institutions (12) together represent 82.6% of the most influential and highly interested stakeholders across all case-studies (Fig. 2). Local communities (38), public, private, and non-governmental educational, research and extension institutions (21) and government agencies (19) together represented 63.4% of "subjects" across all case-studies (Fig. 2).

Only four local community stakeholders were classified as being "key players": an apicultural committee and an Indigenous community in the German yellow-jacket case-study, as well as small-scale poultry producers in the American mink case-study in Chile and private neighbourhoods in the privet case-study in Argentina. Conversely, only eight landowners, producers, rural workers and companies were classified as "subjects". Of these, five were plant nurseries and forestry extensionists in Argentina, two were cider producers and landowners in the German yellow-jacket case-study in Chile, and the last were private corporations in the American mink case-study in Argentina.

The remaining 18 stakeholders (7.2%) were expected to be less interested in INNS and their management, owing to lower negative or positive impacts of INNS on these stakeholders. Only six of these stakeholders (33.3% of 18) were expected to be highly influential and are thus classified as "context-settlers". These include two landowners, producers, rural workers and companies, two media stakeholders, a government agency and a public, private, and non-governmental educational, research and extension institution. Finally, the 12 "crowd" – uninterested and un-influential stakeholders – included landowners, producers, rural workers and companies (3), public, private, and non-governmental educational, research and extension institutions (2), certification agencies for agricultural, livestock and forestry products (2), and one each of: local communities; government agencies; media; professionals, professional associations, societies, and councils; and tourism agencies, tourists, and visitors to green areas.

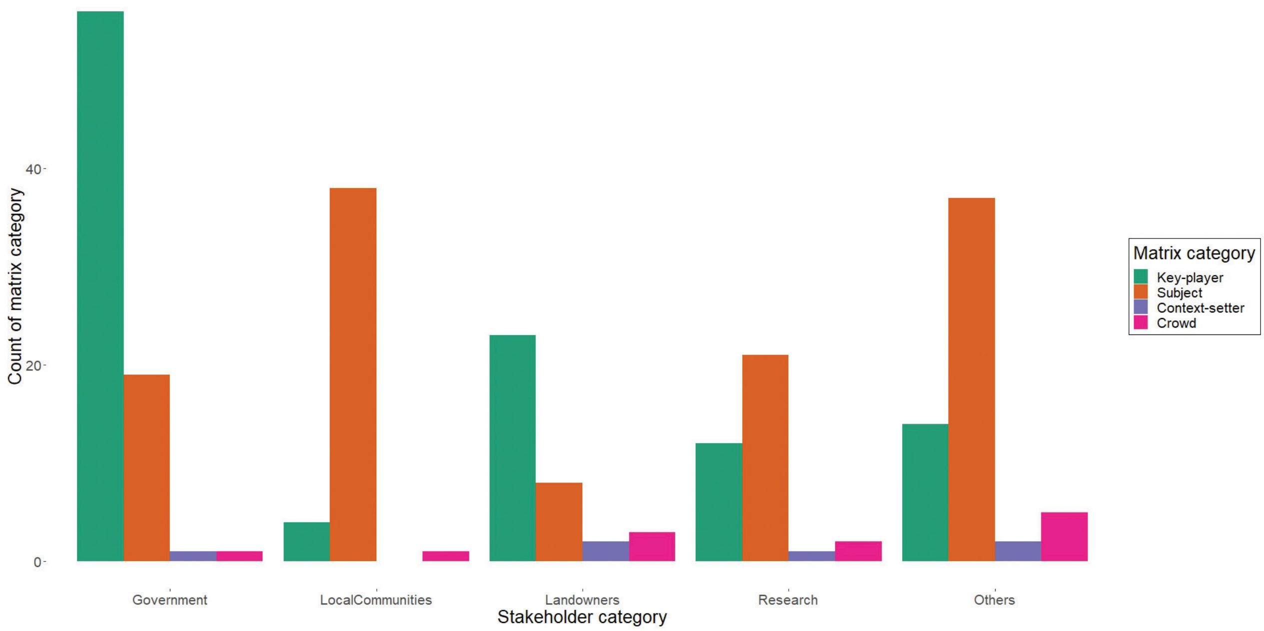


**Figure 2.** Number of stakeholders in each stakeholder matrix category ("key player", "subject", "context-settler", and "crowd") for the four most common stakeholder categories and all other stakeholder categories grouped together.

## Positive and negative impacts of INNS on key players and subjects

The stakeholders expected to be most impacted by INNS were "key players" and "subjects". Overall, there were more major or extreme negative than positive ecological (100 vs. 4), economic (59 vs. 43) or socio-cultural (33 vs. 19) impacts expected for both stakeholder types (Figs 3, 4). The only positive ecological impacts were expected for "key players" in the privet case-study in Argentina. These positive ecological impacts included increased carbon capture and providing vegetation cover after severe disturbances to the environment. On the other hand, negative ecological impacts of all taxa were expected to be felt by all stakeholder categories, particularly government agencies as both "key players" (37) and "subjects" (10), and by public, private, and non-governmental educational, research and extension institutions (5 key players and 13 subjects). Expected negative ecological impacts included native biodiversity loss, threats to endemic and endangered species, and changing forest functionality.

The "key players" and "subjects" most frequently affected by negative economic impacts are government agencies (21) and local communities (27), respectively. Major or extreme negative economic impacts include reductions in productivity affecting cattle grazing and agriculture and tourism. Positive economic impacts were most frequently expected for landowners, producers, rural workers and companies as "key players" (12), and for public, private, and non-governmental educational, research and extension institutions (6) and landowners, producers, rural workers (5) and companies as "subjects", with most related to the two pine case-studies (Fig. 4). As such, major or extreme positive economic impacts mostly relate to forestry production.

As with economic impacts, government agencies (12) were the "key players", and local communities (8) the "subjects", most frequently experiencing negative socio-cultural impacts. These negative impacts include the loss of native medicinal plants used by ITPLCs and the nuisance caused by German yellow-jackets during outdoor and recreational activities. Most of the few expected positive socio-cultural impacts were spread between landowners, producers, rural workers and companies (6 key players and 3 subjects), and public, private, and non-governmental educational, research and extension institutions (3 key players and 4 subjects), with all positive socio-cultural impacts relating to the pine and the privet case-studies (Figs 3, 4). These positive impacts included the creation of jobs in the forestry industry and the harvesting of wood for domestic and subsistence use, respectively.

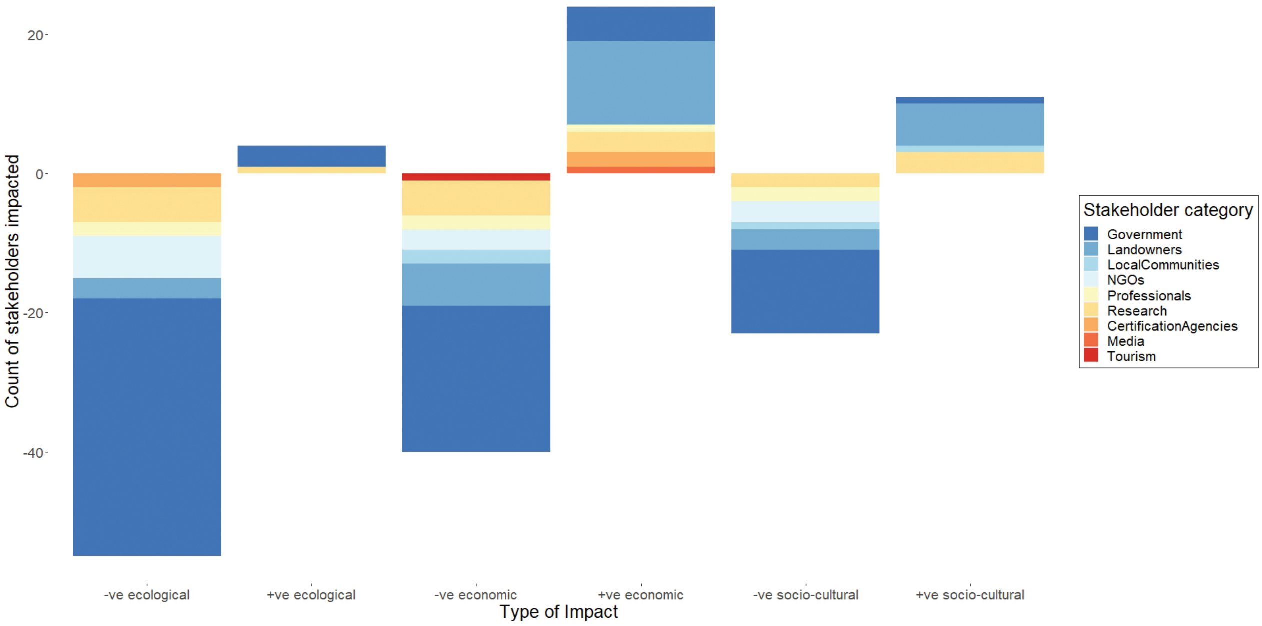


**Figure 3.** Distribution of negative (-ve) and positive (+ve) ecological, economic and socio-cultural impacts between "key player" stakeholder groups.

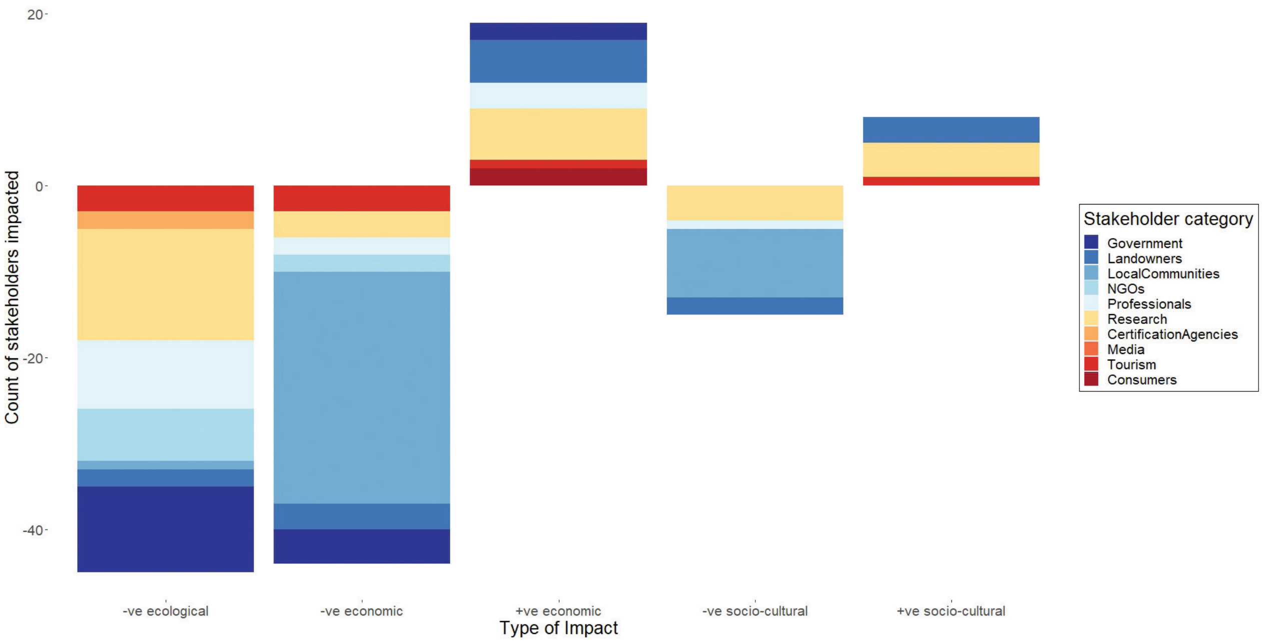


**Figure 4.** Distribution of negative (-ve) and positive (+ve) ecological, economic and socio-cultural impacts between "subject" stakeholder groups.

### Engagement strategies for different stakeholder groups

The participants suggested consensus engagement strategies for each one of the stakeholder influence/interest matrix categories ("key players", "subjects", "context-setters" and "crowd"). In total 70 different strategies were suggested, which we grouped *ad-hoc* into six categories: communication, education, policy, co-planning, active involvement, and networking (Table 2). A complete list of the suggested consensus strategies is available in Suppl. material 5 and the EIDC data package (Erazo et al. 2024). We provide examples drawn from our experience in the discussion.

Overall (Table 2), communication strategies were the most frequently suggested engagement strategies (19), being most frequently suggested for engagement of "crowd" (7) and "subject" (5) stakeholders, i.e. those perceived to have less influence over INNS management. Commonly suggested strategies included workshops, seminars and dialogues, and the use of press, newsletters, leaflets and social media to communicate both the issues caused by INNS and the aims and results of management programs.

The second most proposed type of engagement strategy was active involvement (16), particularly for "subjects" (6) and "context-settlers" (5). These strategies were identified for all case study species in Chile and Argentina, and can be categorised as stakeholder participation in monitoring and management activities, including in a citizen science context, for all stakeholder types. Education strategies (12) were the third most commonly suggested engagement strategy, being identified as important for all countries and species, particularly for subjects (4) and context-setters (4). Specific suggestions for German yellow-jackets, American mink, and privet included workshops and information-sharing with "context setters", "crowd", and "subjects"; capacity building with "key players" and "subjects" and, interestingly, the suggestion to identify specific "subject" stakeholders who could be empowered via the provision of information.

The fourth most commonly identified strategies were those related to policy (10), with the majority suggested for "key players" (6). For all case-study species, envisaged policy actions included the creation of national action plans, legal instruments and guidelines, multi-sectoral agreements and funding agreements and schemes for INNS management.

Co-planning strategies were the fifth most frequently suggested strategy and were identified as being important to engage with "key players" (4), "subjects" (3) and "context-settlers" (2) in the American mink, German yellow-jacket and pine case-studies. These co-planning strategies in the case of pines included the co-development of management strategies with "subjects" and "context settlers", highly interested "subjects" and "key players" engaging other stakeholders to participate, and "key players" providing feedback on research projects. For both American mink and German yellow-jackets, strategies included identifying and enhancing, together with "key players", opportunities for joint work, the participatory co-creation of formal documents, and the co-organisation of workshops and other interaction spaces.

Finally, networking strategies were identified as important for those stakeholders with the highest interest in INNS management, i.e. "key players" (3) and "subjects" (1) in all but the pines' case-study. For privet and German yellow-jackets specifically, it was suggested that "subjects" could be empowered and given more influence via strengthening of contacts and links with relevant "key players".

**Table 2.** Overall number of strategies according to six categories created *ad-hoc* and submitted by the participants in our stakeholder mapping exercise for each stakeholder category (based on their interest/influence level).

| General Strategy Aim | Stakeholder Category | | | | |
|---|---|---|---|---|---|
| | Key players | Subjects | Context-settlers | Crowd | Total |
| ***Communication:*** Any knowledge exchange action or action leading to the dissemination of a message and/or which seeks to influence behaviour. | 4 | 5 | 3 | 7 | 19 |
| ***Active involvement:*** Any participation in activities directly related to the management of the INNS (field trials, volunteering, citizen science, etc.). | 2 | 6 | 5 | 3 | 16 |
| ***Policy:*** Actions that lead to regional, national or international policy mechanisms, or regulations concerning INNS. | 6 | 1 | 3 | 0 | 10 |
| ***Co-planning:*** Strategies that enhance the co-development of actions between stakeholders, decision-makers and/or experts. | 4 | 3 | 2 | 0 | 9 |
| ***Networking:*** Actions that enhance the creation of links and interaction between different stakeholders, decision makers and/or experts. | 3 | 1 | 0 | 0 | 4 |
| **Total** | 20 | 20 | 17 | 13 | 70 |

## Discussion

Here we show how facilitated workshops with researchers and practitioners can be used to plan more inclusive and strategic stakeholder engagement in INNS-related activities. Inclusive environmental management, which aims to ensure process and outcome fairness, is a cornerstone of good practice when tackling complex socio-ecological issues such as INNS management and accompanying ecosystem restoration (Frumento et al. 2019; Chambers et al. 2021; Löfqvist et al. 2023; Tedesco et al. 2023). While, ideally, stakeholder mapping should be carried out with direct involvement of the stakeholders themselves, our experience highlights three critical elements for designing and conducting INNS management activities in South America that aspire to be inclusive: 1) the complex and diverse network of stakeholders affected or involved in INNS management, and the consequent challenge in mapping these stakeholders; 2) the power dynamics and imbalances in INNS governance and, by extension, in environmental governance; and, 3) the potential conflicts arising from the distribution of positive and negative impacts of INNS perceived or experienced by different stakeholders. We elaborate on these three themes below and conclude by discussing how stakeholder mapping and our revealed engagement strategies can help alleviate these core challenges and advance fair planning in INNS management in South America.

First, our results clearly showed the breadth of stakeholders linked to INNS management in South America, spanning government agencies (at all levels) to private business and NGOs, and including up to 97 different stakeholders in the case of pines. Such a breadth of stakeholders will naturally result in a diversity of views and identities, contributing to the complexity of INNS management at both design and implementation stages. Acknowledging this diversity is key to inclusive and effective INNS management planning (Kapitza et al. 2019). Facilitated activities can encourage participants to be as objective and wide-ranging as possible to include all stakeholders who might reasonably be expected to have some interest in and/

or influence over management of a focal INNS. This reflects a positive aspect of implementing our structured methodology with only researchers and practitioners. Specifically, our structured and iterative process can help to reduce the likelihood of bias in stakeholder selection, compared with a narrow focus on engaging stakeholders with whom researchers and practitioners already have relationships or are easier to engage with (Groves and Game 2016). That said, this type of activity should be seen as a starting point for stakeholder engagement, with the next steps being active engagement through the different strategies outlined in this paper.

Our stakeholder mapping also revealed important practical lessons to be considered when designing and conducting such activities. First, the extent of the area covered matters, as our larger case-study (African grasses in the Brazilian Cerrado) relied on high-level stakeholder categories given the very large number of potential individual stakeholders, compared to highly disaggregated stakeholder lists for more local case-studies where participants had a high degree of existing knowledge or prior engagement with stakeholders (e.g., German yellow-jackets in Chile). High-level stakeholder lists for large areas can be used as building blocks to develop more detailed lists for smaller areas embedded within them. Second, stakeholders can be shared across multiple INNS, as in our pines case-studies. This opens the door to improved multi-INNS management if the knowledge and resources available can be pooled across multiple target species (Brandt et al. 2023). Therefore, we encourage researchers and practitioners embarking on stakeholder mapping exercises to consider whether stakeholders might be common across multiple INNS. Last but not least, the management of some INNS requires cross-country coordination (Lambin et al. 2020; Faria et al. 2023), such as in our American mink case-study (Argentina-Chile). In such cases, researchers and practitioners from the relevant countries should identify organisations with similar remits and those empowered with establishing international collaborations, together with more local stakeholders. Additionally, these networks will serve to expedite the transfer of knowledge between different areas facing the same INNS.

Our results show that most of the stakeholders identified were expected to be highly interested in INNS and their management, which is expected given the nature of our mapping exercise. However, there were clear divergences in the expected influence that these stakeholders might wield in decision-making and the success of on-ground interventions. More specifically, government agencies, landowners and large companies were expected to be influential, whereas ITPLCs were thought to have much less influence over decision-making. This reflects the wider pattern of inequity in environmental governance in South America, which speaks not only to the lack of effective participation in existing governance systems and mechanisms, but on a deeper level, is driven by a lack of recognition of fundamentally differing notions of nature, culture, territory, and conservation (De Castro et al. 2016; Martin et al. 2016; Ulloa 2017). It is in this sense that co-planning engagement strategies identified in our exercise could be important (Table 2). These could take the form of co-developing management strategies, participatory elaboration of formal documents, and the creation of instances for collaborative decision-making (Powell et al. 2023). These strategies align well with work on co-production in sustainability, and existing principles and recommendations drawn from this field can guide such co-planning strategies (Norström et al. 2020; Chambers et al. 2021). For example, researchers, local communities, and practitioners can engage in the iterative co-development of simulation models of the system to achieve a shared understanding of the system and jointly evaluate INNS management options (Parrott 2017; Samson et al. 2017; Dunham et al. 2022).

However, for such strategies to be equitably implemented, different systems of knowledge and values must be recognised, respected, and reflected in the decision-making processes themselves and in the results of such processes (Dechoum et al. 2019; Frumento et al. 2019; Tedesco et al. 2023). For example, our American mink case-study in Chile (Los Rios Region) began when small land-holders and subsistence farmers started experiencing losses of chickens to mink depredation, and raised the problem with the local government agency. This led to the design and implementation of a community-based campaign to foster knowledge about the American mink and control their populations. Furthermore, whilst high-level government agencies were the most frequent "key players", many local government agencies were seen as less influential and were classed as "subjects". This is in part due to reduced access to resources or land ownership at local- relative to medium-level government agencies such as Province and State governments or local and regional delegations of central and Federal-level governments (e.g., National Parks agencies). In summary, our results present examples of the widespread 'top-down' approach to environmental management, and highlight the need for addressing power imbalances at multiple governance levels.

Our results highlight potential power imbalances that need to be considered for equitable INNS management, especially as not only were landowners expected to have more influence than were ITPLCs, but they are also the main "key players" expected to experience positive economic and socio-cultural impacts from INNS. This is in contrast to the local communities, who are expected to experience only negative impacts from INNS. This contrast is unsurprising given the history of the region, and has been exacerbated by diverging goals pursued by different agencies of the same government (e.g., see Faria et al. 2023 and Pelicice et al. 2023 for the case of Brazil). This is despite the fact that government agencies were the "key players" most frequently experiencing negative impacts across all three categories (ecological, economic and socio-cultural). For example, pine plantations were incentivised by the state in Chile in the 1970s leading to concentration of these plantations in the hands of forestry companies that own and manage large areas (Reyes and Nelson 2014). Similarly, the use of African grasses as forage for cattle in Brazil has been promoted by agencies supporting primary industries, whilst simultaneously being combated by environmentally-oriented agencies (Baggio et al. 2021). While likely a challenging task, these policy misalignments need to be resolved for the effective implementation of INNS management strategies (Powell et al. 2023). Landowners also hold the key to accessing areas where INNS management should be undertaken. Failing to secure access can sometimes – but not always – impede the effective management of highly mobile INNS or act as sources of ecologically-damaging INNS of economic value for the landowner (Glen et al. 2017). Such divergent costs and benefits of INNS to different stakeholders have the potential to polarise opinions on the importance of, and approaches to, INNS management, leading to conflicts (Beever et al. 2019; Kapitza et al. 2019).

Accounting for positive impacts is essential to ensure that ITPLCs do not bear the brunt of INNS negative impacts while landowners reap the benefits, reinforcing existing inequalities. From an ecological perspective, it is important to consider the possibility that some INNS may play an important ecological role once widespread and integrated in the ecosystem, and managing them might lead to unintended consequences affecting the ecosystem in unforeseen ways (Brandt et al. 2023; Carpouron et al. 2023). Navigating the negative and positive impacts of INNS will be a delicate and context-specific decision in which government agencies, as “key players”, might be indispensable actors mediating and pre-empting conflicts (Newig et al. 2023). This can be guided by the following key tenets of sustainability and equity (Bateman and Mace 2020; Löfqvist et al. 2023; Tedesco et al. 2023): 1) account for the potential irreversible damage by INNS on the environment and manage them accordingly (Vimercati et al. 2020; Lockwood et al. 2023); 2) explore the substitutability of INNS’ positive impacts with native species or non-native species with a low risk profile to prevent the incentivisation and spread of INNS of value (e.g., Pelicice et al. 2023); and 3) consider the distributional effects of INNS and their management upon different societal sectors, with an emphasis on ITPLCs (García-Díaz et al. 2021). Guidelines for the sustainable use of non-native trees of economic importance exist (Brundu et al. 2020), and the investigation of potential substitutes for ecologically-damaging INNS is recognised in INNS policy documents such as the “Estrategia Nacional sobre Especies Exóticas Invasoras” in Argentina, which lists INNS of productive use in its “Category 2” (Gobierno de Argentina 2021). Social multi-criteria evaluation, cost-effectiveness analyses, and a diversity of tools for evaluating the positive and negative ecological and socio-economic impacts of INNS can support decision-making to formulate interventions whilst considering their positive and negative impacts (Bacher et al. 2018; Etxano and Villalba-Eguiluz 2021; Vimercati et al. 2022).

We reiterate the caveat that our exercise and results stem from the informed opinions of our expert participants on the stakeholders of each case-study. Additionally, the number of participants per case-study varied substantially (from one to six). These features imply that our results should be interpreted with caution and cannot be extrapolated beyond a preliminary assessment of stakeholders and a tool to help practitioners and researchers establish an initial basis for understanding and engaging their stakeholders. A robust understanding of stakeholders will require at least two components. First, it would be desirable to engage a greater number of participants for each case-study to an extent that is commensurate with the area each covered. For example, while five participants is a reasonable sample size for the German yellow-jacket case-study, one participant, as in the case of pines in Argentina, is clearly insufficient. Similar activities should seek to actively recruit participants from diverse backgrounds to achieve a comprehensive picture of the potential stakeholders, and more accurate expert opinions by summarising across experts within each case-study (Groves and Game 2016). Secondly, INNS impacts and perceptions of stakeholders should ideally be elicited from the stakeholders themselves, and identified iteratively.

Despite these limitations, our stakeholder mapping was a valuable first step. Our engagement strategies proved useful in framing and guiding our project activities both prior to and after the workshop. In total, we conducted 91 engagement activities across our case-studies, including press releases in Spanish and Portuguese (e.g., Chile: https://www.diariosostenible.cl/noticia/actualidad/2022/09/impulsan-control-comunitario-de-chaqueta-amarilla-en-rio-cruces; Argentina: https://radio3cadenapatagonia.com.ar/capacitacion-sobre-especies-exoticas-invasoras-en-el-parque-nacional-lago-puelo/; Brazil: https://agencia.fapesp.br/an-international-research-group-proposes-six-guidelines-for-managing-the-impacts-of-invasive-species/35298), the organisation of eight workshops with decision-makers and protected area managers (e.g., Brazil: https://www.youtube.com/watch?v=8GNrA2k_bgo), participation in multiple conferences and workshops related to INNS and their management, presence at local fairs to raise awareness, contributions to technical documents on INNS and their management in the local languages (Spanish and Portuguese), actively connecting with researchers and practitioners beyond our case-studies yielding ongoing collaborations (Zaninovich et al. 2023), and 17 training workshops to build capacity and capability.

## Conclusion

In conclusion, effectively managing the multidimensional socio-ecological issue of INNS requires the collaborative action of multiple stakeholders, from researchers to government agencies and ITPLCs (Novoa et al. 2018; Alter et al. 2019; García-Díaz et al. 2022). This calls for establishing and maintaining strong linkages among researchers, practitioners, decision-makers, and the community, which in turn hinges on an accurate understanding and deep communication with the relevant stakeholders. As more policies and initiatives are being formulated and implemented to tackle INNS in South America, our stakeholder mapping tools can be used to produce engagement strategies to bolster and strengthen connections between those with a shared interest in a focal INNS. Moreover, as we have showcased here, such an exercise in mapping stakeholders can uncover "key players" instrumental to INNS management and power imbalances that require specific attention (e.g., "subjects"), as well as identify potential conflicts that need to be managed carefully. Thus, we echo previous work highlighting the value of stakeholder mapping for environmental management in general, and for INNS management in particular (Stokes et al. 2006; Reed 2008; Samson et al. 2017; Novoa et al. 2018; Newig et al. 2023). This approach can be expected to result in enhanced social, ecological, and economic outcomes of INNS management, although it cannot be assumed to be a silver bullet and will require active research and adaptability to improve and match the needs of the local context (Alter et al. 2019; Pagès et al. 2019; Chambers et al. 2021; Newig et al. 2023).

## Acknowledgements

Servicio Agrícola y Ganadero, Gobierno de Chile, is one of the CONTAIN project partners, and it is represented by ER in this paper. However, the opinions and results presented in this document are entirely those of ER and may not represent SAG position on the topic.

## Additional information

### Conflict of interest

The authors have declared that no competing interests exist.

### Ethical statement

No ethical statement was reported.

### Funding

The stakeholder mapping activities were funded by project CONTAIN under the Latin American Biodiversity Programme as part of the Newton Fund (NE/S011641/1), with contributions from NERC (UK), the Argentine National Scientific & Technical Research Council (CONICET,-2019-

74-APN-DIR#CONICET), the São Paulo Research Foundation (Brazil, FAPESP 2018/14995-8), and the Chilean National Commission for Scientific & Technological Research (CONICYT). Additional support was provided by the project 'Invasive alien species management to decrease impacts on biodiversity, rural poverty and carbon storage' (2022GCBCCONTAIN) funded by the UK Global Centre on Biodiversity for Climate (GCBC), Department for Environment, Food & Rural Affairs (DEFRA). MC (FAPESP grant #2020/04713-5) and GD (FAPESP grant #2018/09054-0) received support from São Paulo Research Foundation during the development of stakeholder mapping activities. AP and CP were funded by ANID/BASAL FB210006. PG-D was partially supported by PICT 03355 (FONCyT, Argentina).

## Author contributions

Conceptualization: PGD, JCP, ME, MC, BL. Data curation: ME, JCP, KM, BL, PGD. Formal analysis: PGD, ME, BL, KM. Investigation: SM, DFRPB, AP, KM, IR, JM, XL, BL, GD, LF, AF, EL, LM, EP, JCP, ER, JAT, IRJ, TWB, PGD, ME, MC, MFH, PAP. Methodology: ME, JCP, PGD, MC. Visualization: KM, PAP. Writing – original draft: PAP, MFH, PGD, KM, EP, JM, EL, XL, MC, LM, BL, JCP, GD. Writing – review and editing: AP, EP, LM, MC, EL, XL, JCP, ER, JAT, MFH, IRJ, SM, TWB, JM, PGD, IR, PAP, KM, BL, GD, DFRPB, LF, AF.

## Author ORCIDs

Pablo García-Díaz https://orcid.org/0000-0001-5402-0611
Bárbara Langdon https://orcid.org/0000-0001-8397-1774
Karen Mustin https://orcid.org/0000-0002-2828-2316
Mário Cava https://orcid.org/0000-0002-6630-5347
Gabriella Damasceno https://orcid.org/0000-0001-5103-484X
Magdalena F. Huerta https://orcid.org/0000-0003-4999-4723
Jaime Moyano https://orcid.org/0000-0002-7072-0527
Priscila A. Powell https://orcid.org/0000-0003-3911-0912
Thomas W. Bodey https://orcid.org/0000-0002-5334-9615
David F. R. P. Burslem https://orcid.org/0000-0001-6033-0990
Alessandra Fidelis https://orcid.org/0000-0001-9545-2285
Xavier Lambin https://orcid.org/0000-0003-4643-2653
Sofía Marinaro https://orcid.org/0000-0001-5512-7832
Aníbal Pauchard https://orcid.org/0000-0003-1284-3163
Euan Phimister https://orcid.org/0000-0002-6483-0113
Eduardo Raffo https://orcid.org/0000-0001-9218-0632
Ignacio Rodríguez-Jorquera https://orcid.org/0000-0001-8854-8422
Jorge A. Tomasevic https://orcid.org/0000-0002-0800-2110
J. Cristóbal Pizarro https://orcid.org/0000-0002-5240-2816

## Data availability

The data underpinning the analyses reported in this paper are deposited in the NERC EDS Environmental Information Data Centre at https://doi.org/10.5285/450fd469-5cd7-4c8f-b113-ba469c358caf.

# References

Alter T, Martin P, Hine D, Howard T (2019) Community-based control of invasive species. Csiro Publishing. https://doi.org/10.1071/9781486308880

Bacher S, Blackburn TM, Essl F, Genovesi P, Heikkilä J, Jeschke JM, Jones G, Keller R, Kenis M, Kueffer C, Martinou AF, Nentwig W, Pergl J, Pyšek P, Rabitsch W, Richardson DM, Roy HE, Saul W-C, Scalera R, Vilà M, Wilson JRU, Kumschick S (2018) Socio-economic impact classification of alien taxa (SEICAT). Methods in Ecology and Evolution 9(1): 159–168. https://doi.org/10.1111/2041-210X.12844

Baggio R, Overbeck GE, Durigan G, Pillar VD (2021) To graze or not to graze: A core question for conservation and sustainable use of grassy ecosystems in Brazil. Perspectives in Ecology and Conservation 19(3): 256–266. https://doi.org/10.1016/j.pecon.2021.06.002

Ballari SA, Barrios-García MN (2022) Mismatch between media coverage and research on invasive species: The case of wild boar (Sus scrofa) in Argentina. PLoS One 17(12): e0279601. https://doi.org/10.1371/journal.pone.0279601

Banks PB, Byrom AE, Pech RP, Dickman CR (2018) Reinvasion is not invasion again. Bioscience 68(10): 792–804. https://doi.org/10.1093/biosci/biy076

Bateman IJ, Mace GM (2020) The natural capital framework for sustainably efficient and equitable decision making. Nature Sustainability 3(10): 776–783. https://doi.org/10.1038/s41893-020-0552-3

Bayliss H, Stewart G, Wilcox A, Randall N (2013) A perceived gap between invasive species research and stakeholder priorities. NeoBiota 19: 67–82. https://doi.org/10.3897/neobiota.19.4897

Beever EA, Simberloff D, Crowley SL, Al-Chokhachy R, Jackson HA, Petersen SL (2019) Social–ecological mismatches create conservation challenges in introduced species management. Frontiers in Ecology and the Environment 17(2): 117–125. https://doi.org/10.1002/fee.2000

Blackburn TM, Pyšek P, Bacher S, Carlton JT, Duncan RP, Jarošík V, Wilson JR, Richardson DM (2011) A proposed unified framework for biological invasions. Trends in Ecology & Evolution 26(7): 333–339. https://doi.org/10.1016/j.tree.2011.03.023

Brandt AJ, Png GK, Jo I, McGrannachan C, Allen K, Peltzer DA, D'Antonio C, Dickie IA, French K, Leishman MR, Ostertag R, Parker IM, Stanley MC, Suding KN, Bellingham PJ (2023) Managing multi-species plant invasions when interactions influence their impact. Frontiers in Ecology and the Environment 21(8): 370–379. https://doi.org/10.1002/fee.2658

Bridger JC, Alter TR, Frumento PZ, Howard TM, Adams LB (2019) Community engagement theory for a new natural resource management paradigm. Community-based Control of Invasive Species: 84.

Brundu G, Pauchard A, Pyšek P, Pergl J, Bindewald AM, Brunori A, Canavan S, Campagnaro T, Celesti-Grapow L, Dechoum M de S, Dufour-Dror J-M, Essl F, Flory SL, Genovesi P, Guarino F, Guangzhe L, Hulme PE, Jäger H, Kettle CJ, Krumm F, Langdon B, Lapin K, Lozano V, Le Roux JJ, Novoa A, Nuñez MA, Porté AJ, Silva JS, Schaffner U, Sitzia T, Tanner R, Tshidada N, Vítková M, Westergren M, Wilson JRU, Richardson DM (2020) Global guidelines for the sustainable use of non-native trees to prevent tree invasions and mitigate their negative impacts. NeoBiota 61: 65–116. https://doi.org/10.3897/neobiota.61.58380

Bryce R, Oliver MK, Davies L, Gray H, Urquhart J, Lambin X (2011) Turning back the tide of American mink invasion at an unprecedented scale through community participation and adaptive management. Biological Conservation 144(1): 575–583. https://doi.org/10.1016/j.biocon.2010.10.013

Canessa S, Trask AE, Ewen JG (2021) Mind the gap (between assessing risks and prioritizing management). NeoBiota 68: 1–4. https://doi.org/10.3897/neobiota.68.60816

Carpouron CJ, Zuël N, Monty MLF, Florens FBV (2023) Breeding success of an endangered island endemic kestrel increases with extent of invasion by an alien plant species. Journal for Nature Conservation 72: 126366. https://doi.org/10.1016/j.jnc.2023.126366

Chambers JM, Wyborn C, Ryan ME, Reid RS, Riechers M, Serban A, Bennett NJ, Cvitanovic C, Fernández-Giménez ME, Galvin KA, Goldstein BE, Klenk NL, Tengö M, Brennan R, Cockburn JJ, Hill R, Munera C, Nel JL, Österblom H, Bednarek AT, Bennett EM, Brandeis A, Charli-Joseph L, Chatterton P, Curran K, Dumrongrojwatthana P, Durán AP, Fada SJ, Gerber J-D, Green JMH, Guerrero AM, Haller T, Horcea-Milcu A-I, Leimona B, Montana J, Rondeau R, Spierenburg M, Steyaert P, Zaehringer JG, Gruby R, Hutton J, Pickering T (2021) Six modes of co-production for sustainability. Nature Sustainability 4(11): 983–996. https://doi.org/10.1038/s41893-021-00755-x

Comité Operativo para la Prevención, el Control y la Erradicación de las Especies Exóticas Invasoras (2014) Estrategia Nacional Integrada para la Prevención, el Control y/o Erradicación de las Especies Exóticas Invasoras. Ministerio del Medio Ambiente, 1–26.

Conroy MJ, Peterson JT (2013) Decision making in natural resource management: a structured, adaptive approach. John Wiley & Sons, West Sussex, UK. https://doi.org/10.1002/9781118506196

Crowley SL, Hinchliffe S, McDonald RA (2017) Invasive species management will benefit from social impact assessment. Journal of Applied Ecology 54(2): 351–357. https://doi.org/10.1111/1365-2664.12817

De Castro F, Hogenboom B, Baud M (2016) Environmental Governance in Latin America. Springer Nature. https://doi.org/10.1007/978-1-137-50572-9

De la Mora G (2023) Conceptual and Analytical Diversity of Environmental Governance in Latin America: A Systematic Review. Environmental Management 71(4): 847–866. https://doi.org/10.1007/s00267-022-01739-z

Dechoum M de S, Giehl ELH, Sühs RB, Silveira TCL, Ziller SR (2019) Citizen engagement in the management of non-native invasive pines: Does it make a difference? Biological Invasions 21(1): 175–188. https://doi.org/10.1007/s10530-018-1814-0

Defossé GE (2015) ¿Conviene seguir fomentando las plantaciones forestales en el norte de la Patagonia? Ecología Austral 25(2): 93–100. https://doi.org/10.25260/EA.15.25.2.0.154

Diagne C, Leroy B, Vaissière A-C, Gozlan RE, Roiz D, Jarić I, Salles J-M, Bradshaw CJA, Courchamp F (2021) High and rising economic costs of biological invasions worldwide. Nature 592(7855): 571–576. https://doi.org/10.1038/s41586-021-03405-6

Dunham JB, Arismendi I, Murphy C, Koeberle A, Olivos JA, Pearson J, Pickens F, Roon D, Stevenson J (2020) What to do when invaders are out of control? WIREs. Water 7(5): e1476. https://doi.org/10.1002/wat2.1476

Dunham J, Benjamin JR, Lawrence DJ, Clifford K (2022) Resist, accept, and direct responses to biological invasions: A social–ecological perspective. Fisheries Management and Ecology 29(4): 475–485. https://doi.org/10.1111/fme.12574

Early R, Bradley BA, Dukes JS, Lawler JJ, Olden JD, Blumenthal DM, Gonzalez P, Grosholz ED, Ibanez I, Miller LP, Sorte CJB, Tatem AJ (2016) Global threats from invasive alien species in the twenty-first century and national response capacities. Nature Communications 7(1): 12485. https://doi.org/10.1038/ncomms12485

Erazo M, García Díaz P, Langdon B, Mustin K, Cava M, Damasceno G, Huerta MF, Linardaki E, Moyano J, Montti L, Powell PA, Bodey TW, Burslem DFRP, Fasola L, Fidelis A, Lambin X, Marinaro S, Pauchard A, Phimister E, Raffo E, Rodríguez-Jorquera I, Roesler I, Tomasevic JA, Pizarro JC (2024) Expert-based stakeholder mapping and engagement strategies for six invasive non-native species case studies in Argentina, Brazil, and Chile, 2021. https://doi.org/10.5285/450fd469-5cd7-4c8f-b113-ba469c358caf

Essl F, Lenzner B, Bacher S, Bailey S, Capinha C, Daehler C, Dullinger S, Genovesi P, Hui C, Hulme PE, Jeschke JM, Katsanevakis S, Kühn I, Leung B, Liebhold A, Liu C, MacIsaac HJ, Meyerson LA, Nuñez MA, Pauchard A, Pyšek P, Rabitsch W, Richardson DM, Roy HE, Ruiz GM, Russell JC, Sanders NJ, Sax DF, Scalera R, Seebens H, Springborn M, Turbelin A, van Kleunen M, von Holle B, Winter M, Zenni RD, Mattsson BJ, Roura-Pascual N (2020) Drivers of future alien species impacts: An expert-based assessment. Global Change Biology 26(9): 4880–4893. https://doi.org/10.1111/gcb.15199

Etxano I, Villalba-Eguiluz U (2021) Twenty-five years of social multi-criteria evaluation (SMCE) in the search for sustainability: Analysis of case studies. Ecological Economics 188: 107131. https://doi.org/10.1016/j.ecolecon.2021.107131

Faria L, de Carvalho BM, Carneiro L, Miiller NOR, Pedroso CR, Occhi TVT, Tonella LH, Vitule JRS (2023) Invasive species policy in Brazil: A review and critical analysis. Environmental Conservation 50(1): 67–72. https://doi.org/10.1017/S0376892922000406

Frumento PZ, Whitmer WE, Alter TR, Muth AB, Marshall DP, Shuffstall WC (2019) Strategy and practice for community engagement. In: Martin P, Alter TR, Hine D, Howard T (Eds) Community-based control of invasive species. CSIRO – CABI, Clayton South, VIC, Australia; Wallingford, UK; Boston, USA, 97–121.

García-Díaz P, Cassey P, Norbury G, Lambin X, Montti L, Pizarro JC, Powell PA, Burslem DF, Cava M, Damasceno G, Fasola L, Fidelis A, Huerta MF, Langdon B, Linardaki E, Moyano J, Núñez MA, Pauchard A, Phimister E, Raffo E, Roesler I, Rodríguez-Jorquera I, Tomasevic JA (2021) Management Policies for Invasive Alien Species: Addressing the Impacts Rather than the Species. Bioscience 71(2): 174–185. https://doi.org/10.1093/biosci/biaa139

García-Díaz P, Montti L, Powell PA, Phimister E, Pizarro JC, Fasola L, Langdon B, Pauchard A, Raffo E, Bastías J, Damasceno G, Fidelis A, Huerta MF, Linardaki E, Moyano J, Núñez MA, Ortiz MI, Rodríguez-Jorquera I, Roesler I, Tomasevic JA, Burslem DFRP, Cava M, Lambin X (2022) Identifying Priorities, Targets, and Actions for the Long-term Social and Ecological Management of Invasive Non-Native Species. Environmental Management 69(1): 140–153. https://doi.org/10.1007/s00267-021-01541-3

GEKKO, Grupo de Estudios en Conservación y Manejo, Departamento de Biología, Bioquímica y Farmacia (2023) InBiAr. Base de Datos sobre Invasiones Biológicas en Argentina. http://www.inbiar.uns.edu.ar/especies [August 7, 2023]

Glen AS, Latham MC, Anderson D, Leckie C, Niemiec R, Pech RP, Byrom AE (2017) Landholder participation in regional-scale control of invasive predators: An adaptable landscape model. Biological Invasions 19(1): 329–338. https://doi.org/10.1007/s10530-016-1282-3

Gobierno de Argentina: Lista oficial de especies exóticas en Argentina. https://www.argentina.gob.ar/ambiente/biodiversidad/exoticas-invasoras/lista

Groves CR, Game ET (2016) Conservation planning: informed decisions for a healthier planet. Roberts and Company Publishers, Greenwood Village, Colorado, USA, 580 pp.

Kapitza K, Zimmermann H, Martín-López B, von Wehrden H (2019) Research on the social perception of invasive species: A systematic literature review. NeoBiota 43: 47–68. https://doi.org/10.3897/neobiota.43.31619

Lambin X, Burslem D, Caplat P, Cornulier T, Gabriella D, Fasola L, Fidelis A, García-Díaz P, Langdon B, Linardaki E (2020) CONTAIN: Optimising the long-term management of invasive alien species using adaptive management. NeoBiota 59: 119–138. https://doi.org/10.3897/neobiota.59.52022

Lockwood JL, Lieurance D, Flory SL, Meyerson LA, Ricciardi A, Simberloff D (2023) Moving scholarship on invasion science forward. Trends in Ecology & Evolution 38(6): 495–496. https://doi.org/10.1016/j.tree.2023.01.006

Löfqvist S, Kleinschroth F, Bey A, de Bremond A, DeFries R, Dong J, Fleischman F, Lele S, Martin DA, Messerli P, Meyfroidt P, Pfeifer M, Rakotonarivo SO, Ramankutty N, Ramprasad V, Rana P, Rhemtulla JM, Ryan CM, Vieira ICG, Wells GJ, Garrett RD (2023) How social considerations improve the equity and effectiveness of ecosystem restoration. Bioscience 73(2): 134–148. https://doi.org/10.1093/biosci/biac099

Martin A, Coolsaet B, Corbera E, Dawson NM, Fraser JA, Lehmann I, Rodriguez I (2016) Justice and conservation: The need to incorporate recognition. Biological Conservation 197: 254–261. https://doi.org/10.1016/j.biocon.2016.03.021

Mason NW, Kirk NA, Price RJ, Law R, Bowman R, Sprague RI (2023) Science for social licence to arrest an ecosystem-transforming invasion. Biological Invasions 25(3): 873–888. https://doi.org/10.1007/s10530-022-02953-w

MERCOSUR (2019) Lineamientos para la Elaboración de un Plan para la Prevención, Monitoreo, Control y Mitigación de las Especies Exóticas Invasoras. https://www.iri.edu.ar/wp-content/uploads/2020/12/tm2019GMCres38.pdf

Ministerio de Ambiente y Desarrollo Sostenible (2022) Estrategia Nacional sobre Especies Exóticas Invasoras. Ministerio de Ambiente y Desarrollo Sostenible de la Nación, 1–144.

Mittermeier RA, Turner WR, Larsen FW, Brooks TM, Gascon C (2011) Global biodiversity conservation: the critical role of hotspots. In: Zachos FE, Habel JC (Eds) Biodiversity hotspots: distribution and protection of conservation priority areas. Springer, 3–22. https://doi.org/10.1007/978-3-642-20992-5_1

Newig J, Jager NW, Challies E, Kochskämper E (2023) Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. Global Environmental Change 82: 102705. https://doi.org/10.1016/j.gloenvcha.2023.102705

Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, Bednarek AT, Bennett EM, Biggs R, de Bremond A, Campbell BM, Canadell JG, Carpenter SR, Folke C, Fulton EA, Gaffney O, Gelcich S, Jouffray J-B, Leach M, Le Tissier M, Martín-López B, Louder E, Loutre M-F, Meadow AM, Nagendra H, Payne D, Peterson GD, Reyers B, Scholes R, Speranza CI, Spierenburg M, Stafford-Smith M, Tengö M, van der Hel S, van Putten I, Österblom H (2020) Principles for knowledge co-production in sustainability research. Nature Sustainability 3(3): 182–190. https://doi.org/10.1038/s41893-019-0448-2

Novoa A, Shackleton R, Canavan S, Cybele C, Davies SJ, Dehnen-Schmutz K, Fried J, Gaertner M, Geerts S, Griffiths CL, Kaplan H, Kumschick S, Le Maitre DC, Measey GJ, Nunes AL, Richardson DM, Robinson TB, Touza J, Wilson JRU (2018) A framework for engaging stakeholders on the management of alien species. Journal of Environmental Management 205: 286–297. https://doi.org/10.1016/j.jenvman.2017.09.059

Núñez MA, Pauchard A (2010) Biological invasions in developing and developed countries: Does one model fit all? Biological Invasions 12(4): 707–714. https://doi.org/10.1007/s10530-009-9517-1

Oberlack C, Tejada L, Messerli P, Rist S, Giger M (2016) Sustainable livelihoods in the global land rush? Archetypes of livelihood vulnerability and sustainability potentials. Global Environmental Change 41: 153–171. https://doi.org/10.1016/j.gloenvcha.2016.10.001

Oliver MK, Piertney SB, Zalewski A, Melero Y, Lambin X (2016) The compensatory potential of increased immigration following intensive American mink population control is diluted by male-biased dispersal. Biological Invasions 18(10): 3047–3061. https://doi.org/10.1007/s10530-016-1199-x

Omondiagbe HA, Towns DR, Wood JK, Bollard-Breen B (2017) Stakeholders and social networks identify potential roles of communities in sustainable management of invasive species. Biological Invasions 19(10): 3037–3049. https://doi.org/10.1007/s10530-017-1506-1

Pagès M, Fischer A, van der Wal R, Lambin X (2019) Empowered communities or "cheap labour"? Engaging volunteers in the rationalised management of invasive alien species in Great Britain. Journal of Environmental Management 229: 102–111. https://doi.org/10.1016/j.jenvman.2018.06.053

Parrott L (2017) The modelling spiral for solving 'wicked' environmental problems: Guidance for stakeholder involvement and collaborative model development. Methods in Ecology and Evolution 8(8): 1005–1011. https://doi.org/10.1111/2041-210X.12757

Pelicice FM, Agostinho AA, Alves CBM, Arcifa MS, Azevedo-Santos VM, Brito MFG, de Brito PS, de Castro Campanha PMG, Carvalho FR, da Costa GC, Cozzuol MA, Cunico AM, Dagosta FCP, Dias RM, Fernandes R, Franco ACS, Garcia DAZ, Giarrizzo T, Gubiani ÉA, Guimarães

EC, Ikeda L, Katz AM, Magalhães ALB, Montag LFA, Nogueira MAMP, Orsi ML, Ottoni FP, Pavanelli CS, Peixoto TG, Petry AC, Pompeu PS, Ramos TPA, Rodrigues LRR, Sabino J, Sampaio WMS, dos Santos VLM, Smith WS, Souza G, Tonella LH, Vitule JRS, Montag LF de A, Nogueira MAM de P, Orsi ML, Ottoni FP, Pavanelli CS, Peixoto TG, Petry AC, Pompeu PS, Ramos TPA, Rodrigues LRR, Sabino J, Sampaio WMS, dos Santos VLM, Smith WS, Souza G, Tonella LH, Vitule JRS (2023) Unintended consequences of valuing the contributions of non-native species: Misguided conservation initiatives in a megadiverse region. Biodiversity and Conservation 32(12): 3915–3938. https://doi.org/10.1007/s10531-023-02666-z

PNUD (2017) Catálogo de las especies exóticas asilvestradas/naturalizadas en Chile.

Powell PA, García-Díaz P, Fernández Cánepa G, Grau A, Herrera L, Nuñez C, Quiroga MP, Quiroga PA, Rojas TN, Ruiz de Huidobro N, Speziale KL, Vidal-Russell R, Zaninovich S, Montti L (2023) Insights from experiences comanaging woody invasive alien plants in Argentina. Ecological Solutions and Evidence 4(4): e12272. https://doi.org/10.1002/2688-8319.12272

Pyšek P, Hulme PE, Simberloff D, Bacher S, Blackburn TM, Carlton JT, Dawson W, Essl F, Foxcroft LC, Genovesi P, Jeschke JM, Kühn I, Liebhold AM, Mandrak NE, Meyerson LA, Pauchard A, Pergl J, Roy HE, Seebens H, van Kleunen M, Vilà M, Wingfield MJ, Richardson DM (2020) Scientists' warning on invasive alien species. Biological Reviews of the Cambridge Philosophical Society 95(6): 1511–1534. https://doi.org/10.1111/brv.12627

Raymond CM, Cebrian-Piqueras MA, Andersson E, Andrade R, Schnell AA, Romanelli BB, Filyushkina A, Goodson DJ, Horcea-Milcu A, Johnson DN (2022) Inclusive conservation and the Post-2020 Global Biodiversity Framework: Tensions and prospects. One Earth 5(3): 252–264. https://doi.org/10.1016/j.oneear.2022.02.008

Reed MS (2008) Stakeholder participation for environmental management: A literature review. Biological Conservation 141(10): 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Reed MS, Oughton L (2017) Stakeholder analysis. Soil Care for profitable and sustainable crop production in Europe, Newcastle, UK.

Reed MS, Graves A, Dandy N, Posthumus H, Hubacek K, Morris J, Prell C, Quinn CH, Stringer LC (2009) Who's in and why? A typology of stakeholder analysis methods for natural resource management. Journal of Environmental Management 90(5): 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001

Reyes R, Nelson H (2014) A tale of two forests: Why forests and forest conflicts are both growing in Chile. International Forestry Review 16(4): 379–388. https://doi.org/10.1505/146554814813484121

Robertson PA, Mill A, Novoa A, Jeschke JM, Essl F, Gallardo B, Geist J, Jarić I, Lambin X, Musseau C, Pergl J, Pyšek P, Rabitsch W, von Schmalensee M, Shirley M, Strayer DL, Stefansson RA, Smith K, Booy O (2020) A proposed unified framework to describe the management of biological invasions. Biological Invasions 22(9): 2633–2645. https://doi.org/10.1007/s10530-020-02298-2

Samson E, Hirsch PE, Palmer SC, Behrens JW, Brodin T, Travis JM (2017) Early Engagement of Stakeholders with Individual-Based Modeling Can Inform Research for Improving Invasive Species Management: The Round Goby as a Case Study. Frontiers in Ecology and Evolution 5: 149. https://doi.org/10.3389/fevo.2017.00149

Sapsford SJ, Brandt AJ, Davis KT, Peralta G, Dickie IA, Gibson RD, Green JL, Hulme PE, Nuñez MA, Orwin KH, Pauchard A, Wardle DA, Peltzer DA (2020) Towards a framework for understanding the context dependence of impacts of non-native tree species. Functional Ecology 34: 944–955. https://doi.org/10.1111/1365-2435.13544

Sax DF, Schlaepfer MA, Olden JD (2022) Valuing the contributions of non-native species to people and nature. Trends in Ecology & Evolution 37(12): 1058–1066. https://doi.org/10.1016/j.tree.2022.08.005

Seebens H, Bacher S, Blackburn TM, Capinha C, Dawson W, Dullinger S, Genovesi P, Hulme PE, van Kleunen M, Kühn I, Jeschke JM, Lenzner B, Liebhold AM, Pattison Z, Pergl J, Pyšek P, Winter M, Essl F (2021) Projecting the continental accumulation of alien species through to 2050. Global Change Biology 27(5): 970–982. https://doi.org/10.1111/gcb.15333

Shackleton RT, Richardson DM, Shackleton CM, Bennett B, Crowley SL, Dehnen-Schmutz K, Estévez RA, Fischer A, Kueffer C, Kull CA, Marchante E, Novoa A, Potgieter LJ, Vaas J, Vaz AS, Larson BMH (2019a) Explaining people's perceptions of invasive alien species: A conceptual framework. Journal of Environmental Management 229: 10–26. https://doi.org/10.1016/j.jenvman.2018.04.045

Shackleton RT, Adriaens T, Brundu G, Dehnen-Schmutz K, Estévez RA, Fried J, Larson BM, Liu S, Marchante E, Marchante H, Moshobane MC, Novoa A, Reed M, Richardson DM (2019b) Stakeholder engagement in the study and management of invasive alien species. Journal of Environmental Management 229: 88–101. https://doi.org/10.1016/j.jenvman.2018.04.044

Speziale KL, Lambertucci SA, Carrete M, Tella JL (2012) Dealing with non-native species: What makes the difference in South America? Biological Invasions 14(8): 1609–1621. https://doi.org/10.1007/s10530-011-0162-0

Stokes KE, O'FNeill KP, Montgomery WI, Dick JTA, Maggs CA, McDonald RA (2006) The importance of stakeholder engagement in invasive species management: A cross-jurisdictional perspective in Ireland. In: Hawksworth DL, Bull AT (Eds) Human Exploitation and Biodiversity Conservation. Springer, Dordrecht, 2829–2852. https://doi.org/10.1007/978-1-4020-5283-5_27

Tedesco AM, López-Cubillos S, Chazdon R, Rhodes JR, Archibald CL, Pérez-Hämmerle K-V, Brancalion PH, Wilson KA, Oliveira M, Correa DF, Ota L, Morrison TH, Possingham HP, Mills M, Santos FC, Dean AJ (2023) Beyond ecology: Ecosystem restoration as a process for social-ecological transformation. Trends in Ecology & Evolution 38(7): 643–653. https://doi.org/10.1016/j.tree.2023.02.007

Turbelin AJ, Malamud BD, Francis RA (2016) Mapping the global state of invasive alien species: Patterns of invasion and policy responses. Global Ecology and Biogeography 26(1): 78–92. https://doi.org/10.1111/geb.12517

Ulloa A (2017) Perspectives of Environmental Justice from Indigenous Peoples of Latin America: A Relational Indigenous Environmental Justice. Environmental Justice 10(6): 175–180. https://doi.org/10.1089/env.2017.0017

Vimercati G, Kumschick S, Probert AF, Volery L, Bacher S (2020) The importance of assessing positive and beneficial impacts of alien species. NeoBiota 62: 525–545. https://doi.org/10.3897/neobiota.62.52793

Vimercati G, Probert AF, Volery L, Bernardo-Madrid R, Bertolino S, Céspedes V, Essl F, Evans T, Gallardo B, Gallien L, González-Moreno P, Grange MC, Hui C, Jeschke JM, Katsanevakis S, Kühn I, Kumschick S, Pergl J, Pyšek P, Rieseberg L, Robinson TB, Saul W-C, Sorte CJB, Vilà M, Wilson JRU, Bacher S (2022) The EICAT+ framework enables classification of positive impacts of alien taxa on native biodiversity. PLoS Biology 20(8): e3001729. https://doi.org/10.1371/journal.pbio.3001729

Zaninovich SC, Herrera L, Carro NG, Zugasti EAG, Montti L (2023) Bases para el manejo adaptativo de la leñosa invasora Acacia melanoxylon (Fabaceae) en la Reserva Natural Privada Paititi, sierras del Sistema de Tandilia, Argentina. Boletín de la Sociedad Argentina de Botánica 58(1): 21–30. https://doi.org/10.31055/1851.2372.v58.n1.38462

Ziller S, Zenni R, Souza Bastos L, Possato Rossi V, Wong LJ, Pagad S (2020) Global register of introduced and invasive species – Brazil. Version 1.5. Checklist dataset/Invasive Species Specialist Group ISSG.

## Supplementary material 1

**File with instructions and guidance for completing the stakeholder spreadsheet**

Authors: Manuela Erazo, Pablo García-Díaz, Bárbara Langdon, Karen Mustin, Mário Cava, Gabriella Damasceno, Magdalena F. Huerta, Eirini Linardaki, Jaime Moyano, Lía Montti, Priscila A. Powell, Thomas W. Bodey, David F. R. P. Burslem, Laura Fasola, Alessandra Fidelis, Xavier Lambin, Sofía Marinaro, Aníbal Pauchard, Euan Phimister, Eduardo Raffo, Ignacio Rodríguez-Jorquera, Ignacio Roesler, Jorge A. Tomasevic, J. Cristóbal Pizarro

Data type: pdf



Link: https://doi.org/10.3897/neobiota.93.121386.suppl1

## Supplementary material 2

**Example Stakeholder Spreadsheet shared with all participants**

Authors: Manuela Erazo, Pablo García-Díaz, Bárbara Langdon, Karen Mustin, Mário Cava, Gabriella Damasceno, Magdalena F. Huerta, Eirini Linardaki, Jaime Moyano, Lía Montti, Priscila A. Powell, Thomas W. Bodey, David F. R. P. Burslem, Laura Fasola, Alessandra Fidelis, Xavier Lambin, Sofía Marinaro, Aníbal Pauchard, Euan Phimister, Eduardo Raffo, Ignacio Rodríguez-Jorquera, Ignacio Roesler, Jorge A. Tomasevic, J. Cristóbal Pizarro

Data type: xlsx

Explanation note: This is an example used to create the individual Stakeholder Spreadsheets completed by participants.



Link: https://doi.org/10.3897/neobiota.93.121386.suppl2

## Supplementary material 3

**File containing the consensus lists of stakeholders for each of our six case-studies**

Authors: Manuela Erazo, Pablo García-Díaz, Bárbara Langdon, Karen Mustin, Mário Cava, Gabriella Damasceno, Magdalena F. Huerta, Eirini Linardaki, Jaime Moyano, Lía Montti, Priscila A. Powell, Thomas W. Bodey, David F. R. P. Burslem, Laura Fasola, Alessandra Fidelis, Xavier Lambin, Sofía Marinaro, Aníbal Pauchard, Euan Phimister, Eduardo Raffo, Ignacio Rodríguez-Jorquera, Ignacio Roesler, Jorge A. Tomasevic, J. Cristóbal Pizarro

Data type: csv

Explanation note: Data have been anonymised.



Link: https://doi.org/10.3897/neobiota.93.121386.suppl3

## Supplementary material 4

### Example matrix

Authors: Manuela Erazo, Pablo García-Díaz, Bárbara Langdon, Karen Mustin, Mário Cava, Gabriella Damasceno, Magdalena F. Huerta, Eirini Linardaki, Jaime Moyano, Lía Montti, Priscila A. Powell, Thomas W. Bodey, David F. R. P. Burslem, Laura Fasola, Alessandra Fidelis, Xavier Lambin, Sofía Marinaro, Aníbal Pauchard, Euan Phimister, Eduardo Raffo, Ignacio Rodríguez-Jorquera, Ignacio Roesler, Jorge A. Tomasevic, J. Cristóbal Pizarro

Data type: pdf

Explanation note: Example of an empty matrix (page 1) to be completed by participants with proposed engagement strategies for each of the four types of stakeholder ("context settlers", "crowd", "key players", and "subjects"). Page 2 shows a matrix for invasive non-native plants in Brazil.



Link: https://doi.org/10.3897/neobiota.93.121386.suppl4

## Supplementary material 5

### File containing the consensus stakeholder engagement strategies for our six case-studies

Authors: Manuela Erazo, Pablo García-Díaz, Bárbara Langdon, Karen Mustin, Mário Cava, Gabriella Damasceno, Magdalena F. Huerta, Eirini Linardaki, Jaime Moyano, Lía Montti, Priscila A. Powell, Thomas W. Bodey, David F. R. P. Burslem, Laura Fasola, Alessandra Fidelis, Xavier Lambin, Sofía Marinaro, Aníbal Pauchard, Euan Phimister, Eduardo Raffo, Ignacio Rodríguez-Jorquera, Ignacio Roesler, Jorge A. Tomasevic, J. Cristóbal Pizarro

Data type: csv



Link: https://doi.org/10.3897/neobiota.93.121386.suppl5