



The IPBES invasion-management framework supports informed decision-making for managing biological invasions

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Abstract The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Thematic Assessment Report on Invasive Alien Species and Their Control presents a “conceptual diagram of management-invasion continuum”, introducing a versatile framework to support decision-making on the management of biological invasions. Drawing on an extensive synthesis of current knowledge, this IPBES invasion-management

framework has been developed to broaden the scope of existing invasion curves—which primarily overlay generic management objectives onto a sigmoid curve depicting the expansion of the affected area over time—and to illustrate the applicability of the concept of effective management at different stages of the biological invasion process. To introduce the IPBES invasion-management framework to a wider audience, this paper explains the features of the framework and defines the invasion-stage-based management approaches and the potential outcomes envisaged

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therein. Reflecting the currently limited management options for biological invasions in marine and other connected-water systems, unlike in terrestrial and closed-water systems, the IPBES invasion-management framework clearly distinguishes between these two groups of systems. For each, it presents management approaches including three key factors that decision-makers should consider concurrently: management objectives, targets, and actions. This framework supports informed decision-making in the management of biological invasions in all ecosystems.

Resumen La Plataforma Intergubernamental Científico-Normativa sobre Diversidad Biológica y Servicios de los Ecosistemas (IPBES) en su evaluación temática de las especies exóticas invasoras y su control presenta un “diagrama conceptual del continuo gestión-invasión”, introduciendo un marco versátil para apoyar la toma de decisiones sobre la gestión de las invasiones biológicas. Basándose en una amplia síntesis de los conocimientos actuales, este marco de gestión de invasiones de la IPBES se ha desarrollado para ampliar el alcance de las curvas de invasión existentes—que principalmente superponen objetivos de gestión genéricos sobre una curva sigmoide que representa la expansión del área afectada a lo largo del tiempo—y para ilustrar la aplicabilidad del concepto de gestión eficaz en diferentes etapas del proceso de invasión biológica. Con el fin de dar a conocer el marco de gestión de invasiones de la IPBES a un público más amplio, este artículo explica las características del marco y define los enfoques

de gestión basados en las etapas de la invasión y los posibles resultados previstos en el mismo. Reflejando las opciones de gestión actualmente limitadas para las invasiones biológicas en los sistemas marinos y otros sistemas de aguas conectadas, a diferencia de lo que ocurre en los sistemas terrestres y de aguas cerradas, el marco de gestión de invasiones de la IPBES distingue claramente entre estos dos grupos de sistemas. Para cada uno de ellos, presenta enfoques de gestión que incluyen tres factores clave que los responsables de la toma de decisiones deben tener en cuenta simultáneamente: objetivos de gestión, metas y acciones. Este marco facilita la toma de decisiones fundamentadas en la gestión de las invasiones biológicas en todos los ecosistemas.

要旨 生物多様性及び生態系サービスに関する政府間科学-政策プラットフォーム (IPBES) が公表した侵略的外来種とその管理に関するテーマ別評価報告書では、「侵入段階に応じた管理の概念図」において、生物学的侵入の管理に関する意思決定を支援するための汎用的な枠組が提示されている。このIPBES侵入管理枠組は、現在の知見を幅広く統合した成果に基づき、従来の侵入曲線—侵略的外来種の影響を受けるエリアが時間とともに拡大する過程を表すS字曲線の上に一般的な管理目標を重ね合わせたもの—のスコープを広げ、生物学的侵入の各段階において効果的な管理がどのように適用されるかを示すために開発された。本稿では、IPBES侵入管理枠組をより多くの読者に紹介するため、その特徴を概説するとともに、枠

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組が示す侵入段階に応じた管理アプローチと、それによって期待される潜在的な成果について解説する。陸域や閉鎖的な水系とは異なり、海洋や河川を含む連続的な水系では、生物学的侵入に対する管理の選択肢が限られている。このような現状をふまえ、IPBES侵入管理枠組は、これら2つの系を明確に区別している。各系について、本枠組は、意思決定者が同時に考慮すべき要因である、管理目標・管理対象（ターゲット）・具体的な管理措置（アクション）の3つを相互に結び付けたアプローチを提示している。IPBES侵入管理枠組は、あらゆる生態系における生物学的侵入の管理において、科学的知見に基づく意思決定を支援するものである。

Keywords Containment · Ecosystem restoration · Eradication · Preparedness · Prevention · Widespread control

Introduction

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Thematic Assessment Report on Invasive Alien Species and Their Control (the “IPBES IAS Assessment”, IPBES 2023) provides conclusive evidence of threats from invasive alien species worldwide (Roy et al. 2024). A synthesis of the available data shows that by 2050, the number of established alien species—currently estimated at 37,000—may increase by 30% over estimates in 2005 (Seebens et al. 2023). Of these 37,000 established alien species, approximately 10% (3500) are invasive alien species with substantial impacts on biodiversity, ecosystem services, and people’s livelihoods (Bacher et al. 2023). Nonetheless, evidence compiled in the IPBES IAS Assessment shows that with sufficient resources and long-term commitment, management of the impact and spread of invasive alien species is attainable and can yield important long-term benefits for ecosystems and human well-being (Sankaran et al. 2023).

Managing biological invasions requires responsive and informed decision-making based on knowledge of the stages of invasion. To this end, an invasion curve that conceptualizes the process of biological invasions was developed (Hobbs and Humphries 1995). The invasion curve is a sigmoid curve with time on the x-axis and an index representing the extent of invasion (e.g.,

species abundance or impacted area) on the y-axis, conceptually illustrating how the extent of invasion increases over time. Because of its easy-to-understand representation, the invasion curve has been widely adopted for research and governance (e.g., Victorian Government 2010; Geburzi and McCarthy 2018; South Florida Ecosystem Restoration Task Force 2020). As a result, it has substantially contributed to decision-maker’s understanding that allowing invasive alien species to establish and spread can lead to significant impacts. However, since the invasion curve primarily serves as a simple and generic theoretical representation, it does not fully address the diverse and complex ecological and management contexts of biological invasions. For example, invasion curves provide only partial insight for managing highly dynamic, spatially unbounded aquatic invasions.

To expand the applicability of the concept of effective management across different ecosystems, we developed a conceptual diagram that introduces a versatile invasion-management framework to the basic invasion curve (“IPBES invasion-management framework”) as part of the IPBES IAS Assessment (Sankaran et al. 2023), based on an extensive synthesis of previous stage-based management strategies (e.g., Hobbs and Humphries 1995; Blackburn et al. 2011; Lodge et al. 2016; Robertson et al. 2020). This IPBES invasion-management framework encompasses the spectrum of potential management objectives, targets, actions, and expected outcomes along the stages of biological invasions, and serves as a conceptual basis for invasive alien species management in any given ecosystem by explicitly differentiating marine and other connected-water systems from terrestrial and closed-water systems. To introduce the IPBES invasion-management framework to a wider audience, this paper (1) outlines the utility and opportunities for refinement of the existing invasion curves, (2) presents the purpose and features of the IPBES invasion-management framework, and (3) defines the invasion-stage-based management strategies, including objectives, targets, and actions, and the potential outcomes envisaged therein.

Utility and opportunities for refinement of existing invasion curves

Typically, invasion curves plot the hypothetical change in the area impacted by a generic invasive

alien species over time as a flattened S-shaped (sigmoid) curve. Along the curve, the sequence of invasion processes is conveniently divided into five stages: absence, introduction, establishment, spread, and widespread. The area impacted captures the concept that a newly introduced alien species may become established and spread widely, causing significant damage in the absence of effective management. The original invasion curve by Hobbs and Humphries (1995) instead used invader abundance on the y-axis, and the South Florida Ecosystem Restoration Task Force (2020) used control costs in addition to area impacted, while conveying the same invasion dynamics. In all cases, no scales or units are shown on the axes, as the diagram serves as a conceptual schematic of the invasion process and is therefore not confined to specific spatial or temporal scales.

Invasion curves typically overlay the potential and most appropriate generic management objectives applicable at each invasion stage: that is, prevention, eradication, containment, and control (or suppression). In addition, from 2010, they started to include economic returns as cost–benefit ratios related to each management objective (Victorian Government 2010), highlighting the concept that prevention is the best option for managing biological invasions. These cost–benefit ratios were based not on robust economic evidence, but rather on hypothetical supposition in accordance with the key principle in the policy context that “prevention is better than cure” (Leung et al. 2002; Venette et al. 2021).

Invasion curves originated from, and have been based mostly on, experiences of alien plant invasions in terrestrial ecosystems (Hobbs and Humphries 1995)—invasions that occur within spatially bounded areas that can be delimited. Indeed, the population dynamics of various terrestrial invasive alien plant species closely follow the shape of these curves (Antunes and Schamp 2017), thereby rendering the associated invasion-stage-based management objectives broadly realistic. In contrast, the applicability of these curves to marine and other connected-water ecosystems, where a lack of spatial limits allows invasive alien species to spread without impediment, has remained inherently limited. In addition to the absence of physical boundaries, marine ecosystems present further logistical challenges: for example, low visibility in a fluid environment where larvae and spores can spread without being detected. As a result,

new marine alien species are often discovered only after they have spread widely, making eradication difficult (Giakoumi et al. 2019; Green and Grosholz 2021). Eradication success has generally been limited to specific instances, such as when organisms with low mobility have been detected in small, enclosed areas during the very early stages of invasion (Katsanevakis et al. 2023). Ultimately, many of the typical management objectives depicted in the classical invasion curves are mostly unattainable in marine and other connected-water systems.

Aims and features of the IPBES invasion-management framework

Through an extensive synthesis of current management knowledge conducted for the IPBES IAS Assessment, we recognized opportunities to develop a broadly applicable management framework by refining the invasion curve while building on its strengths, and by integrating context-specific management options to support responsive decision-making. Accordingly, the IPBES invasion-management framework, represented in the conceptual diagram of management-invasion continuum (Fig. 1), was formulated. The IPBES framework has four notable features:

1. It highlights the differences in management options between terrestrial and closed-water ecosystems, and marine and other connected-water ecosystems along the invasion stages by displaying two separate panels. In terrestrial and closed-water systems, the appropriate management options depend on the stage of invasion, spanning the continuum from the absence to the widespread stage, with a focus on prevention where possible. In marine and connected-water systems, achievable management options generally diminish as invasions progress. Given the dearth of evidence supporting the effectiveness of other management options, prevention is generally considered the only effective management option in these systems (Hewitt and Campbell 2007; Galil and McKenzie 2019; Sankaran et al. 2023).
2. It includes comprehensive and viable management strategies by presenting and linking three key outputs that decision-makers should consider

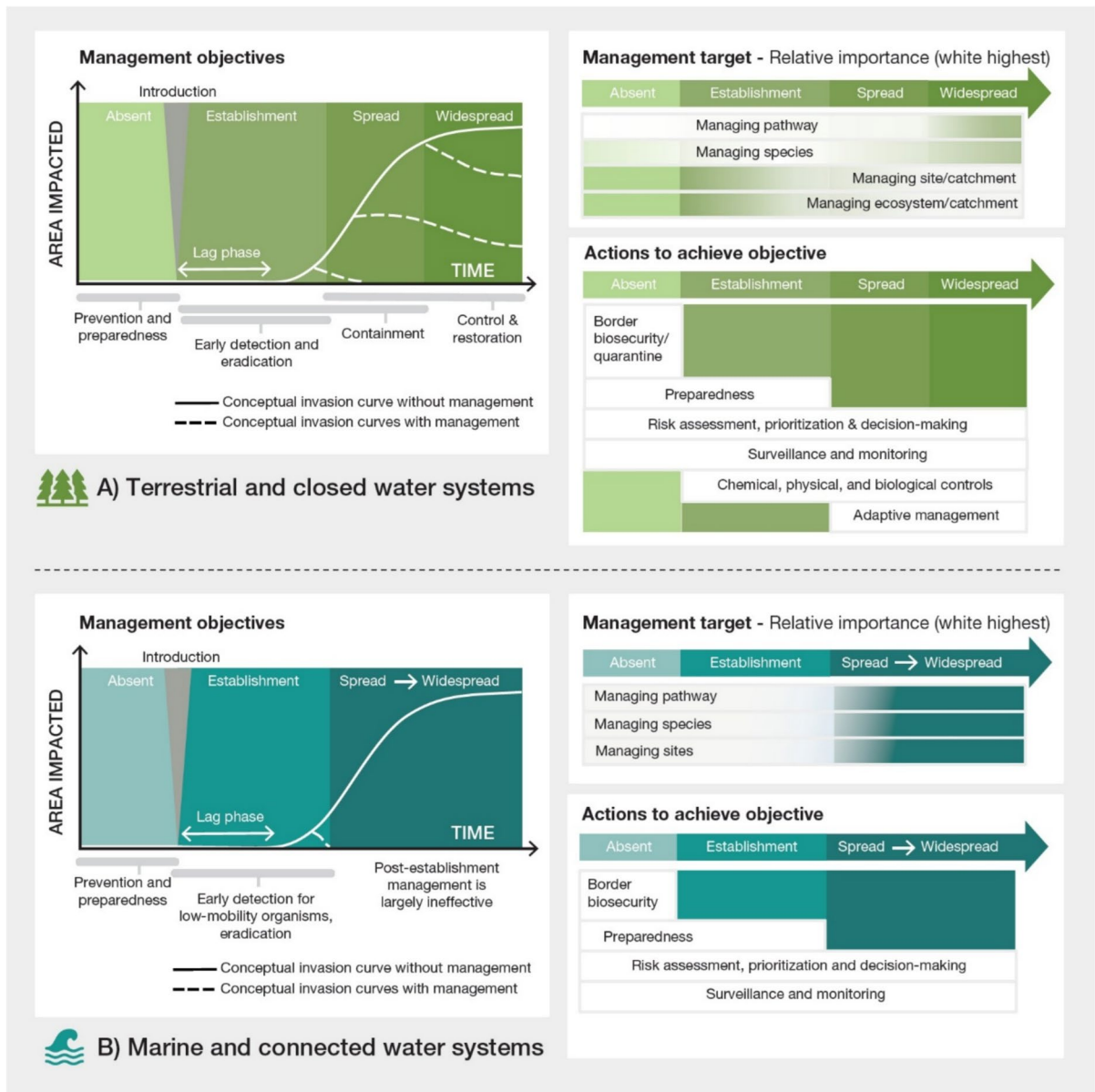


Fig. 1 Conceptual diagram of management-invasion continuum (IPBES 2023), which introduces the IPBES invasion-management framework for (A) terrestrial and closed-water systems and (B) marine and connected-water systems. It includes a generalized invasion curve (solid line) and optimal management approaches, along with the expected changes in

the trajectory of the invasion curve with management (dashed lines). The color gradient of the management targets illustrates how the focus of management evolves as the invasion progresses. Reproduced from IPBES (2023). © IPBES. This figure is third-party material and is not covered by the Creative Commons Attribution 4.0 International License of this article

concurrently: management objectives, targets, and actions. Management objectives are the outcomes to be achieved through the implementation of management measures. Targets represent the focus of management (pathway-, species- or site-/

ecosystem-based, or a combination thereof). In Fig. 1, a color gradient illustrates how the relative importance of these targets shifts across the invasion stages. In terrestrial and closed-water systems, pathway- and species-based management

approaches dominate during the early and middle stages of the invasion process, whereas site- and ecosystem-based approaches become increasingly important in the later stages. By contrast, in marine and connected-water systems, the importance of all management targets is concentrated at the early stages of the invasion process. Actions include implementing on-site measures, establishing institutional frameworks, and adopting integrated governance approaches in order to achieve the management objectives (McGeoch et al. 2023).

3. It includes four distinct management objectives related to different stages of the invasion process, namely prevention and preparedness, early detection and eradication, containment, and control and restoration. Preparedness has long been discussed in the context of unavoidable natural disasters and hazards but has not always been emphasized in biological invasion management. However, preparedness is crucial in the context of biological invasions, as it complements prevention and ensures a rapid response when prevention fails or is not possible (Ricciardi et al. 2011; Burgiel 2020). Restoration is often necessary to achieve recovery of the function of previously invaded sites or ecosystems (Byun et al. 2018, 2020).
4. It explicitly depicts two scenarios: (1) the expected progression of biological invasions when management is implemented (shown as dashed lines in Fig. 1), and (2) the expected results when management is not applied (shown as solid lines in Fig. 1). This graphic refinement of the existing invasion curves gives decision-makers a better perspective on the expected conceptual outcomes of management.

In developing the IPBES invasion-management framework, we did not incorporate economic returns (cost–benefit ratios) to characterize each management strategy. This reflects the fundamentally different characteristics of the management strategies involved. For example, in terms of scope, prevention and preparedness need to take into account many more alien species than does eradication of established alien species, which in turn needs to consider more species than the final number of invasive alien species spreading or widespread and requiring control. The

operational dynamics of these strategies also differ substantially. Eradication often involves rapid and short-term but intensive targeted responses to spatially dispersed and stochastic arrival- and establishment events (Liu et al. 2023). Such responses are typically not expensive when populations are small, but confirming freedom from the species through thorough surveillance can substantially increase costs. By contrast, control during later invasion stages, which centers on mitigating the impacts of invasive alien species, requires sustained, adaptively prioritized interventions under finite resource constraints (Lambin et al. 2020). Because of these inherent differences in scope and operational dynamics, we found that it is challenging to generalize and compare the economic returns on investment across management strategies. Instead, the IPBES IAS Assessment recognizes that cost effectiveness of management is likely to decrease along the invasion stages (Sankaran et al. 2023). Cost effectiveness considers a level of return on investment beyond economic benefit to include social well-being, cultural benefits, biodiversity, and conservation outcomes. Thus, when all socio-ecological consequences of management, including potential side effects on non-target species and conflicts among stakeholders, are comprehensively considered, prevention and preparedness clearly emerge as the most cost-effective management options. Cost effectiveness is a key criterion for defining the success of management, because management success must be evaluated across environmental, social, and economic dimensions (Vanderhoeven et al. under review).

Management strategies for biological invasions in different ecosystems

To reinforce understanding of the IPBES invasion-management framework, we define the invasion-stage-based management strategies and their associated potential outcomes.

Identification of invasion stage

To determine the most appropriate management strategy, it is essential to first identify the invasion stage of the species of interest. This identification is supported by reliable information on species occurrence, abundance, first recorded locations and

dates, invasiveness, impacts, introduction pathways, and other relevant factors. For example, Finley et al. (2023) assign species to appropriate management tiers along the invasion curve (e.g., prevention, eradication, containment, or local control) based on empirical information on invasiveness and occurrence within and around target areas. While sufficient information is not always readily available, invasion stage identification is often still feasible using information from other regions or model-based approaches. Tools for collecting and modelling species distributions and abundance are advancing rapidly, making such information increasingly accessible (Sankaran et al. 2023).

Prevention and preparedness

In the absence of an alien species, management is aimed primarily at preventing any new introductions (Fig. 1). Prevention is achieved through systems-based pathway management, targeting both long-distance and international pathways (e.g., trade and human travel) and short-distance pathways (e.g., local travel and transport) (Hulme 2009; Wilson et al. 2009). To achieve this, prioritization of pathways and detection of new entry through on-site surveillance, monitoring, and stringent implementation of biosecurity measures at the border are required (Fig. 2). Prevention is considered the most cost-effective option in the long term (CBD 2002; Leung et al. 2002; Venette et al. 2021); successful examples are given in Fig. 2. It is the only management option that has so far proven effective in marine and connected-water systems (Hewitt and Campbell 2007; Galil and McKenzie 2019). Consistent with this, the eradication campaign against zebra mussels (*Dreissena polymorpha*) in Highline Lake, Colorado, USA, which was launched after the species had already become established, proved unsuccessful despite the application of molluscicides and water-level reduction, underscoring the critical need for preventive rather than reactive measures (Firestone et al. 2025).

Although prevention is cost effective, it is not always possible and may fail (Tay et al. 2022). Prevention is therefore best complemented by preparedness, which builds response capability before alien species become established (Ricciardi et al. 2011; Burgiel 2020). Preparedness includes ensuring the availability of eradication tools and early detection and rapid response planning, such as the development

of watch lists of alien species (or priority pest lists) covering both species at risk of introduction and those already introduced but not yet reported. Such lists can strategically guide pre-discovery surveillance, facilitate timely reporting, and support post-discovery monitoring and subsequent response measures (Reaser et al. 2020). Preparedness strategies require collective agreement on how to respond to new incursions; this agreement often extends beyond practitioners and requires input from society, including at the inter-government level (McGeoch et al. 2023).

Early detection and eradication

Upon the introduction of an alien species, the lag phase (the time from arrival to the start of spread) is crucial as a window of opportunity for successful species-based eradication (Fig. 1). Effective eradication requires the capacity for early and clear detection, as well as critical rapid response planning and delivery, underpinned by preparedness. Actions to achieve eradication include prioritization, specific surveillance and monitoring for early detection of target species, and elimination of established populations (Fig. 2). Eradication programs typically use physical and chemical measures, including traps and toxins (Sankaran et al. 2023). Follow-up monitoring is required to ensure that the species is fully eradicated from a defined geographic area and that cryptic or un-detected reproductive individuals are not present.

In successful cases where appropriate measures are implemented and follow-up engagement is sustained, conceptually, the size of the impacted area trends downwards after eradication, reaching zero as the impact of the species decreases over time (Fig. 1). In terrestrial ecosystems, eradication can be highly cost effective, proving successful, for example, for vertebrates, especially on islands (Spatz et al. 2022). Notable examples include the removal of invasive rats (*Rattus norvegicus*) from Isola delle Femmine, Italy, through an integrated campaign involving bait stations, monitoring, and follow-up surveys (Canale et al. 2019), and the eradication of feral goats (*Capra hircus*) from Aldabra Atoll, Seychelles, through systematic monitoring and targeted elimination (Bunbury et al. 2018). On islands around New Zealand, adaptive eradication programs integrating multiple control techniques with comprehensive follow-up

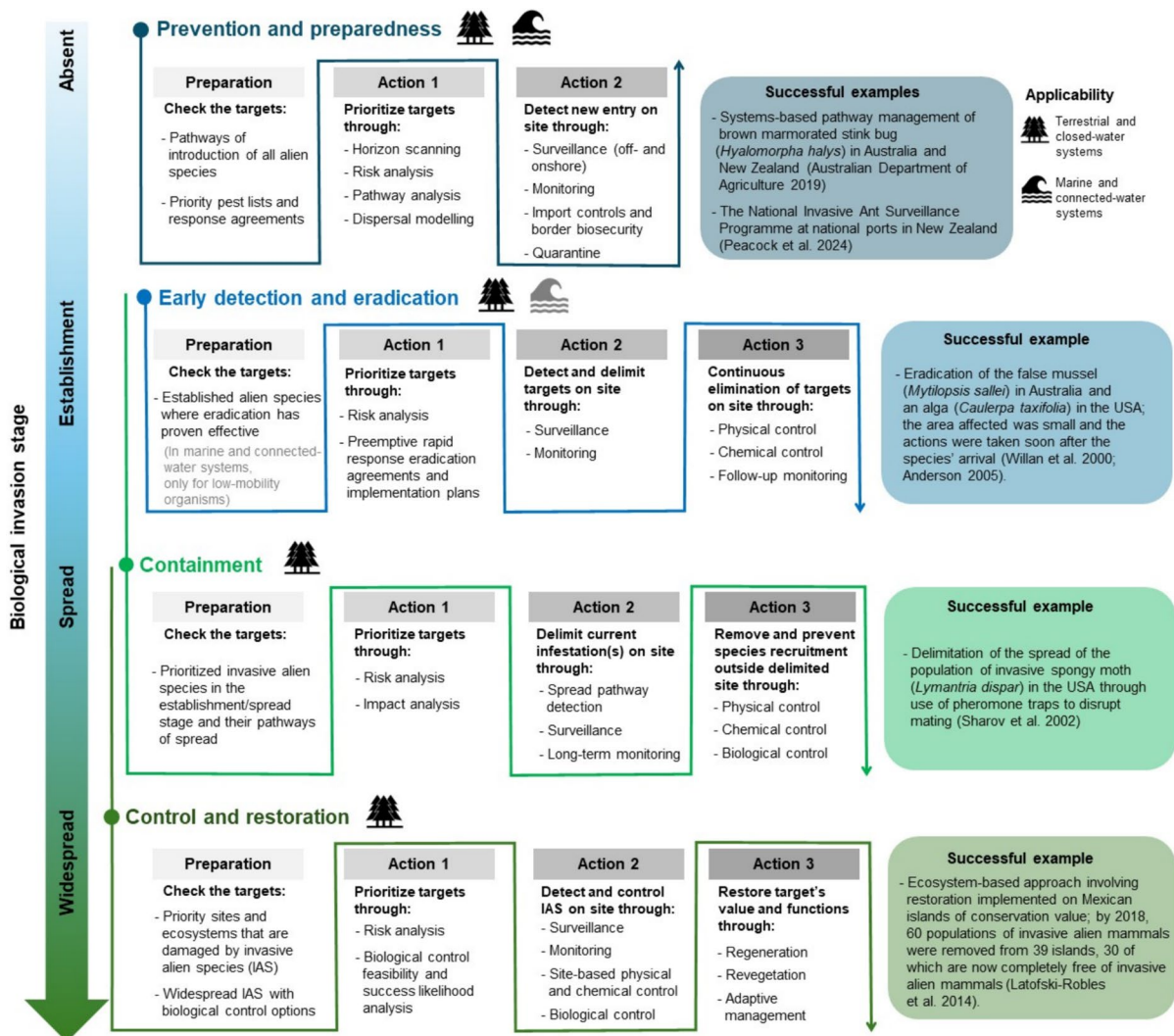


Fig. 2 Management objectives and practical approaches across biological invasion stages in the IPBES invasion-management framework

monitoring have achieved the successful removal of invasive rodents while enhancing cost effectiveness (Towns and Broome 2003). However, success has been much more challenging and therefore infrequent for the eradication of plants with long-lived seedbanks and for invertebrates with limited detectability and delimitability, and even less successful for highly mobile vertebrates such as birds, especially on the mainland (Sankaran et al. 2023). In marine and connected-water ecosystems, early detection and eradication are currently considered effective only for low-mobility or sessile organisms established in

enclosed bays or small areas. For example, eradication projects targeting the false mussel (*Mytilopsis sallei*) in Darwin, Australia, and the invasive alga (*Caulerpa taxifolia*) in California, USA, succeeded because measures were implemented at a very early stage, when populations were still small and confined to closed environments (Willan et al. 2000; Anderson 2005). In contrast, eradication efforts for the American red swamp crayfish (*Procambarus clarkii*) in Malta and many management attempts for invasive mussels (*Dreissena polymorpha* and *D. bugensis*) in North American lakes failed, likely because control

measures could not be applied across the entire distribution range within interconnected water systems, which allowed recolonization from untreated areas linked by water flow (Dahlberg et al. 2023; Caruana et al. 2024).

Containment

At the invasion stages, when the area impacted starts increasing, containment to prevent further multiplication and spread and to limit impacts becomes the management objective (Fig. 1). Containment primarily targets invasive alien species and their pathways of spread, to capture and eliminate outlying recruitment. It involves prioritization of species as the first step, followed by areawide delimitation of the species through physical and chemical control methods and, in some cases, augmentative biological control (Fig. 2). This requires constant surveillance and monitoring to gauge the effectiveness of control techniques. Conceptually, successful containment can prevent a species from entering the rapid increase or spread stage, maintaining the extent of the area impacted by the species to below that at the start of management and below an impact threshold, and halting the capacity for further spread (Fig. 1).

Containment has been effective in terrestrial and closed-water systems where the geographical distribution of the species can be delimited. For instance, containment efforts for spongy moths (*Lymantria dispar*) that combined pheromone trapping with aerial application of a biocontrol agent effectively slowed the moth's spread (Sharov et al. 2002; Liebhold and Kean 2019). Pathway-focused containment measures, such as quarantines on host plant movement, have likewise curbed the spread of the European bark beetle (*Scolytus multistriatus*) in New Zealand and the European woodwasp (*Sirex noctilio*) in Australia (Liebhold and Kean 2019).

In contrast to terrestrial and closed-water systems, containment is generally not considered a broadly effective management strategy in marine and connected-water systems, primarily due to their open biogeographic or topographic features (Sankaran et al. 2023). Nonetheless, containment measures have been attempted to suppress the spread of invasive alien species in aquaculture settings. For example, on Prince Edward Island, Canada, barges were towed into water 25 m deep to clean hulls to which

the colonial tunicates *Botryllus schlosseri* and *Botrylloides violaceus*, known to damage farmed mussels, could attach (Locke et al. 2009). Although such physical containment was recognized as only a temporary measure (Locke et al. 2009), more institutional containment approaches, specifically protocols governing the movement of aquaculture products from already infected waters, have been considered meaningful in slowing the spread of tunicates (ACRDP 2010).

Control and restoration

In terrestrial ecosystems, when invasive alien species spread widely, containment of the species is no longer effective. Management in the widespread stage requires a more site- and/or ecosystem-based perspective, and generally focuses on restoring the values or functions of invaded sites or ecosystems rather than on complete control of the species (Fig. 1). At this stage, the only generally viable species-based management option is classical biological control, which has been shown to achieve long-term suppression in the right species context (Cock et al. 2016). Site- or ecosystem-based management involves site-based physical and chemical control, or biological control of invasive alien species (or a combination of all of these), as well as restoration aimed at the protection and recovery of the values and functions of the sites or ecosystems, as exemplified by the case of Mexican islands of conservation value (Latofski-Robles et al. 2014 in Fig. 2).

Natural or assisted regeneration of native species as part of restoration can improve ecosystem functions (e.g., habitat structure, species interactions, soil nutrient status, and natural fire regimes) and increase resistance to future invasions. For example, restoring native vegetation after removing alien shrubs on the granitic island of Mahé in the Seychelles improved pollinator diversity and enhanced the stability of pollination networks (Kaiser-Bunbur et al. 2017). Similarly, in dry sand grasslands in Hungary that have been invaded by alien plant species, seeding native species combined with mowing and carbon addition helped restore the ecosystem and reduced the spread of certain, though not all, alien species (Sáradi et al. 2025). In Australia, the selective use of herbicides at times of the year when native plants are much less susceptible has led to the effective, integrated management of invasive bitou bush (*Chrysanthemoides*

monilifera subsp. *rotundata*) (Toth and Winkler 2008). All these examples underscore the effectiveness of combining invasive alien species control with active regeneration of native species.

At sites where invasive alien species have been controlled and regeneration of native species is promoted, long-term monitoring is necessary to evaluate management effectiveness and to continue to detect and remove any new incursions. Given the cost, time, and ongoing commitment for restoration, the spatial areas where it can be implemented are usually limited.

In marine and connected-water systems, the restoration of invaded ecosystems is not currently considered an achievable goal (Giakoumi et al. 2019). This is largely because control of invasive alien species, which needs to be addressed alongside restoration efforts, is difficult to implement effectively (Lopez et al. 2006). However, ongoing methodological and technological advances may improve the future feasibility of restoring aquatic ecosystems and increasing their resistance to biological invasions, given that restoration success in marine environments depends heavily on the methodology used and that recent advances in protocols and techniques have markedly increased success rates of restoration (Danovaro et al. 2025).

Concluding remarks

As biological invasions become an increasingly significant threat, rapid decision-making and implementation of suitable management measures are critical (Roy et al. 2024). The IPBES invasion-management framework, backed by the extensive evidence in the IPBES IAS Assessment, provides decision-makers with guidance on what management strategies to implement and when. As has been repeatedly emphasized, prevention, together with preparedness, is the most cost-effective management option (IPBES 2023), but in terrestrial and closed-water systems, additional options are available during subsequent invasion stages (Sankaran et al. 2023). In marine and connected-water systems, by contrast, prevention is the only management option whose effectiveness has been consistently demonstrated under current conditions. However, advances in tools and technologies may expand the applicability of additional strategies

in connected aquatic systems in the future (Simberloff 2021). For instance, if advanced techniques become more established and readily available, it may be possible to detect highly mobile aquatic invasive alien species even during the lag phase immediately following introduction, thereby widening the window of opportunity for successful eradication (Flitcroft et al. 2025). Nonetheless, the principle that prevention is better than cure remains fundamental.

Management of biological invasions entails costs, and some control methods also involve risks, including potential adverse effects on non-target species. To ensure sustained and successful management outcomes, it is essential that these costs and risks are recognized and shared across communities and society (IPBES 2023). Achieving cost- and risk-sharing requires a common understanding of overarching management objectives, targets, and the actions needed to address invasive alien species (Novoa et al. 2018). The IPBES invasion-management framework supports this by highlighting how management efforts focused on pathways, species, sites, and ecosystems are interconnected and can be integrated with each management objective and action. It provides guidance for building consensus and a shared understanding among all those involved in managing biological invasions across ecosystems, ensuring clarity around the strategies adopted and ultimately mitigating the threat of invasive alien species to biodiversity and human well-being.

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