

Regulation 1143/2014 has yet to curb the European Union's invasive species crisis

Why EU Regulation 1143/2014 needs a science-driven overhaul

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Abstract

The European Union's flagship legislation on invasive species, Regulation 1143/2014, was intended to deliver coordinated biosecurity across Member States. However, it continues to fall short of its ambitious goals as enforcement remains inconsistent, ecological priorities are often overridden by economic interests, taxonomic, geographic and ecosystem biases, and practical on-the-ground management is severely underfunded. Only 114 species are included in the list of species of Union concern, whereas over 13,000 non-native species are already established and new ones continue to arrive. Moreover, most of the few species listed continue to spread. Despite raising awareness, its reliance on a slow, politically burdened species list has limited its effectiveness, while adding new species every few years has become more of a symbolic gesture with questionable practical value. A shift toward proactive, science-based pathway management is therefore not only warranted but urgently needed to meet the EU's ambitious biodiversity targets. We highlight key policy directions to facilitate this transition towards an improved management of biological invasions.

INTRODUCTION

Biological invasions, *viz.* invasive species, are globally recognised among the leading threats to biodiversity, public health, and economic stability (IPBES, 2023). In response to the growing challenges associated with biological invasions, the European Union (EU), as a party to the Convention on Biological Diversity (CBD), introduced Regulation 1143/2014, a comprehensive and harmonised legally binding framework adopted under Article 192(1) of the Treaty on the Functioning of the European Union (TFEU) and entering into force in 2015 to prevent and manage the introduction, establishment, spread, and impacts of non-native species for which management is feasible across all Member States. As provided under Article 193 TFEU, this common framework does not preclude Member States from maintaining or introducing more stringent protective measures, subject to compatibility with the Treaties. Initiated by the Directorate-General for Environment in the 2000s, this legislation represented a significant and much-anticipated milestone, particularly among conservation scientists, environmental NGOs, and environmental managers. It was underpinned by the EU's commitments to biodiversity conservation, first articulated in the 2008 Communication "*Towards an EU Strategy on Invasive Species*" (COM(2008) 789 final) and later reinforced in the EU Biodiversity Strategy to 2020 (COM(2011) 244 final) and international obligations, such as the CBD or the Convention on the conservation of European wildlife and natural habitats (CETS No. 104). Despite its ambitious and well-intended goals, critical gaps between policy intentions and real-world outcomes of Regulation 1143/2014 remain, thus limiting its effectiveness in practice (Canelles et al., 2025).

Although the rate of first records of non-native species in the EU appears to have slowed in pace since the late 1990s (Fig. 1A), the core prevention objective of Regulation 1143/2014 remains. Indeed, with numbers of non-native species continuing to increase and with already more than 13,000 established non-native species in Europe (Henry et al., 2023), the Regulation's objectives of prioritising the most harmful non-native species and ensuring resources are effectively targeted to prevent their introduction and spread are more of a band-aid solution than a cure—especially as successful containment (*i.e.* preventing new introductions, establishment and spread) and eradication of non-native species at the continental or even national scale remains scarce (Nunes et al., 2025). With socio-economic and cultural considerations often overriding ecological and conservation issues at national levels (Nentwig et al., 2018), the continued threat of biological invasions continues to outweigh the mitigating abilities of Regulation 1143/2014.

Here, we evaluate the structural outcomes of Regulation 1143/2014 by synthesising empirical patterns of establishment, spread and management expenditure with governance outcomes. Our contribution is therefore not a claim of conceptual novelty, as pathway-centred prevention and the political economy of listing have been argued for more than a decade (Hulme, 2015; Hulme et al., 2017), but an evidence-based, EU-wide quantification of how these well-known limitations have played out under the specific institutional design of Regulation 1143/2014. We show that the mismatch between the 114 listed species and the >13,000 established non-native species in Europe (Henry et al., 2023), the continued range expansion of most listed taxa after 2015 (Magliozzi et al., 2024), and the persistent under-investment in management relative to damage costs (Diagne et al., 2020; European Commission, 2021) are not transitional teething problems but predictable consequences of a species-listing regime operating under strong political and economic constraints. On this basis, we outline pragmatic avenues for reform that remain within the legal architecture of the EU, while addressing the implementation deficit that characterises much of EU environmental law. We also argue that there remains a need to revisit the Regulation to create a stronger,

more adaptive, evidence-based framework that enables EU Member States to improve pathway management, strengthen enforcement, foster transboundary cooperation, and align socio-economic incentives with ecological imperatives.

PROMISES AND EARLY STRENGTHS

To its credit, Regulation 1143/2014 has significantly raised awareness, established important legal foundations for managing non-native species across the EU, and likely reduced introductions and spread (Canelles et al., 2025). At its core, Regulation 1143/2014 promised a unified, science-based approach to tackling non-native species across administrative or national borders. Central to this framework is the “Union List”, a legally binding catalogue of 114 non-native species (i.e. Invasive alien species of Union concern) subject to stringent controls, limiting their possession and trade, and obliging active management. This list is periodically updated based on scientific risk assessments (Nunes et al., 2025) and serves as the EU’s foundation for a coordinated biosecurity and management framework. The Regulation also includes provisions for pathway action plans (Article 13), monitoring, and periodic evaluation mechanisms intended to allow adaptive management.

The Regulation’s underlying rationale was clear and commendable: by harmonising efforts across borders, the EU sought greater ecological, economic, and social resilience. A significant strength of Regulation 1143/2014 is its explicit focus on prevention, aiming to halt the introduction and spread of non-native species before their establishment, widely recognised as the most cost-effective and efficient way to manage biological invasions (Britton et al., 2023). Further, it needs to be acknowledged that Regulation 1143/2014 gives Member States the ability to take emergency measures if a new non-native species that is not listed is perceived as an imminent threat (European Commission, 2021). Such a situation has not yet happened, despite well-documented early warnings and clear evidence of high ecological and economic risk following initial detection, as illustrated by the introduction of species such as the Asian hornet (*Vespa velutina*), emerald ash borer (*Agrilus planipennis*), Asian longhorn beetle (*Anoplophora glabripennis*), or the plant pathogen *Xylella fastidiosa* (Dana et al., 2019). However, the establishment of a shared legal framework across Member States has improved awareness and established a formalised basis for prompt action, offering managers and policymakers a solid legal and communicative basis to justify control (or even eradication) measures and increase stakeholder support simply by pointing to a species’ inclusion on the list, thus reducing resistance to management actions. There has been some evidence for national policies prior to the implementation of the Regulation to have significant protective effects, particularly on invasion rates in the EU and the United Kingdom (Canelles et al., 2025). Across Member States, however, the persistent enforcement gaps and structural shortcomings suggest that the Regulation has yet to deliver fully on its core objectives, with a lack of meaningful actions and a lack of substantive follow-up actions across Member States.

CRITICAL SHORTCOMINGS AND STRUCTURAL BARRIERS

The EU List is subject to political and bureaucratic constraints and has profound taxonomic and geographical biases (Fig. 1B), which severely undermines its scientific objectivity and, by extension, the Regulation’s effectiveness. While the EC’s own review largely acknowledges several implementation frictions, such as slow listing, uneven surveillance, lagging pathway action plans, and underfunding, they are framed as transitional issues that will resolve with time, reporting, and incremental compliance

(European Commission, 2021). Moreover, Regulation 1143/2014 has already been the subject of implementation-gap critiques at the Member State level (Roman & Mauerhofer 2022; Pietrzyk-Kaszyńska et al. 2024) as well as analyses of taxonomic and regulatory biases (Baquero et al., 2023). We, however, argue instead that several of these issues reflect *structural* failures of a species-listing regime detached from ecological reality, including political gating, perverse incentives and trade substitution, and mismatch with pathway-driven risk. Moreover, key blind spots (especially systematic taxonomic omissions, marine/pathway jurisdiction gaps, and incentive structures that reward delay) are not treated as central constraints on effectiveness and fail to translate into a coherent implementation or measurable outcomes across Member States.

Union List biases and political gating

Although risk assessments are reviewed by the Scientific Forum, final listing decisions rest with the IAS Committee and must weigh socio-economic and cultural factors under Article 4(6) of Regulation 1143/2014. This legal design means that the list is not, and was never intended to be, a purely scientific catalogue, since economic and political considerations are formally embedded. As a result, the Union List excludes non-native pathogens (i.e. bacteria, fungi, and viruses), with potentially major consequences for European biodiversity. Pathogens, including chytrid fungi *Batrachochytrium dendrobatidis* and *B. salamandrivorans* (Scheele et al., 2019) and ash dieback fungus *Hymenoscyphus fraxineus*, already wreak havoc on amphibian populations and forests, respectively, but are excluded because they are considered by other international biosecurity agreements, such as the World Trade Organization (WTO) sanitary and phytosanitary (SPS) Agreement. More critically, the list does not reflect the taxonomic composition of non-native species established in the EU. Of the currently 114 listed non-native species (65 animals, 49 plants), 62 are terrestrial, 47 freshwater, but only 5 are marine species. This under-representation of marine species likely reflects both genuine difficulties of attributing impacts and limited feasibility of management once species are established in marine systems (Cahill et al., 2025), because listing species that cannot be controlled would consume scarce resources without measurable gains. The underrepresentation of marine species thus remains troubling, given the extensive ecological and socio-economic damage marine invasions can inflict and the multitude of introduction pathways across European coasts (Katsanevakis et al., 2023). Moreover, Regulation 1143/2014 also deliberately excludes plant pests already covered by sectoral legislation (e.g. the Plant Health Regulation; Carboneras et al., 2018) to avoid duplication of effort.

Moreover, decisions over which species are included on the list are heavily influenced by lobbying, where economic, cultural and/or political considerations have led to a reluctance to list certain taxa, despite their known risks (e.g. the black locust *Robinia pseudoacacia* or the Pacific oyster *Magallana gigas*) or congeneric species (e.g. slider turtles of the genus *Trachemys*), thereby undermining the scientific integrity, relevance, and overall efficacy of the list (Rato et al., 2025). In several cases, listing decisions are often slowed by political negotiation, especially when the proposed species affects trade or a specific industry. For example, several affected Member States may block or delay listings of species that they economically benefit from. In a new set of 26 deemed highly impactful species that were listed in 2025, the EU has chosen to defer action on the American mink *Neogale vison* and North American beaver *Castor canadensis* by 24 months to accommodate fur farming and regulatory complexities. This decision indicates that the process is politically entangled and thus highly inefficient for delivering urgent biosecurity challenges, especially given the detrimental ecological impacts these invasive species can incur (see Recital (7) and Article 2 of Regulation 1422/2025). In fact, the risk assessment on the American mink was submitted and approved by

the Scientific Forum that advises the EU already by 2018 but has not yet been adopted by the EC (Harrington et al., 2021). Although such hurdles and resulting taxonomic biases ought not be insurmountable, the process of adding new non-native species to the Union List involves a high administrative and bureaucratic burden, therefore limiting its ability to reflect and engage with conservation urgency. This time lag can inadvertently provide the necessary window of opportunity for some non-native species to establish and spread before commensurate management actions can be implemented, reducing the likelihood of successful actions.

The rationale for non-native species selected for Regulation 1143/2014 was intended to be evidence-based and transparent but struggles with its intent. Evidence supporting selected species may seem, in some cases, anecdotal or derived from external contexts. Specifically, the list focuses predominantly on non-native species with ecological impacts where management is considered feasible, with lesser emphasis on socio-economic and cultural dimensions—a disjuncture representing a critical misalignment between regulatory ambition and scientific reality. This also reveals another fundamental issue: definitions of what constitutes an “invasive” non-native species vary among experts. For instance, Regulation 1143/2014 has been challenged by emerging concepts such as neonative species (established non-native species integrated into contemporary ecosystems; Essl et al., 2019), archaeophytes (species introduced before ~1500 CE; Pyšek et al., 2002), and neophytes (species introduced after ~1500 CE; Axmanová et al., 2024), which may blur distinctions between non-native and native status and complicate consistent risk assessment and listing decisions. Although the ability of a non-native population to spread often serves as the primary determinant of its impact magnitude (i.e. the potential to incur impacts across diverse spatial contexts) and hence invasiveness, the scientific rationale underlying the inclusion of non-native species in the Union List frequently overemphasises documented impacts on natural resources. While a reasonable assumption from an applied management perspective, selecting a non-native species based solely on demonstrated impact rather than its spread potential overlooks scientific realities (Haubrock et al., 2026a, b). However, invasion impacts are fundamentally a population-level phenomenon, not simply a species-level issue due to context-dependent processes (Haubrock et al., 2024), but the Regulation in its current form is largely insensitive to context-dependencies. Indeed, a non-native species considered “problematic” in northern Europe may not pose the same threat in Mediterranean ecosystems (e.g. pink salmon *Oncorhynchus gorbuscha*) and *vice versa*. While Regulation 1143/2014 acknowledges invasions as population-level phenomena in recommending actions concerning individuals and populations at local and regional scales, failure to acknowledge this in species-listing further undermines the logic of regulatory frameworks that rely primarily on species-based listings. However, although a pathway-based approach cannot eliminate context-dependency, it reduces reliance on species-level impact judgements that are highly sensitive to local conditions and instead focuses management effort on shared introduction mechanisms that operate across multiple contexts. This tension is inherent in Regulation 1143/2014’s design because under the Internal Market rationale and the “weakest-link” principle, species of Union concern must be controlled uniformly across all Member States, even when impacts are strongly context-dependent.

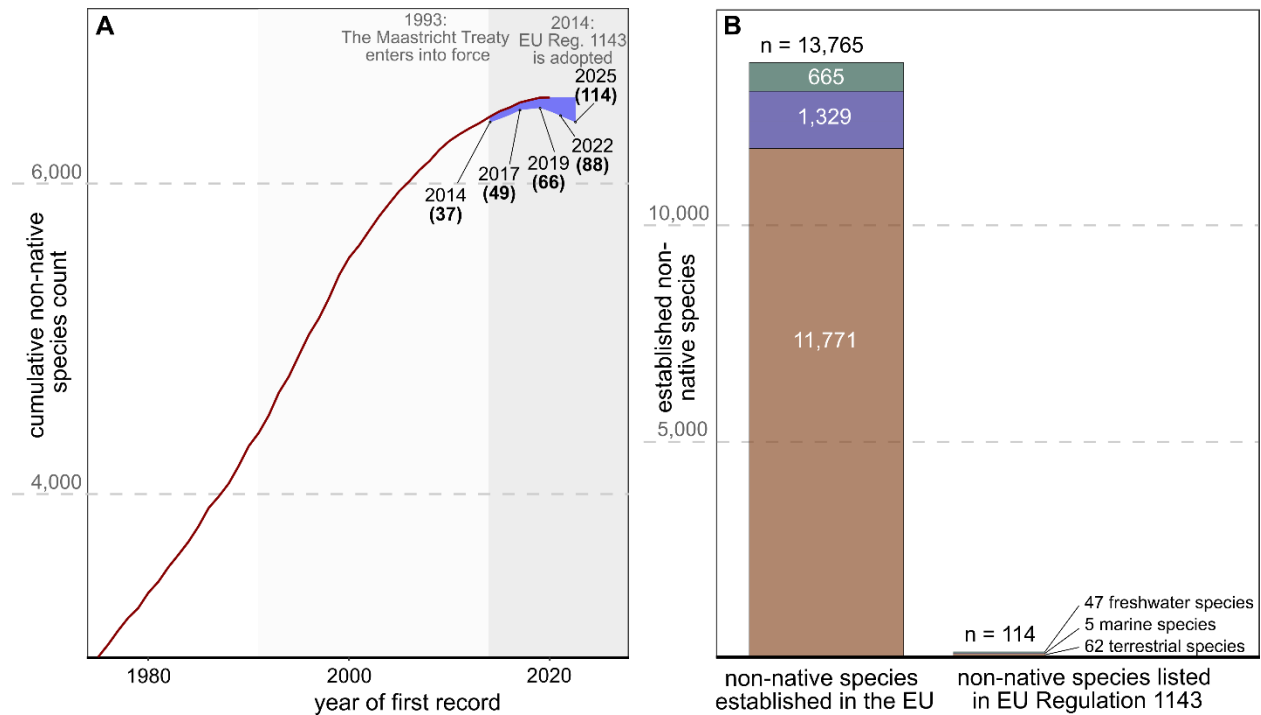


Fig. 1. Overview of temporal and environmental patterns of non-native species in the EU. (A) Temporal accumulation of non-native species in Europe, showing cumulative counts (solid red line) from 1975 to 2020, based on the *Global Alien First Records Database* (Seebens et al., 2021). Key years highlight the foundation of the EU in 1993 and the later adoption of EU Regulation 1143/2014 on non-native species, concomitant to the corresponding number of regulated species by selected years (blue area) in relation to reported non-native species—arguably subject to a lag time in reporting (Seebens et al., 2021). (B) Composition of established non-native species across major environments (terrestrial in brown, freshwater in green, marine in blue) in the EU (left) and of the 114 species currently listed under EU Regulation 1143/2014, derived from the *Established Non-native Species* dataset (Henry et al., 2023).

Post-listing spread and insufficient containment

Particularly as new non-native species reports started to decline markedly over a decade before the adoption of Regulation 1143 (Fig. 1A) (Seebens et al., 2021), intra-EU introductions continued to rise (Supplementary Material 1). In light of this, the Union list becomes inadequate, especially when compared to the magnitude of the numerous established non-native species and associated environmental challenges the EU is facing. Analyses have indicated that while existing legislative policies can slow the rate at which new non-native species are introduced and succeed at establishing, their effects can only be evident when compared to historical baselines, meaning that total numbers may continue rising and mask progress (Canelles et al., 2025). Recent data even suggested that most species listed by Regulation 1143/2014 expanded their distribution in Europe after 2015, with documented changes ranging between 30%–13,432% for plants (and only the Carolina fanwort *Cabomba caroliniana* declining) and 16%–5,767% for animals (with only the Chinese mitten crab *Eriocheir sinensis*, the spiny-cheek crayfish *Faxonius limosus*, and striped eel catfish *Plotosus lineatus* declining) (Magliozzi et al., 2024) (Fig. 2). It remains unclear whether these patterns reflect genuine species expansions, increased detection resulting from enhanced monitoring under the Regulation 1143/2014, or a combination of both. In an attempt to fill this gap, the EC established a baseline distribution for listed species corresponding to the time of adoption of the Union List in 2013,

aimed to enable future evaluation of changes in distribution and management outcomes. However, substantial data gaps and inconsistencies in surveillance and reporting among Member States limit the ability to robustly assess changes relative to this baseline and, consequently, the effectiveness of containment at the EU scale (European Commission, 2021).

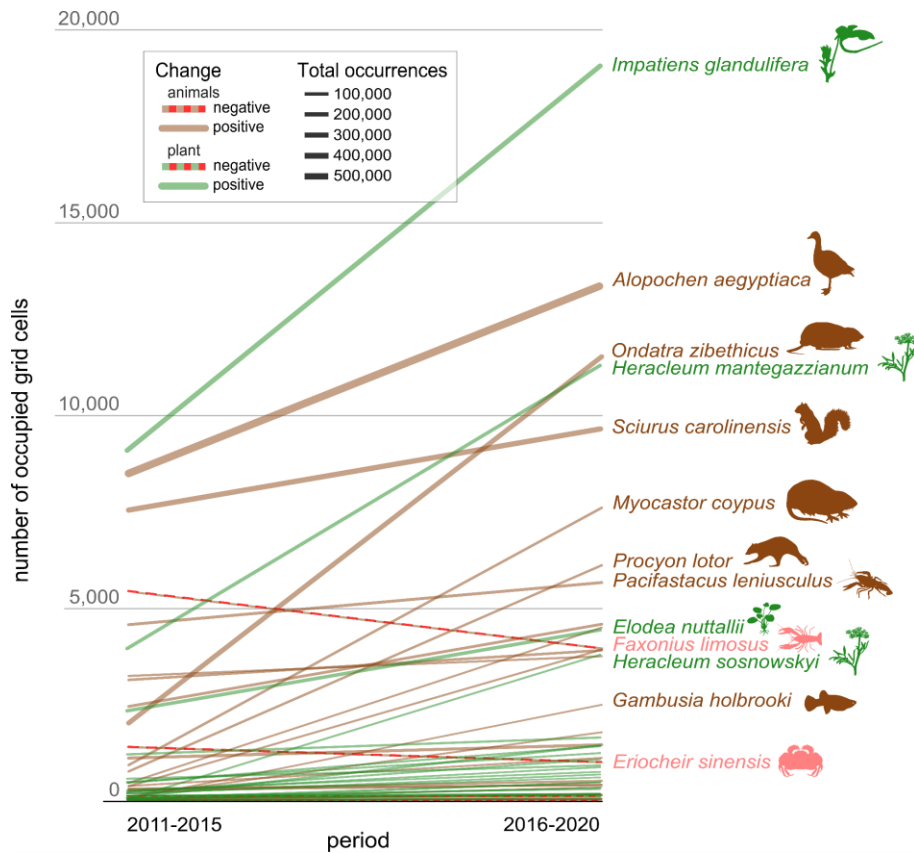


Fig. 2. Recorded geographic extent of listed non-native species in the EU before and after implementation of Regulation 1143/2014. Change in the number of occupied 10 km × 10 km grid cells between 2011–2015 and 2016–2020 for 26 non-native plant (green) and 29 non-native animal (brown) species listed in Regulation 1143/2014 with sufficient data availability in Europe according to the *European Alien Species Information Network* (EASIN; Magliozzi et al., 2020). Each line represents a non-native species, with line thickness scaled to its total number of recorded occurrences. Solid lines ($n = 51$; 93%) indicate an expansion in range, while dashed red lines ($n = 4$; 7%) highlight species with a reduction in occupied grid cells.

Reactive blacklisting and pathway neglect

The Regulation also faces intrinsic limitations due to its inherent species-listing (i.e. "blacklisting") approach. While listing known non-native species that are harmful may be seen as necessary, it also lists non-native species like the Himalayan balsam *Impatiens glandulifera* and the topmouth gudgeon *Pseudorasbora parva*, which cause severe impacts, but have already achieved pan-European distribution and where management is lacking (or absent) in many regions and countries. Mandating the management of non-native species that are already so widespread renders "blacklists" futile and diverts limited resources

from more strategic priorities, while exposing the Regulation’s lack of enforceable mechanisms. Moreover, this reactive model overlooks the more critical task of managing invasion pathways and preventing new invasions proactively (Hulme 2015; Hulme et al. 2017). The reliance on species-specific listings may create a false sense of security and divert attention from comprehensive biosecurity and pathway management strategies that could more effectively mitigate invasion risks in the long-term. Consequently, harmful non-native species like the Japanese knotweed *Reynoutria japonica*, the Prevost squirrel *Callosciurus prevostii*, and the brown algae *Chrysonophos lewisii* continue to spread in parts of Europe but fall outside listing criteria. Thus, these species may gain less scientific attention and remain understudied and unmanaged, perpetuating the cycle of biological invasions. This is particularly evident in marine systems, where Regulation 1143/2014 has largely failed to provide robust, unified biosecurity support despite explicit obligations under Articles 7(2) and 13, overlooking multiple primary and secondary pathways, with the Suez Canal—the most important pathway in the Mediterranean—being beyond the Regulation’s authority. Evidence shows that a country’s legacy of historical invasions remains the strongest predictor of future introductions, highlighting persistent vulnerabilities that current regulatory mechanisms fail to address (Canelles et al., 2025). These vulnerabilities are further exacerbated by numerous conflicts with economic interests that frequently undermine effective management (Kourantidou et al., 2022). Restrictions imposed by Regulation 1143/2014 can disrupt trade in horticulture, aquaculture, and the pet industry, creating economic friction and lobbying pressures that dilute biosecurity measures implemented at the national level and limit overall compliance. In practice, bans on specific species are frequently circumvented by shifting trade to alternative taxa (Rato et al. 2024), further undermining the Regulation’s intent.

Implementation capacity and chronic underfunding

Another critical shortcoming lies in the on-the-ground prevention, early detection, eradication, control, and containment of listed established non-native species, where many EU Member States lack the sustained commitment, capacity, or resources to carry out effective management (Garcia-Lozano et al., 2025). Indeed, the EC’s own evaluation indicates limited management success, reporting that only 6% of management measures resulted in eradication, 21% reduced target populations, 14% produced no detectable change, 17% coincided with population increases despite intervention, and 42% yielded unclear outcomes. This suggests that, even where measures were implemented, their effectiveness was often either limited or insufficiently documented, raising concerns about whether current approaches can achieve the Regulation’s stated prevention and management objectives (European Commission, 2021). This is not surprising considering that the culling of non-native species frequently faces public objection and lacks political support, undermining practical biosecurity measures (Britton et al., 2023). Although reported damage costs incurred by non-native species declined in the decade preceding the adoption of Regulation 1143/2014, reported management expenditure did not increase afterwards, falling short of the investment levels needed to meaningfully manage non-native species and to reduce long-term damage costs (Fig. 3). For example, the economic costs incurred by damages from the eucalyptus snout beetle *Gonipterus platensis* in Portugal between 1996 and 2016 exceeded 11,000,000€, while the Portuguese Ministry of the Environment and Energy had a total fund of 1,490,000€ for 2024 to be divided over 24 projects—with a maximum fund of 100,000€ per project—to eradicate, control or contain non-native species listed on Regulation 1143/2014. This disparity raises serious concerns about whether the attributed funding (i.e. ~1% of damage cost budgeted for management) is anything more than a symbolic gesture and is particularly concerning in contexts where higher investment in timely management measures (e.g. eradication) could substantially reduce potential future economic and ecological costs by several orders of magnitude (Leung et al., 2002).

Finally, the EC's self-assessment identified persistent implementation gaps across Member States, including incomplete action plans, insufficient funding and administrative capacity, uneven surveillance and coordination, and structural limitations inherent to a species-listing approach that cannot address all invasive species (European Commission, 2021). These gaps in practical implementation are further compounded by uneven implementation and enforcement across Member States, as reflected in inconsistencies in and lacking knowledge about recorded distributions of listed species as well as monitoring systems that had not adequately covered all listed species or national territories, allowing non-native species to persist and spread largely unchecked.

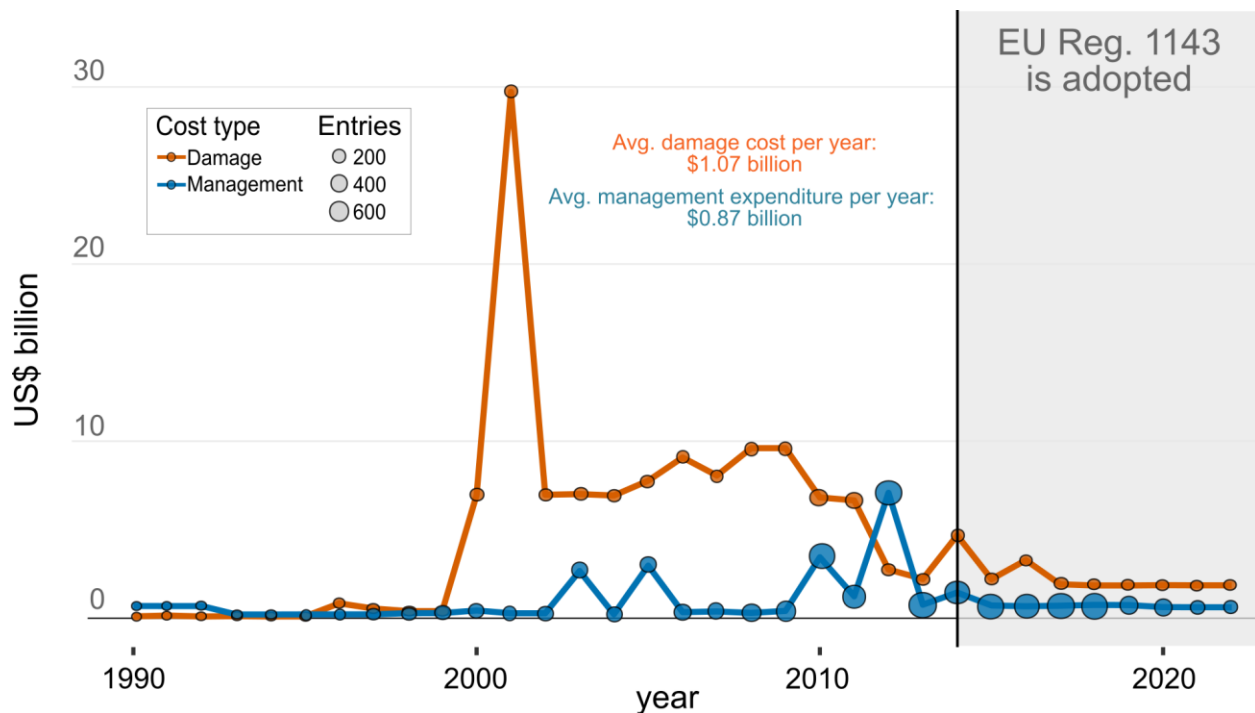


Fig. 3. Reported economic costs of invasive species in the EU over time, distinguishing damages and management. Temporal trends in total reported monetary costs of invasive species (in billion US\$) in 27 European member states and the United Kingdom, split into damages (orange) and management expenditures (blue). Point sizes are scaled by the number of cost entries in the given year. The shaded area (grey) indicates the periods after the adoption of EU Regulation 1143/2014 on non-native species in 2014 (black solid line). Data on the monetary cost of invasive species are sourced from the *InvaCost* database (Diagne et al., 2020). The peak observed for damage costs in 2001 is based on a single study (Perrings et al., 2010), which reported costs from the foot-and-mouth disease virus in the United Kingdom exceeding 20 US\$ billion.

Geographic disparities and fragmented governance

Beyond taxonomic biases, significant geographic disparities in species distribution data and biosecurity standards exist across the EU. Some frontier regions, such as the Arctic, are notably overlooked despite being highlighted in other EU conservation and research priorities, given the recent geopolitical tensions in the region (Tosun, 2023). Major trading partners, including the United States, China, and the UK, are sources of introduction pressure via insufficiently managed trade and transport vectors and excluding

neighbouring non-EU states like the Balkans from Regulation 1143/2014 results in political borders that non-native species ignore. Despite these clearly observable trends, direct causal attribution between regulatory design and invasion outcomes is inherently difficult. Finally, policies like Regulation 1143/2014 often remain largely reactive—introduced in response to already-established problems without proof of successful eradications—thus suffering from gaps between commitments on paper and enforcement in practice (Canelles et al., 2025). In fact, and even more concerning, six Member States—Bulgaria, Greece, Ireland, Italy, Latvia, and Portugal—had no national plan for non-native species until very recently, prompting the European Commission in January 2023 to initiate infringement proceedings against them for failing to adopt comprehensive action plans or to properly transpose Regulation 1143/2014 into national law, in some instances only following legal pressure. These implementation gaps have already been documented in detailed Member State case studies (Roman & Mauerhofer 2022; Pietrzyk-Kaszyńska et al. 2024). Moreover, Magliozzi et al. (2020) identified a mismatch between the river catchment-scale pressures of biological invasions and their inconsistent incorporation into EU water policy frameworks, particularly the Water Framework Directive, in direct relation to Regulation 1143/2014 indicating the urgent need to better integrate their management with broader water policies to more effectively safeguard Europe’s freshwater ecosystems.

CHARTING A PATH TO EFFECTIVE LEGISLATION AND MANAGEMENT

More than a decade into its implementation, it becomes clear that Regulation 1143/2014 has become an extensive bureaucratic framework with limited practical impacts because it is fundamentally ineffective in preventing new high-impact invasions, including the few species already listed. A combination of conceptual, structural, and political shortcomings, including a sluggishly updated Union List that overlooks dynamic regional contexts, tailoring to Europe’s biogeographic regions (Rato et al., 2025) and emerging species threats—reduce Regulation 1143/2014 to a rather symbolic tool that enables superficial action while deflecting attention from deeper systemic reform.

To bridge the gap between policy aspirations and reality requires urgent and substantial reform. One potential direction is to retain a blacklist but rebuild it under a transparent, two-stage protocol that separates risk-based representativeness (taxa/regions/realms, including marine, and pathway exposure) from management feasibility (actionability tiers), so that the Union List reflects ecological and socio-economic risks rather than only what has been deemed politically or operationally manageable. However, merely expanding the Union list risks turning the Regulation into a bureaucratic hydra—sprawling and complex, yet no closer to resolving the core problems it was designed to address.

An alternative, already implemented in jurisdictions such as New Zealand, is a precautionary “white-list” approach in which only species assessed as low risk are permitted for trade or introduction, shifting the burden of proof from demonstrating harm after introduction to demonstrating safety beforehand (Boonstra, 2010). We recognise, however, that white-listing does not eliminate political and industry pressure; it relocates it onto the risk-assessment process itself (Hulme, 2020). Similar political-economy constraints on precautionary approaches have been documented elsewhere (Hulme, 2020; see also Lodge et al., 2016). In a multi-state polity with heterogeneous trade interests, the same sectoral lobbying that currently delays black-list additions would simply target safety determinations. Consequently, white-listing alone is not a panacea. A more realistic evolution for the EU is to retain a refined black-list while placing far greater operational weight on pathway-based controls (Hulme, 2015; Ricciardi & MacIsaac, 2022),

measures that remain effective even when novel taxa appear and that are less vulnerable to species-by-species political bargaining. Science and policy thus need to transition towards bolder and more comprehensive pathway management, which, when coupled with stronger controls on trade and movement of potentially harmful non-native species, would mark the necessary evolution beyond the current blacklist-centric model.

Operationally, this could include a targeted strengthening of controls on high-risk trade pathways such as live aquatic organism imports, ornamental horticulture supply chains, hull fouling management in maritime transport, and regulation of e-commerce, including online pet trade and horticultural platforms. Unlike species-based listing, measures focused on pathways target introduction mechanisms directly and may remain effective even when novel species are translocated, as exemplified by the IMO Ballast Water Management Convention (Ricciardi & MacIsaac, 2022). However, this also includes better management of species already widespread across the EU's landscapes and waters and internalising the environmental externalities of economic activities (e.g. trade and travel regulations). This concern is further substantiated by a recent critical take on the EU Biodiversity Strategy for 2030, which is unlikely to be attained through direct invasive species management alone, because impact evidence remains incomplete, invasive species are rarely the dominant driver relative to other stressors, and the underlying indicator relies heavily on inconsistent and taxonomically biased Red List assessments (Ojaveer et al., 2025).

A consequential next step is therefore to systematically evaluate the effectiveness of Regulation 1143/2014 by upscaling environmental monitoring transcending national borders through embracing technological innovation (Box 1). Core indicators could include changes in the area of occupancy and extent of occurrence (i.e. abundance or density) of listed species, rates of secondary spread, pathway-specific introduction frequencies, and response times between detection and management action before and after their inclusion. For this, existing infrastructures such as EASIN and national biodiversity monitoring schemes could serve as the needed backbone of such an evaluation framework. These efforts could be further bolstered by strengthening enforcement capabilities (Carpio et al. 2019) and securing sustained funding at regional, national, and the EU level, which would substantially improve compliance and practical implementation. This need is reflected in the IUCN Rapid Response Fund that was launched in 2025, comprising a 2.1 million euros initiative co-funded by the EU that aims to provide targeted grants in support of urgent on-the-ground conservation action to prevent the spread and establishment of harmful invasive species across Europe. Even though this initiative represents a step in the right direction, more systematic financing mechanisms proportionate to invasion risk and readily accessible rather than contingent upon competitive project applications are needed to ensure timely and effective action. Crucially, enhancing transnational cooperation and sharing responsibilities among Member States must move from rhetoric to concrete action. Incentivising countries to develop robust national strategies aligned with EU-wide objectives could empower member states to address specific regional threats more effectively. Importantly, greater inclusion of local and sectoral stakeholders, who are often sidelined by the Regulation's top-down approach, is needed to build legitimacy and reduce resistance from affected industries, hobbyists, and other actors.

Technical proposals are necessary but insufficient. The binding constraints revealed by Regulation 1143/2014's first decade are political will and enforcement capacity and listing decisions continue to be deferred to protect sectoral interests (Harrington et al., 2021; see also Regulation 1422/2025). Moreover, unlike the Habitats and Birds Directives, where the threat of infringement has historically been more

concrete and has driven greater national investment, enforcement pressure under Regulation 1143/2014 has remained relatively weak (European Commission, 2023). Operationalising directions as indicated in **Box 1** therefore requires leveraging existing EU instruments that already carry stronger conditionality, e.g. by linking non-compliance more tightly to the Nature Restoration Regulation and the Common Agricultural Policy, strengthening the Commission’s use of infringement procedures once pathway action plans are shown to be non-prescriptive, and building coalitions of Member States that face the highest invasion pressure. Without such political mechanisms, even the best-designed technical reforms risk remaining symbolic.

Box 1. Key policy directions emerging from this analysis include

1. Strengthening pathway-based prevention while reducing taxonomic, geographic and ecosystem biases in species listing.
2. Establishing EU-wide monitoring indicators linked to measurable outcomes, complemented by country-scale in-depth evaluations that can trigger infringement proceedings when measures fail.
3. Improving alignment and clear objectives between Regulation 1143/2014, the Water Framework Directive, the Habitats and Birds Directives, and the Nature Restoration Regulation.
4. Securing sustained, risk-proportionate funding mechanisms rather than competitive project-based financing.
5. Allowing regionally adaptive implementation that reflects Europe’s ecological heterogeneity while retaining clear, enforceable minimum standards.

Ultimately, the EU thus faces a critical choice: either it adopts a rigorous zero-tolerance approach that includes much stricter pathway management or embraces a more pragmatic, impact-focused strategy that continues to expand the list indefinitely—layering on ever more assessments and bureaucratic mechanisms that offer little meaningful protection—but the current muddled path fails on both fronts. Only by aligning regulatory mechanisms with ecological realities and substantially enhancing enforcement capacities can the EU fulfil its ambitious commitments under the Kunming-Montreal Global Biodiversity Framework and its own Biodiversity Strategy for 2030—targets that call for halving both the introduction of non-native species and their impacts on threatened species within just a few years. In an era of escalating geopolitical tensions, where many nations are preparing to channel unprecedented shares of GDP into military spending (Sousa et al., 2025), and many other problems humanity faces, the question remains: where will the resources come from to deliver such ambitious biosecurity promises, especially when a regulation that began with good intentions has largely failed to tackle this vast environmental and economic challenge, diverting critical focus from comprehensive pathway management to a narrow, slowly evolving species list.

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430 **Competing interests**

431 The authors declare no competing interests

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