

A Review of European Union Strategies for Biodiversity Conservation: Actions Against Invasive Alien Plant Species

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Abstract

Invasive alien species pose a significant threat to biodiversity and ecosystem functioning globally, ranking among the top five causes of biodiversity loss in Europe and beyond. Their detrimental impact on native flora and fauna, through competition for vital resources such as food, water, and habitat, underscores the urgency for effective management strategies. In response to this global challenge, the European Union (EU) has enacted Regulation (EU) 1143/2014, aimed at mitigating the impact of invasive alien species and safeguarding the environment and biodiversity across its territories. The primary objective of this regulation is to prevent the introduction and proliferation of invasive alien species while effectively managing those already established within the EU. Moreover, both the EU Biodiversity Strategy for 2030 and the European Green Deal strengthen efforts and commitments to manage established invasive alien species and reduce the threat they pose to Red List species by 2030. These strategies include specific targets and actions aimed at enhancing invasive species management, such as increased funding for eradication programs and the development of innovative control methods. This review article critically examines the strategies employed by the EU to address invasive alien species, assessing their efficacy and identifying potential areas for improvement in biodiversity conservation efforts.

Keywords: invasive species, impact, management measures, biodiversity, EU strategy.

1. Introduction

Invasive alien species (IAS) pose a significant threat to biodiversity and ecosystem integrity, representing animals and plants introduced accidentally or intentionally into environments where they are not native, leading to adverse consequences for their new habitats [18,33,4]. In Europe, they stand as one of the primary causes of biodiversity loss, exacerbating challenges for native flora and fauna [3]. The European Commission's report underscores the magnitude of this threat, estimating annual damages to the EU at €12 billion [17], while also highlighting potential risks to human health through their pollen and toxins [22], including asthma and allergies [29,11].

Many of the IAS has been established in Europe for over two centuries, rapidly proliferating due to favorable conditions [20]. Research indicates that a substantial portion, approximately 62.8%, were intentionally introduced for purposes such as ornamental, agricultural, or horticultural use, with the remainder unintentionally introduced through transport or seed dispersal [13,25].

Europe, encompassing a rich tapestry of plants, animals, and ecosystems, boasts unparalleled biodiversity globally. However, this natural heritage faces persistent decline due to various anthropogenic activities, including urban expansion, intensive farming, forestry practices, and pollution. Such trends underscore the urgency of addressing biodiversity loss and

ecosystem degradation, recognized as among the foremost challenges confronting humanity in the coming years [6]. According to future projections based on scientific modeling, the number of IAS in Europe is forecasted to increase by approximately 64% between 2005 and 2050 [27].

This estimate underscores the significant and ongoing challenge posed by IAS to European ecosystems. In response to the pressing threat posed by IAS and the broader decline in biodiversity, the European Union (EU) has undertaken significant measures and strategies to safeguard native biodiversity. Regulation (EU) 1143/2014 represents a pivotal initiative aimed at preventing and managing the introduction and spread of IAS within the EU. This regulation signifies an important first step towards compiling a comprehensive list of IAS pertinent to the Union's interests [3].

The European Commission and EU Member States have been actively engaged in research and analysis to address IAS, with a primary focus on mitigating their adverse impacts on native biodiversity and ecosystem services, as well as limiting associated socio-economic ramifications. Additionally, the European Green Deal and the European Biodiversity Strategy for 2030 emphasize the imperative of placing nature on a trajectory towards regeneration by 2030, emphasizing enhanced protection and restoration of healthy ecosystems [9,12].

This review article aims to critically analyze the multifaceted measures adopted by the European Union (EU) to protect biodiversity from the adverse effects of IAS. Focusing on key-policy frameworks and implementation strategies, this analysis will assess the effectiveness of EU measures, identify challenges in implementation, and explore areas for improvement. Starting with a synthesis of the primary concerns regarding IAS in Europe, this analysis aims to contribute to a deeper understanding of the complexities surrounding IAS management and its implications for ecosystem health and resilience.

2. Concerns about invasive plant species in Europe

2.1. Main invasive alien plant species in Europe. Europe has historically been a hub for international trade, resulting in the establishment of numerous non-native species within its borders. Without increased efforts to

manage pathways of introduction, the number of invasive alien plant species (IAPS) continues to rise, prompting national governments in Europe and the European Union to prioritize the development of policies for their reduction and management [16]. Studies conducted in several European countries during the late 19th century have contributed to an extensive database on the introduction, spread, and distribution of IAS [19,24]. In recent years, there have been concerted efforts at the European level to understand the invasion phenomenon and assess its impacts on ecosystems, economies, and human health. The International Union for Conservation of Nature (IUCN), through its Invasive Species Specialist Group (ISSG), has played a pivotal role in identifying and prioritizing the most aggressive IAS, as well as developing biodiversity conservation measures [1].

Initiatives such as the Delivering Alien Invasive Species in Europe (DAISIE) project have provided invaluable information on biological invasions, with over 12,000 IAS listed in Europe according to the DAISIE database [6]. The European Commission's list of IAS of interest to the Union comprises 88 species, including 47 animals and 41 plants, with updates made periodically since its inception in 2016 [11].

One of the most problematic plant invaders is Japanese knotweed (*Fallopia japonica*), recognized for its aggressive growth habits and ability to colonize diverse habitats. Similarly, Himalayan balsam (*Impatiens glandulifera*) has become widespread along watercourses and riparian zones, spreading rapidly and displacing native plants.

Moreover, the giant hogweed (*Heracleum mantegazzianum*) poses dual threats to both biodiversity and human health. The list of IAPS of interest to the Union also includes six tree species: *Acacia saligna* (saligna acacia), *Ailanthus alissima* (ash tree), *Baccharis halimifolia* (baccharis), *Hakea sericea* (reed canary grass), *Prosopis juliflora* (mesquite) and *Triadica sebifera* (Chinese tallow tree).

The species included in this list are subject to the restrictions and measures laid down in Regulation (EU) 1143/2014 on the conservation, import, sale, breeding, rearing and release into the environment. Effective management strategies, including early detection, eradication, and restoration efforts, are essential for mitigating the impacts of these invasive species and safeguarding Europe's rich biodiversity for future generations.

2.2. Impact of IAPS on biodiversity. The impact of IAPS on biodiversity in Europe (and globally) is profound and multifaceted. These non-native species pose a significant threat to native flora and fauna by competing for essential resources such as food, water, and space [26]. As they outcompete native species, IAPS can lead to the decline of indigenous populations and even contribute to local extinctions.

Furthermore, IAPS can alter ecosystem dynamics and disrupt ecological interactions [21], such as predation and pollination, which are vital for maintaining biodiversity.

Changes in vegetation structure and nutrient cycling induced by IAPS can further exacerbate the degradation of habitats and threaten the survival of native species.

One such an example is Japanese knotweed, a perennial herbaceous plant that forms dense stands that outcompete native vegetation, reducing biodiversity and altering ecosystem dynamics.

This IAPS is notorious for its robust root system, capable of penetrating asphalt, concrete, and building foundations, leading to costly infrastructure damage [32]. Another aggressive IAPS is *Impatiens glandulifera*, which has an explosive seed dispersal mechanism, facilitating its colonization of new areas, and exacerbating its invasive potential [5].

Heracleum mantegazzianum is another IAPS, with a towering stature and broad leaves which shade out native plants. Its sap contains phototoxic compounds that can cause severe skin burns and blistering upon contact, presenting a hazard to unwary individuals [2].

IAS has been involved in 60% of global plant and animal extinctions and has incurred costs exceeding \$400 billion since 1970. A recent report by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) highlights the significant global threats posed by over 3,500 out of 37,000 alien species introduced to regions worldwide through human activities, impacting nature, economy, food security, and human health [14]. With the rise in globalization, environmental degradation, and climate change, projections suggest that the number of invasive alien species and their impacts will continue to escalate in the future.

The recent IPBES biodiversity and ecosystem services global assessment indicates a 70% increase in the number of IAS per country since 1970 across 21 countries with detailed records [7]. Comprehensive analyses of long-term temporal trends in biological invasions,

based on over 45,000 first records of more than 16,000 IAS that became established following introduction, provide valuable insights into invasion patterns [23].

3. European Union strategy on invasive species control

3.1 The Regulation (EU) No. 1143/2014 of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species. The Regulation (EU) 1143/2014 represents a robust legislative instrument aimed at addressing the growing threat of IAS in Europe. This legislation stands as a cornerstone in the EU's efforts to combat the detrimental impact of IAS on biodiversity, ecosystems, and human well-being. Enacted on October 22, 2014, this regulation represents a pivotal legislative framework aimed at preventing and managing the introduction and spread of IAS within the EU territory [28]. At its core, Regulation 1143/2014 outlines a comprehensive set of measures designed to address the multifaceted challenges posed by invasive species. These measures encompass various aspects, including prevention, early detection, rapid response, and management of established invasive species.

One of the key provisions of the regulation is the establishment of a Union list of IAS of concern, comprising species whose presence within the EU poses significant risks to biodiversity and ecosystems. This list serves as a fundamental tool for prioritizing and coordinating actions at the EU level. Species included on the Union list are subject to stringent restrictions and measures, such as bans on import, sale, breeding, and release into the environment, as described in the previous section.

Furthermore, Regulation 1143/2014 mandates EU Member States to develop and implement national strategies for the prevention and management of IAS. Member States are required to take proactive measures to identify and manage pathways of unintentional introduction, conduct risk assessments, and establish surveillance and monitoring systems for early detection of invasive species. In addition to prevention and early detection, the regulation emphasizes the need for effective management of established invasive species. Member States are tasked with developing action plans for the management of invasive species already present in their territories, employing measures to

control and mitigate their impacts on native biodiversity and ecosystems.

3.2 Biodiversity strategy for 2030. The EU Biodiversity Strategy for 2030 presents a well-defined plan, anchored in established principles, aiming in the long term to protect nature and reverse ecosystem degradation by 2030 [14]. This strategy includes specific actions and commitments aimed at benefiting people, the climate, and the planet. Emphasizing prevention in accordance to the Regulation (EU) 1143/2014, the strategy primarily focuses on measures to prevent the introduction of IAS into European ecosystems, employing strict border control measures, monitoring, and management of IAS in vulnerable areas, and promoting public awareness of the threat posed by IAS [27]. The report produced by the European Commission equips stakeholders with effective tools and measures to achieve the ambitious new global target on invasive alien species - Target 6 of the recently adopted Kunming-Montreal Global Biodiversity Framework, aiming to reduce the introduction and establishment of invasive alien species by at least 50% by 2030.

Furthermore, the strategy underscores measures for managing established IAS in European ecosystems, including the identification and monitoring of IAS, development of specific action plans, and application of appropriate control measures to limit their spread and impact. Additionally, it promotes ecosystem restoration and protection efforts to rehabilitate damaged habitats, restore native communities, and conserve biodiversity in ecosystems impacted by alien species invasions.

Under Regulation (EC) No 1143/2014, all Member States are mandated to identify and manage pathways for the introduction and spread of IAS, considering that a significant proportion of such species are unintentionally introduced into the Union. These objectives are also outlined in the EU Biodiversity Strategy for 2030, published in 2020, aiming to ensure Europe's biodiversity is on a path to recovery by 2030, aligning with the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change. In the EU Biodiversity Strategy for 2030, the EU and all Member States committed to implementing more than 100 actions by 2030, supported by a tracking tool designed to monitor the status of projects and actions, ensuring progress toward the goals set forth by Regulation (EU) 1143/2014. As of now, a summary indicates that

50 actions have been completed, 46 are in progress, and 8 are delayed [30].

3.3 Innovative tools for managing the problems associated with the introduction and spread of invasive species. The species listed on the Union list are subject to restrictions and measures outlined in the Regulation (EU) 1143/2014. These measures encompass limitations on keeping, importing, selling, breeding, and growing IAS classified as of Union concern. Member States are mandated to address pathways of unintentional introduction, implement measures for early detection and rapid eradication of these species, and manage species that have already widely spread within their territories [8].

Another innovative tool for managing the challenges associated with the introduction and spread of IAS is the European Alien Species Information Network (EASIN), a platform developed and managed by the European Commission. EASIN plays a pivotal role in facilitating information exchange among EU Member States and contributes to coordinating IAS management efforts at the European level through a diverse range of tools and services [30]. This platform facilitates information on alien species occurring in Europe and supports the EC services and EU Member States competent authorities in the implementation of the EU Reg. 1143/2014 on Invasive Alien Species.

This platform includes an online database providing detailed information on IAS, interactive maps for visualizing their geographical distribution, and risk analysis and assessment tools. By utilizing EASIN, EU Member States and other stakeholders gain access to a centralized and up-to-date information source on IAS, aiding decision-making and policy development in invasive species management and contributing to the protection of European biodiversity and ecosystems.

IAS can be searched through a simple search, mapped by using multiple layer types, and geospatial data filtered by Data Partners and EASIN-Lit information [30]. Fig. 1 provides an example of the usefulness of the EASIN tool, which has allowed us, as can be seen, to classify EU Member States according to the number of IAS identified and reported by each country. As detailed in Fig. 2, the most threatened countries by the invasion of IAS are Germany, France, Norway, Sweden and Spain. On the other side, among the EU member countries less exposed to the invasion phenomenon are Bulgaria, Hungary, Poland and Romania.

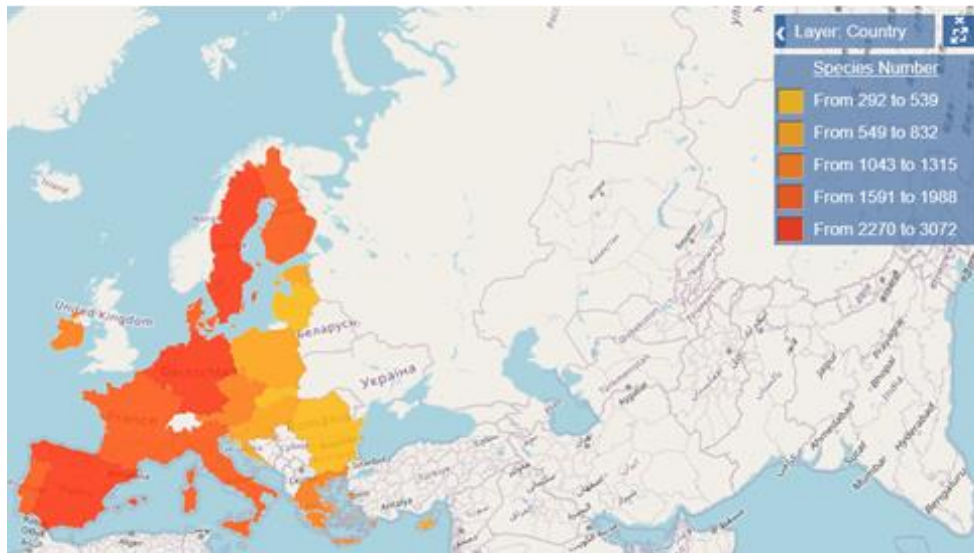


Figure 1. Mapping the invasive alien species found in the EU [34]

4. Challenges and future directions

Addressing the challenges posed by IAPS remains a critical endeavor for the EU as it navigates the complexities of biodiversity conservation and ecosystem protection. While significant progress has been made in research concerning IAPS, continued adherence to existing regulations, particularly Regulation (EU) 1143/2014, is essential to effectively address this issue. However, there is still a need to ensure that these regulations are rigorously followed to mitigate the detrimental impacts of IAPS on native biodiversity, ecosystems, and human well-being.

As detailed in the previous sections, the globalization of trade and transportation has significantly contributed to the introduction and spread of IAPS within EU territories [10]. With new trade routes opening and enhanced transportation, the number of species being introduced into new areas is rising.

A study published in 2017 highlighted that over one-third of all IAS introductions in the past 200 years occurred after 1970, exacerbating issues related to biodiversity loss, human health, and native species decline [23]. This underscores the need for strengthened biosecurity measures and early warning systems to intercept and prevent the introduction of invasive species into EU ecosystems.

Furthermore, the management of established IAPS presents a formidable challenge, particularly in light of climate change-induced shifts in ecological dynamics. Effective control, containment, and eradication strategies are

essential to mitigate the impacts of established IAPS, especially those expected to worsen due to climate change. The most cost-effective measure to address the impacts from IAS is to prevent their introduction [31]. This can be achieved by establishing effective and well-resourced biosecurity measures to manage priority pathways of introduction, supported by early warning systems and rapid eradication capacity.

Looking ahead, future directions in IAPS control and management in the EU will require innovative solutions and proactive measures to adapt to evolving threats posed by climate change. Embracing emerging technologies, enhancing international cooperation, and fostering public awareness and engagement will be instrumental in safeguarding EU ecosystems and biodiversity from the detrimental impacts of IAPS.

5. Conclusion

Invasive alien species are among the primary drivers of biodiversity loss and species extinctions. The concerns surrounding IAPS are paramount in the EU's efforts to safeguard biodiversity and ecosystem integrity, as evidenced by Regulation No. 1143/2014, the European Green Deal, and the Biodiversity strategy for 2030. While considerable progress has been made in research and policy development, continued adherence to existing regulations and the implementation of innovative strategies are essential to effectively address the threat posed by IAPS in a changing climate.

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