INVALIS
Interreg Europe

PROTECTING EUROPEAN BIODIVERSITY
FROM INVASIVE SPECIES

European Union
European Regional
Development Fund

Good practice guide on invasive alien species management tools

BUCHAREST-ILFOV REGIONAL DEVELOPMENT AGENCY

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INTRODUCTION

The **INVALIS project** aims to improve EU territorial policies on biodiversity and environmental protection, by promoting and supporting measures on the prevention, early detection, control and eradication of invasive alien species (IAS) in natural ecosystems. To accomplish this goal, INVALIS participating organisations are summoned to share good practices on various aspects and dimensions of invasive alien species management.

A good practice is a process or methodology that has proven (through experience or research) to work well within a specific context (geographical or organisation settings), has succeeded in achieving its strategic and operational objectives, and therefore can be recommended as a reference model. It refers to a successful experience, which has been tested and validated in practice and demonstrate high transferability potential. Good practices need to be disseminated and widely adopted to benefit a greater number of people or/and organisations.

The essence of identifying and sharing good practices is to get inspiration and learn from others, who have already faced and successfully overcome similar challenges, and to encourage the application of existing knowledge and experience to new situations. A practice, characterised as "good" should not be regarded as prescriptive or flawless, nor can it apply to all contexts and conditions. Instead, it needs to be adapted to the context to respond to site or organisation specific challenges.

This Good Practice Guide (GPG) presents 15 IAS management practices and tools, which have positively contributed to the detection, documentation, monitoring of biological invasions in partnership regions and across Europe, and hence can be used as reference models in similar endeavours. These practices include species databases and inventories, risk assessment frameworks, surveillance systems, reporting and monitoring applications and expert networks from across the EU-28.

The Guide aspires to assist project partners and organisations working on addressing biological invasions, to increase their efficiency by adopting tools (or components of them) which have proved to work well in similar contexts, capitalising on existing knowledge (without the need to reinvent the wheel). Any interested bodies will be able to study how these (successful) practices and tools function and eventually take on those that suit better to the needs and features of their territories – in all cases localisation and adaptation to individual needs is required.

The Guide is structured as follows. Section 1 describes the main categories of management practices and tools, commonly employed by invasive species practitioners and policy makers in the battle against invaders. Section 2 sketches the methodological framework upon the collection of IAS management practices by partners was realised. Section 3 outlines the approach employed for the identification of good practices, including a score table with evaluation results. Section 4 presents in details the most successful cases of IAS management tools (as collected by project partners), showcasing the results and accomplishments achieved.

1 CATEGORIES OF IAS MANAGEMENT PRACTICES AND TOOLS

This section outlines the main categories of management practices and tools typically employed by invasive species practitioners and policy makers in the battle against biological invasions. The focus is on information systems and registries that can be used to increase awareness on biological invasions and foster effective IAS management policies. Such practices and tools can essentially:

1. Improve the ability to track areas' invasion history (species databases and inventories)
2. Assess the risks and impacts of incursions (risk assessment frameworks)
3. Improve the detection of new arrivals and take prevention measures at source (surveillance systems)
4. Report sightings and track spatial distribution (reporting and monitoring tools)
5. Coordinate management and prevention efforts (expert networks)

1.1 Species databases and inventories

By definition, a database is a collection of data/information that is organised so that users can easily access, manipulate and update content. Invasive Species databases are searchable sources of information about species that are non-native in natural environments and adversely impact biodiversity. These databases may cover specific taxonomic groups (group specific) or have a more comprehensive scope addressing different taxonomic groups from micro-organisms to flora and fauna. Similarly, invasive species databases may be site specific covering a given natural ecosystem (e.g. a forest or a marine protected area) or have a broader geographical focus to cover an entire country or continent.

Their overriding purpose it to track and keep record of the introduction and spread of invasive species in natural ecosystems so as to facilitate effective prevention and management activities based on scientific knowledge and validated data. This is because the capacity to respond to the prospect of biological invasions largely depends on the availability of accurate and updated information, easily accessible at the appropriate scale.

Species databases provide users (that may be policy makers, managing authorities, scientists) with the opportunity to see if a particular organism has any records of invasiveness, the scientific names and characteristics of alien species that have been introduced and established in a given geographical area, their documented or expected impact on biodiversity and ecosystem services, and possibly the different pathways and vectors through which they entered in natural ecosystems.

Examples of invasive species databases/inventories are the European Alien Species Information Network (EASIN Catalogue), the Global Invasive Species Database (GISD), and the European Alien Species Database (DAISIE). For instance, the European Alien Species Information Network provides a comprehensive list of invasive alien species reported in Europe. The inventory currently contains more than 15,000 taxa across

all types of natural ecosystems (terrestrial, freshwater and marine) and provides information for each taxon on the following categories: a) alien status (alien, cryptogenic, questionable), b) year and country of the first observation in Europe, b) native range, c) synonyms and common names, d) pathways and vectors and e) impact on biodiversity and human health.

1.2 Risk assessment frameworks

To effectively address the problem of biological invasions, it is pertinent to analyse the factors[1] that affect the introduction, establishment and spread of invasive species, identify potential risks at an early stage and suggest technically and financially justified measures to mitigate these risks. Broadly speaking, risk assessment refers to the process of estimating the probability and severity of an undesired event or hazard (e.g. biological invasions) based on an analysis on the influential factors, whilst considering measures to mitigate the risk.

For example, one way to predict and prevent the introduction of unwanted alien species is to study invasiveness records of these species somewhere else (more especially in neighbouring areas) and assess the risk to enter new lands or environments (since biological invasions is a phenomenon that is not limited to specified geographical borders and spread rapidly).

Risk assessment for invasive species is generally carried out to a) evaluate the likelihood of introduction of invasive species in natural ecosystems, b) gain insights on the main pathways and conveyances prior to establishment to guide decisions on prevention measures, and c) support decision making concerning the allocation of resources for the control or/and eradication of established populations including actions to alleviate impact on environment or human health.

Typical examples of risk assessment frameworks for ecological and biological stressors are the EPA risk paradigm, the EPPO scheme on Pest Risk Analysis, and the OIE risk analysis programme for animals and animals' product. The EPA risk assessment framework is the dominant paradigm in ecological risk analysis and can be applied to invasive species. The EPA analysis comprises three distinct phases a) problem formulation, b) analysis, and c) risk characterisation. "Problem formulation" is about defining the hazard to be analysed (e.g. biological invasions), including determining what ecological entities may be at higher risk and must be protected. The "Analysis" phase includes assessing the likelihood of the introduction and spread of invasive species (focusing on one or more potentially invasive species), discussing the threats associated with biological invasions and estimating the severity of negative impacts. Finally, the "Risk Characterisation" stage uses the results of analysis to determine the vulnerability to biological invasions and estimate the risks posed to ecological entities.

[1] Factors that determine natural ecosystems' vulnerability to the introduction and establishment of invasive alien species include invasion history, possible effects of climate change, range of possible sources of introduction, status of species or habitat under threat.

1.3 Surveillance systems

A surveillance system for invasive species is a system for detecting the arrival of new non-indigenous species and monitoring the dispersal of already established populations at a particular geographical area (e.g. protected area, country, macro-region, EU). Surveillance activities are usually carried out at high risk pathways and entry areas to prevent introduction at source such as:

- Entry points for tourist and commercial arrivals (e.g. airports, ports, and stations).
- Areas with economic activities or adjacent to facilities where alien species may escape or/and intentionally get released (e.g. aquaculture, zoo, pet shops, farms).
- Corridors for spontaneous spread (e.g. marine transportation corridors, canals, roads, coasts).
- Highly disturbed and ecologically sensitive areas.

These activities may take the form of field research (e.g. underwater visual surveys), official border controls, and quarantine measures (usually a combination of different surveillance activities) and are aimed at preventing and minimising the risk of introducing alien species that could become invasive and most importantly protecting particularly vulnerable areas with fragile natural ecosystems and native species under threat.

Surveillance activities, to be effective, should engage key stakeholders and civil society (e.g. tourism and shipping stakeholders, environmental organisations, local authorities), apply at a large scale to address all possible entry points and pathways, promote standardised procedures to collect, analyse and promptly disseminate information on new incursions, and coordinate with actors implementing similar surveillance or monitoring programmes in other areas to share information and guarantee rapid response actions.

An indicative example is the UK's surveillance framework for non-native invasive mosquitoes. This framework prescribes the mix of passive and active surveillance strategies (e.g. systems and structures for early detection, risk analysis, cross-jurisdictional & cross-tenure communication) to be employed for raising cross-border capability for the early detection to new invasive mosquito incursions and facilitate rapid response. Passive surveillance, including a national mosquito recording scheme and local authority nuisance biting reporting, are complemented with active surveillance activities such as larval surveys and mosquito magnets at seaports, airports, used tyres importers, and motorway service stations.

1.4 Reporting and monitoring tools

IAS reporting and monitoring tools have a key role in supporting effective invasive species management as they provide functionalities such as:

- Reporting sightings of known or potentially invasive species
- Monitoring the abundance and distribution patterns of invasive species, incl. population changes.

These tools are information systems designed to provide a better understanding of invasive species' introduction pathways, geographical distribution, and patterns of spread so that decision makers and

competent authorities are able to evaluate vulnerability status, identify the most appropriate management options, and estimate the consequences of newly introduced species on biodiversity and other socioeconomic aspects. For example, the spatial and habitat distribution of a given alien species can provide useful insights on which areas are most at risk of being invaded in the future.

IAS reporting and monitoring tools allow the organisation, management and visualisation of information related to invasive species. They compile and present large amounts of data in a format that is easy to understand and analyse. All information on IAS sightings is represented spatially on maps so that decision makers and competent authorities can pinpoint patterns and trends. Geographical presentation is realised thanks to Geographical Information Systems (GIS).

Reporting, the main function of these tools, works as follows. Users (e.g. scientists, members of environmental organisations, hunters, fishermen, citizens) submit sighting reports (usually online) for species they consider to be non-native to a natural ecosystem. Next, a scientific committee reviews their findings to approve or decline their submission. The species, verified as alien and invasive, are then catalogued to the tool's database and pinpointed on the map with a conventional sign.

IAS reporting and monitoring tools might have a different scope; they can be deployed for specific regions and types of natural ecosystems (aquatic or terrestrial) or cover specific taxonomic groups species (e.g. marine species). For instance, MEDMIS is an online information system, created by IUCN for reporting and monitoring marine invasive species in Marine Protected Areas (MPAs) across the Mediterranean Basin. Other examples of invasive species monitoring applications are Washington Invasive Smartphone App, Bugwood Apps – Center for Invasive Species and Ecosystem Health Mobile Applications and RINSE application "That's Invasive".

1.5 Expert networks

Dealing effectively with the problem of biological invasions requires multidisciplinary and cross-regional collaboration in research activities, scientific information exchanges and management of alien species. Scientists, researchers and other professionals with experience in environmental management and more especially with expertise on invasive species issues need to combine efforts to provide practical solutions to an issue that is not restricted by national borders and is not site specific. In this category, it is pertinent to include scientists and researchers that might not have a specific expertise on invasive species but with capacities and skills that can be utilised to halt biological invasions across the different stages of IAS management chain (i.e. prevention, detection, monitoring, control, eradication). These professionals may have managerial or technical skills that may be useful for purposes related to the design of communication and management protocols, the prioritisation of control and eradication actions, as well as the allocation of resources towards areas with more fragile natural ecosystems and communities largely dependent on natural resources.

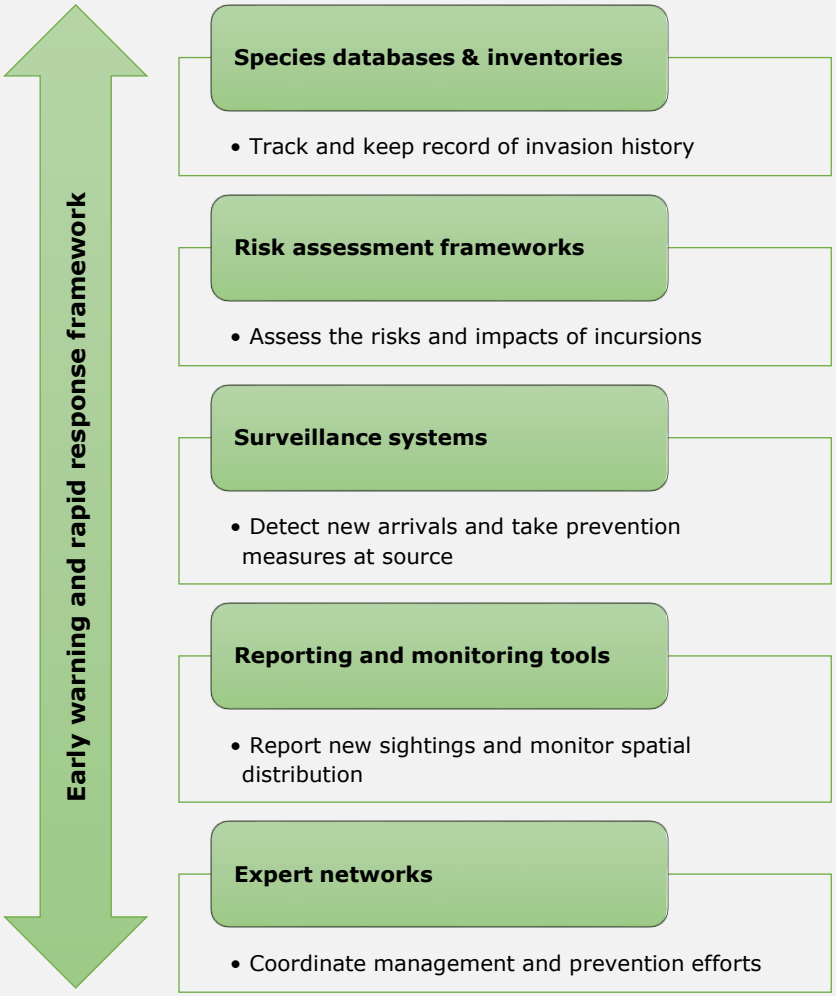
Invasive species management programmes are fragmented and infrequent and are mostly implemented at national or sub-national level.

This implies that the experience and knowledge acquired throughout research activities is distributed across different organisations and institutions even in the same country. Dedicated networks on invasive species seek to link and mobilise current expertise (even from different disciplines) in order to deal with biological invasions in a more collective and coordinated approach. They facilitate the exploration of alien species information from a variety of distributed information sources, promote the exchange of experience among participants, provide guidance to competent authorities to draw up action plans to tackle biological invasions, and support the implementation of projects to increase resilience of natural ecosystems across neighbouring countries.

Several networks on invasive alien species exist at the EU level such as the European Network on Invasive Alien Species (NOBANIS), the East and South European Network for Invasive Alien Species (ESENIA) and the European Alien Species Information Network (EASIN). For instance, EASIN is a dedicated platform devised by the European Commission to facilitate access to existing data on alien species reported in Europe. The platform brings together 19 expert registries, universities and environmental organisations from across Europe (e.g. IUCN, ELNAIS, GBIF) to deliver up-to-date information and mechanisms, to facilitate the implementation of the EU Regulation on Invasive Alien Species.

The aforementioned categories of invasive species management practices and tools can be components of a broader early warning and rapid response framework designed to respond to biological invasions.

Figure 1: Categories of IAS management practices and tools



2 METHODOLOGY OVERVIEW

2.1 Purpose and research details

The purpose of this research activity was to identify good practices that pertain to information systems and registries whose contribution to the detection, documentation, monitoring and management of invasive species is positive and well documented. The rationale behind the documentation of good practices is to share lessons learned, gather practical insights on how to improve and adapt strategies and activities through reflection and analysis, and implement large-scale, sustained and more effective interventions based on validated results and evidence.

The scope and details of this investigation are briefly described as follows:

- Thematic area: IAS management practices and tools
- Contributors: Participating organisations in the INVALIS project consortium
- Data collection method: Desk Research
- Data collection tool: Case documentation form
- Geographical scope: EU28 with a particular focus on the countries represented in the project consortium (Greece, Italy, Spain, France, Romania, Portugal and Latvia).

Data collection lasted for more than 1 month, from 1 April to 15 May 2019, in order to secure the sufficient collection of cases/practices from across the EU area. The Bucharest-Ilfov Regional Development Agency (ADR-BI) was the organisation in charge of coordinating data collection, informing about delays or shortcomings, and encouraging partners to collect as many cases as possible.

2.2 Data collection method

Good practices and case studies on invasive species management practices and tools were collected with the contribution of all INVALIS project partners through desk (secondary) research. Desk research involves the collection, sorting and synthesis of relevant information and data from previously conducted and documented research work. This approach was preferred so that partners can build on existing experience and available practices, and not duplicate research efforts every time they implement initiatives and measures targeted at invasive species. Desk research also bears the advantage of providing perspectives based on extensive and already validated evidence and data, which partners can filter and use only the parts the current research is targeting.

The identification of cases was made by:

- Reviewing national regulations, legislative acts, and action plans on biological invasions.
- Reviewing literature and experts' opinions on the issue.
- Examining similar research studies carried out in the context of other EU projects (e.g. especially projects under the LIFE+ programme).
- Searching evidence in relevant environmental agencies and information centres such as the US National Invasive Species Information Centre.

- Gathering information by interacting with scientists, academics and researchers from own region who have experience in environmental management and biology.

2.3 Case documentation form

This methodology delivered a structured documentation form to ensure a comparable presentation of collected practices. The form was common for all project partners, and intended to facilitate the documentation of relevant evidence and information (as retrieved from multiple secondary sources) and guarantee that all identified practices would be reported in a consistent and clearly structured manner. The case documentation form was made up of 4 core sections:

1. **Practice identification**. This section provides the context of the practice, addressing the following issues:
    - Category of IAS management practice
    - Geographical scale
    - Location
    - Ecosystem(s) covered
    - Start year
2. **Practice description**. This section seeks to answer the following questions:
    - What is the practice about?
    - What was the problem that needed to be addressed?
    - What are the main objectives?
3. **Implementation of the practice**. This section seeks to answer the following questions:
    - What are the main functions of the practice (e.g. detection, reporting, monitoring)?
    - Who created/launched the practice? Who are the key actors involved and support its operation?
    - What were the financial requirements? How was the practice funded?
4. **Results and transferability potential**. This section seeks to address the following questions:
    - What are the concrete results achieved with regards to outputs and outcomes?
    - How has the practice benefitted the management of invasive species?
    - What are the main features that make the practice transferable?

3 IDENTIFICATION OF BEST PRACTICES

The methodology defined a set of minimum quality requirements and evaluation criteria to guide the assessment of cases delivered by project partners on a "good practice" basis. Overall, a good IAS management practice can be defined as a tool or process that a) is suited to the priorities and policies related to the detection, reporting, monitoring and management of invasive species (relevant), b) has positively contributed to the fight against biological invasions (impactful), c) has a forward-looking orientation and can be sustained in the long run with limited resources (sustainable), and d) can be easily transferred and applied to other regions and settings (transferable).

The identification of good practices was a two stage process. The first stage involved an initial screening to identify whether the collected cases meet the minimum quality requirements prescribed in the methodology and whether the accompanied data and information is complete and accurate. From the 41 cases gathered by project partners, only 24 satisfied the following minimum specifications:

- Cases pertaining to the categories of IAS management practices and tools defined in Section 1. Cases that do not fall into these categories (for instance biodiversity strategies, legal acts and policies on the management of biological invasions, eradication and control measures, and awareness raising and communication activities) were excluded from the analysis.
- Cases retrieved from the countries represented in the project consortium (Greece, Italy, Spain, France, Romania, Portugal and Latvia), and where relevant from EU-28.
- Cases have been replicated in other areas/settings, or demonstrate high transferability potential as they address common needs for invasive species practitioners across Europe and entail low deployment/implementation risks.

During the second stage, the cases that successfully passed the quality assurance and control process, were assessed on the basis of the good practice (evaluation) criteria with the aim to identify the 15 most successful ones. Tables 1 and 2 present the evaluation criteria, together with the classification of practices based on the score obtained. The cases that stood out as "good" and had the higher score, have been selected to be presented in the Good Practice Guide. Table 3 presents the scoring grid that has led to the identification of the 15 most successful IAS management practices.

Table 1: Evaluation criteria

Relevance This criterion measures the extent to which the identified case is suited to the priorities and policies related to the detection, documentation, monitoring and management of invasive species. In evaluating the relevance of the practice, it is useful to consider the following questions: - Are the activities and outputs of the case consistent with EU or national priorities for (ideally proactive) IAS management? - To what extent are the objectives of the practice still valid & up-to-date?
Impact This criterion identifies the benefits delivered and defines the extent to which the practice has positively contributed to the detection, documentation, monitoring & management of biological invasions. It also identifies whether the declared objectives have been met. The practice should have achieved results that are measurable & well documented.
Sustainability This criterion measures practice's ability to be maintained in the long run with the available resources. Elements that guarantee the continuation of a practice is long–term planning and forward-looking orientation, financial and institutional support, key stakeholders' engagement, stable organisational structure, and capable human resources.
Transferability This criterion evaluates whether the identified practice or tool, as carried out or with context adaptation, demonstrate strong evidence that it can be also effective for other taxonomic groups, environmental realms, and EU regions.

Table 2: Classification of practices

Classification	Description	Score
Poor	A practice that has neither reached its objectives nor produced measurable results and enhanced the fight against invasive species. A poor practice entails substantial constraints during implementation (e.g. cost) and poor results. Its relevance, effectiveness and potential for transferability for other taxonomic groups, environmental realms and regions cannot be proven.	5-9
Promising	A practice that has worked for a taxonomic group, ecosystem or a country/region and has produced some tangible, measurable results. A promising practice should be characterised by cost-effectiveness and show potential to be transferred in other regions or natural ecosystems.	10-13
Good	A practice or tool that has proven to work well within a specific context (geographical or organisation settings), has succeeded in achieving its strategic and operational objectives. A good practice should have brought positive results on the detection, documentation and monitoring of invasive species populations and demonstrate a sustainable and transferable approach.	14-20

Table 3: Scoring grid of good practices

No	Country	Title	Relevance	Impact	Sustainability	Transferability	Total score	Classified as
1	North and Central Europe	European Network on Invasive Alien Species	5	5	5	5	20	Good
2	EU	European Alien Species Information Network	5	5	5	5	20	Good
3	International	Invasive Species Specialist Group	5	5	5	4	19	Good
4	Mediterranean	MedMIS platform	5	5	4	4	18	Good
5	Italy	Decision Support System for American grey squirrel	5	4	4	4	17	Good
6	Greece	Ellenic Network on Aquatic Invasive Species	5	4	4	4	17	Good
7	France	Corsica Alien Network	5	4	4	4	17	Good
8	Romania	IAS early detection and monitoring system in Constanta	5	4	4	4	17	Good
9	Portugal	"Invasoras" platform	5	4	4	4	17	Good
10	Spain	Risk assessment & surveillance system for zebra mussel	5	4	4	3	16	Good

No	Country	Title	Relevance	Impact	Sustainability	Transferability	Total score	Classified as
11	Italy	Surveillance Framework for *Popilla japonica*	5	4	3	4	16	Good
12	Greece	"Is it alien to you? Share it"	5	3	4	4	16	Good
13	Spain	Surveillance System for IAS trade in Extremadura	4	5	3	4	16	Good
14	EU	"Invasive Alien Species in Europe" mobile application	5	3	3	4	15	Good
15	Latvia	Volunteering network "Do for Nature"	4	3	3	4	14	Good

4 GOOD PRACTICES ON IAS MANAGEMENT

4.1 European Network on Invasive Alien Species

The European Network on Invasive Alien Species (NOBANIS, www.nobanis.org) is a gateway to information on alien and invasive species in North and Central Europe. It was established in 2002 on an initiative of the Nordic Council of Ministers. Its establishment followed the recommendations came out of the Convention on Biological Diversity held in Paris (2002), calling for enhanced regional cooperation to efficiently tackle with biological invasions, which had been recently recognised as one of the greatest threats to biodiversity and ecosystem services with substantial societal and economic implications. The rationale is that regional cooperation can prove essential in fostering an integrated approach to IAS management that will allow to address common territorial challenges. Biological invasions are a phenomenon, which is not limited to specific geographical borders but extend across countries, as alien species by nature are breaking down the physical borders between regions and become invasive in environments with favourable conditions for their establishment and multiplication.

Mission

The primary goal of the network was to provide an array of tools of informative character for implementing and making more operational a precautionary approach against the unintentional dispersal of invasive alien species. In addition, the network of NOBANIS aims to gather and disseminate valuable information on invasive species from all partnership countries, share experiences and lessons learnt on the management of biological invasions, raise awareness on the devastating impacts of invasive species on natural ecosystems, native biota and local communities, and finally contribute to surveillance by serving as an "early" warning system.

Overall, NOBANIS can be regarded as a cooperation platform, which through information sharing, can assist competent public authorities in partnering countries to successfully deal with the eradication, control and mitigation of these species. The network was initially funded by the Nordic Council of Ministers. Through the years, the network has become financially self-sustaining. The necessary funds for its activities are

secured by voluntary contributions from organisations in participating countries, and EU funding programmes.

Functions

The NOBANIS network has developed a portal to provide users with easy access to information on biological invasions and species characteristics. The portal covers all the types of ecosystems and consists of the following sections.

1. **Country statistics**. The portal provides country statistics on invasive alien species. These statistics can be used by interested parties to identify species that are invasive at present and species that may become invasive in the future. It also provides information on how the species are introduced, their distribution at (spatial) scale, what habitats they may infect, what ecological and socio-economic effects they may have in the short and long run and references to relevant literature. More specifically, the database presents up-to-date information on: the number of alien species found in the country in question, categorising them as not invasive, invasive, and potentially invasive.
    - The number of alien species by habitat (natural ecosystem).
    - The number and type of alien taxonomic groups by pathway of introduction.
    - The number of alien species by pathway of introduction.
    - Trends in introduction of alien species per type of ecosystem.
2. **Marine Identification Key**. The "Marine Identification Key" section presents information on the marine invertebrates and fish presently known to be introduced in Nordic waters. This is to facilitate the detection and recognition of marine organisms that are alien and invasive in sea waters, and considered particularly hard to identify without advanced taxonomic knowledge. This section has been designed to allow scientists and biologists to supplement existing descriptions with new information drawn from scientific research, and report new marine species once detected in Nordic waters. The "Marine Identification Key" is primarily addressed to those involved in the management of invasive species and biodiversity in marine ecosystems and do not have advanced biological and taxonomic knowledge, but it can be useful to anyone with an interest in marine life.
3. **Species alert.** This section of the portal contains information on Invasive Species Alerts issued for the partnership counties. It is an integral part of the NOBANIS' early warning and rapid response framework, notifying national competent bodies of the incursion of a new invasive species, and guiding rapid response measures intended to eradicate or control the invasive species before they become established. This function also aims to encourage the reporting of additional sightings of alien species, and inform the public on species' range and potential impacts and on what actions may be required on their part to mitigate negative effects.
4. **Invasive species factsheets**. These resources are intended to assist public authorities and invasive species practitioners in their battle against biological invasions. These documents provide information on the biology (taxonomic group, native range), ecology

(habitat, reproduction, lifecycle, natural enemies, and dispersal) and distribution (history of introduction, possible pathways, occurrence status, population) of a specific alien species in the recipient ecosystems, at least as witnessed and monitored in the NOBANIS network. The factsheets present also the adverse impact of the examined species on natural habitats and indigenous species, including also the economic and societal consequences in local communities. In addition, each publication provides best management practices and specific examples for operational activities and measures, covering all the stages of IAS management process from prevention to eradication and control.

5. **Image gallery & catalogue of national regulations**. The portal features two additional sections to further support public authorities' efforts in addressing biological invasions. The first is a gallery with images of invasive species, as taken by local residents and professionals in their territory and confirmed by scientists from the NOBANIS network. The second function is an overview of national regulations on invasive aliens currently applied in the countries participating in the NOBANIS network. This is to guide alien species practitioners' further actions and management measures.

Results

The network has generated impressive results. To begin with, the NOBANIS portal contains more than 80 factsheets for the most common species that have been reported in partnership countries, covering both animals and plant as well as microorganisms. It has also published 12 identification keys for marine organisms. The NOBANIS network has developed a (continuously growing) register of invasive species experts, a repository with academic publications on IAS management, and a catalogue with national regulations and legal acts on biological invasions from 20 countries, which over the time, have turned into searchable databases and valuable sources of information for scientists, environmental organisations, public authorities actively involved in the field of IAS management.

The network has also contributed, by providing scientific knowledge and information on invasive species, to 12 international programmes and projects within the same thematic area, including Global Invasive Species Programme, GloBallast, The Non-Indigenous Aquatic Species Database Working Group, European Research and management Network on Aquatic Invasive Species, and the FAO database on introductions of aquatic species. Finally, the portal provides IAS statistics, at the moment, for 20 countries in North and Central Europe with more countries expected to join the network in the near future. Country statistics are regularly updated with new data and figures.

To conclude, all the above have positively contributed to the creation of a favourable and enabling environment for IAS management in North and Central Europe by improving the capacity of competent national and regional authorities to address IAS related issues, providing valuable information and building new knowledge proved to be critical in the battle against biological invasions, and raised the level of cooperation between key actors not only at national but also at transnational and cross-regional

level. This has helped to employ a proactive and coordinated approach to IAS management though active information sharing, making partnership territories more resilient to new invasions and better mitigating the impacts of established populations. The network was largely responsible for raising public awareness on the threats and socioeconomic ramifications of invasive species, and was also a catalyst (mostly through the early warning system) for increasing participation of local communities in IAS related activities.

Transferability

The network currently brings together public authorities and invasive species practitioners from 21 countries from North and Central Europe, and seeks constantly ways to expand with more countries from across the continent, with an inspiration to emerge as a Pan-European network for information sharing on invasive species. The network demonstrates high transferability potential as the needs addressed are common among EU regions (considering that biological invasions is a universal threat) and incurs low implementation risks. What is more, other regional and national networks such as the ESENIAS (East and South European Network for Invasive Alien Species) and Invasive Species Ireland, have used NOBANIS as point of reference.

4.2 European Alien Species Information Network

The European Alien Species Information Network (EASIN, https://easin.jrc.ec.europa.eu/easin) is an initiative of the Joint Research Centre (JRC) of the European Commission. It brings together 22 partners from across Europe to develop an integrated information system that facilitates the exploration of existing alien species (including those which are invasive) from distributed information sources through interoperable web services. The Joint Research Centre has established a data discovery portal for the implementation of EASIN. This tool intends to provide the information that officers and scientists need to support decision-making and guide management measures. Such information may include the distribution of alien species, introduction pathways, invasiveness records, indicative management solutions, and impacts on native biota. The portal features diverse reporting tools and web services to facilitate exploration, visualization, and best use of existing alien species data.

Mission

The network was established in 2012 upon the recognition of the increasing serious threats posed by biological invasions for natural ecosystems and local communities' social and economic fabric. It provides easy access to data and information on alien species in Europe, aiming to support public authorities' efforts to deal with biological invasions in an informative way. EASIN has been recognised by the DG Environment as the most comprehensive information system on biological invasions in Europe, and is used as a source of reference for the implementation of the EU Regulation on Invasive Alien Species. The network is directly funded by DG Environment and JRC Institutional Fund.

Functions

The EASIN portal features 3 web services: EASIN catalogue of invasive species, EASIN literature, and EASIN notification system.

1. **EASIN catalogue.** The catalogue of invasive species is the core of the EASIN. It is a comprehensive database of all alien species reported in Europe (across all types of ecosystems), as provided by 43 different information systems/sources. The catalogue provides species-specific information such as taxonomic classification, vectors of introduction, year and country of first invasion, and native range. All data included in the catalogue has been validated by external experts and scientists. Users can also retrieve spatial

information for alien species distribution. The portal allows to extract occurrence records and distribution maps per country and at terrestrial, river basin & marine ecosystem level.

2. **EASIN literature.** The portal features a geo-database that provides access to spatial data on species distribution as published in scientific literature and different technical and environmental reports. Due to the vastness of literature available and the continuous release of new publications, the repository is regularly updated. EASIN–Lit is connected to the main catalogue so as to provide more accurate spatial information on the distribution of identified alien species in Europe and surrounding sea basins.
3. **EASIN notification system.** The network has developed a tool to facilitate the timely notification of new sightings of alien species of Union concern, and suggest at an early stage appropriate eradication & control strategies. It is used by Member States' competent authorities to notify the EU Commission & other Member States on new detections once they are reported in own territory.

Results

EASIN gathers 22 data partners from across Europe with scientific excellence and substantial contribution to the management of biological invasions, such as the Norwegian biodiversity information centre, IUCN MedMIS, the Global Invasive Species Information Network, and the UK national biodiversity network. The network has also 10 collaborating experts to support network's operations and secure the validity of information provided. The EASIN catalogue compiles information from 43 online information systems: 7 with global coverage, 2 with European coverage, 5 with macro-regional coverage, 26 with national coverage and 3 with regional and local coverage. The catalogue contains information for over 14,000 taxa alien species in 49 European and neighbouring countries. In total, over 53 million occurrences of invasive species have been reported, so far, in EASIN featured databases. In addition, EASIN-Lit provides information from about 230 publications, including geo-referenced records for 236 species and country-level occurrences for 3105 species. Finally, the EASIN notification system has been appointed by the European Commission as the official tool for Member States to report the new detections of invasive species of Union concern (Reg. 1143/2014).

Transferability

EASIN is the most comprehensive information system, currently operating in Europe. It is administered by the European Commission, and is widely used by national competent authorities in support of policy measures on biodiversity and invasive alien species. While EASIN demonstrates high transferability, the rational choice would not be to create a similar structure at national or regional level but to link all existing databases and inventories that are fragmented and sporadically distributed in different EU countries with the EASIN central catalogue. This will help to create a common one-stop information shop for all interested partied in Europe, paving also the way for coordinated actions and management measures.

4.3 Invasive Species Specialist Group

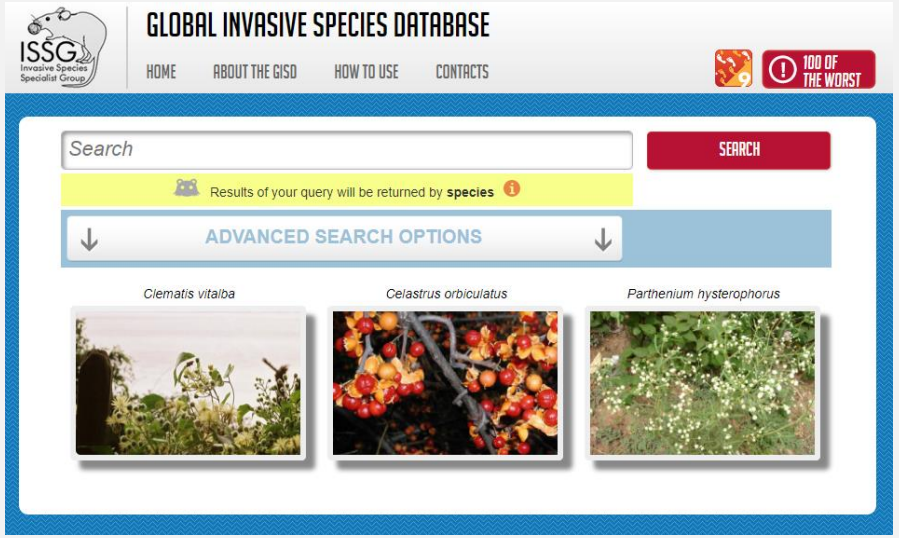
The Invasive Species Specialist Group (ISSG, www.issg.org) is an international network of scientific and policy experts on invasive alien species, organised under the auspices of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN). The network promotes and facilitates the exchange of alien invasive species knowledge across the globe, to ensure the connection between scientific knowledge and policy making, fostering informed decision making.

The Group was one of the very first endeavours of the international community to deal with the problem of biological invasions. It was established in 1994, at a time when invasive species was only an issue of discussion and study area for a small group of biologists, and little attention paid by national governments. The Group currently has 196 core members from over 40 countries around the globe and a wide informal international network of over 2000 conservation practitioners and experts.

Mission

The Group's strategic mission is to minimise the threats posed by biological invasions to natural ecosystems and native biodiversity by increasing public awareness on invasive alien species, and suggesting feasible ways to prevent, control or eradicate them. To achieve this, the Group is primarily focused on promoting information exchange and providing information-based policy and technical advice to invasive species practitioners and national competent authorities.

ISSG operations are funded by IUCN and contributions from core members. The Group is chaired by Dr. Piero Genovesi, who is the President of the Italian Institute for Environmental Protection and Research (ISPRA).



Functions

The Group performs 3 key functions: information exchange, delivery of technical and policy advice and networking.

1. **Information exchange**. ISSG has devised several mechanisms and tools to facilitate data and information exchange such as the Global Invasive Species Database, and "Alien" newsletter. The Global Invasive Species Database is the core of ISSG tools and

publications. It is an online searchable inventory of invasive alien species which are harmful for ecological integrity and biodiversity in invaded environments, containing information on their taxonomy, ecology, invasion history and impacts. Its aim is to raise public awareness on the highest potentially impacting species and facilitate effective prevention and management activities by disseminating scientific knowledge and best practices to a global audience. The Group also publishes a biannual newsletter with articles on issues related to biological invasions. ISSG has also developed a range of thematic datasets that enrich existing knowledge and can be used as analytical tools by invasive species practitioners and policy makers to direct decision making and guide management activities. For instance, the Island Biodiversity and Invasive Species Database (IBIS) is focused on insular areas providing validated information on the occurrence, attributes, and impact of invasive species on native species and ecosystems on islands.

2. **Technical and policy advice.** The Group seeks to support informed decision making and a coordinated approach to IAS management by providing information based advice to policy makers and invasive species practitioners. Firstly, ISSG provides technical advice to invasive species practitioners to support their work (from an operational perspective) in managing biological invasions in infested areas, and updates IUCN Members on the latest developments in the field to support their participation in international fora such as the Convention on Biological Diversity. Secondly, ISSG provides scientific knowledge to national and regional competent authorities for developing effective policies and strategies to tackle biological invasions.
3. **Networking.** The Group facilitates linkages and collaboration between conservation experts and invasive species practitioners through "ALIENS-L"; a mailing list server with the contact details of subscribed (insightful) stakeholders. The server functions as a platform that allows registered users to share information on invasive species and conservation issues.

Results

ISSG, over the past 20 years, have contributed to key accomplishments in terms of policy support and advocacy:

- ISSG actively participated in the consultation process that led to the adoption of the EU Regulation on invasive alien species.
- Recommendations on management measures made by the Group have been endorsed in various international fora, including the CBD, the Council of Europe, and the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals –CMS, http://www.cms.int).
- ISSG were contracted by the CMS during 2012–2013 to complete an assessment on the impacts of invasive alien species on migratory species. The report resulted in the Resolution 11.28 'Future CMS Activities Related to Invasive Alien Species' that was adopted during the CMS Conference of the Parties (COP) 11.

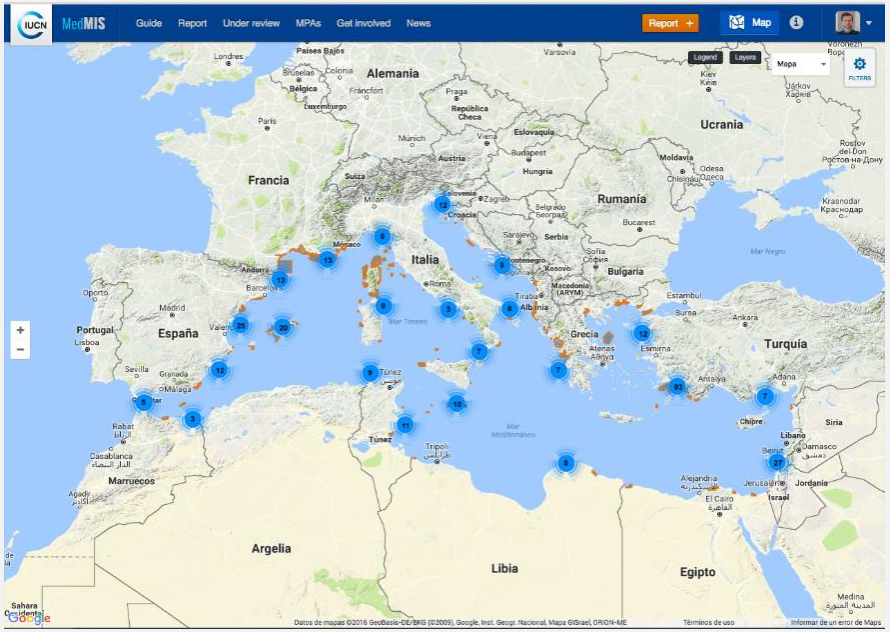
- GISD inventories are being used by several countries in setting targets, and measuring success of management and control options.
- GISD data and information from the archives of the ISSG shaped the baseline information for the assessment of development in the achievement of Aichi Biodiversity Target 9, in the review of the State of Conservation in Oceania (SOCO) report.
- The ISSG information products were key to the development of the global IAS indicators within the Biodiversity Indicator Partnership (BIP), which was published in the Global Biodiversity Outlook 3 and 4 (Secretariat of the Convention on Biological Diversity 2014), and in numerous other publications.

Transferability

ISSG is a global network of conservation experts with acknowledged contribution to policy developments in the field of biological invasions. ISSG can act as a source of inspiration for similar initiatives at national level; initiatives set aside to promote the exchange of invasive species knowledge between practitioners within the same country, and technically support public authorities in shaping strategies and articulating measures that can effectively address with biological invasions.

4.4 MedMIS platform

The MedMIS platform (www.iucn-medmis.org) is an online information system for keeping track of invasive alien species in Marine Protected Areas (MPAs) across the Mediterranean Sea. By taking MPAs as a reference, MedMIS works as an "alert system", which facilitates the reporting of suspected invasive species, after scrutiny and confirmation by experts.



These records are displayed on the map and stored in a centralised database, which contains information on the identified marine species that have invaded the Mediterranean Sea, their biological characteristics and identification keys, and their distribution on scale. These information are used by the managing authorities of MPAs to assess the extent of biological invasions in the area concerned and plan actions to prevent the settlement, expansion and potential impact of these species in the MPAs.

The MedMIS platform was deployed in 2012 in the context of the MEDPAN North project under the Mediterranean Program of the European Regional Development Fund. It is led by IUCN-Med and involves various organisations and initiatives such as the Réseau Alien Corse, Society for the Protection of Aquatic Ecosystem (iSea), Med Obs-sub Iniciative, MedPAN, and the Invasive Species Specialist Group (ISSG) of the Species Survival Commission (SSC), and has the financial support of the MAVA Foundation.

Mission

Over the last decades, pressure on the Mediterranean marine environment has increased at an unprecedented rate: over-exploitation of resources, habitat destruction, pollution and the increasing impacts of climate change. The introduction of invasive alien species has further enhanced these impacts, putting at risk the marine ecosystem and, therefore, our subsistence. To combat this situation, is necessary a better linkage between politics and science, as well as increase awareness and the participation of all those stakeholders involved in coastal and marine activities.

The platform, primarily addressed to MPA managers, was designed to support and coordinate the management of biological invasions in

Mediterranean marine protected areas by providing a service that will facilitate reporting and monitoring and act as a reference source for prioritising actions and programmes on the prevention of new introductions, and control of established marine invasive species. The data collected contributes to marine conservation by increasing the chances of stopping invasive species permanent establishment and thus limiting their potential impact on ecosystems rich in biodiversity. In particular, the objectives of the platform are to:

- Build awareness and capacity building.
- Prevent and reduce the introduction of invasive marine species or mitigate their impact, where possible, in MPAs and their surroundings.
- Promote active participation (diving clubs, amateur or professional fishermen, marine technicians, universities, networks, research centres, and businesses) in detection and management activities.
- Generate knowledge on invasive marine species and the biological, economic and social importance in the Mediterranean.
- Provide a long-term centralised database on marine alien species to joint efforts at national/international level.

Functions

The platform serves 4 key functions: reporting, monitoring, storing and sorting.

1. **Reporting.** Registered members of the platform that have identified the presence of an invasive alien species in a marine ecosystem should develop and submit a report that will contain the following information: at least one photograph of the observation, the possible scientific name of the invasive species seen, a location, the area where the observation took place, the range of depth, and the date. The report is then reviewed by MedMIS group of experts to confirm whether this species in native or not, and check the validity of evidence.
2. **Monitoring.** The platform provides the opportunity to track on the map the presence of invasive species in marine ecosystems, allowing thus to identify introduction and spread trends.
3. **Storing (database)**. The platform features a centralised database with all the invasive species reported since the application made live. It includes information on the location of observation and typical habitat (coordinates, the range of depth, abundance, ecosystem, benthic sediment) and provides key identifying features, accompanied by photos.
4. **Sorting.** Visitors can sort and extract data on the recorded presence of marine invasive species per Marine Protected Area and type of species (algae, fishes). Species reports can be downloaded for further analysis.

Results

The platform has achieved considerable and concrete outcomes in the battle against biological invasions in Mediterranean MPAs. The online information and reporting system covers 184 Marine Protected Areas that are distributed across 19 Mediterranean countries. The platform has a wide appeal to invasive species practitioners, maritime professionals, and local citizens. Over 35,000 users have visited the platform to retrieve

information on identified marine invasive species and/or report new sightings. The number of reported sightings exceeds 1160, and is constantly growing. In addition, the platform, based on information received and upon consultation and confirmation with field experts and biologists, has published a priority list with the highest potentially impacting species, to raise public awareness, facilitate identification in other areas, and guide management measures. Finally, the platform provides 51 identification factsheets of the most important invasive species reported in the Mediterranean Sea. To conclude, all the above have contributed to raise the level of cooperation between MPAs' authorities, maritime professionals & citizens, generate new knowledge in the field and increase participation in reporting activities.

Transferability

The platform shows high transferability potential. The needs addressed ae common among EU regions; further to this, this case entails low implementation risks and is based on standardised procedures and digital technologies. The platform can be used as frame of reference for deploying similar information and reporting systems at national or regional level. Relevant initiatives should not be limited to marine ecosystems, but cover terrestrial and freshwater ecosystems as well.

4.5 Decision Support System for American grey squirrel

The Decision Support System (DSS) for the control and management of the American grey squirrel in northern Italy was developed the period 2010-2015 in the context of the LIFE project "EC-SQUARE" (www.rossoscoiattolo.eu). The project arose from the need to preserve the European red squirrel, an endangered native species in North and Central European countries, which is severely threatened with extinction due to the rapid spread of the American grey squirrel.

Grey squirrel is a species with similar to European red squirrel biology, which was deliberately introduced in Europe (mainly for economic purposes), over the time adapted to local conditions, and now represents a serious danger for local biodiversity. The 2 species are in high competition for food and space (habitat). This means that the most resilient and strongest one will survive the competition (when co-existing). The grey squirrel can also cause extensive damage to trees through bark-stripping, which affects re-growth and natural tree reproduction in commercial plantations and other forest ecosystems.

Mission

The mission of the project (funded under the LIFE programme) was to halt the proliferation of the grey squirrel in 3 different regions of Northern Italy: Piedmont, Liguria and Lombardy, where the population of red squirrels is in a sharp decline. The primary goal was to elaborate a decision support system for the identification of the most efficient management strategy in each region, and to elaborate the most appropriate methods and guidelines for grey squirrel control and eradication. In addition, the project brings together regional administrations, universities and environmental organisations to:

- Assess the current status of occurrence and distribution of the grey squirrel in the areas concerned.
- Carry out conservation actions aimed to improve and restore natural habitats quality, increase food availability, and prevent forest fragmentation.
- Re-introduce red squirrels on selected sites to establish a minimum viable population, following the removal of grey squirrels.
- Limit or even forbid the trading of grey squirrels in the country, which is on the rise.
- Increase public awareness on the threats posed by invasive species to natural ecosystems and biodiversity, and different aspects of our social and economic life.

Functions

The Decision Support System consists of 3 main components: a current state analysis, a risk assessment framework, and a management plan.

1. **Current state analysis**. The first step was to define the current situation on the occurrence and distribution of the grey squirrel in the regions of Lombardy, Piedmont, and Liguria (Action A.3). At each site, where the presence of the grey squirrel had been verified, relevant data was collected through direct observation, with the use of hair-tube and photo-traps. This technique works by attracting animals inside artificial tubes, equipped with hair traps. When the animal comes in, it inevitably brushes against the tape, leaving hairs attached. This genetic material is then collected by trained scientists, and sent for laboratory analysis. Results revealed the taxon of species entered the tube, allowing to confirm grey squirrel's occurrence in different spots, and thus determine its population and dispersal across the areas in question.
2. **Risk assessment framework**. The project produced risk assessments for both the *Sciurus carolinensis* (grey squirrel) and *Callosciurus erythraeus* (red squirrel) at the European level. The risk assessment framework included 6 areas of study:
    - Active IAS introduction gateways and corridors in Europe.
    - Pathways of IAS introduction within specific ecosystems.
    - Probability of establishment based on climate, abiotic and biological conditions, taking also into account existing management activities.
    - Probability of spread based on climate, abiotic and biological conditions, taking also into account existing management activities.
    - Potential impact (economic losses expected in properties, facilities and plantations including costs associated with managing invasive populations, environmental harm on biodiversity, ecosystem functions, and conservation status, social impact including human health and quality of life).
    - Aspects of climate change that can affect the introduction and spread of invasive species.
3. **Management plan**. This contained the elaboration of a comprehensive action plan with specific objectives, measures and methods for managing the established population grey squirrel in the areas concerned and indicators for monitoring implementation and assessing measures' effectiveness. The plan also prescribed a series of conservation measures for the native red squirrel, as well as communication and educational activities for the public.

Results

The project generated substantial environmental benefits in the areas, where control and eradication measures were applied.

- The project removed grey squirrel from a total woodland area of about 3000 ha in the 3 regions. Re-colonisation by red squirrel was observed in some sites, following the completion of project activities.
- Different management strategies, tailored to site specific characteristic, were adopted based on current state analyses and risk assessment results.
- The project developed specific guidelines for the management of forest habitats, to improve the habitat quality and to increase woodland connectivity for red squirrel.
- The project managed to raise public awareness and sensitize local communities to become part of the effort against biological invasions through workshops in schools, meetings with regional stakeholders and citizens, presence in media and social media activity.
- Thanks to the project, a national trade ban on three non-native squirrel species, *Sciurus carolinensis*, *Callosciurus erythraeus* and the fox squirrel (*Sciurus niger*), was approved in 2012. This ban prohibits the trade, rearing and ownership of the above-mentioned species.
- The assessment reports produced for both the *Sciurus carolinensis* (grey squirrel) and *Callosciurus erythraeus* (red squirrel) have been appointed as reference documents for EU Member States.

Transferability

This case demonstrates high transferability potential. Relevant initiatives can be deployed by regional authorities to deal with specific species evidenced on sensitive sites, and which threaten endangered native species and can cause extensive damage to natural ecosystems. This case can be regarded as an identical example of how invasive species practitioners should deal with biological invasions, starting from a current state analysis to continue with risk assessment and ending with a comprehensive action plan with concrete management measures and targets. Other elements that make this case transferable is that the needs addressed are common across regions, and the demonstrated achieved benefits outweigh investment costs by far. Possible sources of funding for relevant initiatives are the EU's funding instruments for the environment and climate action (e.g. LIFE).

4.6 Ellenic Network on Aquatic Invasive Species

Recognising the need for national cooperation in research scientific information exchange and management of marine alien species in Greece, the Hellenic Centre for Marine Research established the Ellenic Network on Aquatic Invasive Species (ELNAIS, https://elnais.hcmr.gr/). The network (experts' registry) gathers over 80 scientists from 14 research institutes and universities, with diverse background, who actively carry out cutting-edge research on issues relating to aquatic invasive species in Greece. ELNAIS has developed an online information system to collect and report spatial information on the distribution of Aquatic Alien Species in Greek waters. The system is free to use by all interested bodies (e.g. policy makers and scientists) and provides easy and unlimited access to the latest publications and research results.

In a nutshell, the system features: a) a list with national and international projects on marine conservation and IAS issues, including latest news and developments in the field, b) the registry of Greek experts working on biological invasions, with contact details, research areas, and thematic focus, c) a comprehensive database with aquatic invasive species detected in Greek waters with information on their introduction data and pathway, as well as photos and dispersal maps and d) a repository of academic publications discussing biological invasions in the country. Data providers include primarily the scientific community (evidence are retrieved from past and ongoing research activities, and existing autonomous databases), and secondarily competent public administrations, local communities and civil society.

Mission

The Hellenic Centre for Marine Research formed the network in 2007 with the aim to provide a collaboration and networking platform that will foster information exchange at national level, stimulate joint research activities, guide informed decision and policy making, and most importantly set forward a coordinated approach to managing aquatic invasions in the country. Network's particular goals are to:

- Provide a sustainable and centralised database on marine alien species, to act as a point of reference for decision making and management activities.
- Prevent and reduce the introduction of aquatic invasive species or mitigate their impact, where possible, in MPAs and their surroundings.
- Promote active civic participation in reporting and management activities.
- Raise public awareness on the aquatic invasive species threatening freshwater and marine ecosystems, and affect relevant economic activities.

- Promote international cooperation and represent the Greek scientific community in international networks and fora.

Functions

The ELNAIS online information system supports 3 core functions: reporting, informing and monitoring.

1. **Reporting.** The main data provider is the scientific community. Information archived in ELNAIS database may come from different sources such as academic publications, annotated national species checklists, findings from field surveys and monitoring projects in Greek aquatic environments, independent databases (e.g. IMAS-Fish), circumstantial field observations and expert opinions. Citizens, divers, underwater photographers, amateur and professional shell collectors, fishermen and port authorities may also report new sightings on aquatic invasive species by sending photos of unusual species they consider to be non-native in the area of identification. In this case, a verification process where ELNAIS experts check the validity of the detected species is employed. The contribution of local communities has proven of paramount importance in monitoring biological invasions in Greek waters, having timely alerted the scientific community for the occurrence of harmful and highly invasive species such as Lagocephalus sceleratus.
2. **Informing (database).** The ELNAIS online information system features a comprehensive database (deployed in MS Access) with all the aquatic invasive species reported, so far, in Greece. For each species, the following information is provided: taxonomy, habitat types, origin, known or suspected mode of introduction, first sighting date, occurrence status (established, eradicated), and sources of information. Where available, images of invasive species are also provided to facilitate identification. Finally, the area of occurrence is archived in hierarchical levels (Sea: North Aegean, South Aegean, Ionian; Gulf: for the main gulfs; island complex: Dodecanesa, Sporades, Kyklades).
3. **Monitoring.** To address the need for monitoring distribution of species across the country, the sightings retrieved from literature and other sources of information have been georeferenced (relying on available info and coordinates) to produce geospatial maps for each species with its distribution in the country. For species that have punctual presence, the exact location is stored in the geodatabase in the form of point shapefiles. For species whose occurrence is not precisely defined in the literature (with exact coordinates) but spotted across a broader area, the data is stored in the form of line shapefiles for species reported in a coastal area and in the form of polygon shapefiles for species identified on marine ecosystems.

Results

ELNAIS has considerably contributed to increasing the available information on species occurrences in Greek waters, and supporting information exchange within the scientific community.

- The ELNAIS database contains 322 aquatic alien species (239 marine, and 83 freshwater) that have been detected in Greek waters over the years. Of these, 194 are classified as established (including 20 invasive), 69 as casual records, 28 as cryptogenic while for 31 species the establishment status is not known.
- A total of 315 academic publications on aquatic alien species are reported in ELNAIS database, from 1934 to date.
- A total of 559 scientists have contributed to the cited literature.

Overall, ELNAIS is considered to be the primary source of information for aquatic invasive species in Greece. It is widely consulted by public authorities when formulating biodiversity policies and strategies. In 2012, ELNAIS joined the European Alien Species Information Network, as a regular data partner. Its role is to provide information/data on alien species identified in Greek aquatic environments.

Transferability

ELNAIS' structure is similar with this of other macro-regional networks on alien species that exist in Europe such as NOBANIS, ESENIAS, DAISIE and EASIN. It brings together knowledgeable experts and researchers to address needs relating to biological invasions that are common among EU Member States, follows standardised procedures and entails low implementation risks. Besides, analogous ventures and initiatives have been documented in other EU countries such as Germany (Neobiota) and Spain (invaSIBER).

4.7 Corsica Alien Network

The introduction and proliferation of alien species in marine environments represents one of the most important menaces to biodiversity, ecosystem functioning and environmental sustainability in Corsica, having also serious social and economic implications for coastal communities. For this reason, in 2003, the Environemental Agency of Corsica (OEC) established the Corsica Caulerpa Network; an association of Corsican stakeholders specifically devoted to the monitoring of 2 introduced species *Caulerpa taxifolia* and *Caulerpa cylindracea*, which was on the rise at this time. The identification of new marine exotic species in Corsica made regional partners (Office de l'Environnement de la Corse, Direction Régionale de l'Environnement, de l'Aménagement et du Logement) extend this approach, to cover all brackish and marine water alien species, setting up the Corsica Alien Network (RAC).

The **Corsica Alien Network** integrates various invasive species practitioners, regional and local authorities, research institutes, universities, environmental organisations, divers, professional and citizens' associations, to help meet the need of timely identifying new invasions and acting upon, so as to prevent their establishment, and if this is not possible, at least to mitigate adverse environmental impact. The network is funded by the Regional Directorate for Environment, Development and Housing (known as DREAL) and Corsica Regional Government.

Mission

The overriding purpose of this network is to detect as early as possible any new arrival of alien invasive species along the coasts of Corsica, and monitor their establishment and distribution, so as to guide informed decision making and suggest appropriate management measures. Other objectives are to:

- Raise public awareness on biological invasions, and alert the public for their impact.
- Prompt local communities to participate in management activities, starting, at a first stage, from reporting to the network new sightings of invasive species.
- Support informed decision and policy making.
- Guide appropriate management measures to control invasive species' expansion across the Corsican coastline.

Functions

1. **Reporting**. The network has developed several tools and forms to assist stakeholders (e.g. citizens, recreational fishermen, divers) with the identification of invasive species and for collecting

data and reporting new sightings. To facilitate identification, the network produced and distributed 20 species identification sheets for the main taxonomic groups found in Corsican waters (e.g. Microalgae, Annelida, Tunicata). The identification sheets provide identical images of the species concerned, their scientific and common names, their geographical origin, and key biology and ecology features. Other information displayed in the sheets are the species' history of invasiveness, mode of spread and breeding, info on their natural environments and way of life (e.g. substrate, depth, eating habits, behavior, breeding), and major differences from similar species to avoid possible confusion. In addition, the network created a standardised form to aid citizens and stakeholders with the reporting of new sightings in the Corsican coastline. The form contains the following fields: i) coordinates, ii) location of observation, and iii) type and number of species observed. Observers need to fill in the form with all the information required and send it to the network together with images and/or samples from the species for verification. After receiving the form, scientists and specialists registered within the network are responsible for confirming the authenticity of the sighting. Once verified, the sighting is indexed in a geographic information system, which visually displays species distribution at scale.

2. **Active monitoring.** Following a huge number of reported sightings of the invasive crab *Percnon gibbesi* along the Corsican coastline, the network launched an active monitoring programme; a visual inspection of favourable habitats (mostly shallow rocky areas) for the identification and documentation of *Percnon gibbesi***.** Monitoring activities can take place either as organised field surveys on specific locations with the use of underwater viewers or by amateur swimmers and scuba divers who want to contribute with their observations in the monitoring procedure. For each sighting of *Percnon gibbesi*, the GPS system had been calibrated to provide the following information to the network's inventory of sightings: coordinates, depth, temperature of water, characteristics of the specimen (size, sex) and type of habitat.
3. **Dissemination.** At the end of each year, all the validated data is sent to the International Union for Conservation of Nature (IUCN) and uploaded in the Mediterranean Marine Invasive Species platform (MedMIS) for dissemination and communication purposes.

Results

Around 50 invasive alien marine species have been reported and validated in Corsica, so far. Most of the sightings came from researchers and invasive species practitioners. This is reasonable considering the difficulty of spotting introduced species if you are not familiar with diverse taxonomic groups. In contrast, the sightings made by other contingents such as divers and recreational fishermen, concerned species that are more advertised to the general public and hence easier to recognise. Only 2% of submitted observations have not been validated due to lack of

information or inaccurate data; 70% were validated from images provided by observers, and 20% by experts registered in the network. Concerning the monitoring of *Percnon gibbesi*, 12 sites have been surveyed in Corsica since 2017. Overall, 43 reported sightings resulted in the observation of 124 individuals over the whole period. The most impressive achievement of the network is that 20 diver+ clubs, 16 marinas and over 1,000 boaters took part in monitoring activities.

Transferability

This case demonstrates high transferability potential. The network addresses common needs relating to the identification and monitoring of invasive species in coastal and marine environments. The tools developed to facilitate the identification of species, data collection and reporting are applicable to different contexts and settings, with the possibility to cover all types of ecosystems. Further to this, similar monitoring activities can be launched in Marine Protected Areas and coastal and marine ecosystems across the EU-28.

4.8 IAS early detection & monitoring system in Constanta

Romania hosts one of the most valuable ecosystems at EU level, including nature reserves, national parks and nature parks and most importantly the Danube Delta Biosphere Reserve. Romania's protected areas total 1.6 million hectares, making it the richest EU country in terms of biodiversity.

According to a recent estimate, there are over 982 alien species reported in Romania. The most abundant group are plants with 490 species, followed by terrestrial animals with 390 species (of which 90% are invertebrates), and aquatic organisms with 102 species (44 freshwater and 58 marine). The big majority of alien species originate from North America and Southeast Asia, and most of them have been introduced accidentally.

Constanta County is the major entrance point of invasive alien species in Romania. This is mostly due to the intensive shipping activity taking place in the port of the city, on the western coast of the Black Sea. The above makes Constanta County an ideal place for studying alien species, and an intervention target area to focus national efforts in order to prevent the spread of invasive species (at an early stage) and mitigate the severity of the problem.

To support the fight against biological invasions, the University Ovidius (faculty of Natural and Agricultural Sciences) designed an early detection and monitoring system (www.specii-invazive.ro), which comprises a coordinated set of actions to identify, monitor and control potential invasive species in the Constanta County before they spread and take control over native biota.

Mission

The mission was to establish a system to facilitate the early detection and monitoring of invasive alien species in the County of Constanta. The main objectives were to:

- Develop, test and validate methods for identifying high priority species and at-risk sites.
- Study selected highly invasive alien species to understand their ecology and biology and evaluate their impact on native biodiversity and ecosystem functioning.
- Elaborate predictive models to assess IAS spread and distribution over time.

- Identify appropriate and safe eradication and control measures.

Functions

The system features the following functions and components to support early detection and monitoring of invasive alien species in the area.

1. **Data availability and accessibility.** It is important that data concerning biological invasions should be broadly accessible and easy to use, and all involved bodies have access to all available data without the need to look into different sources. To this end, the system features an integrated catalogue of the invasive alien species (from all types of ecosystems) reported so far in the region, consolidating data from different databases and research studies. To enhance data availability and in support of early detection, the system has also crafted a prioritised list with potentially invasive taxonomic groups.
2. **Research.** Research is required to understand and model the parameters that may contribute to biological invasions and identify the main pathways and channels of introduction, in an attempt to focus detection and surveillance activities. To this end, the system foresees field surveys for determining species density and monitoring distribution at scale, as well as the conduct of laboratory analyses for selected highly invasive and harmful species (e.g. *Amphibalanus improvises*", "*Corbicula fluminea*", "*Cameraria ohridella*"), seeking to understand their ecology and study possible interactions with native biota.
3. **Training.** It is pertinent for individuals to be engaged in the detection, collection and reporting of suspect invasive alien species to have sufficient training so that they are able to identify non-indigenous species, collect specimens for laboratory analyses and decrease the frequency of inaccurate reports and sightings of the same species. The system prioritises actions on training volunteers and professionals, including but not limited to workshops, educational materials, identification sheets and good practice guides for those working in corridors such as customs, ports, airports and border posts.
4. **Public outreach.** The system makes explicit mention on the importance to involve civil society in early detection and monitoring activities, and facilitate public understanding of the problem of biological invasions. To this end, the system features a web portal with all updated information on the topic of alien species in Romania. The portal contains, among others, a list with the most dangerous IAS in the country together with identification guides.

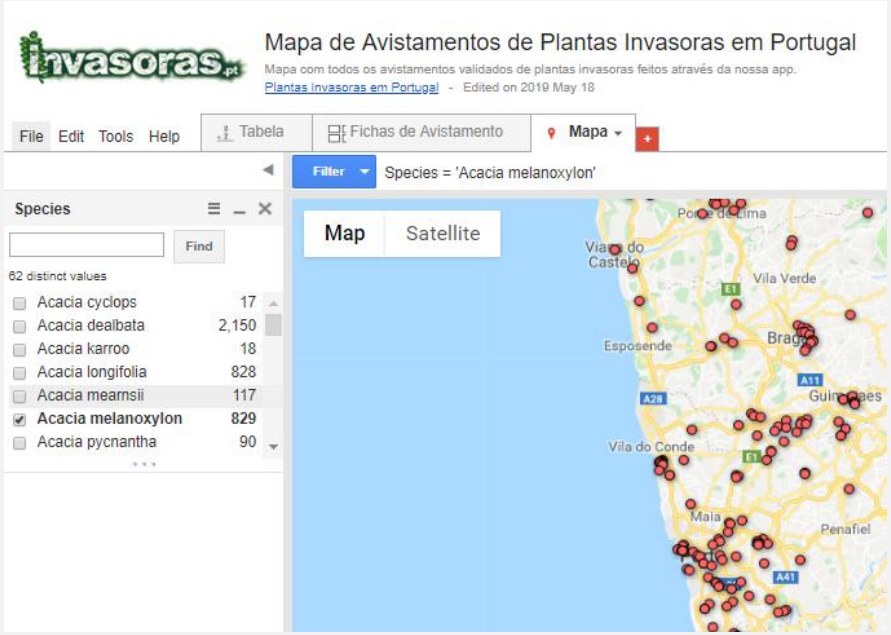
Results and transferability

The field studies carried out in the area of Constanta Port led to the identification of 430 vascular plant taxa, of which 107 taxa are non-native. Among the recorded alien plants, 45 taxa are invasive, 10 are naturalized and 52 taxa are casual. The above figures confirm that Constanta County is the major introduction pathway of alien species in the country, accounting for almost five times more alien plant species per area as compared to the whole country. Relevant actions resulted in 6

publications that have aided to assess the current status of biological invasions in the country and guide appropriate control and eradication measures. This practice can prove useful for regions that have not yet developed strategic frameworks (or they make their first steps) to address biological invasions in a holistic way. It is based on a standardised approach with step-by-step actions to define the situation at hand, set the ground for the effective management of invasive alien species in a coordinated and proactive way.

4.9 "Invasoras" platform

"Invasoras" is a national project (http://invasoras.pt/en/), launched in 2012 in Portugal, with the aim to halt the introduction and proliferation of biological invasion in the country. It is primarily focused on the alien flora in terrestrial ecosystems.



In mainland Portugal, over the last two centuries, and especially in more recent decades, the number of exotic species (including casual, naturalized and invasive) has increased significantly, currently amounting to about 670 species. This number corresponds to approximately 18% of the total native flora in the country. In the archipelagos of Madeira and the Azores, the number of exotic species is also very high, and on the rise. For the Madeira and Savage Island archipelagos, 430 exotic species have been recorded so far, a figure equivalent to approximately 43% of all the vascular plants found in these archipelagos. In the Azores, of the approximately 1000 species of vascular plants, around 60% are exotic. Several of the exotic species listed in Portugal are considered invasive, with considerable economical losses, huge impacts on biodiversity, changes in the ecosystems services and even public health issues.

The project has developed a dedicated platform (the main focus of the present case study), with several resources and functionalities to support the identification, reporting and management of alien flora in the country. In brief, the platform contains comprehensive profiles of the species considered invasive in Portugal, provides useful tools and information for managers, scientific community members and anyone interested in the topic, and offers learning material for environmental education.

Mission

Its mission is to raise awareness on the problem of biological invasions in Portugal, educating not only citizens but also managers, practitioners and scientific personnel on how to identify/recognise and control invasive species, and mitigate the associated impacts on biodiversity. The project pursues the following goals:

- To diffuse knowledge on the different invasive alien plants currently found in Portugal.
- To stimulate public participation in the detection and monitoring of new plant species.

- To support the implementation of control and eradication measures.
- To educate invasive species practitioners, scientists, and technical personnel on how to recognise, report, and monitor the occurrence(s) of invasive plant species.

Functions

The platform serves 3 key functions related to the management of biological invasions: a) detection, b) reporting and c) monitoring.

1. **Detection.** The platform features species fact sheets to assist stakeholders (e.g. citizens, environmental organisations, invasive species practitioners, scientists) with the identification of alien plant occurrences in the country. In particular, the platform provides factsheets on the main invasive plant species currently found in Portugal, with guidelines on how to recognise each species. These documents shape the profile of non-native species, providing information on their biology (taxonomic group, native range), ecology (habitat, reproduction, lifecycle, natural enemies, and dispersal) and ongoing distribution in the country (favourable invasion environments, history of introduction and possible pathways, and occurrence status). They also present the impact of species concerned on natural habitats and indigenous species, discussing also possible socioeconomic consequences. In addition, each publication prescribes a series of control and eradication methods (with details for its application) that could be applied for essentially restricting species' establishment and expansion. To further facilitate the identification of new incursions, the platform contains a comprehensive glossary (database) with descriptions and indicative images for all reported invasive (plant) species in Portugal.
2. **Reporting.** The platform provides different ways to report new sightings of alien flora. To begin with, stakeholders may submit a report with their observations on the platform by completing a standardised form with information on the location of observation (coordinates are requested), the date of observation, the degree of certainty they have that their evidence are accurate, the type of habitat, the density of observed species, and their stage of development. Observers are also encouraged to supplement their reports with images taken from the location of observation. The form is available at the platform's web portal. Alternatively, stakeholders can use the "INVASORAS" mobile application to register their recordings. The process is as follows. At a first stage, users need to select the species they have observed from a pre-determined list with 46 plant species commonly found in Portuguese natural ecosystems. To help users, the application provides detailed descriptions and identical images of relevant species. After selecting the correct species, users need to register their sighting, completing the special form and following the instructions provided by the tool. The tool recommends using a GPS tracker to record the precise location of the observation. In general, filling out the form is quick and not all the fields are compulsory. After being validated, the

submitted sightings (from both the web portal and mobile application) are displayed on the platform's map.

3. **Monitoring**. As previously mentioned, the platform features a geo-spatial map that contains all the validated sightings of invasive alien plant species reported by stakeholders via both the platform and the mobile application. In this way, users can monitor the distribution of the most harmful and invasive species across the country, discover if a species of interest has been sighted in their location, and explore if someone else has already spotted a species nearby and hence confirm their suspicions. The map allows users to apply filters for different taxonomic groups, to retrieve species-specific information on population and distribution, and display relevant dispersal maps**.** Only the last 500 validated sightings are displayed in the map.

Results and transferability

INVASORAS has substantially contributed to raising public awareness on the problem of biological invasions, increasing the available information on alien plant species occurrences in Portuguese terrestrial ecosystems, and supporting the identification and reporting of new sightings. The results can be summarised as follows.

- 47 plant species fact sheets
- Over 18,500 validated sightings
- 62 different invasive species in continental and insular terrestrial ecosystems
- Over 5,000 app downloads
- The app is rated with 4.2 in Google Play

To end with, this case demonstrates significant transferability potential. The network addresses common needs relating to the identification and reporting of invasive species, even though exclusively focused on flora. In fact, the resources and tools created to facilitate the identification of species, data collection and reporting can be applied to different contexts and settings, with the possibility to cover all taxonomic groups and types of natural ecosystems.

4.10 Risk assessment & detection system for Zebra mussel

The zebra mussel (*Dreissena polymorpha*) is an invasive species that has proliferated in rivers and lakes in Spain in recent decades. It arrived from the basins of the Black and Caspian seas, and is a serious environmental and socioeconomic problem for local communities. In areas where zebra mussels become prevalent, the macroinvertebrate community radically changes.

In some cases, zebra mussels have been deliberately introduced to increase water clarity in some aquatic environments (touristic destinations) as they are extremely efficient filter feeders. Most incursions, however, have been accidental, with many unanticipated impacts on a host of ecosystem services.

To survive, zebra mussels attach themselves to things like rocks, logs, and the hulls of ships, including native species. Many native mollusk species are at risk of becoming extinct or endangered because of zebra mussels. Even slow-moving crayfish have been found covered with zebra mussels. Zebra mussels can serve as food for some native species (e.g. waterfowl) and compete with others for space and food (e.g. native mussels). They also alter substantially the light and nutrient environment of marine ecosystems by filtering contaminants out of the water. Still, the toxins they filter out of the water are concentrated on their bodies and passed on their predators (both fish and birds) and then to consumers. Finally, zebra mussels clog water intake pipes. They colonize the edge of these pipes and eventually completely block off flow, creating substantial economic damage to water intensive industries and water treatment plants.

The problem is prevalent in the Guadiana and Tagus river basins in the Iberian Peninsula. To halt the loss of biodiversity caused by invasive zebra mussels, the Guadiana Hydrographic Confederation and Tagus Hydrographic Confederation in association with General Directorate for the environment, designated a risk assessment and surveillance framework to prevent the proliferation of zebra mussels.

Mission

The framework, developed in the context of the LIFE project "INVASEP", aims to achieve the following goals:

- Determine risk areas for the introduction of zebra mussels in the Guadiana and Tagus basins.
- Deploy cleaning and disinfection systems to prevent the introduction and spread of zebra mussels.
- Develop an early detection system.
- Inform and change the perception of local societies on the problem of biological invasions.
- Achieve effective cooperation among all bodies directly or indirectly affected by invasive species.

Functions

The framework consists of 4 components: risk assessment, eradication and control measures, early detection system and awareness raising.

1. **Risk assessment**. This includes the determination of risk areas for the introduction of zebra mussels in the Guadiana and Tagus river basins. Risk analysis of zebra mussels is inherently an interdisciplinary problem, involving ecology and economics. Ecosystem conditions and species' characteristics determine whether zebra mussels will establish itself in a new location and whether it will cause damage. Economic conditions influence the transport of zebra mussels, and influence the resources that are spent on preventing an invasion versus control after an invasion. Reasonable resource expenditure is, in turn, influenced by the expected consequences of the invader. Thus, ecological and economic parameters together define non-indigenous species risks providing the techniques that allow the most rigorous analysis possible. Accounting for the ecological and economic links and feedbacks is now critical in invasion biology. The research is focused on the impact on industry of reduced water intake efficiency caused by fouling of pipes by zebra mussels. Although lake-wide control of established zebra mussels is currently impossible, industry applies toxins to pipes to reduce fouling. The model to choose between alternative management strategies in terms of when and how often power plants should perform control efforts using toxins. As prevention of zebra mussel spread to uninfected aquatic environments is possible through public education and the management of boat traffic to consider how much society should be willing to pay to reduce the probability of invasion of currently uninvaded areas, to maximize the net benefits. In general, boat traffic is considered to be primary vector of zebra mussel spread. In the context of the project, a study has been carried out where the areas of greatest risk of zebra mussel introduction have been determined, preparing the corresponding introduction risk maps according to a series of criteria. Additionally, several studies have been carried out in relation to the risk of spreading the species once established in a basin wetland, as well as the mussel dispersion through the main channels and reservoirs.
2. **Disinfection systems**. Several control strategies for zebra mussel have been developed to mitigate the large economic impact of mussel fouling in industrial facilities that depend on water intake. However, for open water bodies these strategies are generally not suitable as they can be ecologically damaging, expensive, and ineffective. The only accepted practical approach for preventing and managing

biological invasions in open waters is thought to be prevention-oriented management measures including public outreach and education. The increasing use of public signage and wash stations at potential introduction points (e.g. boat launches) are typical examples. However, these efforts only limit the introduction and spread of invasive species, so control approaches are also needed to prevent, manage, and eradicate dreissenids in open water systems. To prevent the entry of zebra musselsinto the basins of the Tagus and Guadiana rivers, on their way through Extremadura, mobile disinfection equipment has been acquired for the cleaning and disinfection of boats and material related to sport fishing. This system is made up of a mobile-type pressure washer, which allows disinfecting boats and thus preventing thus the introduction of invading bivalves.

3. **Early detection system.** In order to detect the introduction of zebra mussel in adult state, two controls (a submerged pole and a buoy) have been placed in each of the reservoirs classified as of high and moderate risk (according to the determination study of risk areas of zebra mussels). These controls were installed in 21 reservoirs. The consortium also developed a protocol with instructions for the inspection of witnesses towards the early detection of adult zebra mussel in the Guadiana River Basin. In addition, for the detection of larvae of this species, continuous monitoring systems of zebra mussel larvae have been installed in 2 reservoirs of the Guadiana river basin.
4. **Awareness raising.** Brochures and merchandising material have been developed and distributed for sensitizing local communities and specific target groups that can act as vectors for new incursions about the need to disinfect boats before entering the rivers.

Results and transferability

Public authorities' efforts led to the following results:

- Definition of control points and barrier zones for preventing the spread of zebra mussels.
- Preparation of a protocol for the detection of zebra mussels' adults & larvae.
- Placement of 58 informative posters about zebra mussels.
- Installation of 6 mobile and 4 mixed disinfection stations.
- Placement of witnesses for detection of the species.
- Disinfection of over 1500 boats.
- Deployment of 21 early detection systems and 2 larval monitoring systems, across the basins districts.

The above activities have substantially contributed to a) maintaining zebra mussel-free basins, b) causing an attitude change among recreational fisheries and water sport clubs, and c) raising public awareness on the impact of zebra mussels and other invasive species reported in the area. To conclude, given that zebra mussels is an invasive species that have been only witnessed in rivers and lakes in Spain, the framework's potential to be replicated in other EU regions is quite low. All disinfection and monitoring systems are species specific. Still, the philosophy behind setting up a risk assessment and surveillance

framework for preventing the introduction and spread of an invasive species can work for all species and ecosystems.

4.11 Surveillance framework for *Popillia japonica*

The Lombardy Region in association with the Ticino Park launched in 2012 a surveillance program for identifying the introduction of *Popillia japonica* (Japanese beetle) and monitoring the distribution and spread of already established populations in natural ecosystems. *Popillia japonica* Newman, commonly known as "Japanese beetle" is a species of scarab beetle, native to East Asia. It is an invasive destructive pest of turf, landscape, and ornamental plants. It was accidently introduced to eastern North America in about 1911 and since then has become invasive in most of the eastern states, and in the southern parts of Ontario, Canada. The first incursion in Europe occurred in autumn 2014, when large numbers of adults were detected in Lombardy Region, near Milan, Italy.

The surveillance system was devised as a response to the rapid reproduction and high dispersal of *Popillia japonica* in the Lombardy region; its occurrence in Lombardy is associated with serious impacts on native biota (especially plants of high environmental value) and destruction of agricultural crops.

The framework comprises 3 surveillance strategies and procedures: a) systems and structures for the detection and monitoring of larval specimens of *Popillia japonica*, b) systems and structures for the detection and monitoring of adult specimens of *Popillia japonica*, and c) risk analysis and vulnerability assessment of surrounding sites currently uninfected by *Popillia japonica*.

Mission

Surveillance activities are aimed to a) assess the occurrence and proliferation of *Popillia japonica* in natural environments across Lombardy showcasing specific locations where the species concerned is in abundance, b) detect new incursions in sites previously considered to be uninfected, c) control and eradicate established populations where possible, and d) prevent new colonisations by protecting particularly vulnerable areas with favourable conditions for establishment and fragile natural ecosystems.

Functions

1. **Larvae monitoring.** Larvae monitoring is intended to identify the areas that have been infested by *Popillia japonica* and evaluate the extent of infestation. Monitoring activities comprise field surveys carried out in sites with high humidity such as grassy meadows (especially those irrigated) as they are the ideal environment for *Popillia japonica* to lay its eggs. In terms of timing (reproduction process), the eggs are deposited from June to October; larvae can be found in autumn, while at the start of winter all the larvae have reached their final stage of development. Larvae are found at a depth of no more than 20 cm, typically near the roots of herbaceous plants. Field surveys

may also take place in playgrounds and recreation spots with large grassy fields (at least 5,000 m^2), such as riding stables and golf courses.

2. **Adult specimens monitoring.** Relevant monitoring activities comprise visual inspections of adult specimens of *Popillia japonica* during the time period when larvae transform into their adult form by a process of metamorphosis and begin to fly. These activities help to specify infested areas and provide indications on species' population density. The adults are gregarious; they are attracted by odour trails that reveal the presence of receptive females or host plants. They are more visible on the vegetation during the cooler times of day. They feed on leaves, consuming the soft tissues while leaving the veins untouched. These signs of feeding are possible evidence of their presence. Further to visual inspections, adult monitoring includes the placement of traps in infested areas to facilitate captures and gradually lead to the eradication or control of established populations. Traps are equipped with GPS system that allows to track species' movement at scale.
3. **Risk assessment.** The system includes a procedure of identifying the sites and facilities within an infested area that are more likely to act as vectors of unintentional introduction (passive dispersal) of the invasive insect to areas that have not been previously infected. Sites at high risk may include car and truck parking area, loading and unloading docks, surrounding areas of factories or businesses, refuelling stations, areas where organic waste is stored temporarily and composting centres, airports, heliports, bus stations, railway stations, and wholesale markets. Risk classification is based on 3 parameters: a) site location; for instance a facility adjacent to an irrigated meadow with host plants entails a high risk of dispersal, b) degree of infestation; for instance a site located within a zone with seasonal captures of over 100,000 adult specimens is classified as high risk, and c) type and intensity of human/economic activity on site; for instance a site with sporadic or occasional loading activity is classified as low risk. Each site is assessed and classified by accumulating the scores values obtained in the 3 different assessment parameters. The risk status of sites within an infested area will guide the adoption of relevant control and management measures, to prevent limit their dispersal and prevent new colonisation.

Results

The surveillance system aided regional authorities to establish a comprehensive picture of the occurrence and density of *Popillia japonica* in Lombardy's natural ecosystems. Through monitoring activities, competent authorities managed to specify/confirm the areas (defining also their geographical boundaries) which had been infested by the species in question, assessing also the extent of infestation. The system produced a database with all relevant information generated during monitoring activities such as GPS coordinates and surface of infested areas/sites, population density and characteristics, names and addresses

of landowners, and bodies with administrative authorities in the infested area concerned. The system also benefitted the management of *Popillia japonica* by developing a code of conduct for infested areas to limit its dispersal and prevent new introductions, and guiding appropriate management measures to control or eradicate established populations (e.g. traps and application of pesticides). Finally, based on risk assessment results, regional and local authorities adopted a series of measures to minimise the likelihood of spontaneous, unintentional spread to uninfected areas. These included:

- Elimination of the vegetation the adults feed on, using mowers, herbicides and shredders or soil turning over.
- Special treatments using insecticides and/or other repellents.
- Artificial traps.
- Temporary partial or total closure of the site.

Transferability

Even though *Popillia japonica* is a species detected/evident only in Italy for the time being, the practice demonstrates high transferability potential across Europe. It provides a practical framework to define the geographic extent of species distribution, assess the risk of new incursions and prevent introduction at source, and guide appropriate management measures. It is based on standardised procedures, easily adjustable to territorial specificities. It can mostly work for plants, animals and pests in terrestrial ecosystems.

4.12 "Is it alien to you? Share it"

In 2016, iSea (https://isea.com.gr), an environmental organisation based in Thessaloniki, Greece, launched the citizen science project named "Is it alien to you? Share it!!!" with the aim to monitor the expansion and establishment of marine alien species in Greece and neighbouring countries in the Eastern Mediterranean (Albania, Cyprus and Turkey). The project is based on observations of non-experts that spend their time at the sea (divers, fishermen). iSea is licensed by the Greek Ministry of Environment to collect specimens of alien species and perform laboratory analyses, so as to better understand their ecology, assess their adaptability to local conditions, and study possible interactions with native populations.

Biological invasions represent a major menace to Greek marine biodiversity. More than 300 alien species have been detected in Greek waters. A number of these are considered particularly invasive, causing considerable ecological damage such as displacement of indigenous species, loss of genotypes, alteration of the structure of indigenous communities, change of food webs etc. Equally, biological invasions have detrimental effects on local economies in coastal regions across the country, as they affect fishing catches and tourism.

To facilitate the reporting of IAS sightings, the project created a dedicated **group** on FaceBook, which was gradually emerged as an important tool/space for reporting and monitoring marine non-indigenous species in the Greek Seas. Individuals can post pictures of alien species or marine species they have witnessed in Greek waters and they are not able to identify. All validated info and images are used by the project's experts and staff to keep a database on marine alien species, monitor invasive species' distribution at scale and learn more about alien species in Eastern Mediterranean.

The project is administered and funded by iSea, an organisation which works to maintain the biodiversity in vulnerable marine habitats, and return them to a healthy and productive, state for the benefit of local communities. iSea's activities focus on 4 main pillars:

1. Fisheries sustainable resource exploitation
2. Alien species
3. Human and Aquatic Ecosystems
4. Aquatic litter

Mission

The primary goal of the "Is it alien to you? Share it" tool is to facilitate the recording of the presence and distribution of alien species in the Greek seas, as well as to inform public opinion on the consequences of biological invasions to native biodiversity and sea-based economic activities (fisheries, aquaculture). Further to this, the group aims to a) stimulate information exchange and interaction between scientists and non-experts primarily concerned for the protection and quality of marine ecosystems, b) facilitate informed decision making, and c) prompt competent public authorities to take measures to mitigate the problem.

Functions

This practice serves 2 key functions related to IAS management: reporting and monitoring. The group works as follows. At a first stage, all individuals with an interest in marine biological invasions should register the project's FaceBook page. Once you become a member, you can post your observations of marine alien species, check the validity of your findings with other participants, and of course comment and discuss other member's findings. In each post, members need to report the area and coordinates of identification, the length or size of species (in centimetres), the depth of observation and substrate type (e.g. sandy bottom, muddy bottom, seaweed beds, rocky bottom, underwater caves), the type of observation (e.g. boat based fishing, scuba diving, shore photography), and the date of observation. Members are also encouraged to officially submit their observations by completing an online application form (available in 4 languages), which should contain in more details the same kind of information. The online form also contains a list with the most common invasive species in the Greek waters, to make easier the identification for users. Overall, the online form aims to collect information on the occurrence, the distribution and potential expansion of alien and rare indigenous species in Eastern Mediterranean. All evidence provided are checked and validated by biologists and experts. Finally, based on validated observations, the project has deployed a geospatial map with all the occurrences of marine invasive species in Eastern Mediterranean to help with monitoring. The map is updated on a monthly basis.

Results

The results achieved so far are really impressive.

- The group has crossed 7,000 members.
- The group has a high engagement rate translated into average 3 posts per day, 10-15 comments and over 15 likes per post.
- 1013 unique observations have been published so far, and the number is constantly increasing.
- 81 different marine invasive alien species
- 3 new invasive species in the Mediterranean, first time reported through the Group.

In addition, the project maintains long-term partnerships with key stakeholders directly related to IAS management like Marine Protected Areas Management Bodies, diving and fishing clubs, NGOs, Research Institutes etc., with the aim of informing the inventory of aquatic alien

species in Greece, and keep a close relation with scientific community. iSea is currently collaborating with the Ellenic Network on Aquatic Invasive Species (ELNAIS), the European Alien Species Information Network (EASIN), IUCN MED MIS, and the Marine and Environmental Research Lab.

Transferability

This case provides a practical way to engage local communities and citizens in reporting and monitoring activities. Social media are on the rise, and provide multiple opportunities for collaboration and interaction among individuals with same interests and concerns. They can also help to create buzz for the problem of biological invasions, and raise public awareness on the damage that invasive species can cause to local biodiversity and sea-based economic activities. In addition, they do not entail significant deployment and maintenance costs; what is required is only an administrator or a group of administrators to keep the content updated and moderate discussions and postings. The elements that make this case highly transferable is that the needs addressed are common among countries; it can work for all types of ecosystems and natural environments and finally it is based on software which is free to use and widely used worldwide.

4.13 Surveillance system for IAS trade in Extremadura

While the trade of pet species may represent opportunities for economic growth, it can also lead to the introduction and proliferation of invasive alien species, and gradually the overharvesting of rare and endangered endemic species. Released or escaped exotic pets may survive in the wild, become highly invasive and progressively dominate over the naturally controlled native species.

The autonomous regional government of Extremadura pays particular attention to the trade of pet species, which is considered to be one of the major potential channels of introduction of non-indigenous species. After the publication of the national catalogue of the most invasive alien species in 2014 and the issuing of regulations (e.g. RD 630/2013) prohibiting the commercialisation of alien species of national concern the same year, regional authorities established a surveillance system to minimise the risk of intentional or unintentional release of alien pet species.

The surveillance framework involves a mix of activities to prevent the introduction of non-indigenous species, merely focusing on monitoring and regulating the trade market. To increase the likelihood of reaching the goal of limiting illegal trade, regional authorities involved different key stakeholders in surveillance activities including pet retailers (pet stores, tree plant nurseries, plant shops), environmental agencies, civil society, police authorities and trading authorities.

Mission

The surveillance system pursues the following objectives: a) to inform economic operators (e.g. pet stores, tree plant nurseries, plant shops) who may act as vectors of exotic species' incursions, about the alien species included in the IAS catalogue of national concern, as well as the restrictions posed by national and regional regulations on keeping, importing and selling alien species, b) carry out regular inspections on pet stores, tree plant nurseries, plant shops to check whether illegal species are traded, c) track online sales of illegal wildlife and invasive alien species and related products.

Functions

The surveillance system is made up of 3 functions: a) informing retailers, b) inspections on physical shops, and c) monitoring online trade.

1. Outreach campaigns and information materials for raising public awareness on the problem of biological invasions in the Region of Extremadura, and the damages they can cause to biodiversity and social and economic fabric of local communities. Communication activities were mostly targeting at economic operators (retailers), who could act as introduction vectors; these include pet stores, tree plant nurseries, plant shops and zoo. Communication campaigns followed the publication of the national regulation that prohibits the trading of alien species (incl. endangered native species), which can be invasive and have detrimental effect on native flora and fauna. Regional authorities informed economic actors on the taxonomic groups contained on the national registry of invasive species, calling for immediate action to prevent their further expansion. Retailers were also informed about restrictions on keeping, importing and selling alien species, as well as the sanctions foreseen for illegal trading. Those who were trading invasive alien species (before the issuing of this regulation), were forced to handover them to competent regional services without any sanction. The overriding purpose of information campaigns was to sensitise local communities and invite economic actors to become facilitators and support the efforts made for tackling biological invasions in the region.
2. On-site audits and regular inspections on pet stores and garden centres were also conducted by the Nature Protection Service (SEPRONA) in association with regional authorities, to control for the occurrence and trading of invasive alien species. In addition, competent authorities requested from economic operators to supply their customers, who have alien species as a pet, with useful instructions on how to keep the pet healthy and adequately housed and controlled, in order to minimise the risk of acquiring diseases and released into the wild.
3. Regular online monitoring by SEPRONA civil guard, particularly from 2014 onwards, of online shops and e-commerce platforms based on Extremadura Region, to explore illegal online trade of invasive alien species. SEPRONA's role has been to detect advertisements for illegal alien species on the web, contact with online retailers to let them know about restrictions on trading these species, and ask them to withdraw such advertisements from all platforms they are exposed. Unless retailers comply with warnings, SEPRONA in conjunction with competent regional authorities undertake to remove/delete such advertisements, and impose sanctions on offenders. In addition, SEPRONA proceeded with blocking code words used to describe illegal species and related products. Overall, SEPRONA's research into the online retail community reveals that the trading of wildlife and alien species has shifted away from online retailers to social media platforms.

Results and transferability

Major retailers in Extremadura Region, who previously ignored the problem and consequences of biological invasions, have now become important allies in public authorities' efforts to stamp out illegal alien species trade. Their contribution has resulted in a sustained decrease in the commercialisation of such species. For 2014-2018, regional authorities inspected 72 pet stores and 57 tree plant nurseries and garden centres across the Extremadura Region. No evidence for illegal trading of alien species were recorded during on-site investigations. The following alien species were collected from public green areas:

- 165 Florida Turtles *(Trachemy scripta)*
- 1 Monk parakeet *(Myiopsitta monachus)*
- 12 Common waxbill *(Estrilda astrild)*
- 3 Chipmunks *(Tamias sibiricus)*

Finally, the number of online advertisements for illegal alien species fell dramatically, following regular inspections and the blocking of code words.

To conclude, this practice demonstrates high transferability potential, as the illegal trading of exotic pet species is a common source of alien species' introduction in Europe, and a growing threat to native biodiversity. Establishing a surveillance framework for monitoring trade activity does not incur substantial investment costs, but requires commitment, cooperation and active involvement of all relevant bodies.

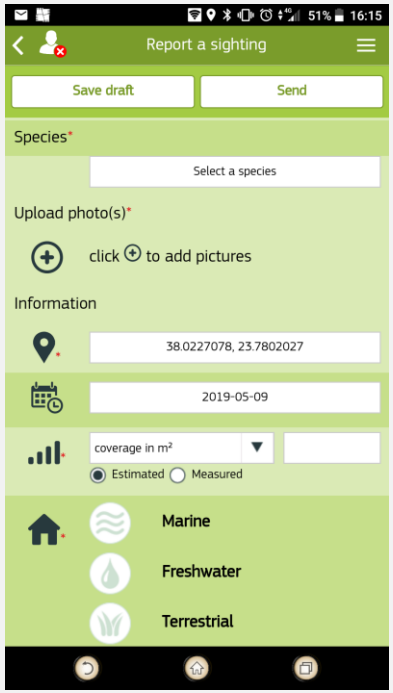
4.14 "Invasive Alien Species in Europe" application

The "Invasive Alien Species in Europe" application, powered by the Joint Research Centre (JRC), is a reporting and monitoring tool that enables EU citizens to receive and share information on invasive alien species. The application provides information about 49 invasive alien species listed as of Union concern, in an attempt to raise public awareness and facilitate identification. The application enables users to report IAS occurrences in their areas, and thus contribute to the early detection of new invaders. Based on users' input and sightings, the application generates maps that visually display species' spatial dispersal across Europe. This can aid the identification of invasion trends (critical to prevent new introductions and implement rapid responses), help to assess the extent of damage caused by certain species, and indicate environments which are more vulnerable to specific invasive species. Overall, the application invites EU citizens to become a part of the efforts made to confront the worst IAS in Europe. The application is currently available in 5 languages (English, German, Spanish, Italian and Romanian).

Mission

Dealing with invasive alien species requires international collaboration, harmonisation and sharing of data, and this is where the Invasive Alien Species Europe app comes into play. The application was deployed in 2017 by a private software company for the Joint Research Centre (JRC) of the European Commission, within the MYGEOSS project under Horizon 2020 research and innovation programme. The aim was to provide a practical tool that will allow to:

- Record invasive species occurrences by using citizen phones' GPS system and phones' cameras;
- Provide species specific information (taxonomy, habitat types, ecology, pictures), focusing on those species currently listed as of Union concern
- Foster public awareness on the problems caused by IAS in Europe and actively encourage EU citizens to get actively involved and contribute to the management of biological invasions.



Functions

The "Invasive Alien Species in Europe" app performs 3 key functions: informing, reporting and monitoring.

1. **Informing (database).** The application features a database with information on the about 49 invasive alien species, currently listed as of Union concern (Regulation EU 2017/1263). Species included in the database can be easily searched, filtered and visualised. The database has 2 core functions; first, it provides access to species specific information such as taxonomy, habitat types, ecology, invasion history and native range and second, it displays all available images of species (as provided by the Species Catalog) to assist users with their identification and avoid possible confusion with species having similar features.
2. **Reporting**. The application provides users with the possibility to report a new sighting of an invasive species of Union concern, using their phones' GPS system and camera. Users need to fill in a reporting template, a) specifying the species detected, b) uploading at least one picture of the species, c) defining its location, d) making an estimation of its distribution in m^2 or/and its population, and e) selecting the habitat type. The reported sighting will be uploaded to the application upon approval by JRC. Once checked for accuracy, the information is also included in the European Alien Species Information Network (EASIN) to complement existing information on the distribution of those species across Europe.
3. **Monitoring.** The application features a geo-spatial map that visually displays (at a spatial scale) all sightings of IAS of Union concern reported by users through the app. In this way, users can monitor the distribution of the most harmful species across the continent, discover if a species of interest has been sighted in their area, and explore if someone else has already spotted a species nearby and hence confirm their suspicions.

Results

The application has contributed to raising public awareness on the most harmful and dangerous invasive species in Europe, stimulating also the participation of EU citizens in the detection of new invasions. Since its deployment, over 100 sightings of invasive species have been reported by users through the application. Of these, 60 have been validated by experts, and are currently displayed on the map. Overall, the app has been downloaded over 1000 times and is currently rated by users with 4.6 in Google Play.

Transferability

"Invasive Alien Species in Europe" is a hybrid mobile application available for Android (version 4.4) and iOS (version 8). It is based on HTML 5, CSS 3 and JavaScript (widely used web technologies for software development) and its architecture is rather simple. Similar applications can be easily deployed using the aforementioned web technologies. Other elements that make this tool transferable is that the needs addressed by the application are common throughout Europe; it entails low implementation risks, as well as low funding requirements.

4.15 Volunteering network "Do for Nature"

"Daru labu dabai (Do for Nature)" is an initiative that aims to work with local communities and volunteers, to promote environmental protection in Latvia. The initiative is led by the Nature Conservation Agency and is funded by the World Wildlife Fund and by in-kind contributions from environmental organisations, private entities and volunteers.

Biological invasions are regarded as a major threat to biodiversity and ecosystem functioning, being responsible for the decline of native species and causing effects like bank erosion and soil degradation. In Latvia, 633 of the 1937 species of plants and seedlings found in nature are non-native. Most of these species are relatively peaceful, but some have become aggressive and have a negative impact on Latvia's natural environment.

The network is looking for volunteers to join efforts in the battle against invasive species. Volunteers should be passionate about nature and have a strong desire to contribute in conserving fragile natural ecosystems and keeping it clear of invasive alien species, for the benefit of native wildlife and local communities.

The experienced staff of the Nature Conservation Agency is responsible for recruiting and training volunteers, and for planning conservation actions across the country. Everybody can join and participate in such activities (enterprises, schools, families, sport teams), having the liberty to select the place and service they will offer according to network's needs in staff and resources, and own capacities.

Practical work is combined with capacity building activities, awareness raising campaigns, recreational opportunities and excursions in Latvian nature.

Mission

The initiative seeks to create a sense of cohesion between public authorities, environmental organisations, volunteers and local communities and set forward a participatory and coordinated approach to IAS management. The aspiration is that local community participation and volunteering will sustain over time, making this a sustainable long-term solution for the management of invasive species. Overall, the initiative aims to halt the proliferation of invasive alien species, by raising public awareness on the problems biological invasions cause and engaging local communities in reporting, control and management activities.

Functions

The network provides a wide range of opportunities/ways for volunteers to contribute to IAS management, from invasive plant removal to reporting new sightings.

1. **Reporting.** Volunteers can report new sightings of invasive species, providing information on species' location, population density, ecology, natural habitat, and date of sighting. Volunteers should complete and send a purpose made reporting form together with photos of the species identified (if possible) that will help validate the findings reported. In addition, the network organises field surveys with the participation of volunteers in natural protected areas, looking for unrecorded invasive plant locations and monitoring how removal and control measures are performing.
2. **Control measures**. Volunteers are provided with several opportunities to actively participate in IAS control measures. The network forms working groups (from 10 to 100 individuals) for the removal of not-native plant species with the use of specialised machinery and hand tools. Relevant control activities are usually carried out in areas with large infestations, easily accessible, and with plantation that permits removal by hand or with a spade. Furthermore, volunteers can work alongside network's qualified staff to destroy nests and egg mushes, and set artificial barriers such as traps and repellents to mitigate the spread of invasive animal species. Volunteers can also assist with the application of herbicide for invasive plan control using knapsack sprayers or stem injectors. In all cases, the network takes care of the health and safety of volunteers, providing step-by-step instructions, protective clothing and safety equipment.
3. **Habitat restoration**. Volunteers can participate in activities for the recovery of (previously infested) natural areas after the successful removal of invasive species' populations. For instance, if dense stands of invasive plants have been removed from a site, this can leave behind nothing but bare open ground which may be prone to erosion and other natural consequences which place the native biota at risk. Volunteers can therefore contribute to land restoration and ecological recovery by doing things like tree planting, seeding with native grass/wildflower mix or planting native flower plugs.

Finally, the network actively supports volunteers by providing training and qualifications in outdoor first aid, pesticide application, trap installation, and equipment to use to tackle biological invasions.

Results and transferability

Over the years, the initiative achieved to bring together environmental organisation, businesses, public authorities and local communities to join efforts against biological invasions. Local communities are now part of the solution, and an integral part of the management process, actively contributing in all stages of IAS management chain (identification, reporting, control and eradication). Thousands of volunteers have so far participated in initiative's activities tackling invasive species in Latvia.

They originate from diverse target groups (businesses, schools, civil society organisations, professional associations, citizens, researchers). This can be seen as one of the most important achievements of the volunteer network, acting as a clear evidence of the initiative's universal acceptance within the society. Since 2017, the initiative has been actively supported and sponsored by the BTA Baltic Insurance Company AAS. To increase the public interest for environmental protection and make the initiative better heard, BTA donates EUR 0.25 from each real estate insurance product sold to support initiative's environmental protection activities. Further to this, BTA funded the development of the network' web portal so that possibly broader range of Latvian population can learn initiative's mission and activities. The company also encourages its staff to organise joint work sessions of nature restoration.

To end with, this initiative demonstrates high transferability potential. Similar volunteering initiatives are currently being implemented in several countries across the EU. Volunteering can essentially aid to embed invasive species management at local level, creating a long-term commitment and co-responsibility within the society.

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