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2 Seas Magazine

SPECIAL FOCUS

INTERREG IV A 2 MERS SEAS ZEEËN

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A cluster initiative:

SEFINS; Safeguarding the Environment from Invasive Non-native Species

2 Mers Seas Zeeën
INTERREG IV A
FRANCE - ENGLAND - VLAANDEREN - NEDERLAND

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Pavel Poc
is a member of the Environment, Public Health and Food Safety Committee, recently nominated as the Rapporteur for the proposed Invasive Species Regulation.

The European Commission has recently tabled a long-awaited proposal for a Regulation on Invasive Non-native Species. This proposal is directly focused on the prevention, early detection and rapid eradication of these species within Member States. It forms a solid foundation for future cooperation and coordination, including improved mechanisms for data sharing, use of uniform strategies between countries, and involving members of the public within this important work.

After much hard work, we are currently nearing the end of the legislative process. **The work conducted and the outputs supplied by collaborative European projects such as SEFINS are ideally placed to provide a source of extensive and up-to-date knowledge on the impacts and spread of invasive species,** which we hope will aid Member States in adapting to the new measures outlined in the Regulation. This information is critical for informing further discussion on the legislature with the European Parliament. Broad support is essential for effective implementation in the Member States.

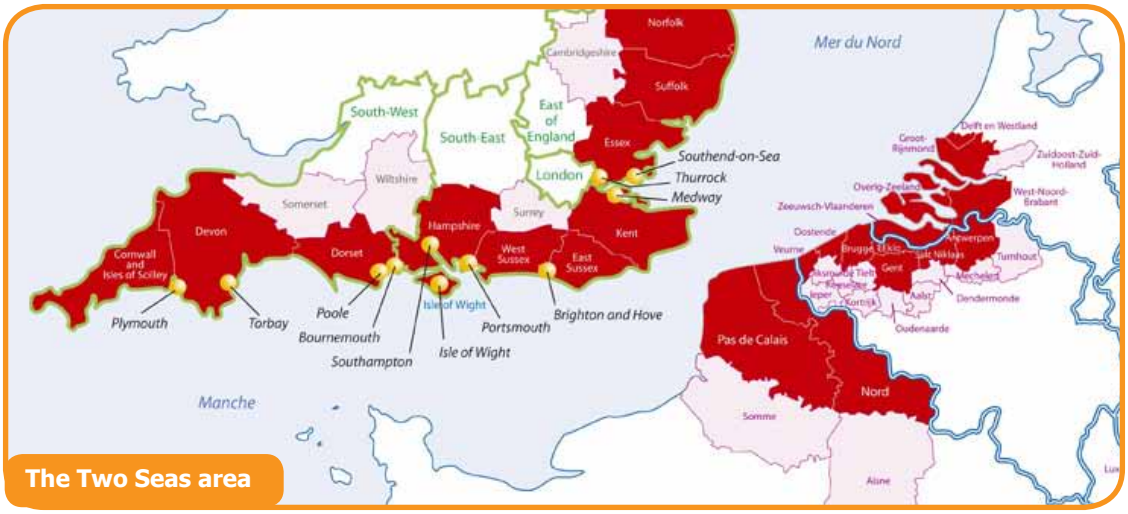
Cooperation needs to be swift and effective: without consensus, we will lose before we have even begun. **Cross-border efforts such as SEFINS and the preceding projects RINSE, MEMO and Invexo have played a key role in developing a united European front,** combining the resources and expertise of scientific and non-governmental organisations against the challenge of invasive species.

Pavel Poc
Member of the European Parliament (MEP)

Introduction

Field demonstration (France)

Invasive non-native species (INS) are species which have moved outside of their natural range, usually with the aid of humans, and are causing environmental or economic damage. At a global level, INS are believed to be one of the most significant causes behind loss of biodiversity – second only to habitat destruction. Their economic impact is also substantial. A recent study by the European Environment Agency (EEA) estimated that **INS cost Europe in the region of 12 billion Euros every year.** Despite the severe damage these species are causing, there is little in the way of a coordinated effort to reduce their impact and spread across Europe.



The Two Seas area

Over recent years a number of projects have sought to improve the management of INS across the Two Seas area, by bringing together research institutes, universities, local government, land managers, businesses and other relevant stakeholders to form cross-border partnerships. **RINSE (Reducing the Impact of Non-native Species In Europe) focussed primarily on INS within freshwater and terrestrial habitats.** It undertook a broad range of activities in order to share best practice across the region, develop new ways to manage INS, improve the capacity of local organisations to manage INS, prioritise INS already present in the region for action and identify species likely to cause problems in the near future. **The MEMO (Mnemiopsis Ecology, Modelling and Observation) partnership was composed of experts in marine INS and focussed on one species in particular – the American comb jelly *Mnemiopsis leidyi*.** This invasive jellyfish-like species was accidentally introduced to the Two Seas area and has since spread along the coasts of northern France, Belgium and the Netherlands. MEMO undertook a range of activities to assess awareness and perceptions of the jelly amongst key stakeholder groups and to increase our scientific knowledge on this species. **Invexo aimed to improve the management of four of the most damaging INS in Belgium and the Netherlands.** The project used field trials to improve control and eradication methods and developed an early warning system for high risk INS in the project area.

RINSE project partners

Discussions between partners from the RINSE, MEMO and Invexo projects indicated that added value could be created through the formation of a 'cluster' project, bringing together the expertise and the experiences gained from each of the three projects. **As a consequence, SEFINS (Safeguarding the Environment From Invasive Non-native Species) was established in January 2014.** Since then, the partnership has held a number of constructive workshops and meetings on the topic of INS. It was clear that despite each project working on different species in different habitats, there was a large degree of crossover. A number of key themes emerged, which the partnership agreed require further work in order to allow EU Member States to meet the new requirements of the upcoming European Regulation on Invasive Species:

1) **Knowledge transfer, training and advice**
2) **Data and inventories**
3) **Risk management and impact assessments**
4) **Citizen science and awareness raising**

This publication uses these **key themes as chapters,** describing in more detail the activities carried out by RINSE, MEMO and Invexo within these areas. Key outputs are summarised, outlining the significant progress made by the SEFINS partners and their previous projects towards the effective management of INS across the Two Seas area. However, there is clearly much work still to be done – this publication will also look forwards, outlining where we believe work on INS should focus in the immediate future.

RINSE

Memo

invexo
minder invasieve planten en dieren

CHAPTER 1

Knowledge transfer, training and advice

Best practice workshop, Flanders

Ensuring that relevant knowledge is shared between and within groups involved in the research and management of invasive non-native species is crucial to successfully mitigate and reduce the impact of the many species already present in the Two Seas area, and the large number predicted to arrive in the near future. In Britain, knowledge transfer has been facilitated by central coordination from the GB Programme Board for non-native species and its Non-native Species Secretariat (NNSS). Given the wide range of organisations involved in responding to non-native species across the three countries of Great Britain, this central coordinating mechanism has played an important role in building and maintaining links between policy officials, stakeholders, practitioners and researchers. The NNSS website has also provided a vital central clearing house for the dissemination of information, guidance and good practice developed by a wide range of groups across GB.

Despite improvements, there is still much progress to be made. While there are a number of excellent examples of knowledge transfer among and between practitioners and researchers, there is much to be gained by improving and facilitating this process. Initiatives such as the RINSE good practice workshop held in Ghent in 2013 show the benefits of bringing these groups together from across Europe - highlighting the shared issues we face and the lessons we can learn without duplicating effort.

As the drive to deliver real change in Europe increases, it will be more important than ever to ensure invasive non-native species management is effective and efficient. Improving knowledge transfer between practitioners, researchers, and across Member States, will increase the chance of delivering significant environmental, economic and social benefits at an international scale.

Olaf Booy,
GB Non-native Species Secretariat

Types of knowledge transfer

Management and research of invasive species involves many different sectors, including local authorities, government bodies, charities, universities, businesses and private landowners. Methods of knowledge transfer can be split into two main categories: **those that facilitate the sharing of knowledge within a sector (horizontal transfer) and those that facilitate the sharing of knowledge between sectors (vertical transfer).** In order for the maximum value to be gained from knowledge possessed by an organisation or individual, effective mechanisms must be in place to allow this knowledge to be shared in both directions. This problem is illustrated most clearly by the gap frequently perceived to exist between scientists and practitioners. **Often, scientific research is conducted seemingly in a 'vacuum'.** Practitioners may be unaware of the latest research, may not have access to it, or may simply find it irrelevant to their area of interest. Similarly, academic research does not always include those 'on the ground', delivering the day-to-day management of INS. Both communities have the potential to offer observations and information of great value to the other. Furthermore, the disconnect between academia and practice serves to obscure areas most in need of further research and funding. **Closing the gap between these sectors is key to delivering efficient management of INS in the future.**

The SEFINS partners agreed that establishing new mechanisms to facilitate knowledge transfer is a priority for work in this area. Among the approaches identified for horizontal and vertical dispersal of information were more effective training, enhanced online tools, improved integration of data management systems, an increased frequency of workshops and expansion of expertise networks in order to share best practice protocols and agree future research directions. Methods facilitating cross-border knowledge exchange are also in need of improvement. The Two Seas area covers a wide area, **which shares geographical and climate characteristics** and which is **interconnected by ever increasing cross-border trade and transport links.** This region is therefore a **hotspot for biological invasion,** however these connections mean there is much to be gained by linking stakeholders from across the region and opening communication channels.

Delivering knowledge transfer, training and advice

The Interreg projects represented within SEFINS approached the issue of knowledge transfer in different ways, largely as a consequence of how the project partnerships were composed. For example, MEMO consisted principally of academic institutions, leading to horizontal knowledge transfer strategies focussed on dissemination of outputs within this sector. RINSE and Invexo represented larger, more diverse partnerships, with

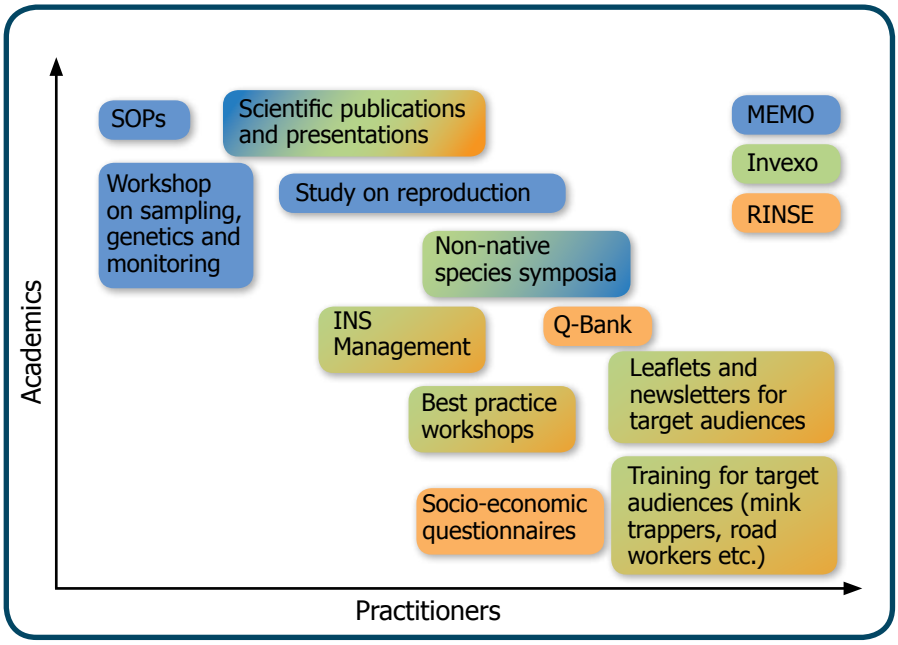
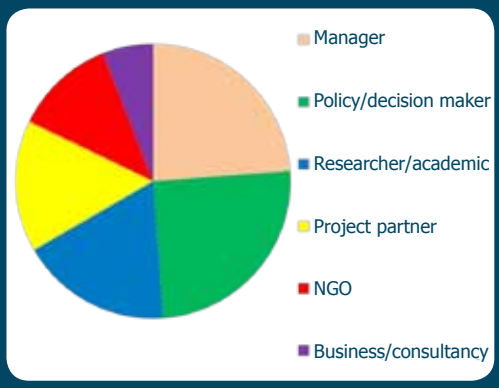
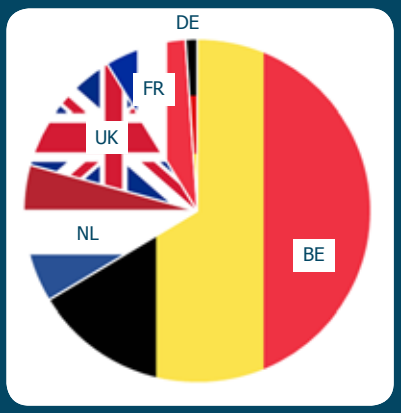


Figure 1: Horizontal and vertical knowledge transfer

CASE STUDY: Best practice workshops

Species such as Chinese muntjac deer and Canada goose are a growing ecological and economic problem across the Two Seas area. A two-day Workshop was hosted in Ghent by the Flemish Institute for Nature and Forests (INBO) and the Belgian project partner RATO vzw as part of the RINSE project. This attracted almost **100 participants from different backgrounds**, including managers (24%), decision makers (22%) and researchers (20%). Participants were also drawn from each of the countries within the Two Seas area, with almost **half of all attendees based outside of Belgium**. This success was due to the innovative and engaging Workshop Programme, consisting of case study presentations by experts in this area combined with live field demonstrations of management strategies. Participants were able to witness preparation, capture and dispatch of Canada geese as demonstrated by experienced professionals. Feedback confirmed this original Workshop format to be extremely beneficial to participants and of greater value than presentations alone. **Further information is available at www.rinse-europe.eu/resources**





greater emphasis placed on vertical movement of information between different groups and sectors. The differences in knowledge transfer are illustrated with examples of project activities in Figure 1.

All three projects consistently used **Best Practice Workshops as an effective format for knowledge transfer.** These brought together stakeholders from different backgrounds to discuss their experiences and to share information on particular issues. Best Practice Workshops are particularly suited to sharing knowledge across borders, giving participants **an opportunity to engage with people facing similar issues,** and the different methods used to approach them.

The MEMO project hosted a Best Practice Workshop in order to share advancements in sampling, genetic analysis and modelling techniques for the American comb jelly *Mnemiopsis leidyi*, an invasive ctenophore present in the North Sea which could cause problems for commercial fisheries and aquaculture. This targeted a highly specialised area of research and was intrinsic in the **horizontal transfer of the cutting-edge protocols** developed by MEMO across the scientific community. MEMO also organised a major three day conference on 'Non-indigenous species in the North-East Atlantic'. The conference was held in Ostend during November 2013 and brought together 62 key stakeholders from a broad range of backgrounds. Presentations were given by a range of experts, with take-home messages tailored to be of interest to all groups: scientists; policy-makers and practitioners.

The role of new technologies

The value of 'face-to-face' interactions in facilitating the transfer of knowledge between individuals is clear. **Traditional media and communication techniques can also be reimagined and used for knowledge transfer** with great effect. The Invexo project produced perhaps one of the most **original examples** of knowledge transfer in the


Canada geese

form of a cookbook, outlining a variety of recipes for dispatched invasive geese which are often available in Belgium. However, new technology is playing an increasingly important role in this area. RINSE, MEMO and Invexo all utilised new technologies to connect with external audiences to some degree. Each project used **websites** to disseminate key outputs, published **online project reports** and produced frequent **electronic newsletters.** RINSE also engaged with the general public on **social media,** via networking sites such as **Twitter and Facebook**, in order to **communicate messages to a wider audience.**

Mind the gap

An issue which has become apparent through discussions within SEFINS is that knowledge transfer needs improvement not only between sectors, but also across areas of interest within sectors. For example, in academia a 'silo' mentality can prevail, leading to marine experts failing to communicate to freshwater specialists. This can mean that valuable techniques developed for use in one habitat might not be transferred to another. It has also led to a **gap in the geographical coverage of scientific research on INS,** such as the **coastal and estuarine areas** where these two habitats meet. There is clearly great potential to use existing information and techniques to acquire new data in estuarine areas, however to achieve this we need to encourage **collaboration between the marine and freshwater realms.**

CASE STUDY: Q-bank

The Netherlands Food and Consumer Product Safety Authority (NVWA), a partner in the RINSE and SEFINS projects, demonstrated innovative use of cutting edge technology to transfer knowledge. A novel online tool was developed to help both practitioners and academics to identify plant species faster and more accurately, via the Q-bank Invasive Plants Database. This serves as an identification and reference database, focussing on vascular plants with a particular emphasis on freshwater species. The database is specimen based and summarises existing knowledge on plant species which threaten biodiversity across Northern Germany, the Netherlands, Belgium and North-West France, and is also relevant to the UK. It is composed of electronic identification keys for groups of potentially invasive species. These have been specially designed to be user-friendly, relying on image-driven recognition and avoiding specialised technical or botanical terms as far as possible. Look-a-like species, which may be confused with INS but which do not pose a risk, are also included to aid accurate identifications. Each key is updated regularly with new images and additional information as further data becomes available and is supported by fact sheets to aid identification in the field. **Further information is available at www.q-bank.eu**

Australian swamp stonecrop

In summary

The projects represented in this cluster utilised a wide range of methods to ensure the **new knowledge generated reached those who needed it the most.** It was concluded that a diversity of communication methods across multiple member states achieved the greatest results. Successful vertical and horizontal knowledge transfer should include, but not be limited to, peer-reviewed scientific papers, accessible communication projects such as leaflets, training workshops combining academics and practitioners, scientific symposiums and online or electronic training resources.

Knowledge transfer, training and advice is critical in this area of work. When done well, introductions can be prevented, species can be detected early and management of species 'on the ground' is carried out more effectively, scientists work together more constructively, key sectors act collaboratively against the inadvertent dispersal of species, the risks of novel INS are assessed more accurately and the impacts of invasive species on our environment and economy are reduced.

CHAPTER 2

Data and inventories

A dense mat of water fern covering the surface of a canal (UK)

The data gaps for invasive non-native species are enormous. There are tens of thousands of actual and potential invasive species, covering a vast area. The difficulties associated with data collection and management are formidable. Moreover, new data is required every season. Climate change, eutrophication and land-use change predispose landscapes to INS. The numerous stakeholders, including conservationists, farmers, foresters, fisheries, leisure industries and traders, have conflicting interests. These interests can only be balanced from a position of knowledge. Yet, rather than being daunted by the scale of data collection, we must prioritise. Our attention must be focused where impacts will be greatest, whilst being flexible enough to rapidly identify new problems. Data silos are often delimited by region, language and taxonomic group, yet organisms do not respect these boundaries. This can obscure the "bigger picture". Only by breaking down technological, linguistic and political boundaries can data be effectively used to generate reactive and reliable knowledge. Data requirements are wide-ranging and varied. Activities such as horizon scanning, distribution modelling and management need data on climate, landscapes, dispersal routes, vectors, species traits and more. Even if we could collect all the data we need, our greatest challenge is to make it available to and discoverable by the people that need it, when they need it, in a usable format.

Quentin Groom, Meise Botanical Garden (Belgium)

CASE STUDY: the RINSE registry for non-native species

RINSE collated information on the **status and occurrence of non-native species** across **Great Britain, France, Belgium and the Netherlands.** Data on invasion history and susceptible environments were obtained through expert consultation. This dataset represents a registry of species non-native to the region but recorded in the wild in at least one of the four countries, with **information on 6,661 taxa, from single-celled algae to mammals.** The data were collated from web- and print-based sources and scientific journals. This registry will serve as a basis to develop effective, **cross-boundary strategies for management and control of non-native species** with potential severe ecological and economic impacts. It can also be used as a general reference for both scientists and practitioners and as a tool to cross-check the reliability and comprehensiveness of other databases. The registry is available via the RINSE website, however there is potential to set-up web-based services in order to make it more interactive and accessible to all. **Further information is available at www.rinse-europe.eu**

Accessible non-native species registries

Tackling and containing biological invasions requires knowledge of what is there, what is not there and what may arrive in terms of non-native species. Thus, comprehensive overviews of non-native species are an essential first step. Non-native species registries ideally consist of **species lists by country or region,** accessible online and derived from published and other traceable sources. In order to be useful for biosecurity policies and preventive actions, information on **pathways of introduction,** dates of **first observation** and other relevant aspects of a species' **invasion history** should also be included. Many initiatives collate information on non-native species, but focus only on those which are invasive, i.e. those with a known impact on biodiversity, society or economy. However, since many non-native species have the **potential to become invasive,** a broader approach, including all non-native species, is needed. There is a clear need for such initiatives to be funded for the long-term, in order to ensure sustainability of partnerships and continuous information updates.

CASE STUDY: Alert list for invasive non-native species

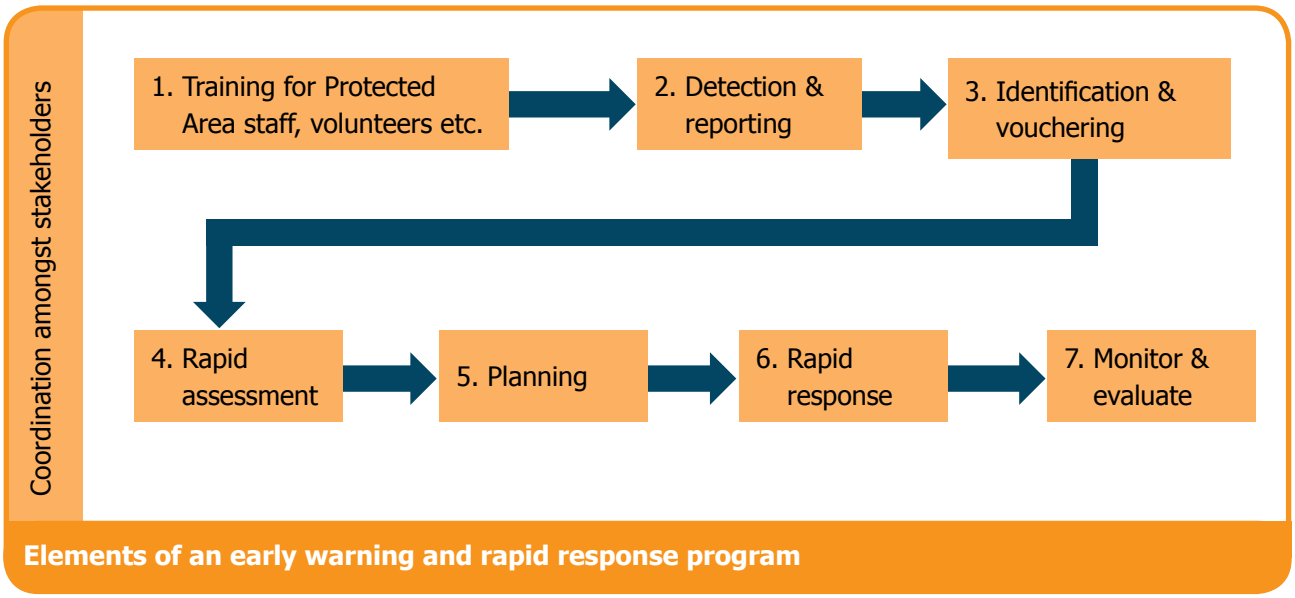
Lantana

RINSE targeted and prioritised non-native species within the Two Seas area (England, France, Belgium and the Netherlands). A meta-list of **6000 potentially harmful invasive species** was drafted using a variety of on-line sources. This was downscaled to a more workable **selection of 350 species** (relevant to the region) for further screening. These were subjected to **systematic risk assessment** using a simplified protocol. This rapid screening involved evaluation of ecological impact, management difficulty, invasive potential and economic impact in the region, based on the **best available scientific information** as well as expert consultation. The result was a list of **81 non-native species,** not yet present,

Japanese sea star

but representing, with reasonable certainty, a **potential biological threat to the region. Further information is available at www.rinse-europe.eu/prioritisation-horizon-scanning**

Emerald ash borer



Elements of an early warning and rapid response program

Horizon scanning

Horizon scanning **anticipates and prepares for future challenges,** trends, threats and opportunities and represents **an essential part of any INS management strategy.** Lists of non-native species, derived from high-risk species registries for a region, are screened. This information is crucial to preventing new introductions, implementing regulatory frameworks and informing authorities for rapid eradication. Proactive horizon scanning has proven net **economic and ecological benefits** and can inform monitoring and surveillance programs aimed at **early detection of invaders,** thereby offering a more targeted response.

Risk mapping

Risk mapping involves **modelling the potential distribution of a species under current or future climatic conditions.** This is an essential resource for biosecurity agencies, allowing dedicated inspections and risk-oriented surveillance activities. Risk mapping is an important part of species risk assessments, identifying areas under threat of successful invasion or establishment. These powerful models are typically based on observations of non-native species within their native and invasive ranges, overlaid with maps of climate data, land use or topography.

Early warning

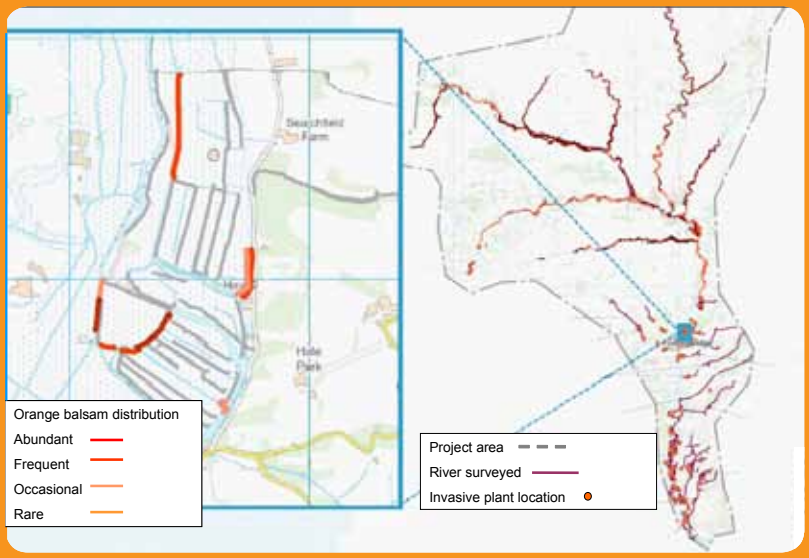
Prevention is the most efficient approach to addressing the threat of INS. Pathway regulation, biosecurity protocols and trade regulation are vital tools, but legislative measures take time. Swift detection of newly established species and a rapid response are therefore essential. **New invasions can be contained with relatively little effort,** but once established, they cause more damage and become increasingly expensive and difficult to control. Consequently, **early warning tools and rapid response protocols** are being developed across Europe. These consist of knowledge on potentially harmful species (via repeated horizon scannings and risk assessment), observation and reporting mechanisms, rapid validation and ultimately prompt information dissemination to responsible managers and relevant stakeholders. The time lag between observation, reporting and appropriate response should be as small as possible.

The European COST project **"Alien Challenge"** aims to establish formats for non-native species information in accordance with the requirements of early warning tools and rapid response systems, **integrating data collated via citizen science initiatives** (e.g. NatureWatch or Eye on Earth). The SEFINS project will take note of these recommendations and provide the project with data.

CASE STUDY: the VLIZ Alien Species consortium

Water primrose

This group of experts is coordinated by Flanders Marine Institute (VLIZ), a SEFINS Associate Partner. It consists of a network of **50 experts from 20 different institutes** with complementary expertise in non-native species. The initiative was launched in 2006 within the framework of the project **'Non-indigenous species of the Belgian part of the North Sea and adjacent estuaries'.** The consortium systematically collects information from scientific literature and from the validated observations of experts working in the fields of marine and estuarine biology. The **information is freely available online** to scientists, policy makers and interested members of the public via the alien species portal of the Coastal Wiki. It includes an updated and annotated **list of alien marine and coastal species,** fact sheets with extensive information on life cycles and ecology, methods of introduction and distribution, potential effects or measurable impacts on the environment, possible management measures, taxonomic information, pictures and relevant links. The consortium is committed to the permanent challenge of updating information and developing further products, such as an index of invasiveness or biogeographic species data. **Further information is available at www.vliz.be/wiki**



Map at catchment level scale used for orange balsam control with DAFOR scale © Sam Stork

Management: planning and evaluation

Eradication is the complete and permanent removal of all wild populations from a defined area, by means of a time-limited campaign. The success of such action is largely dependent on reaction time and the extent of the infestation. Many INS have, however, already extended their distribution area and continue to cause substantial damage to biodiversity and economy. In this

instance, control actions are needed to mitigate their impact. Control typically implies that species abundance is suppressed to an acceptable threshold. For both eradication and control to be successful, **rigorous planning is essential.** Effective protocols, combined with operational capacity, coordination and budget, and accurate, up-to-date distribution data of the managed species are essential. These data should be in a readily useable format, such as an abundance scale (e.g. the DAFOR scale: Dominant, Abundant, Frequent, Occasional, Rare), allowing monetary and time budgets to be accurately predicted.

Communication of both success and failure, whether eradicating, containing or controlling INS is pivotal for **modifying management plans and maintaining stakeholder support.** The new European Strategy on the prevention and management of invasive species will require member states to report to the European Commission and to each other on the type of measures taken and their effect. Assessing management success or failure ideally involves monitoring a site prior to and following management actions, over regular time intervals. For plants, insects and many other organisms, sites may **require regular observation for many years** to ensure elimination of all individuals. It is important to realise that even **"rapid" eradication can take considerable time,** requiring careful planning and prioritisation, and taking into consideration the environmental as well as social context and resources.

Sharing is caring: a harmonised approach to data

INS disperse naturally across national boundaries. Pan-European mechanisms to share information with neighbouring countries, trading partners and comparable ecological regions are needed. However, information on INS is scattered across Europe in a multitude of sources: regional and national databases; peer-reviewed and grey literature; published and unpublished research projects and institutional or individual datasets.

In recent years, several initiatives have attempted to collate information into centralised databases. These differ in temporal, geographical and ecological coverage, resolution and applied taxonomy, and are not always widely accessible. **An operational European information system for non-native species must be web based, in the form of an online open source data system. It should be the subject of long-term, internationally coordinated continuous effort, supported and controlled by experts for all taxa and covering all ecological niches. Data providers and stakeholders should have access in their own language within a personalised user framework.**

Removing Parrot's feather (Belgium)

CHAPTER 3

Citizen science and awareness raising

Surveying for American skunk cabbage

As pressures on our natural environment continue to increase, mitigating against these pressures and facilitating natural adaptation can only be achieved through effective management policies. Management policies must, however, be underpinned by robust evidence supported through monitoring schemes, providing long-term time-series which supply vital evidence regarding the drivers, nature and direction of change. There is currently a shortage of capacity to deliver such evidence throughout Europe. Citizen science can offer a cost-effective addition to professional monitoring, whilst seeking to raise awareness of environmental issues and affect attitudinal change across all of society, providing greater advocacy towards sustainability. Citizen science has immense value in this respect by increasing the scientific literacy of those involved whilst promoting a greater understanding of the value and challenges of scientific research.

Heather Sugden,
Newcastle University

'Citizen science' put simply is **the collection of scientifically robust data by non-professional volunteer scientists.** Citizen science differs from traditional environmental volunteering by facilitating **public participation in organised research efforts** via the gathering, processing and interpretation of scientific data. It can provide an opportunity to mobilise and direct enthusiasm for environmental volunteering in a way that is meaningful and effective, benefitting policy makers, environmental managers and scientists alike. Effective citizen science initiatives require solid **volunteer programmes,** providing a clear scientific direction with adequate training and support to ensure the quality and robustness of the data collected.

Environmental volunteering has an extensive legacy across Europe and there is an increasing **desire amongst the public to participate** in activities to conserve natural environments. The number of volunteering programmes established to monitor and conserve the environment has been steadily increasing over recent decades. Despite this many programmes seek only to engage volunteers to raise awareness on specific issues without addressing the need or opportunity to collect robust data. The disentanglement of these two aspects of citizen science is a key challenge for future projects to address.

RINSE family activity booklet

The growth of this **"participatory population"** must be accompanied by reflection on the recruitment process, including the role, scope, retention and value of the participants. **This is key to promoting the sustainable development of public involvement in scientific processes.** This is particularly true when citizen science relates to INS, as species may be aesthetically pleasing and could therefore benefit from public sympathy, counteracting the management or eradication of these species.

Promoting public involvement in citizen science campaigns

Building a successful citizen science program requires considerable effort from scientists and habitat managers, requiring them to reach out to members of the public and respond positively and effectively to their feedback. A wide variety of communication methods are available to citizen science campaigns. However, these must be carefully selected and refined to suit the target audience, in terms of both location and population, and tailored to the context and culture within a country. **Adaptation and flexibility is fundamental to maximising contact and raising awareness** at the beginning of a new project. Above all, it is extremely important that the **entertainment and 'fun factor' aspects of citizen science** initiatives are both prioritised and emphasised above or equally to any scientific value obtained.

However, the approaches used to achieve this can vary significantly and are heavily dependent on the difficulties encountered when recruiting participants. These are assessed using various criteria, such as the sensitivity of the target audience to the subject of INS and the number of participants to be mobilised. The data produced are directly linked to the size of the operating area of the project, which determines many key properties of the target audience, such as size, ability and level of interest. In addition, this also governs access to information such as assistance from local experts, training, mentoring and administration advice. The minimum requirements for maximum public involvement include:

- **Project communication** utilising existing media, such as newsletters or websites.
- **Creation of new media** around the project, such as websites, smartphone applications ("apps"), online forums and mailing lists.
- **Creation and dissemination of informative tools** accessible to all audiences, such as distinctive, eye-catching flyers.
- **Project participation** in regional fairs, festivals, forums and conferences in order to showcase citizen science opportunities to the public.
- **Reaching out** to people in their own areas during their spare or leisure time.
- **Reducing remote contact** and participant travel times by taking the project to them.
- **Continuous feedback** on progress and results from the people working with the data acquired by the program.

The role of citizen participants in implementation

Empowering local groups and engaging volunteers and locals in data acquisition, surveillance and monitoring (as well as management) can be beneficial in creating a sense of ownership and responsibility. It is important to ensure participants do not feel isolated, but instead are involved and guided through all issues and processes. This is achieved with frequent direct contact promoting information exchange via meetings, telephone calls and emails exchanges. More targeted systems can be implemented, such as sending letters to individuals prior to the start of survey work or field seasons. The links established by partners are varied, ranging from direct contact over distance to whole communities, to more personal, one-on-one relationships with each participant. This helps project partners to meet the monitoring and management challenges involved in effective citizen contributions to programs.

A volunteer field scientist

CASE STUDY: bullfrog early warning system

Partners within Invexo established an **early warning system** for the invasive bullfrog using a network of volunteers. This pilot project used **nature observation and online recording websites** across Belgium and the Netherlands to share information and mobilise participants. These were used for reporting sightings, accessing fact sheets and setting up **user-driven automated email alerts** which could be tailored according to the needs of different users, such as daily digests of sightings in their local area. Training sessions were held in species recognition and specific survey areas were then designated to each volunteer. This bespoke citizen science system engaged around 25 volunteers and **successfully identified bullfrog breeding grounds,** enabling rapid implementation of management actions to limit species spread. **Further information is available at www.rinse-europe.eu**

How to retain participants? Or should we rely on opportunistic volunteers?

Retention of volunteers is not always linked to the quality of data collected. Often, it is sufficient to have the same number of participants with a similar geographic distribution for datasets to be comparable from year to year. Participant loyalty is generally more important in improving the quality of observations in INS monitoring protocols, than in the more simple species inventories. Loyalty is also key when the possibility of volunteer renewal is limited, so is therefore critical to maintaining participant numbers.

Supporting participants as "field scientists" and "custodians"

The heart of a citizen science program lies in its foundation on collaborative

INS information poster produced by RINSE

data. Protocol suitability must be considered at the start of a project, accounting for issues such as the accessibility of an area and the ease of species identification. However, experience has shown it is useful to review protocols one to two years after start-up, in order to better account for the real constraints of the target audience. The simplicity, usability and approachability of online tools for data input facilitate the work of the participants. Nevertheless, data input tools cannot be solely computer based, due to their potentially exclusive nature. It is important to ensure that the elderly, children or people without computer access do not feel rejected. Postcards or booklets remain excellent vehicles for making science accessible to the wider population. The technical and scientific aspect of a project should be carefully balanced to allow the general public to take part whilst providing new capabilities and skill sets to participants.

The methods used within the SEFINS partnership can be grouped under three broad headings:

- **Accompaniment**

Joining participants in fieldwork allows technical and scientific information to be dispensed as needed, and to be tailored to the sightings made by participants. This elevates fieldwork beyond simple data collection to a more scientific approach. Data collection was enhanced by the use of fact sheets and information posters created by the RINSE project.

- **Knowledge transfer**

SEFINS partners committed significant time to ensuring a strong flow of information between citizens and scientists. Engagement of volunteers in data collection on the natural environment and biodiversity is boosted by technological developments. The increasing availability of smartphones represents a revolution in data collection, allowing almost real-time data collection. A good app requires thoughtful design and minimal data demand to the user. The RINSE project created a smartphone "app" to ensure the latest information on INS identification was available and useable to all levels of expertise.

- **Promoting exchange between participants**

The scientific and technical capacity of participants can be increased by information exchanges between them. Discussions via email groups provide a real-time, effective method for observations to be shared across communities, often allowing participants to work as a team to resolve their own identification or practical issues.

CASE STUDY: "That's Invasive!" smartphone app

The app is a tool developed to **report sightings of INS with a few taps on a mobile phone.** Fact sheets contain detailed information on the biology, ecology and impacts of over **35 INS within the Two Seas area.**

Each species has a photo gallery to browse, a list of key features and information on commonly confused species. **The app is free and requires no registration** in order to maximise public participation. Records are made simply by taking a photograph of the species. In-built GPS then records the exact location and the data is uploaded to the iRecord database for environmental recording as soon as an internet signal is available.

This form of communication engages people from outside of regular volunteer conservation circles, thereby building awareness of INS. The popularity of this approach is clear, with close to **700 downloads** of "That's Invasive!" since its launch. However, the availability of a growing number of similar apps makes ensuring data quality, comparability and accessibility a particular challenge. The use of apps can also lead to highly opportunistic recording, rendering data less effective for research purposes. Efforts are also needed to prevent apps from adding to the issue of fragmentation in biodiversity recording. **Further information is available at www.rinse-europe.eu**

Screenshots from the RINSE app "That's Invasive!"

Field demonstrations

The common features across the citizen science programs within SEFINS have been a multi-stakeholder approach and cross-border cooperation. Different methods and tools have been shared and adapted to the specific requirements of each country. These examples illustrate the value and relevance of the actions of citizen science projects, spanning both scientific and technical research.

In common with the geographical estuarine 'gap', which exists between marine and freshwater expertise, a similar 'gap' exists in relation to citizen science programmes. These programmes are normally developed either by organisations which work only within the marine realm or those which exclusively target freshwater environments. As a consequence, there is little focus on the estuarine habitats on the periphery of each area, as they do not fit easily into either category.

CHAPTER 4

Risk management and impact assessments

Removal of invasive shrubs (Flanders)

The Convention on Biological Diversity states "By 2020, invasive species and pathways are identified and prioritised, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". A common theme shared by the projects tackling invasive species within the SEFINS cluster is the issue of risk management and impact assessment. RINSE and Invexo worked towards prioritising species of concern in freshwater and terrestrial habitats, and further management and policy in close cooperation with practitioners. MEMO operated within the marine area and performed a detailed study on the distribution and potential impacts of a single species known to have a worrying history and focused on cooperation with a scientific public.

Sonia Vanderhoeven
& Etienne Branquart
Belgian Forum on Invasive Species

Trapping Canada geese (Flanders)

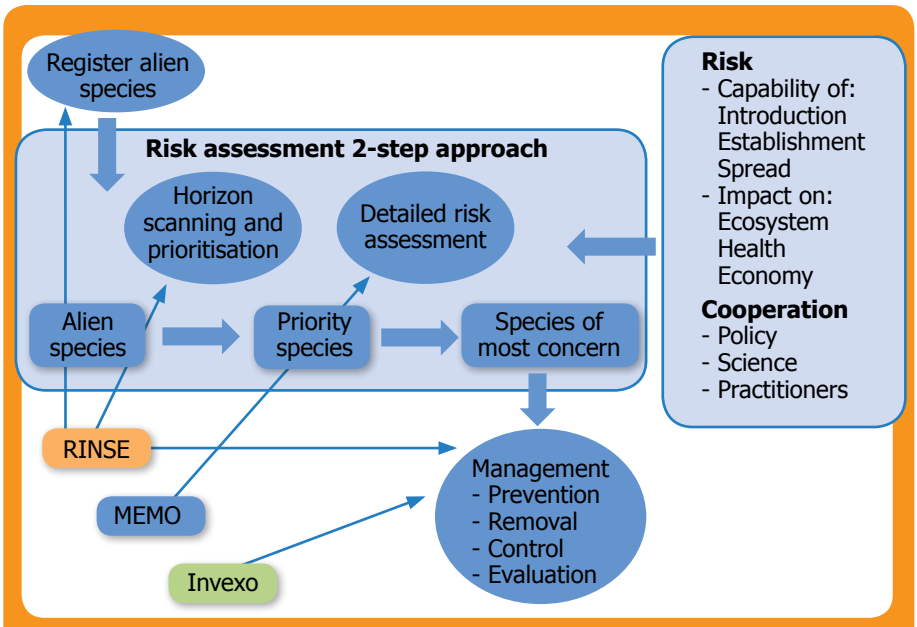
Efforts to curb invasive species require a science-based process to evaluate the risks associated with their introduction and spread. This issue is currently at the top of many national and international policy agendas. In particular, the adoption of the **European Union regulation on Invasive Non-native Species** should ensure harmonisation and prioritisation at the EU-level, acknowledging the importance of prevention, early warning and rapid response and long-term control. Risk analysis is recognised as a **key factor** underpinning sound INS policy and the decision-making process. As stated under the **World Trade Organisation Sanitary and Phytosanitary Agreement,** it encompasses risk assessment, risk management and risk communication. **Risk assessment** focuses on in depth description of the probability of organism introduction and associated consequences, whilst **risk management** covers the evaluation of preventive and control measures needed to reduce the risk to an acceptable level. Different levels of accuracy are expected depending on the objectives of the analysis, from the **quick screening tools** needed to identify emergent species, to the **full risk analyses** required to support regulation on trade. The main challenges encountered within risk analyses are a lack of data, interpretation and communication and the complexity of spatial and temporal relationships. Regardless of the geographical area under consideration, the value of risk assessment can only be gauged by the extent to which it is used by risk managers. It is therefore of utmost importance to **engage scientists** to feed into the process with empirical results, especially when accurate baseline data are lacking. At the same time, it is important to

North American signal crayfish

engage policy makers in order to improve their decisions by considering scientific data on a rationale basis. This will ensure **balance** between addressing **public policy concerns** and satisfying **scientific relevance.**

A two-step approach for risk assessment

In order to predict the long-term impacts of INS, two stages can be distinguished. Firstly, horizon scanning for the presence of potential INS and creation of a prioritised list for species of most concern. Secondly, a detailed risk assessment for these priority species which require management. This approach is explained in the figure below, which also shows the areas studied by the SEFINS partnership. Important issues within this assessment include assessing the likelihood of invasion, establishment, dispersal and the potential consequences on biodiversity, the ecosystem, economy and human and animal health. The combination of the likelihood of introduction and the possible impact equates to the relative risk of the species. This should be balanced against the costs required for prevention, eradication or control if further management is needed.



A two-step approach to risk assessment

Prevention: horizon scanning for INS

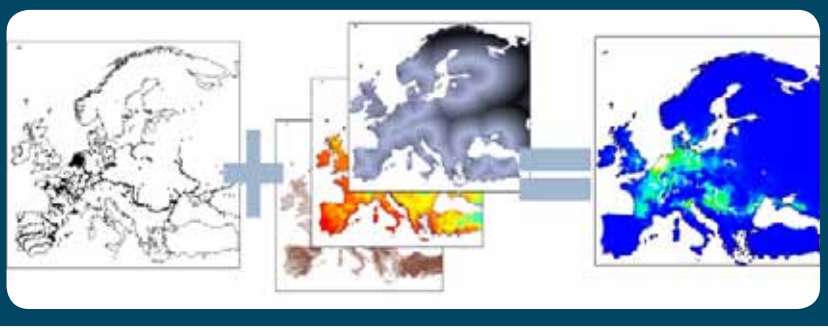
Prevention is the best way to deal with INS, limiting environmental damage and economic cost. To assess the likelihood that a species will become invasive in a particular area, introduction pathways need to be assessed and the possibility of the establishment of a species needs to be predicted. **Horizon scanning of potential new INS** provides an evaluation of the possibility and consequences of the introduction, establishment, spread and impact of an INS, using the best available information. Previous invasion histories can serve as examples to predict future problems. Native habitat screening is performed as introductions are most likely to occur and succeed if environmental characteristics match these of the donor environment. Management of all species exceeds our capabilities, however, this method allows species of most concern to be prioritised, initiates research and monitoring and informs policy to aid development of practical responses.

Priority species are selected based on their high probability of entry, their capacity for rapid spread and potential to cause serious damage. Results need to be communicated in a non-technical, accessible and iterative way to create a behavioural change within the public to be aware and prevent unintentional introductions, as well as informing policy and science.

CASE STUDY: targeting and prioritisation of INS

Within the RINSE project, a **register of notorious INS within Europe** was established. Screening was conducted to identify the worst invaders, focussing on ecological impact. Species were divided into two groups according to their presence within the countries of the RINSE partnership. Of the species detected, **261 were classified on the Black List,** whilst **81 species not yet present** within RINSE countries were placed on the **Alarm List.**

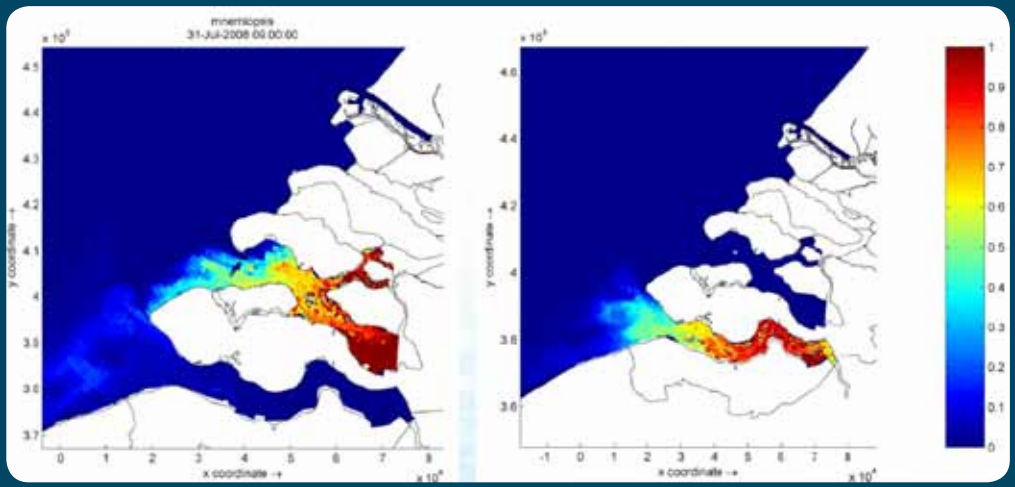
For a number of species from each list, distribution models were developed to **identify regions with traits making them particularly susceptible to INS,** and so prone to multiple invasions. Models were created using **distribution and environmental maps** to calibrate species preferences. In this way, monitoring and management efforts can be focused, based on a calculation of the environmental niche of a species. **Further information is available at www.rinse-europe.eu/prioritisation-horizon-scanning**



Species distribution model for marine species on the RINSE Black List ▸

CASE STUDY: modelling and impact assessment of *Mnemiopsis leidyi* in the North Sea

The distribution, behaviour and invasive potential of the comb jelly *Mnemiopsis leidyi* was estimated in the North Sea by the MEMO project. Originating in the Atlantic, *M. leidyi* was **transported in ballast water to the North Sea,** where it has been observed since 2006. To avoid similar **catastrophic impacts on commercial fish stocks** such as those well-documented in the Black Sea, a risk analysis was performed. Standard Operating Protocols (SOPs) were developed to ensure uniform sampling and preservation, and consistency in morphological and genetic identification. *M. leidyi* was identified as **present in coastal areas of France, the Netherlands and Belgium.** Populations were highest in late summer and autumn within semi-enclosed areas. A habitat model was constructed showing *M. leidyi* can efficiently reproduce in large parts of the North Sea over summer, with highest risk predicted to be in southern coastal and estuarine regions. This allows **close monitoring** of areas where the species has not yet been seen and **preparation for a rapid response** in the event of a sudden population bloom. Data on the biology, physiology and feeding behaviour of the species was obtained via chemical analysis and breeding experiments in order to determine the location and **potential impact of *M. leidyi* on local food webs.** The species was found to feed principally on zooplankton, fish eggs and fish larvae, using energy immediately for either growth or reproduction. Furthermore, the study revealed *M. leidyi* to have a high tolerance for environmental variables. At very low salinities, adult jellyfish could still produce eggs, again furthering their distribution and rapid spread. Data on presence and biology were combined within a model to simulate transport and reproduction in the Scheldt estuary and the North Sea. These models indicated the importance of temperature on the presence of *M. leidyi*. Under current climatic conditions, reproduction in large numbers may not be possible, but simulations suggest that **further global warming could stimulate the success of *M. leidyi* in the North Sea. The importance of estuaries was also clearly shown. These act as nurseries for overwintering populations, which seed offshore populations and aid further spread. Further information is available at www.ilvo.vlaanderen.be/memo**



Estuarine and coastal exchange of Mnemiopsis leidyi (MEMO)

Role of new technology in early detection and rapid response.

Where prevention of accidental INS introduction has failed, or where INS were deliberately released, **research on colonisation, biology and impact is needed.** In the case of intentional introductions for trade purposes, scientific evidence for species impact and risk is needed to be able to evaluate its potential to damage human, animal or plant health, and to impose trade restrictions.

When accidental introductions could not be prevented, early detection of the species when the population is small, followed by a rapid response is the optimal method for avoiding further spread and ensuring effective management. This requires **advanced technology for species detection and identification** to be developed. The life stages of some species can be difficult to detect and identify. This can lead to misidentification and inaccurate distribution information. Some species or invasions can remain unnoticed for several years due to little evidence of their impact (lag phase) or low detection probability. In this case, new technology such as **advanced remote sensing** using optical techniques can supply greater precision than field-based taxonomic methods. Molecular methods such as **DNA barcoding** or **environmental DNA** can be extremely useful for early detection in these instances. Predictive tools, such as **mathematical modelling,** are useful to avoid further spread. For models to be effective, understanding of the history, biology and behaviour of INS, alongside data on presence and preferred environmental parameters are essential. The **influence of climate change** must also be incorporated for accurate predictions of dispersal and establishment. Shifts in biology and genetic variation within INS can promote rapid evolution and adaptation. Understanding connectivity between populations via techniques such as next generation DNA sequencing is a useful tool for determining origin and invasion pathways.

Management: mitigation and control

Where INS are established and rapid eradication is no longer possible, further spread can be prevented via mitigation and control. Physical, mechanical, chemical and biological controls methods may be used, and in some instances, ecosystem restoration may be necessary. Scientific research and cooperation with practitioners is again of great importance to develop and implement efficient and simple management methods.

CASE STUDY: management trials and demonstrations for invasive shrubs in coastal dunes

The RINSE project developed effective protocols for management of some of the most problematic invasive animal and plant species within the Two Seas area. **Coastal dunes** are a unique ecosystem, home to a large number of species of conservation concern. A management trial focused on the removal of the invasive shrubs *Mahonia aquifolium* and *Rosa rugosa*. Both represent a **major challenge** within dune habitats and information on potential management techniques was urgently needed. Trials were performed on the efficacy of **different management techniques** to obtain a reduction in the abundance of these species on the demonstration sites. Shrubs were located using GPS. Some were manually removed with shovels, or treated with an application of herbicide to the leaves, whilst others were cut and painted either with herbicide or a saturated salt solution as a chemical-free alternative. These treatments were compared, allowing **clear advice to be given on effective management strategies** for these areas. The constant interplay between scientist and practitioner ensured the relevance of the field trials, fulfilling the need for a scientific foundation as well as real time knowledge transfer in both directions. **Further information is available at www.rinse-europe.eu/case-studies-guidance**

Mahonia

Management: coordination and structure

The European Parliament legislative resolution of April 2014 proposed a Regulation on the prevention and management of the introduction and spread of invasive species. The challenge we now face is the implementation of this Regulation by the Member States and the development of effective coordination and cooperation between them on this issue. A coordinating body should ideally control implementation of rapid response and management, and facilitate communication. This system should be established before the introduction of INS. In the case of a potential new introduction, a management decision support system with clear responsibilities and binding legislative measures is needed so that scientists and managers can follow a pathway for efficient response.

Treating invasive shrubs (Belgium)

Building on existing knowledge

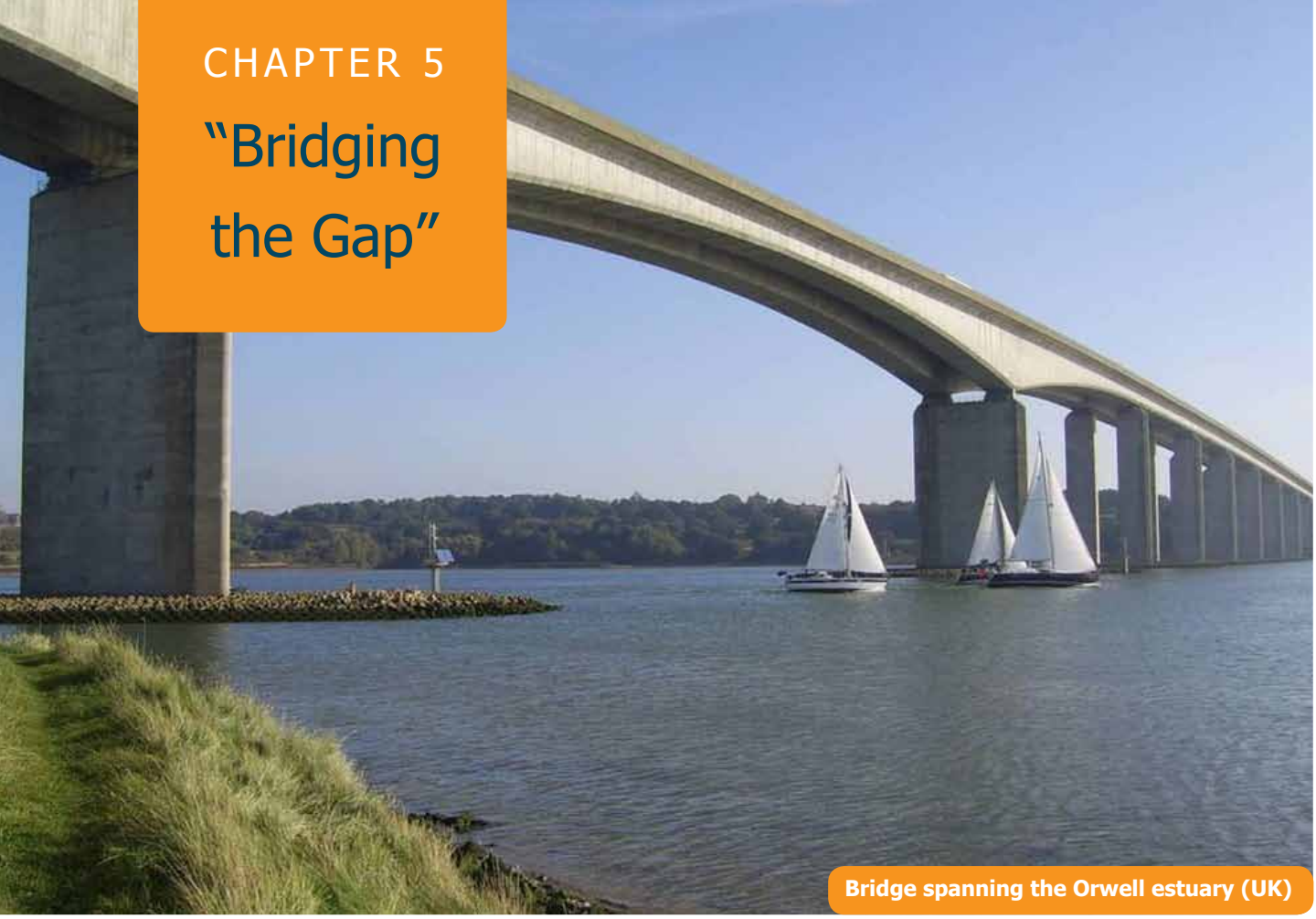
Several initiatives on impact assessment and risk management are already ongoing (e.g. DAISIE, ALARM, NOBANIS, IMPASSE) and a number of dedicated legislative frameworks are in place, acting independently in separate areas (such as trade, aquaculture, health). In addition to this fragmented legislation and framework, there is a lack of data, expertise, international standards and a global information system to address INS. Often, risk classifications from other countries are used in risk assessments. Although recent progress has been made in this area, standardisation within risk assessment protocols and region-specific risk classifications would still offer better comparative data across regions and ensure accurate information for policy and management. The recent drafting of minimum standards for risk assessments at the EU level has gone someway to addressing these difficulties.

Management approaches require implementation of **systematic, targeted methods** combining preventive strategies, early detection and prediction tools with ethical control techniques, monitoring, evaluation, communication and research in close cooperation with local government, stakeholders and the public. Expertise and support from different interest groups is essential. Fundamental research into the history and biology of INS needs to be combined with new technologies for modelling, detection, identification and control. Activities such as **industry, trade and tourism cross national borders and have led to the introduction of many non-native species.** The suitability of the environment enables establishment, which may increase as climate change will allow some species to move further to the North. Risk assessments inclusive of the impact of human activities and environmental suitability are urgently needed. Knowledge must be shared between countries and gaps in trade rules should be closed to limit the spread of INS from one country to another. There is a need for a coordinated response to new invasions and effective management of existing INS.

The exchange of knowledge and expertise within the SEFINS partnership highlights how cooperation can allow a wide range of habitats to be studied. Techniques developed within one project and for one habitat can be shared and expanded to include another. The associated partners of SEFINS have worked together to create a broader expertise, collaborating to close the gaps in INS knowledge and develop better impact assessment and risk management to fulfil the EU Regulation on INS.

CHAPTER 5

"Bridging the Gap"

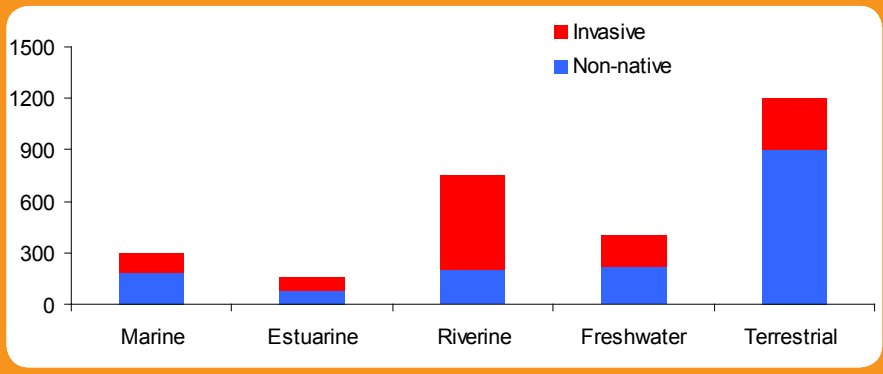


Bridge spanning the Orwell estuary (UK)

The SEFINS partnership has tackled many of the scientific and practical challenges posed by INS in marine, freshwater and terrestrial environments. These areas meet along the coastlines of Europe to form a **unique, vulnerable and frequently overlooked habitat – the estuary.** The previous chapters have highlighted the important work carried out by RINSE, MEMO and Invexo to improve the management of INS, but the majority of these efforts have excluded estuarine environments. Some of the busiest international ports in Europe are located within the Two Seas area and the majority occur in or adjacent to estuaries. The huge volume of freight, fishery, passenger and private vessels which pass through these ports each year represents one of the highest risk pathways of entry for INS into the Two Seas area. **The SEFINS partnership believes that it is now time to address this gap in the INS work conducted to date, by joining forces to prevent further INS introductions via the regions estuaries.**

Estuaries are generally shallow and dynamic systems forming the transitional zone between the freshwater, riverine environment and the marine realm. They are typically characterised by a **salinity gradient** imposed by fresh water input and salt water intrusion. Tides can have a strong influence on estuarine salinity, causing it to vary greatly as they sweep in and out. Currents from the seas and rivers shape estuarine landscapes, producing a wide assortment of different habitats. The **shallow, well-mixed water** of an estuary contains **high levels of nutrients,** supporting many different organisms ranging from microscopic plants to large mammals. These features combine to make estuaries important habitats for feeding and raising young and are vital for species which divide their life cycle between marine and freshwater environments, such as salmon and eel species. In addition, estuaries are also a focus for human attention. They are often widely exploited by **fisheries and aquaculture** and heavily used by **commercial and recreational marine traffic** due to their abundant resources and accessibility. However, the dynamic nature and multiple functions of estuaries also have a downside. The features which make them so attractive to many organisms and people also make them highly **susceptible to invasion.**

Estuaries are potential hotspots for INS as human activities provide many pathways for their arrival, such as via **ballast water used to balance**



Analysis of the number of publications on Web of Science with the words 'invasive' or 'non-native' in the topic, for each of the five different ecosystems shown.

freight vessels, fouling on ship hulls and other forms of accidental or non-accidental introductions. The gradient of conditions found in estuaries makes them vulnerable to species tolerant of freshwater and saltwater, and not just estuarine species alone. Many estuaries are also under **pressure from pollution or artificial changes to habitats,** meaning existing populations are deteriorated or vulnerable and increasing the potential for a successful invasion. Better regulation has seen improvements in environmental quality in degraded estuaries, but unfortunately it may only be alien populations which benefit. Invasive species are characterised by their ability to adapt to changing environmental conditions and their competitive and opportunistic nature. In comparison, native species can be slow to adjust to change and may disappear entirely. Environmental improvements within estuaries therefore need to focus on **rebuilding and restoring natural biodiversity** as well as increasing water quality.

It therefore seems strange that potential invasive non-native species in estuaries have received so little attention. This may be due to the inherent difficulties in **tackling the problem of INS** in such a complex environment. Impacts may be difficult to identify and it may be even more difficult to link them to invasive species. The effects of an invasion may be both positive and negative, further compounding issues around biosecurity. It may also be linked to the **traditional separation** of science and management **between freshwater and marine environments.** Knowledge exchange and collaboration between these two areas of research is currently quite rare. Estuaries are occasionally studied by freshwater specialists, who consider a salt concentration of less than a few grams in a litre to be salty water. Conversely, marine researchers define brackish water to have a salinity of at least 25 grams of salt per litre of water. Current European legislation reinforces this divide, with a **Water Framework Directive (WFD) for freshwater** and a **Marine Strategy Framework Directive (MSFD)** using different instruments and methodologies. Estuaries are partly classified as transitional waters within the WFD (but are often too difficult to handle), whilst the mouths of estuaries are considered part of the MSFD.

It is clear that estuaries face many challenges, both now and in the future. The problems which lie ahead are difficult and complex. However, they are not insurmountable. It will take cooperation, patience and determination but these are issues we can tackle together, to take back these beautiful meeting places between land and sea.

Chinese mitten crab

Sander Wijnhoven, Monitor Taskforce Royal Netherlands Institute for Sea Research (NIOZ)

CHAPTER 6

Conclusions

Sunset on the Canche estuary (France)

One of the key messages that has emerged from the work of the SEFINS partnership is the need to bridge 'gaps' – the knowledge gap that exists between academics and practitioners, the gap between the general public and decision makers, the gap between risk analysis and management protocols and the gaps in data collation and management systems across the Two Seas area. This publication has also emphasised the physical gap in the geographical coverage of INS management within the SEFINS cluster, highlighting the lack of concerted efforts in the management of estuarine INS.

It is now time to begin more strategic management of INS at a regional level. The work of RINSE, MEMO and Invexo has showcased the benefits of cross-border collaboration. There is now genuine enthusiasm amongst stakeholders across the Two Seas area to work together constructively to help solve our shared problems. With the imminent ratification of the new EU Regulation on INS, the legislative drivers needed to promote and encourage further close collaboration will soon be in place.

There is still much to do to tackle the problems of INS, however we can be proud of the progress made in the Two Seas area over the last three years. The combined efforts of multiple stakeholders and an outward looking approach to cross-border working, have ensured the Two Seas area is at the forefront of proactive, strategic and effective INS management.

The SEFINS Partnership

References and useful links

- **Q-BANK**
  www.q-bank.eu/Plants/
- **RINSE registry for invasive species / RINSE Black and Alert Lists**
  www.rinse-europe.eu/prioritisation-horizon-scanning,
- **RINSE invasive species posters (with CPIE Val d'Authie)**
  www.rinse-europe.eu/leaflets-and-posters
- **RINSE app "That's Invasive!"**
  www.rinse-europe.eu/smartphone-apps
- **RINSE Best Practice Workshops**
  www.rinse-europe.eu/best-practice-workshops-2
- **VLIZ Alien Species Consortium**
  www.vliz.be/wiki
- **DAISIE (2009a). European Invasive Alien Species Gateway**
  www.europe-aliens.org
- **NOBANIS (2009). European Network on Invasive Alien Species, gateway to information on invasive alien species in North and Central Europe**
  www.nobanis.org
- **VLIZ (2007). Checklist for aquatic alien species in the Belgian part of the North Sea and adjacent estuaries**
  www.vliz.be/NL/Cijfers_Beleid/Niet_inheemse#lijst

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For further information on SEFINS and its cluster projects, please visit the websites listed below:

www.sefins.eu

RINSE

www.rinse-europe.eu

www.ilvo.vlaanderen.be/memo

invexo
minder invasieve planten en dieren

www.Invexo.nl

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