

Economic impact of the Great Britain Non-native Species Information Portal

Final Report

UK Centre for Ecology and Hydrology

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Executive summary

This study presents an economic impact assessment of the Great Britain Non-Native Species Information Portal (GBNNSIP), hosted by the UK Centre for Ecology and Hydrology (UKCEH). The economic impact assessment is based on a linear theory of change model, which was used to identify the key users, uses, benefits, and beneficiaries of the GBNNSIP and to discern what changes in economic impact would occur in the absence of the GBNNSIP (the counterfactual).

The benefits of GBNNSIP include: avoided economic damages and biodiversity loss due to invasive non-native species (INNS), and avoided costs of prevention and management due to alert systems (noting that either avoided damages or avoided costs data is used). The portal also informs research priorities and public policy, and is an opportunity for those reporting the sightings to benefit from this voluntary activity. Time spent using the portal can also be a minimum indicator of the value of the portal (assuming users trade off time and preference for data quality with the outputs and outcomes they require).

The largest economic impact of the GBNNSIP is the avoidance of substantial damages from the potential establishment of invasive species in Great Britain. Species on the GB alert system were assessed for their likelihood / prevalence of invasion, costs to control, and potential damages if they became established. Given the data limitations for other species, the estimated cost of the Asian Hornet (*Vespa velutina*) if it became established was used as a minimum demonstration of the cost-savings of the GBNNSIP in prevention of INNS establishments. Estimated avoided management costs are at least £200 million, which are far lower than the potential damages that a large-scale invasion could inflict (loss of native honeybees and other important pollinators).

This illustrates that the cost of the GBNNSIP is easily justified in terms of the avoided management costs for the Asian Hornet alone. Further analysis to uncover its full economic benefit requires better monitoring of time spent using the portal and current INNS management costs, establishment of the GBNNSIP's criticality in preventing INNS establishments (some species are more readily monitored by other organisations), and research into the potential management costs if INNS became established.

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Abbreviations & Acronyms

APHA	Animal and Plant Health Agency
EA	Environment Agency
GB	Great Britain (England, Wales & Scotland)
GBNNSIP	GB Non-native Species Information Portal
INNS	Invasive non-native species
LA	Local authority
NGO	Non-governmental organisation
NNSS	Non-native Species Secretariat
NRFA	National River Flow Archive
ToC	Theory of change
UK	United Kingdom
UKOTs	United Kingdom Overseas Territories
WTP	Willingness to pay

1. Introduction

This project aims to conduct an economic impact analysis to uncover and estimate the economic impact of two data resources provided by UKCEH, namely:

- **National River Flow Archive (NRFA):** a historic dataset which includes daily flow, (gauged and natural) runoff, maximum flows, rainfall, and catchment geological information. It is used to assess water availability and impacts of climate change over time.
- **Great Britain Non-native Species Information Portal (GBNNSIP):** provides access to distribution maps and other information for all known non-native species in Britain. Through INNS Mapper or iRecord, members of the public can report sightings.

This report outlines the methodology designed to evaluate the economic impacts of the GBNNSIP in the UK.

This report contains:

- Section 2 – provides an overview of our economic impact methodology, explaining key terms and the background to our approach for selecting a suitable method for the GBNNSIP.
- Section 3 - outlines our method for evaluating the economic impacts of the GBNNSIP.
- Section 4 – contains the economic impact estimates.

2. Economic impact assessment methodology

2.1 Overview and key questions

Our economic impact assessment model is based on a linear theory of change model and aligns with the guidance presented in HMT Magenta book: Central Government Guidance on Evaluation (2020). A Theory of Change (ToC) approach aims to provide an understanding of how an intervention is expected to achieve its desired impacts and is typically done through synthesising existing evidence. This involves setting out the steps required to deliver the desired impacts, the assumptions made, the quality and strength of the evidence supporting them, and the wider contextual factors. This model, with examples from the GBNSIP process, is illustrated in Figure 2.1.

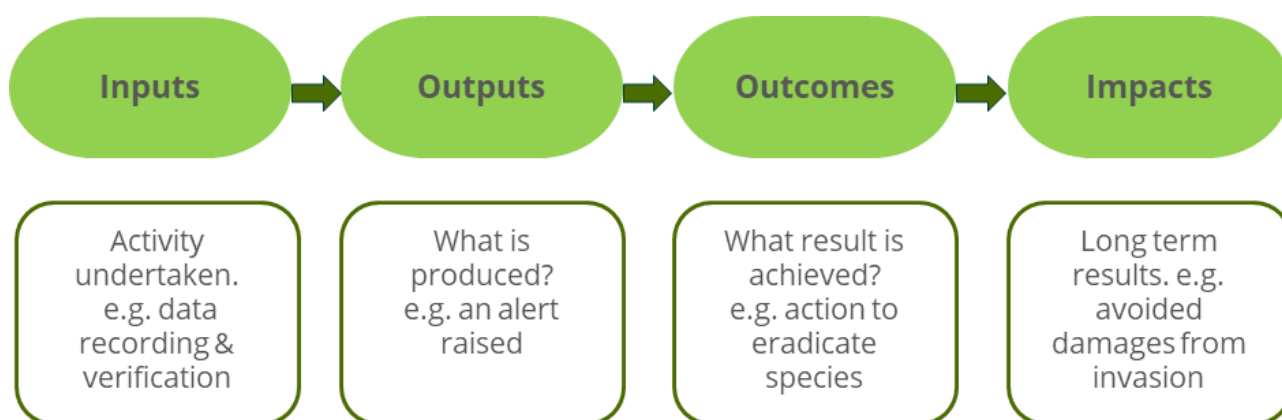


Figure 2.1: Economic Impact Assessment Model

Furthermore, any economic impact analysis must answer four key questions:

- 1) **What is the good or service to be valued?** In this case it is the data contained in the GBNSIP. Answering this question requires an understanding of the process – in other words ‘the value chain’ that leads to the beneficial outputs, outcomes and impacts. For specifics of GBNSIP, see Section 3.2;
- 2) **How is the good or service used and what are the benefits?** This involves understanding the uses of the GBNSIP, and then the subsequent benefits of those uses. Not all the benefits can be evaluated in a project of this size, so choices have been made as to which benefits are the most material to evaluate and which can be evaluated within the resources of this project. The benefits are expressed in relation to a counterfactual where the good or service valued does not exist. i.e., the counterfactual outcomes without the GBNSIP. For specifics of GBNSIP, see Section 3.3.

The assumed counterfactual for GBNSIP is that vital sightings data is not collected in a timely manner or stored in a structured archive. For the GBNSIP, although collection of sightings could continue in the counterfactual case, (with say iRecord), the verification step that UKCEH adds would be missing and this is crucial to providing validated data that no other organisation is prepared to do. ***This is a crucial assumption as it has fundamental consequences for the benefits that can be attributed to these data processes undertaken by the UKCEH.***

A key consideration is whether another organisation can readily step in and fulfil these UKCEH roles. We assume the answer is no, noting the network of key organisations and volunteers, which are critical to the function of this system. This is fundamental to making the case that without public research funding these important tasks would not be done.

- 3) **Who are the users and beneficiaries?** Sometimes the two groups are the same, at others they are not. For example, researchers would be the *users* of data to support, say, policy making. Policy makers and numerous stakeholders, such as water companies and the public on whose behalf the policy is made would be the beneficiaries. For specifics of GBNNSIP, see Section 3.3.
- 4) **What are the benefits worth?** The type of benefit determines the method and data necessary to quantify and monetise the benefit. Selecting the most appropriate method for each benefit will depend upon a range of factors such as the desired level of confidence, availability of data, definition of counterfactual and the extent to which the method is likely to provide a fair representation of the benefit. The methods that use existing data from markets can be grouped loosely as follows – with examples from the case of GBNNSIP, and the list of benefits is described in more detail in Section 3.3:
 - **Avoided losses and damage:** The main welfare benefit is avoiding the spread of invasive non-native species that would occur in the absence of the data available through the GBNNSIP. From an IMPACT point of view this is the avoided damage or losses that would occur if an INNS did establish and spread in the UK. Data on the economic value of damage such as lost crops and damage to property is used to calculate this benefit.
 - **Avoided costs of management:** This could also include avoiding or reducing cost on management such as:
 - **Eradication** – by avoiding invasion and spread of invasive non-native species the costs of eradication at scale can be avoided. Note that this benefit double counts with avoided damages above as eradication and loss are mutually exclusive. Therefore, either this approach or the damage avoided approach must be taken to valuation.
 - **Long term management** – knowledge derived from the portal could be used to find more cost-effective ways to contain and manage species once they are established.
 - **Prevention cost** – Prevention is the most effective approach to managing the threat of biological invasions and can avoid more expensive management cost either altogether or postpone or reduce future costs due to early action. This would be a favourable OUTCOME of the GBNNSIP as presented in Figure 2.1.
 - **Ease of use:** Collation of data by the UKCEH can save time for users of the data when accessing the data.
 - **Benefits for continued research:** Collated datasets are often used in research and are key to enabling the development of knowledge.
 - **Participant benefits:** This is unrelated to how the data is used and outcomes and impacts associated with that use but many citizen science related studies have shown that volunteer input has a value to the volunteers in the form of enjoyment, education and health benefits. The time spent by volunteers is used as a proxy to how they value this time. This is a form of INPUT

measure in the model presented in Figure 2.1.

All the above approaches to using market data are valid and can be used in combination so long as double counting is avoided. For example, as mentioned above, if GBNNSIP data is assumed to prevent spread of invasive non-native species, the analysis should either estimate the avoided loss from damage of establishment or avoided management cost of dealing with an establishment, **but not both** (as if there is no invasion, there would be no management cost). In the case of INNS, the benefit of data may be easier to estimate damage costs for one species whilst for another avoided management costs may be more appropriate. The choice depends on species, how the data is used and the counterfactual (even though here counterfactual is assumed to be the same for all species and data).

All of the above methods use data from one market or another. There are also non-market data that can be used. One such alternative would be to create hypothetical markets and ask users and beneficiaries what they are willing to pay for the benefit of using the data. Through carefully designed surveys, respondents do some of the above trade-offs for themselves when they answer. Such trade-offs include comparing spending money on better research or management, or cost of trying to find the data themselves vs through the database. The resulting 'willingness to pay' for OUTPUTS (e.g., species alerts) in Figure 2.1 is a method that can be used to assess value of data products. However, such an approach is both beyond the scope of this project and would be difficult to implement in this context as those who use or benefit from data (so able to answer the questions) often do not have budget controls and cannot answer the question of how much they would be willing to pay for a currently free service.

Regardless of the method used, the success of an economic impact analysis in the special case of valuing data, portals and related research outputs depends on having a good understanding of the following:

- The value chain of the data and research from their production, through collation and analysis to use – acknowledging that not only the results but also the way the process is conducted that could have economic value.
- The counterfactual of what would happen in the absence of the data resource, including alternative ways of acquiring the same results, and if this is not possible, how the uses of the data / research would be affected.

2.2 Value chain of the data flow process

Answering the key economic impact questions entails understanding the overall value chain of the process for gathering, collating, verifying and providing data for users as shown in the generic process flow in Figure 2.2. This is called a value chain as each stage in the process can add value to the information being processed. This general framework has been applied to both the GBNNSIP and the NRFA and developed into specific data flow processes as described in Section 3.

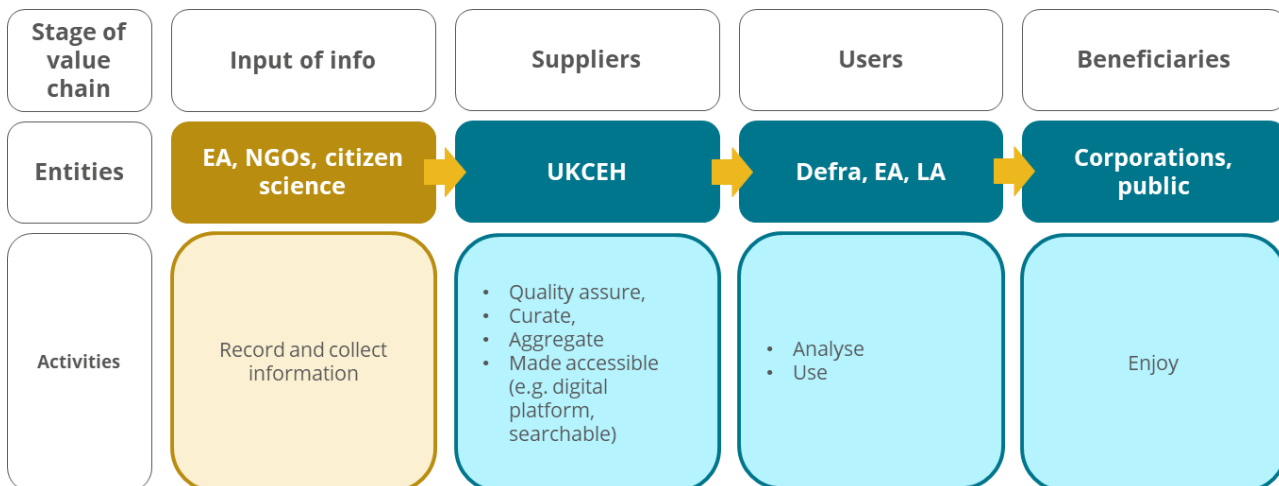


Figure 2.2: Value chain of data provision process

A basic summary of the value chain for GBNNSIP is as follows:

Input of information. The GBNNSIP is the UK’s most comprehensive non-native species database and therefore comprises a large set of data that is regularly being updated. Various organisations including the Environment Agency (EA), Non-governmental organisations (NGOs), including the national recording schemes and societies, and citizen science organisations participate in the input stage by recording and collecting information.

Suppliers. This information is given to UKCEH whose function is to quality assure, curate, and aggregate the information, and make it accessible to the public. The value in this stage is in the improved quality, curation, and accessibility of data from multiple sources.

Users. Users, such as Defra, the Non-Native Species Secretariat (NNSS), EA, private companies, local authorities (LA), and researchers access the information from the GBNNSIP and use it to inform their actions and decision-making (detailed in Figure 3.2). Some users also provide further analysis to the data that is fed back into the data process.

Beneficiaries. Beneficiaries are those who benefit from the actions and decisions of users. This can include avoided damages (e.g., Defra family responding to Asian hornet reports to avoid establishment in the UK).

3. Evaluating the economic impact of GBNNSIP

This section applies the conceptual method described in Section 2 and considers the four key questions for this portal. Following an introduction to the management of invasive non-native species (INNS) (Section 3.1), understanding the data process is described in Section 3.2 (question 1). Describing the uses, benefits, users and beneficiaries is covered in Section 3.3 (questions 2 and 3 as these are intricately linked). Selection of the preferred method from the possible valuation approaches (question 4) is covered in Section 3.4. Finally, Section 3.5 describes the method used to evaluate the benefits, which will be presented in the final section of this report (Section 4).

3.1 Background - Management of invasive non-native species

Figure 3.1 illustrates these stages of INNS extent and the corresponding management actions that can be deployed at each stage of invasion.

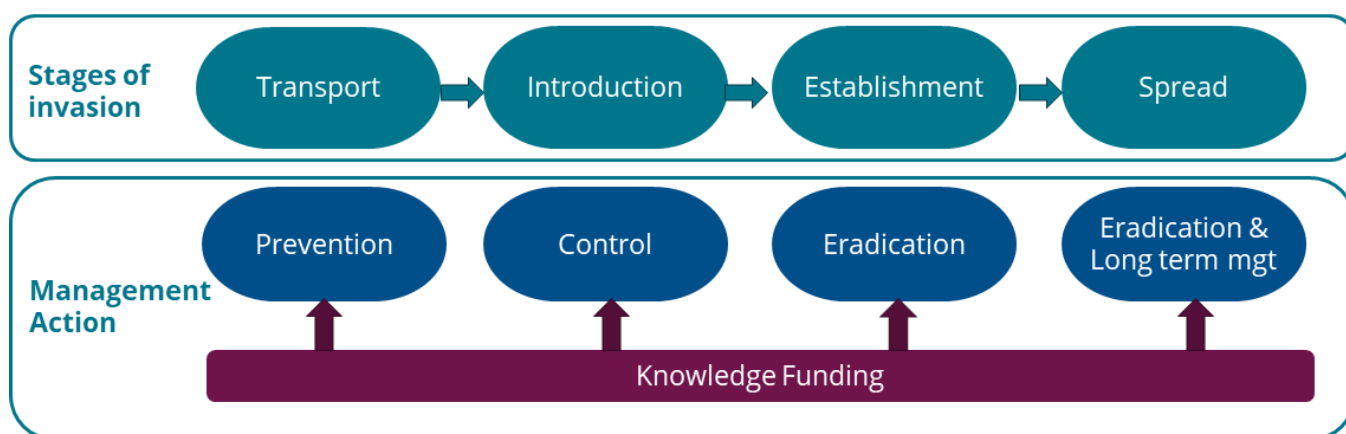


Figure 3.1: Stages of Invasion and corresponding management activity

Key management actions include:

- Prevention.** The GB Invasive Non-native Species Strategy¹ (GB Strategy) places a strong emphasis on prevention as the most effective approach to mitigating the threat of invasive non-native species and the least environmentally damaging intervention, which maximises the reduction in adverse impacts associated with biological invasions. Horizon scanning of the most likely and damaging threats is key to informing the most significant risks and in designing appropriate preventative measures. The GB Strategy has identified six pathways as the highest priority based on risk of introduction of INNS: hull fouling, stowaways on fishing equipment, zoo or botanic garden escapes, contaminants of ornamental plants, horticulture escapes, and ballast water.
- Control.** Involving surveillance, early detection, monitoring and rapid response. GBNNSIP provides

¹ The GB Strategy is the strategic framework by which actions of government departments, their related bodies and key stakeholders are co-ordinated. It is published jointly by Defra, Welsh Government and the Scottish Government. <https://www.nonnativespecies.org/about/gb-strategy>

rapid notification of sightings of alert species and up-to-date information on NNS and their distributions. This is fundamental to making effective decisions on responding to invasions and designing responses that minimise their threat. For example, the alert system has been updated in recent years to make the best use of new technologies and improving the quantity of NNS records. This includes better monitoring (e.g., citizen science initiatives and online systems, such as the 'Plant Alert' and 'Asian Hornet Watch' apps). The GB Strategy recognises that there are still opportunities for improvements, such as ensuring that the process of triaging and responding to alerts is as rapid as possible and that the flow of information to the species register are improved.

- **Eradication.** For example, the Environment Agency have been using the piscicide Rotenone to manage non-native fish populations in Great Britain (Defra et al., 2023). To date, two invasive fish species — the fathead minnow (*Pimephales promelas*) and black bullhead (*Ameiurus melas*) — have been eradicated from GB, with an on-going eradication programme for the species identified through horizon scanning the topmouth gudgeon (*Pseudorasbora parva*). By 2022, topmouth gudgeon have been eradicated from nearly 70% of the known locations. The aim is the complete removal of this high priority species from GB.
- **Long term management.** At some point an invasive non-native species may be so widespread that complete eradication becomes infeasible (e.g., grey squirrel and Japanese knotweed). In these cases, the management actions may involve containment, management of impacts or eradication in certain priority locations.
- **Knowledge funding.** More knowledge on invasive non-native species (e.g., their life cycle, behaviour and interaction with the environment) can help improve the effectiveness of all the above management actions. In this regard the outputs from the GBNNSIP can help inform research priorities.

Many sources emphasise the lower costs of preventative action Cuthbert et al (2022) and Eschen et al (2022) compared to the costs of eradication or damage caused once an INNS has become established.

3.2 Overview of the GBNNSIP process

The GBNNSIP is Britain's only portal that contains data on the occurrence of non-native invasive species. It also contains information on the species and links to the occurrence information that is compiled through the NBN Atlas². It plays a pivotal role in recording species occurrence, trends and maps, which are used to support rapid responses, and develop policy and strategy for managing invasive non-native species in Britain.

The GBNNSIP is both an output and informs other outputs that are generated from the data generating and sharing process. For example, the portal stores species information and informs species trends and traits, which, in turn, inform the Horizon Scanning process. See Figure 3.2 for the list of outputs. Some of these outputs then inform the data gathering process by identifying where better data are needed, such as identifying new potential invasive non-native species.

² The NBN Atlas is an online tool that 'provides a platform to engage, educate and inform people about the natural world'. It is managed by the National Biodiversity Network Trust (NBN Trust). <https://nbnatlas.org/>

The process for gathering, recording and reporting output data on invasive non-native species in Britain is necessarily complex to maximise possibilities to capture information and illustrated at a high level in Figure 3.2. The subsequent users of these outputs, their uses, expected outcomes and final beneficiaries are shown in Figure 3.3, in Section 3.3. As the steps in producing outputs are intricately linked and benefits and impacts of these outputs are difficult to isolate, **we evaluated the benefits of the process for invasive species monitoring, and management together as a package**, i.e., from collecting species data to producing key outputs such as horizon scanning and notifications to the alert system. This includes the outputs listed in Figure 3.2 and the subsequent uses made of these outputs in the monitoring and management of invasive non-native species.

The most significant outputs of this process are:

- The alert system consisting of 19 priority species, which is triggered by sightings that are verified by UKCEH. These are rapidly referred to the Non-native Species Secretariat (NNSS) for subsequent action by an appropriate organisation (e.g., eradication of *V. velutina* nests etc.).
- Information from the portal is used to inform key invasive non-native species management activities, such as GB horizon scanning (predicting invasive non-native species that are currently absent but have the potential to be introduced and establish) and the GB Strategy. These inform preventive measures and rapid response mechanisms to inhibit introductions and establishment of harmful invasive species.

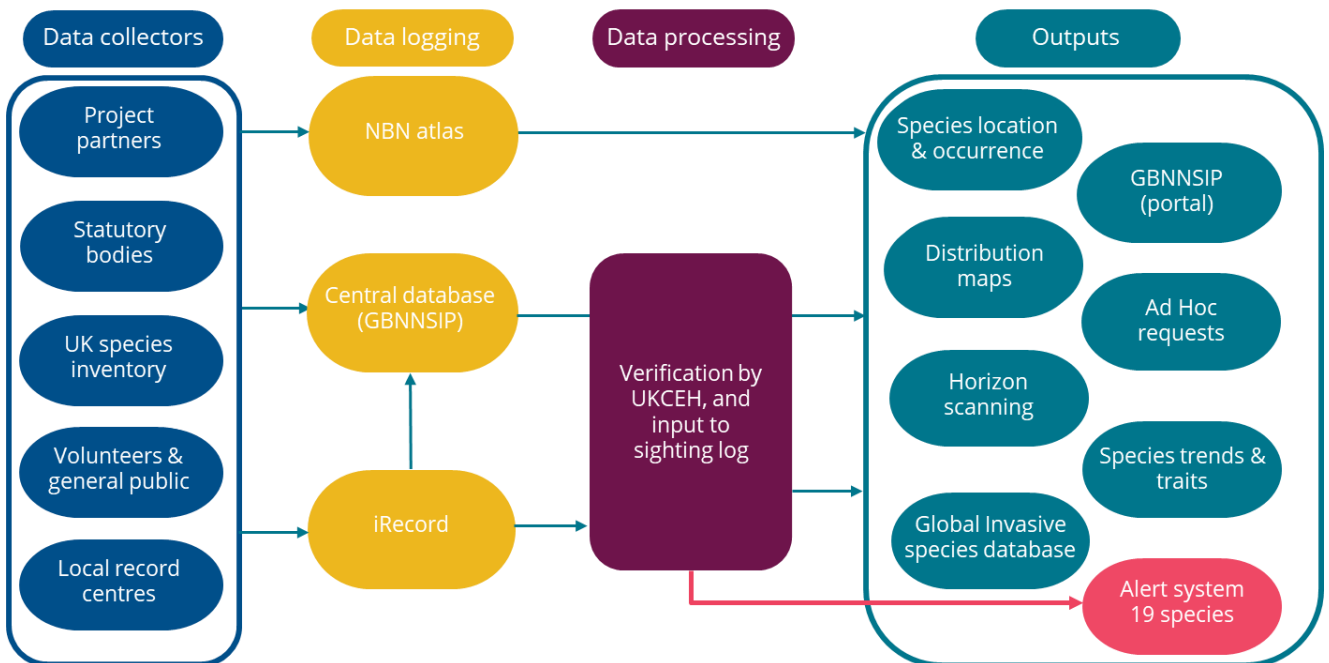


Figure 3.2: GB Invasive species data process

Note: this project is restricted to impacts in GB, but the portal and supporting processes also have benefits to Europe, UK Overseas Territories (UKOT) and globally. Also, the system is assumed to apply to plants and

animals only, i.e., does not include fungi or other pathogens. Furthermore, it excludes threats covered by other rapid response processes in Britain (e.g., public health pathogens and threats to agricultural livestock or crop disease).

3.3 Benefits, users and beneficiaries

This section highlights the most significant benefits that we think are capable of robust economic valuation within the timescales and resources of this project, and describes the other benefits considered, and reasons for not evaluating them here.

In discussion with experts from UKCEH (Helen Roy and Stephanie Rorke) we understand that the principal users, uses, benefits and beneficiaries of the system of invasive non-native species monitoring and reporting include those shown in Figure 3.3.

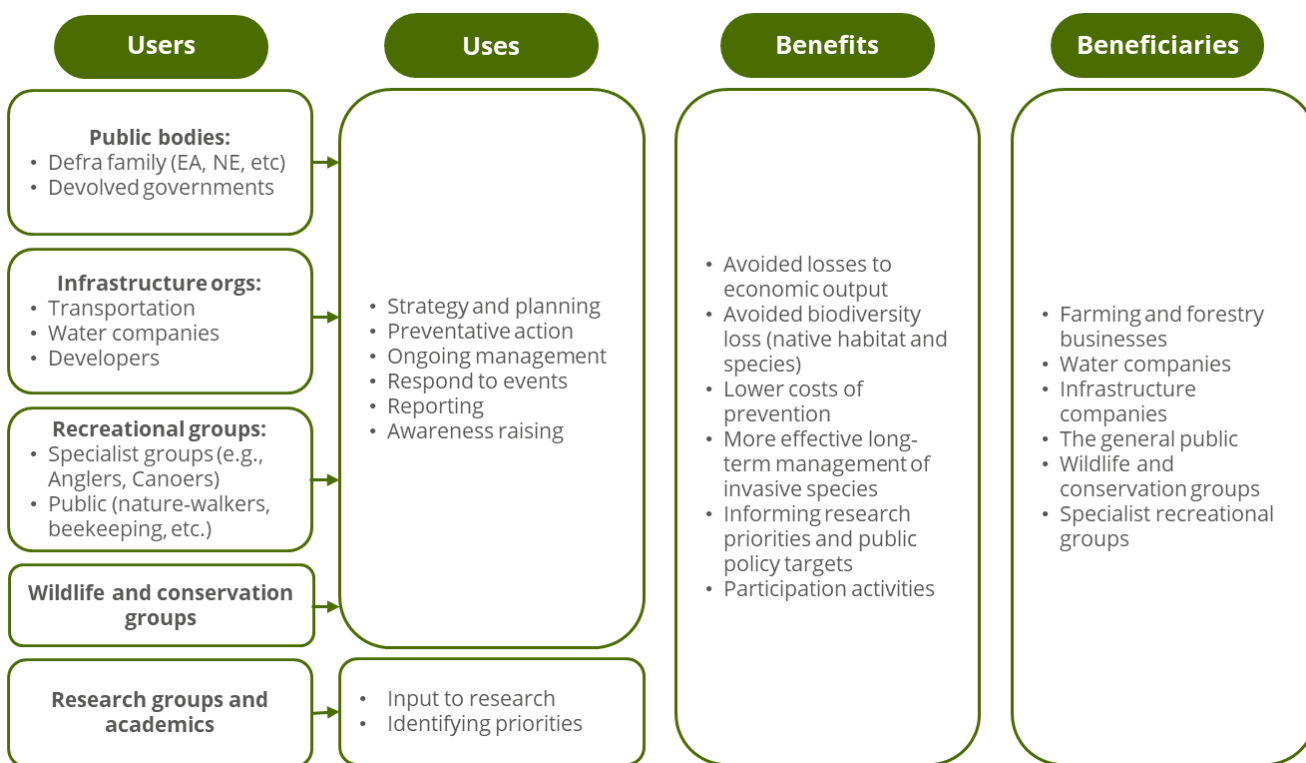


Figure 3.3: Users, uses, benefits and beneficiaries of invasive species monitoring and reporting.

Note: benefit estimates are not all additive, see Section 2.2

Users of the GBNNSIP come from public, private and third sectors. The primary public users of the GBNNSIP are Defra, who funds the programme, the Defra family, other natural-related public agencies of the devolved nations, and local authorities. From the private sector, the main users are those that interact with the environment, such as infrastructure companies (e.g., water and rail companies). Third sector users are primarily research organisations, recreational groups (e.g., anglers), and wildlife and conservation groups, including citizen scientists.

Most users utilise the outputs from the invasive species monitoring system in similar ways, to:

- Create strategies and plans to limit the chance of invasive species introductions (e.g., water companies to avoid clams blocking waterways, and hulling cleaning in fisheries and recreational sports to avoid transport of freshwater invasives);
- Take preventive measures to control introductions and establishments. For example, the pathways strategies in the GB Non-native Invasive Species Strategy;
- Design of rapid response mechanisms as appropriate;
- Using best available knowledge to manage established invasive non-native species, and
- Raising public awareness and recruiting public support for appropriate action.

The benefits of these uses include:

- **Avoided damages and losses:**
 - Avoiding economic losses from invasions, such as timber production losses due to invasive tree pests (e.g., Emerald Ash Borer (*Agilus planipennis*)).
 - Avoiding losses to native habitat and species (e.g., Asian hornet impacts on wild bees).
- **Avoided costs of management:**
 - Avoided costs of eradication due to preventive action or responding to invasions quickly – this can avoid much higher eradication costs if an invasive species did become established.
 - Greater knowledge of INNS life cycle and behaviour can help inform more cost-effective management approaches to containing or possibly eradicating an INNS.
- **Ease of use:**
 - Value of UKCEH's role as organiser/curator of the data (e.g., time saved due to using the portal instead of alternative ways of acquiring the same data, use in research)
- **Support to Research**
 - Use of data in support of further research
 - Informing future research priorities/government policy targets
- **Participation benefits** due to data collection (e.g., volunteer time and education of citizen science groups).

The beneficiary groups are broad and varied, representing the fact that INNS can have a very broad impact: from impacts on specific industries (such as pests that are threats to agriculture, fishing, forestry and water supply businesses), to impacts that can be experienced by the whole of society (e.g., reductions to, or threat of the complete loss of native species, such as red squirrel). Consequently, we do not think it practical to estimate benefits by beneficiary group. Hence, we identified the most material benefits and selected a method that provides a reasonable assessment of each material benefit. Table 3.1 considers the broad range of benefits, including which are and why.

Table 3.1: Overview of benefits and proposed treatment

Benefit Group	Benefit	Level of materiality and proposed assessment
Avoided damage	Avoided damage costs through better prevention and control of INNS	This will be very high for the most harmful species, and for those impacts that have the most direct economic damage.
Avoided costs of management	Avoided eradication costs through better prevention and control of INNS	Where costs of damage are difficult to estimate, an alternative is to assess the costs of eradication as a proxy for the damage avoided. The cost of eradication must be perceived to be lower than cost of damage as otherwise eradication would not take place.
	More cost-effective management approaches to containing or eradicating an INNS	In discussion with UKCEH experts, it is considered very difficult to isolate knowledge on INNS from all other knowledge and factors that can be used to reduce costs of species management. Hence this benefit is not evaluated further here.
	Avoided costs of late intervention	Intervention costs increase the later an invasion is detected, hence early warning avoids these costs. Whilst this is likely to be significant it potentially double-counts with the benefit of avoided damage or avoided eradication costs, so will not be assessed further.
Ease of use	Ease of data access	Accessing data in one place can reduce the time needed ¹ to make planning and research and reduce associated costs. Furthermore, quality assurance of the data by UKCEH also has value for users.
Benefits for continued research	Use of data in research	The GBNNSIP is used extensively in INNS research to further knowledge of these species. Whilst the volume of output can and should be measured quantitatively (citations and number of research projects), the economic impacts are very difficult to predict and assess.
	Insights to prioritise future research funding	
Participation benefits	Recreational enjoyment, education and well-being benefits.	This is likely to be small but important to those involved in recording species.

Note 1: The GBNNSIP is a catch-all repository for INNS data. In its absence users would need visit multiple data sources depending on the type of INNS, i.e., marine or plant life. Time saved through ease of access and quality assurance of data by GBNNSIP would have been the most convenient valuation approach. However, there is no ready user data that could be analysed within the scope of this project. Collecting such data is recommended for future assessments (see Section 4.3)

The most significant benefit of information on INNS is its use to avoid the damage of INNS being introduced, becoming established and spreading across UK territory.

3.4 Valuation approaches

For this project, three valuation approaches were considered. Their description and reasoning for inclusion or exclusion are presented below.

Approach 1. Avoided costs and damage. This approach would assess the losses avoided from use of the GBNNSIP and its impacts on society. In particular, the approach focuses on the benefits of:

- Avoided costs and damages through early detection and avoiding species introductions and establishment. This could be valued by either avoided damage costs of the impacts of species establishment or avoided costs of eradication if a species did become established.
- Reduced costs through better informed management of existing established INNS. However, in discussion with the UKCEH team, this aspect of benefit is relatively minor for the GBNSIP so will not be assessed here.

While avoided costs and damages approach is likely to estimate the biggest benefits, the key challenge is lack of user data and links to what may happen to INNS related decisions. Challenges include:

- Establishing the full economic cost of the damage from INNS impacts mainly due to lack of data and that estimates need to assume a counterfactual scenario of damage. The counterfactual would need to include other pressures on biodiversity, and the economic cost of native biodiversity loss which is particularly difficult to evaluate.
- Predicting counterfactual damage impacts as the range of impact is highly variable with species, location and context.
- Predicting future rates of INNS introduction (both with and without the system of monitoring, detection, early intervention and pathway control strategies). Noting that the trend is accelerating but hard to forecast.
- Predicting the extent to which the GBNSIP and supporting systems can prevent introductions and establishment. Noting that the INNS strategy has a target of 50% reduction in establishments (in 2030 compared to year 2000 rate of establishments).

Even so, and with careful consideration to avoid double-counting, this approach would likely have the closest representative value of the GBNSIP to the UK. We propose that the challenges described above can be addressed as follows:

- The INVACOST database (Daigne et al, 2020) and CABI reports (Eschen et al, 2023) contain estimates of damage and eradication costs by species and by country or region. These estimates are drawn from many sources and use a variety of methods and assumptions about species establishment and impacts. However, some max/min ranges are reported which can be used as a confidence range of losses avoided. Furthermore, a degree of judgement can be used in selecting appropriate species and the estimates of cost impacts that can be relied upon. We take a conservative approach to selection of estimates so that a minimum value of damages avoided can be established. By selecting a representative range of the most significant invasive threat species to the UK, some of the variation in specific species estimates can be expected to be averaged out if the sample is sufficiently large (at least 10). Finally, as some damage estimates apply to other nations and regions, some adjustment to apply them to the UK can be made. Consequently, an estimate of avoided damages compiled as described above should be viewed as an indication of the minimum value of damage that can be avoided.
- The issue of predicting the probability and timing of invasions in the absence of a system of monitoring and management, can be addressed by selecting those species that are most likely to invade in the short term (next 10 to 20 years). A range of probability weighting could be applied, in consultation with the UKCEH team, or by selecting a range of species that provides a balanced view

of the likely probability of invasion. To covering timing aspects, we calculate present values over a 60-year period. We assume a counterfactual profile of invasion costs but assume most damage impacts will commence in the short term (around 10 years).

Approach 2. Cost of time spent using the data as a proxy for benefits of use. This approach can be applied to both users of the data, and to participants who provide data (e.g., submitting sightings). Using the cost of time spent as a proxy for benefits delivered is based on the rationale that users trade off time and benefits and they would not spend the time had they not thought of it as at least as beneficial as the outcome. This provides a practical and quantifiable measure of the value of data and offers a tangible and consistent metric to approximate value.

Both users of the portal and participants who provide sightings information can be surveyed to collect data about the time spent using and participating. In the case of the users, their view on how much time they would need if the portal did not exist can also be asked. Such a survey was not within the scope of this project but now that the impact assessment approach is ready, a survey can be added to the portal or emailed.

For this application, we did use this approach to evaluate some participants benefits but used approach 1 to evaluate the benefits of avoided losses.

Approach 3. Willingness-to-pay for the data. This approach would survey users to elicit their willingness-to-pay (WTP) for using the GBNNSIP. The survey would, in effect, create a hypothetical market and WTP reveals the value of the data. WTP surveys are most useful when services are provided for free (as is the case for the GBNNSIP) and are structured so that both direct users and beneficiaries (who are, or can be made, aware of the issues, risks and threats of INNS but do not use the data themselves). With careful input and testing design, such a survey is an option to consider in the future (e.g. by having a survey link available for users on the portal link which will reduce the cost of data collection).

3.5 Evaluation of the benefits

This section explains our method for evaluating and assessing the benefits we outlined in section 3.3.

3.5.1 *Benefits of avoided damages and costs*

We used a species-based approach to evaluating avoided damages and costs, considering the species that currently pose the greatest risks of loss from future introduction and establishment in the UK. The key assumption is that the GBNNSIP is instrumental to identifying the INNS of most concern, enabling monitoring of sightings and so supporting rapid response and appropriate action to eradicate introductions as they occur.

Avoided damages and costs were evaluated by estimating the counterfactual impact of a likely range of harmful species introductions/establishments. Impacts by each species was evaluated by:

- i. Avoided damage through prevention of that species becoming established in the UK (e.g., loss of UK pollination service from invasion of Asian Hornets.), or,

- ii. Avoided costs of eradication/management action that would be needed if the species were to become established.

In some cases, it may not be possible to adequately capture the full cost of damage, especially for the loss of native biodiversity (e.g., Asian hornet impacts on native bee populations, or Ruddy Duck hybridisation with European White-neck Duck). However, these impacts are described qualitatively wherever possible.

These avoided damages and costs should be set against the ongoing prevention and control costs that are necessary to avoid introductions and establishments in the first place. However, for most species the ongoing monitoring and control costs may be at least an order of magnitude lower than the impacts of major scale establishment. The difference between the two cost profiles over a 60-year period will be the net benefit of the system of GBNSIP monitoring.

Note all costs will need to be evaluated in terms of 60-year present values (PV60) to be comparable over a reasonable time frame (i.e., 60 years, or 2025-85). Clearly, over this time frame new INNS will emerge, and threats can be expected to increase with both climate change and the movement of people and goods with increased levels of trade and economic growth. The impact of these factors is hard to forecast, hence we have excluded them in our analysis.

The list of species assessed (11) was selected from a long list (40) comprising those on the alert system list (19 species) or the top 30 combined ranked horizon scan species (from the 100 species in total). This list prioritised those that have the highest adverse impact rankings, are high priority for the NNSS, and those for which adequate damage or eradication costs are available or estimable. The selection was informed by the ranking from the horizon scan lists, namely:

- Combined impact ranking (top 30 on the horizon scan list)
- Biodiversity risk rating
- Health impact rating, and
- Economic impact rating

The long list is produced in Appendix 1: List of Priority Species.

Damage and eradication cost data were sourced from the INVACOST database (Diagne, et al., 2020) and used UK specific costs/studies as a priority. Where there was no UK data, we used European, and North American data but adjusted on a reasonable basis to a UK context. Where there was no INVACOST data, we used transfer assumptions from the Eschen et al. (2023) report of costs of existing UK INNS on similar species/impacts basis.

Clearly other INNS not on our selected list also pose risks of damage, however as the selected species are prioritised on the highest impact invasions, this will be a conservative but representative indication of the damages that may be avoided.

Finally, whilst monitoring and control actions aim to avoid invasions and establishments, there is a reasonable chance that some invasives species may still establish and spread despite preventative action being taken. This is very difficult to forecast with any degree of confidence and must be considered on an assumed range of success. As an indication, global biodiversity targets (and mirrored in the UK INNS

strategy) aim to achieve a 50% reduction in establishments by 2030 (compared to the rate in the year 2000). Discussions with experts in UKCEH suggest that at least 50% of INNS could be avoided over a 60-year period. We included an estimate of the probability of success in the assessment of counterfactual costs avoided.

3.5.2 *Benefits of data for research*

The value of research is independent of the uses of the data for the management of INNS. The information in the portal is used extensively in research work and represents an important knowledge base for multiple users. Potential research benefits include:

- Provision of information to support research work, and
- Insights to inform future research priorities into INNS and their impacts

We treat these quantitatively since while the economic impact can be substantial but is very difficult to predict. Quantitative indicators considered are:

- Number of GBNNSIP accesses by year (typically 6-10,000 views per year);
- Number of peer-reviewed papers published online using data from GBNNSIP data;
- Number and value of projects funded by NERC that use GBNNSIP, and
- Noting if any research calls or programmes specifically on INNS have been initiated by findings from use of GBNNSIP.

3.5.3 *Participation Benefits*

The method for calculating volunteer benefits estimates the number of hours that members of the public and volunteers spend on reporting INNS. We used UKCEH data on the number of reported sightings, and we used an assumption on time taken to report a sighting to infer total volunteer time. From this we apply a minimum wage per hour for volunteer effort to assess an economic value for this benefit.

Whilst there may be some benefits to physical health from exercise derived from observing species in the natural environment, it is anticipated that this is small so was not evaluated separately.

There are some educational activities linked to INNS (e.g., informing local volunteer action groups on latest learning of INNS risks or identification tips), however this benefit is likely to be small in scale, and not directly related to the GBNNSIP so was not evaluated here.

One aspect that will be difficult to evaluate monetary terms is the extent to which the use of the portal can both encourage public involvement and accuracy in reported sightings. However, this is likely to be an important benefit.

4. Results of economic impact assessment

This section details the evaluation results of the benefits provided by the GBNNSIP.

4.1 Benefits from avoided damages/costs

As explained in section 3.5.1 the method for evaluating the net benefit of avoided damages and costs due to the alert system was to compare current control costs (with the alert system) to the costs that are likely to be incurred in the absence of the GBNNSIP and alert system (the counterfactual case). This has been considered for each of the priority species selected (the selection process is detailed in Appendix 1), and for each species in the counterfactual case we consider either the costs of eradication/management (if applicable), or the costs of damage impacts that would arise if that species became widespread nationally (if estimable). The estimates depend upon defining a realistic scenario of damage for the counterfactual costs in the absence of the alert system. Note that in many cases the damage impacts may be expressed in qualitative terms due to the challenges of quantifying the costs of damages.

To enable a fair comparison over a reasonable timeframe, we compare the 60-year present value of existing control costs with the probability weighted 60-year present value of the counterfactual outcome by species. To arrive at these values, we build up the estimates through the following steps:

1. Select the highest impact species for analysis, to target the highest negative impacts to be avoided;
2. Clarify and confirm the role the GBNNSIP and alert system plays in preventing spread;
3. Estimate likely rates of invasion by species;
4. Establish current control costs;
5. Establish counterfactual impacts and costs, and
6. Conduct 60-year analysis to compare present values.

These steps are described in the following sections and have used information from the NNIS website (e.g., species risk assessments and fact sheets), literature and data sources (e.g. INVACOST database), and discussions with experts from UKCEH and the NNSS. Note: having conducted the above process for the top 11 species, ***only the Asian Hornet had data of sufficient confidence to enable a full cost and counterfactual impact evaluation.*** Costs for other species are partial and require more data to develop a robust impact evaluation.

1. Select priority species for analysis

Selection from the GB Alert system list of the most damaging species for analysis (Table 4.1) was based on those which have the potential for greatest damage and a reasonable likelihood of spreading if monitoring and control measures are absent or fail.

Table 4.1: Species selected of analysis from the GB alert system.

Species	Impacts	Likelihood of spread
Asian hornet	Harms wild bee species, agricultural loss. Damage caused to honeybees and colonies is widely recognised in Asia (Williams, 1988; Shah & Shah, 1991; Abrol, 1994), but little data quantifying cost of species loss is available.	High - became established within about 5 years in France.
American bullfrog	Threatens small amphibians, fish and mammals. Very serious threat to native freshwater species.	High – very suited to UK freshwater environment
Monk parakeet	Competes for food with other birds, infrastructure and potential crop damage.	Moderate/high - current populations have not spread beyond London & Herts.
Ruddy duck	Breeds with native European white-headed in Spain. Global extinction risk. Other damage negligible.	Very likely - UK records from 1960-2000 show it can spread across large areas.
Topmouth gudgeon	Is a voracious predator of zooplankton etc., takes other species' eggs, and is a facultative parasite. Some evidence to suggest it impedes the reproduction of other species. Harm to water quality.	High. Adaptable to UK climate. The susceptible area has been estimated at over 100,000 ha.
Water primrose	Risks to water quality (by covering water surface) and flood risk. Costs incurred would be through the need for management especially in relation to flood control and water lost to irrigation.	High. Now across all of France. Impacts water quality & environment.
Sea myrtle	Is invasive in coastal areas where it outcompetes native plants and alters the ecosystem. Its leaves are toxic to livestock and its pollen and pappus can cause irritation in humans. No known damage costs as slow spread.	Moderate. Can be fast spreading (in Europe). Unsure of UK rate of spread – NNSS adopts precautionary approach.
Raccoon	Preys on native birds and rodents. Potential economic cost to poultry and property.	Very likely to spread if breeding successful as very adaptable to UK environment.
Raccoon dog	Preys on native birds and rodents. Also competes with badgers. Possible vector of rabies	Very likely to spread if breeding successful as very adaptable to UK environment.
American lobster	Risks to native lobster and crab species. Major impact to UK fishing industry.	High
Siberian chipmunk	May threaten other native rodents and some birds through competition for food	Likely. Flexible in their choice of habitat; native habitat consists of woodland with a bushy understorey

2. Clarify the role of GBNSIP

The strategy for preventing the establishment of a new invasive non-native species varies by species, depending on, its current status, and likely pathways of spread. However, whatever the strategy the alert system has a varying role to play in rapid detection and initiation of an appropriate response (Table 4.2).

Table 4.2: Species strategies and role of the alert system in prevention

Species	Current Status	Strategy	Role of alert system
Asian hornet	Regular invasions, not established.	Spot and eradicate when identified. Once established eradication impractical and costly.	Plays a key role in rapid reporting of sightings to aid quick eradication
American bullfrog	Very few invasions	Spot and eradicate when identified. Once established eradication impractical and costly.	Rapid reporting of sightings to aid quick eradication.
Monk parakeet	A few established colonies in London & Herts in process of eradication (almost complete).	Eliminate remaining colony, eradicate if spreads.	Other systems report sightings, hence alert system has limited role.
Ruddy duck	First record in 1952, peak at 6,000 (2000), but population reduced through eradication efforts to only a few breeding pairs.	Eradication as part of EU wide programme. Functional eradication achieved 2021. Prevent re-introduction.	Other systems report sightings to avoid re-introduction, hence alert system has limited role.
Topmouth gudgeon	Regular invasions, established in 34 locations across UK.	Eradications underway. Once complete respond to re-invasion.	Other systems (EA in England and others by devolved nation) report sightings, hence alert system has limited role.
Water primrose	Established in about thirteen locations in the UK, but Defra reports that actual numbers of sites could be up to 60 (in 2007)	Contain sites. Capture any escapes from gardens.	Report sightings (esp. beyond current range). Alert system is main mechanism for detection.
Sea myrtle	1 site established	Contain one site. Capture any escapes from gardens.	Report sightings (esp. beyond current range). Alert system is main mechanism for detection.
Raccoon	Occasional escapees	Capture escapees. Very likely to spread if breeding successful.	Alert system is main mechanism for detection. Rapid reporting of sightings to aid capture or eradication
Raccoon dog	Occasional escapees	Capture escapees. Very likely to spread if breeding successful.	Alert system is main mechanism for detection. Rapid reporting of sightings to aid capture or eradication
American lobster	Established at a few sites.	Capture and report when found	Marine organisations have campaigns and monitoring systems in place. GBNNSIP helps provide GB picture.
Siberian chipmunk	Occasional invasions. Not established	Identify/report and capture	Alert system is main mechanism for detection. Rapid reporting of sightings to aid capture or eradication

Table 4.2 shows that the alert system has a key role to play in the rapid detection of seven of these species (Asian hornet, American bullfrog, Water primrose, Sea myrtle, Raccoon, Raccoon dog and Siberian chipmunk). For some invasive species, other reporting and response mechanisms are in place (e.g., Monk parakeet and Ruddy Duck) as part of an overall programme to eradicate these invasive species. It is not clear what mechanisms will be maintained once these species are eradicated from Great Britain. For the

American lobster and Topmouth gudgeon, agencies such as MMO have processes in place to detect these species, however the GBNSIP does play a role in providing a GB picture by consolidating devolved nations sightings.

3. Estimate likely rates of invasion

To estimate control costs and avoided damages, assumptions must be made on the likely rates of invasion by species. Table 4.3 details the assessments we could make by species (using best available data and expert views) and the rationale for the figures selected.

Table 4.3: Assessments on rates of introduction by species

Species	Invasion history	Assumed invasions per year	Notes
Asian hornet	75 verified sightings in 2024. Pathways through trade and natural movement.	75	Use current rate of sightings as underlying level of invasion
American bullfrog	A few since 1996, roughly 1 per decade.	0.1	Rare so assume 1 per decade.
Monk parakeet	In UK since 1970s. Frequent sightings but colonies have not established beyond London/Herts. Eradication almost complete.	1.0	Species is present, hence new invasions post successful eradication is difficult to predict. Assume at least one per year.
Ruddy duck	From 1960s to peak at c 6,000 birds by 2000. Reduced by culling to only a few breeding pairs. Eradication almost complete.	1.0	Species is present, hence new invasions post successful eradication is difficult to predict. Assume at least one per year. Rate may drop as the species becomes eradicated from mainland Europe.
Topmouth gudgeon	Escapes from trade. 34 known populations in the wild in the UK.	n/a ¹	Unable to source figures for this species
Water primrose	Escapes from gardens and travels with water movement	1.0	Little data. Assume at least one per year
Sea myrtle	Recorded at a small number of sites in GB. Established in one location. Slow spreader	1.0	Little data. Assume at least one per year
Raccoon	13 escapees 2000-7, 34 from 1970-2007.	2.0	Based on historic sightings assumes roughly 2 per year.
Raccoon dog	One or two since 2005	0.1	Rare so assume 1 per decade.
American lobster	Reported in south and east coasts of England (Cornwall to Suffolk) and east coast of Scotland. There was a mass release in Brighton where half were caught.	n/a ¹	Unable to source figures for this species
Siberian chipmunk	Five escapes from captivity in England in the 5 year period 2002-2006. Now illegal to sell in pet trade as of 2015.	1.0	Based on historic sightings assumes roughly 1 per year.

Note 1: Sightings information is collected by national agencies, which was not gathered within the scope of this project.

Future rates of invasion may vary from historic levels, but the assessment in Table 4.3 provides at least an order of magnitude assessment of invasion rates.

4. Establish current control costs

Best estimates for the annual cost of the current monitoring and control system are provided in Table 4.4. The level of control cost will depend mainly on the rate of invasion by species, but also on the management monitoring and response approach adopted. Information on current activity was partial and difficult to gather (except for the Asian Hornet) hence these costs are indicative only, but likely in the range of at least £0.8-1.6 million per year for the selected species. ***This estimate could be significantly improved if information on the scale of current programmes is collected.***

Table 4.4: Estimated on-going control costs

Species	Invasions per year	Annual Costs (£'000/year)	Rationale
Asian hornet	75	465-915	Assume cost of existing effort ¹ in UK at 10-20 Full Time Equivalents (FTE), at average UK earnings (total cost £450-900k), plus £200 per nest eradication at 75 eradications per year.
American bullfrog	0.1	5	Based on eradication cost of £50,000 for one site in S. Sussex. No others known in UK. Introductions very rare, hence low annual estimate.
Monk parakeet	1.0	>100	Annual cost estimate of £67k from Williams et al (2010). Current eradication programme is nearing completion, but no cost estimates were available at the time of compiling this report. Assume costs more than £100k if reinvasion occurs.
Ruddy duck	1.0	20-300	Historic costs £6m in UK for eradication programme (2000-20, or average of £300k/year). Low cost estimate assume say £20,000 per nesting pair in future, high cost could be at scale of previous programme (i.e. £300k/year)
Topmouth gudgeon	n/a	>100	Previous eradications cost c£63,000/year, Britton et al (2010). No recent cost estimates available at the time of compiling this report. Assume costs more than £100k if reinvasion occurs.
Water primrose	1.0	5	Manual control main option ranging from about EUR 1,000 to EUR 10,000 for small sites (Hussner et al., 2016). Assume average of £5,000/site.
Sea myrtle	1.0	12	Cost of eradication for a 1ha site in Spain (£11,825, Sarat et al (2015)).
Raccoon	2.0	40-100	Annual surveillance cost of EUR 7,500 in Netherlands, but this seems low. £20-50k per escapee seems more reasonable in terms of labour effort.
Raccoon dog	0.1	>2	Based on Norwegian national annual control cost of 140,000 NOK, Magnussen et al 2014. £20-50k per escapee seems reasonable.
American lobster	n/a	unknown	Costs of control in fisheries industry in Sweden (2MSEK = £140,000 per year). On-going marine monitoring schemes are significant, but no costs estimates were available at the time of compiling this report.
Siberian chipmunk	1.0	20-50	Based on cost of eradication in France 2020. Each capture likely to cost more than this (seems low). £20-50k per escapee seems reasonable.
Total		800-1,600	

Note 1: It was not possible to obtain data on labour resources used in monitoring and managing Asian hornet invasions, but conversations with experts from the NNSS and UKCEH indicated that effort at this level seems reasonable, and has been used as the basis for estimates.

5. Establish the counterfactual impacts and costs

The counterfactual, i.e. the absence UKCEH role in supporting the alert system, is described in Table 4.5. This table shows that the Alert system plays a main role in early detection for 7 of the alert species.

Table 4.5: Counterfactual assumptions

Species	Assumptions
Asian hornet	Becomes widespread across most of the climatically suitable areas of UK. Management is confinement, eliminating nests to keep the population stable. 100% probability this would occur within 60 years without alert system, most likely within the first 5 years based on evidence from France.
American bullfrog	Populations establish at small scale (up to 10% of suitable territory) as current rate of invasion is low. Eradication programme initiated taking several years to eradicate the species. Moderate probability of occurrence (say 50%) within next 60 years.
Monk parakeet	Pending eradication, ongoing monitoring provided by other organisations hence no change in outcome in absence of GBNSIP/alert system.
Ruddy duck	Pending eradication, ongoing monitoring provided by other organisations hence no change in outcome in absence of GBNSIP/alert system.
Topmouth gudgeon	Other systems in place to monitor invasion hence no change in outcome in absence of GBNSIP/alert system.
Water primrose	Species spreads beyond current distribution. Eradication effort scaled up to contain the population to current distribution. Low area of spread and moderate probability (50%) without alert system.
Sea myrtle	Current population is very small and does not appear to be invasive or spreading. Assume negligible increase in distribution without alert system.
Raccoon	Escapees are few but high risk of spread if a breeding pair establish. Moderate probability of occurrence (say 50%) within next 60 years without the alert system.
Raccoon dog	Escapees are few but high risk of spread if a breeding pair establish. Moderate probability of occurrence (say 50%) within next 60 years without the alert system.
American lobster	Other systems in place to monitor invasion hence no change in outcome in absence of GBNSIP/alert system.
Siberian chipmunk	Escapees are few but high risk of spread if a breeding pair establish. Moderate probability of occurrence (say 50%) within next 60 years without the alert system.

Given these assumptions, an assessment of likely management costs and potential damage impacts are set out in Table 4.6. These estimates combine costs from the INVACOST database, along with other studies and views from experts as appropriate. Management costs reflect the level of ongoing control costs or species eradication costs that are likely to be incurred in response to the spread of that species. Damage impacts are assessments of the damages that could be incurred if the species spread as described in the counterfactual case. Note that in many cases, where damage cost is difficult to evaluate in monetary terms, qualitative descriptions are used. We consider that only the Asian hornet assumptions are sufficiently robust to allow the calculation of a reasonable cost estimate. For other species we set out possible assumptions that could be used for future estimates if more reliable information could be obtained.

Table 4.6: Estimates of counterfactual impacts and costs

Species	Management costs	Damage impacts/costs	Assumptions and rationale for cost selection
Asian hornet	£10m/year	£450m/year (loss of pollinators), major threat to native honeybees and other insects.	<p>Management cost: Estimate based on the annual cost of nest destruction (£9m) if climatically suitable areas in UK are fully invaded, (Barbet-Massin et al, 2020), plus doubling current labour resource (to £1m/year). This is a coping strategy and not full eradication.</p> <p>Damage cost: Based on total loss of UK pollinators, estimated to be £450million per year (NNS risk assessment).</p> <p>Assumption used: management cost (£10m/year) as minimum. Damage costs are uncertain but much higher than the counterfactual management cost. 100% probability this would occur within 60 years without alert system, modelled as occurring within 5 years based on rate of spread in France.</p>
American bullfrog	c£3billion to eradicate for whole of UK, but counterfactual scale hard to predict.	Major loss of GB amphibians and fish	<p>Management cost: £3bn estimate based on EUR4.4 billion for eradication in Germany (EEA). Likely that eradication would occur well before this scale of invasion, so perhaps at 10% of this value.</p> <p>Damage cost: Hard to quantify in monetary terms but could extirpate some UK freshwater species.</p> <p>Possible assumption: Management cost at 10% of full national eradication (i.e. £300m) as a one-off cost. Probability of occurrence 50% without alert system.</p>
Monk parakeet	n/a	n/a	Alert system does not impact the counterfactual case
Ruddy duck	n/a	n/a	Alert system does not impact the counterfactual case
Topmouth gudgeon	n/a	n/a	Alert system does not impact the counterfactual case
Water primrose	Could be several times current control costs (£few k/year)	Damage to native freshwater habitats and species	<p>Management cost: Could be slightly higher than current control costs Early detection and control avoids higher costs experienced in other European countries.</p> <p>Damage cost: Hard to predict scale and value but could be high.</p> <p>Possible assumption: Likely to be a multiple of existing costs, but current estimate not robust. Moderate probability (50%) of occurrence without alert system.</p>
Sea myrtle	Similar to current control costs as spread is slow	Damage native species and altering habitat composition	<p>Management cost: Hard to forecast extent of spread, but difficult and expensive to control or eradicate if it is established.</p> <p>Damage cost: Hard to predict in absence of alert system but likely low as spread is slow.</p> <p>Possible assumption: Assume low to negligible increase in costs for counterfactual case.</p>
Raccoon	Many times greater than current control costs. Depends on scale of spread.	Threat to native birds, rodents and can compete with native carnivores	<p>Management cost: Hard to forecast extent of spread, but difficult and expensive to control or eradicate if it is established.</p> <p>Damage cost: Hard to quantify but likely high loss of native wildlife if established.</p> <p>Possible assumption: Likely to be a multiple of existing costs, but current estimate not robust. Moderate probability (50%) of occurrence without alert system</p>

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Species	Management costs	Damage impacts/costs	Assumptions and rationale for cost selection
Raccoon dog	Many times greater than current control costs. Depends on scale of spread.	Threat to native birds, rodents and can compete with native carnivores. Economic threat to game shooting.	Management cost: Hard to forecast extent of spread, but difficult and expensive to control or eradicate if it is established. Damage cost: Hard to quantify but likely high loss of native wildlife if established. Possible assumption: Likely to be a multiple of existing costs, but current estimate not robust. Moderate probability (50%) of occurrence without alert system
American lobster	n/a	n/a	Alert system does not impact the counterfactual case
Siberian chipmunk	Many times greater than current control costs. Depends on scale of spread.	Risk to low-nesting birds, may compete with native woodland mammals. Some damage risk to crops.	Management cost: Hard to forecast extent of spread, but difficult and expensive to control or eradicate if it is established. Damage cost: Hard to quantify but likely high loss of native wildlife if established. Possible assumption: Likely to be a multiple of existing costs, but current estimate not robust. Moderate probability (50%) of occurrence without alert system

For each species either the counterfactual management cost or the damage cost should be selected to represent the cost or damage avoided. This approach is adopted on the basis that the management costs would be incurred to avoid the even higher damage losses (otherwise the management option wouldn't be selected). Hence either the management cost or damage costs are avoided (but not both).

Other than for the Asian Hornet, the level of uncertainty in the cost estimates was too high to allow production of a robust counterfactual benefit. Figure 4.1 provides an illustration (not to scale) of the costs of the current approach to management of Asian Hornet (circa £18 million, +/- £5m, below the line) and the consequences of the counterfactual case shown as costs above the line. The costs of managing the species (once established) are at least £225 million and this estimate does not assume that full eradication is achieved (just containment). In addition, there are some damages that can be quantified, (such as loss of pollination services c.£13 billion), and some impacts that are very difficult to express in monetary terms (such as the loss of native honeybees and other animals).

With further research it should be possible to construct similar cost comparisons for other invasive species that are avoided by use of the GBNSIP and Alert system (such as Raccoon, etc). The evaluation of the Asian Hornet represents the most significant threat that the GBNSIP currently avoids, however it is an important line of defence against other invasive species and can respond to emerging threats that may materialise over the next 60 years or more.

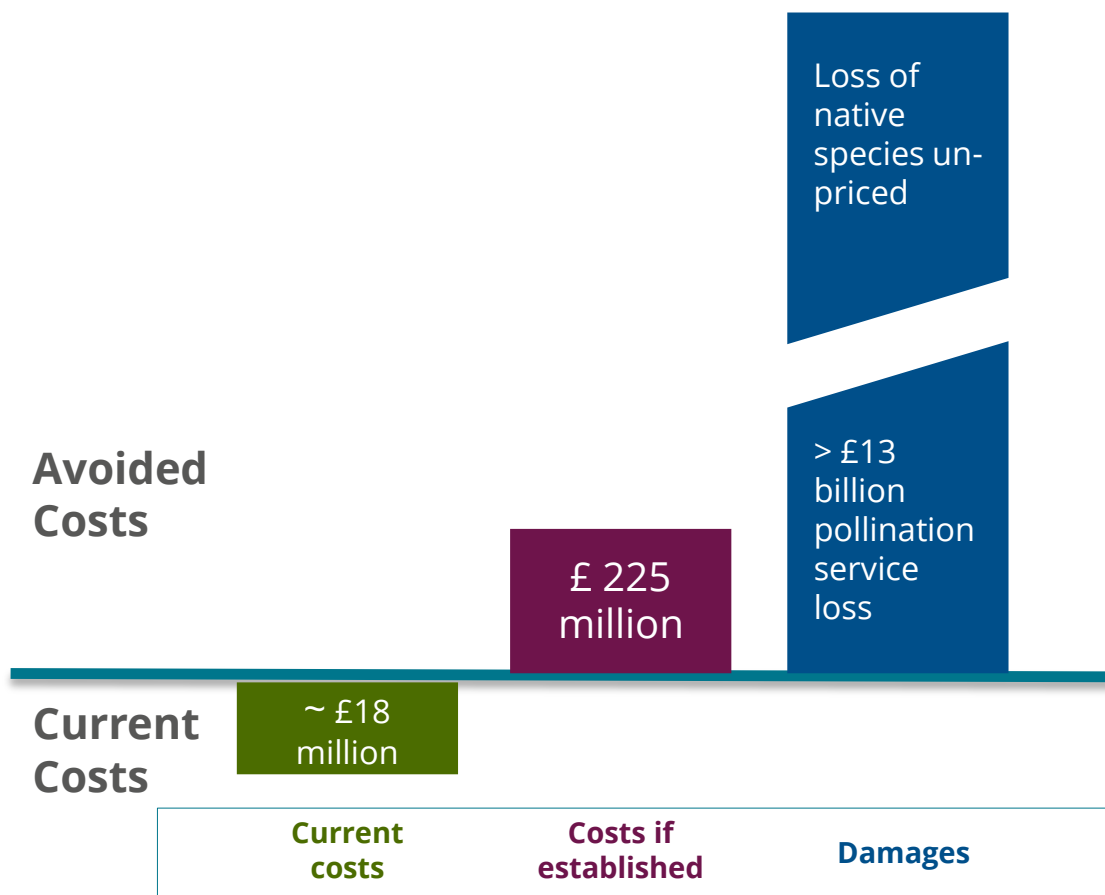


Figure 4.1: Illustration of current management costs to counterfactual costs (not to scale) Costs are 60-year present values in 2024 terms.

For the Asian Hornet, the cost assumptions and probability of occurrence have been used to forecast a future profile of expected costs for both the counterfactual case and the current control scenario over a 60-year period. We assume that the species establishes at 100% probability within 5 years in line with experience from France. This timeframe allows a long-term horizon over which to compare outcomes and costs. The counterfactual costs represent the modelled costs of management for the UK from Barbet-Massin et al (2020) which is a minimum cost of management and is considerably less than the damage costs which are likely to be incurred if the species establishes.

Table 4.7: Comparison of current control costs vs counterfactual case

Scenario	Present value over 60 years (£'m)
Current Control costs	£13-23m
Counterfactual case	>£225m
Difference (avoided losses)	>£200m

4.2 Other Benefits of the GBNNSIP

Use in Research

Additional benefits provided by the GBNNSIP are those associated with provision of the data for research. Use of the portal data can be used for:

- Improving knowledge base of INNS through research, providing better understanding of how species can invade and the effectiveness of measures to prevent and contain particular species.
- Informing priorities for future research through better targeting of future research funding. The portal is very useful in reviewing species for inclusion in the Alert system and for Horizon scanning, which can be used to inform priority species to research.

These benefits are difficult to assess as the impacts and outcomes are hard to predict. However, the scale of these benefits can be evidenced through:

- Number of GBNNSIP accesses by year: typically, 6-10,000 views per year;
- Number of peer-reviewed papers published online using data from GBNNSIP data: circa 20, and
- The GBNNSIP has been an important template for the design of the UK Overseas Territory INNS processes with associated benefits they will generate.

Participation Benefits

From data provided by UKCEH, there are approximately 25,000 sightings reported annually. Assuming around 5-8 minutes to record each, this gives an estimate of time in participation of 2,100- 3,300 hours per year. Valuing at the current minimum hourly wage gives an indicative value of £25-40k per year, or £0.6-1.0 million in present value over 60 years.

4.3 Conclusions & Recommendations

Key conclusions to draw from this impact study are:

- The main economic impact of the GBNNSIP is the avoidance of substantial damages from the potential establishment of invasive species in Great Britain. Forecasting the counterfactual outcomes for invasive species establishment in the absence the GBNNSIP makes it difficult to estimate either likely management costs or future damage costs from establishment, however these can be expected to be in the region of **tens of billions of £GBP over 60 years**.
- Preventing the establishment of the Asian Hornet (*Vespa velutina*) is currently a high priority, and for which there is reasonable data to construct indicative costs of the counterfactual impacts if the GBNNSIP and associated alert system were not in operation. In terms of **avoided management costs this is at least £200 million**, but these costs of eradication are far lower than the potential damages that a large-scale invasion could inflict (loss of native honeybees and other important pollinators).
- This illustrates that the cost of the GBNNSIP is easily justified in terms of preventing the

establishment of the Asian Hornet alone. However, the GBNNSIP and alert system can also provide sightings data and alert warnings for other harmful invasive species. While some of these harmful INNS are monitored and managed by other systems and government agencies (e.g. EA, MMO, APHA etc.), several species are likely to be first sighted and reported via the GBNNSIP/Alert system. There has been insufficient data to evaluate the avoided costs of these species, but these can be substantial.

Recommendations:

- It is clear that there is very little recording of the resources used in monitoring and managing harmful INNS across the devolved nations of Great Britain. Conducting a survey of the main programmes by species (e.g., American Lobster, Monk Parakeet, etc) would be helpful in establishing the costs that could be avoided if broader invasion and establishment were to occur. Such a programme may even help identify opportunities to manage and coordinate resources better and so reduce costs and increase effectiveness.
- There are good reasons why different organisations take the lead in monitoring and managing INNS (e.g. marine organisations for marine species, APHA for species that have high impacts on farming & forestry), but holding a GB wide repository of management costs and effectiveness of measures would help in planning a coordinated approach to the overall management of INNS and promote learning across agencies and devolved nations.
- Conducting a user survey, as a minimum, would improve future economic impact evaluations. Such a survey should ask users the purpose of data use, time spent, alternatives available to them, relative ranking of preference for GBNNSIP (in terms of ease of access and quality of data) and other aspects of the portal. Such a survey can be emailed to those who sign up as part of the sign-up condition and/or left on the portal page over a long time to catch first time and repeat visitors.

References

- Barbet-Massin, M., Salles, J.-M. and Courchamp, F. (2020) 'The economic cost of control of the invasive yellow-legged Asian hornet', *NeoBiota* 55: 11-25. Available at: <https://neobiota.pensoft.net/article/38550/list/8/>
- Britton, J.R., Davies, G.D. and Brazier, M. (2010) 'Towards the successful control of the invasive *Pseudorasbora parva* in the UK', *Biological Invasions*, 12(1), pp. 125–131. Available at: <https://doi.org/10.1007/s10530-009-9436-1>.
- Cuthbert, R.N., Diagne, C., Hudgins, E.J., Turbelin, A., Ahmed, D.A., Albert, C., Bodey, T.W., Briski, E., Essl, F., Haubrock, P.J., Gozlan, R.E., Kirichenko, N., Kourantidou, M., Kramer, A.M. and Courchamp, F. (2022) 'Biological invasion costs reveal insufficient proactive management worldwide', *Science of The Total Environment*, 819, p. 153404. Available at: <https://doi.org/10.1016/j.scitotenv.2022.153404>.
- Diagne, C., Leroy, B., Gozlan, R.E., Vaissière, A.-C., Assailly, C., Nuninger, L., Roiz, D., Jourdain, F., Jarić, I. and Courchamp, F. (2020) 'InvaCost, a public database of the economic costs of biological invasions worldwide', *Scientific Data*, 7(1), p. 277. Available at: <https://doi.org/10.1038/s41597-020-00586-z>.
- Eschen, R., Williams, F., Kadzamira, M., Stutz, S., Ogunmodede, A., Djeddour, D., Shaw, R., Pratt, C., Varia, S. and Constantine, K. (2023) 'An updated assessment of the direct costs of invasive non-native species to the United Kingdom', *Biological Invasions*, 25(10), pp. 3265–3276. Available at: <https://doi.org/10.1007/s10530-023-03107-2>.
- HM Treasury (2020) *Magenta Book*. Central Government guidance on evaluation. Available at: https://assets.publishing.service.gov.uk/media/5e96cab9d3bf7f412b2264b1/HMT_Magenta_Book.pdf.
- Hussner, A., Windhaus, M. and Starfinger, U. (2016) 'From weed biology to successful control: an example of successful management of *Ludwigia grandiflora* in Germany', *Weed Research*, 56(6), pp. 434–441. Available at: <https://doi.org/10.1111/wre.12224>.
- NBN Trust (no date) *NBN Atlas - UK's largest collection of biodiversity information*, NBN Atlas. Available at: <https://nbnatlas.org/> (Accessed: 31 January 2025).
- Roy, H., Peyton, J. and Rorke, S. (2019) *Horizon-scanning for invasive alien species with the potential to threaten biodiversity and ecosystems, human health and economies in Britain*. UKCEH.
- Sarat, E., Mazaubert, E. and Alain Dutartre, N. (2015) *Les espèces exotiques envahissantes dans les milieux aquatiques*, vol. 2 - Expériences de gestion, Le portail technique de l'OFB. Available at: <https://professionnels.ofb.fr/fr/doc-comprendre-agir/especes-exotiques-envahissantes-dans-milieux-aquatiques-vol-2-experiences> (Accessed: 3 February 2025).
- UK Government (2023) *The Great Britain Invasive Non-Native Species Strategy 2023 to 2030*. Available at: <https://www.nonnativespecies.org/about/gb-strategy>
- Williams, F., Eschen, R., Djeddour, D., Shaw, R., Pratt, C., Varia, S., Lamontagne-Godwin, J. and Thomas, S.E. (2010) *The Economic Cost of Invasive Non-Native Species on Great Britain*. Available at: https://www.mari-odu.org/academics/2018s_adaptation/commons/library/Williams_etal_2010.pdf.

Appendix 1: List of Priority Species

Below is the list of 40 species that were considered a priority to assess for likely impacts if established in the UK. The top 40 is based on those listed in the top thirty of the combined horizon scan rankings, or on the alert system list. Those for which there is no INVACOST data on impact costs are shaded grey.

The green highlighted species are those which are on the INNS alert system, a high priority for the NNSS, and for which cost data was available. Species on the alert system were chosen because there was significant evidence of their risk posed to UK society via risk registers published on the NNSS website, and the occurrence of sightings is tracked by the GBNNSIP given their role as communicator of INNS alerts to the NNSS. The risk registers included information on the historic prevalence of the species, eradication attempts, routes of entry, likelihood of invasion/establishment, and potential or known damage costs. The number of sightings, recorded by the GBNNSIP, provides an ongoing record of INNS invasion (or lack thereof) in GB. This information is crucial to modelling potential damages over time in the absence of the alert system.

Species name	Common name	Environment	Combined Horizon Ranking	Alert System Species	Biodiversity Impact Ranking	Health Impact ranking	Economic Impact Ranking	Impact cost Available?
Vespa velutina	Asian hornet	T	1-15	Y	21-30	6-10	6-21	Y
Lithobates catesbeianus	American bullfrog	T	-	Y	-	-	-	Y
Myiopsitta monachus	Monk parakeet	T	-	Y	-	-	-	Y
Oxyura jamaicensis	Ruddy duck	T	-	Y	-	-	-	Y
Homarus americanus	American lobster	M	16-30	Y	11-20	-	1-5	Y
Procyon lotor	Raccoon	T	1-15	Y	1-10	6-10	6-21	Y
Nyctereutes procyonoides	Raccoon dog	T	1-15	Y	21-30	6-10	-	Y
Tamias sibiricus	Siberian chipmunk	T	16-30	Y	41-50	11-20	-	Y
Pseudorasbora parva	Topmouth gudgeon	F	-	Y	-	-	-	Y
Ludwigia grandiflora	Water primrose	F	-	Y	-	-	-	Y
Baccharis halimifolia	Sea myrtle	T	1-15	Y	1-10	1-5	-	Y
Cabomba caroliniana	Carolina fanwort	F	-	Y	-	-	-	Y
Bellamyia chinensis	Chinese mystery snail	F	1-15	Y	11-20	6-10	-	N

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Species name	Common name	Environment	Combined Horizon Ranking	Alert System Species	Biodiversity Impact Ranking	Health Impact ranking	Economic Impact Ranking	Impact cost Available?
<i>Procambarus fallax</i>	Marbled crayfish	F	16-30	Y	1-10	-	-	Y
<i>Ocenebrellus inornatus</i>	Japanese oyster drill	M	16-30	Y	31-40	-	6-21	N
<i>Threskiornis aethiopicus</i>	Sacred ibis	T	-	Y	-	-	-	Y
<i>Ameiurus melas</i>	Black bullhead	F	-	Y	-	-	-	N
<i>Myriophyllum heterophyllum</i>	Twoleaf water milfoil	T	1-15	Y	1-10	-	6-21	Y
<i>Ludwigia grandiflora</i>	Water primrose	F	-	Y	-	-	-	Y
<i>Nassella neesiana</i>	Chilean needle-grass	T	-	Y	-	-	-	Y
<i>Sarracenia purpurea</i>	Purple pitcher plant	T	-	Y	-	-	-	N
<i>Agilus plannipennis</i>	Emerald ash borer	T	1-15	-	1-10	-	-	Y
<i>Celtodoryx ciocalyptoides</i>	Sponge	M	1-15	-	21-30	-	-	N
<i>Aedes japonicus</i>	Asian bush mosquito	T	1-15	-	-	1-5	6-21	Y
<i>Mnemiopsis leidyi</i>	Comb jelly	M	1-15	-	11-20	-	6-21	Y
<i>Gyrodactylus salaris</i>	Salmon fluke	F	1-15	-	1-10	-	1-5	Y
<i>Aedes albopictus</i>	Tiger mosquito	T/F	1-15	-	-	1-5	6-21	Y
<i>Hemigrapsus sanguineus</i>	Asian shore crab	M	1-15	-	1-10	-	-	N
<i>Corbicula fluminalis</i>	Clam	F	1-15	-	1-10	-	-	N
<i>Halyomorpha halys</i>	Brown marmorated stink bug	T	16-30	-	-	-	1-5	Y
<i>Sicyos angulatus</i>	Oneseed bur cucumber	T	16-30	-	31-40	-	6-21	N
<i>Mulinia lateralis</i>	Dwarf surf clam	M	16-30	-	11-20	-	-	N
<i>Ips typographus</i>	European spruce bark beetle	T	16-30	-	-	-	1-5	Y
<i>Anoplophora chinensis</i>	Citrus long-horned beetle	T	16-30	-	11-20	-	6-21	Y
<i>Psittacula eupatria</i>	Alexandrine parakeet	T	16-30	-	41-50	-	-	N
<i>Asterias amurensis</i>	Northern Pacific seastar	M	16-30	-	41-50	-	-	N

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Species name	Common name	Environment	Combined Horizon Ranking	Alert System Species	Biodiversity Impact Ranking	Health Impact ranking	Economic Impact Ranking	Impact cost Available?
Ambrosia trifida	Giant ragweed	T	16-30	-	-	1-5	6-21	Y
Thaumetopoea pityocampa	Pine processionary moth	T	16-30	-	-	11-20	6-21	Y
Cephalothrix simula	Nemertean worm (no common name)	M	16-30	-	-	11-20	-	N
Neogobius melanostomus	Round goby	F	16-30	-	1-10	-	-	N

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