

Invasive Species Surveillance and Monitoring: A Comprehensive Review of Existing Programmes and Initiatives

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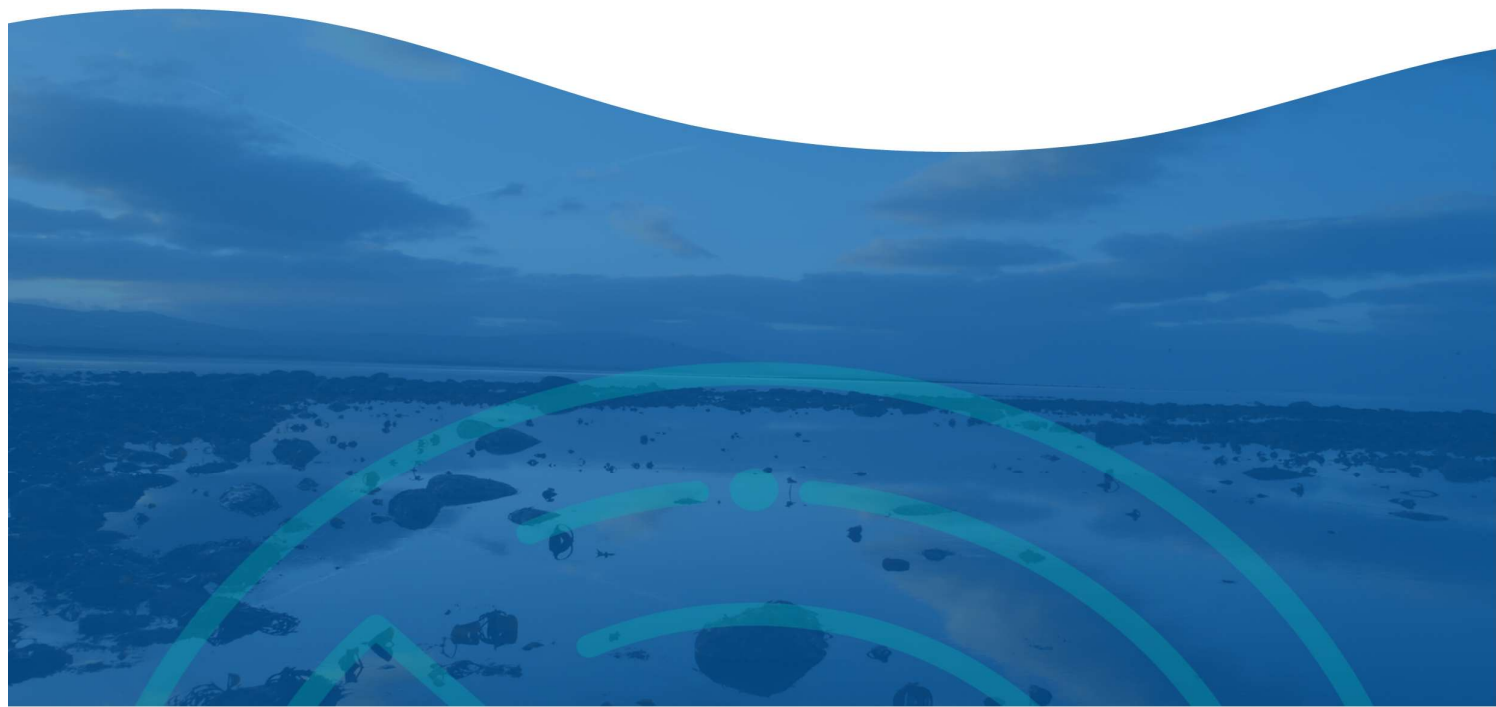
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1. Project Background and Aim

Invasive species¹ are organisms introduced into locations outside their natural range, by human activity, where they cause a negative environmental impact². These impacts include predation on, or resource competition with, native fauna and flora; damage to infrastructure; alteration of habitat; and transmission of disease. The impact of invasive species is recognised as a major driver of global biodiversity loss (IPBES, 2023). In addition, invasive species may have negative impacts on local economies, directly via their effects on recreation and tourism, public utilities, infrastructure, aquaculture and fisheries, and indirectly via management costs. The annual cost of invasive species to the island of Ireland was estimated to be £207,553,528 (€261,517,445) (Kelly et al., 2013).

Monitoring for invasive species is crucial for detecting new introductions and informing rapid responses, tracking temporal and geographical changes in their presence and abundance, determining compliance with legislation, and assessing progress towards management targets. As such, an effective and efficient monitoring system for invasive species, covering the terrestrial, freshwater and marine environments of the island of Ireland, is a key component of invasive species management.

The National Biodiversity Data Centre (NBDC) commissioned this project to support the design of an invasive species monitoring programme spanning the terrestrial, freshwater and marine environments across both Ireland (IE) and Northern Ireland (NI). The project comprises two key components: 1) a review of existing surveillance and monitoring initiatives focused on, or relevant to, invasive species and 2) recommendations and critical success factors for an invasive species surveillance and monitoring programme that effectively and efficiently generates and captures relevant invasive species data. This report focuses on the first component. The second component is reported in (Tidbury et al., 2025).

In order to achieve effective and efficient monitoring for invasive species across Ireland it is important to understand existing coverage. The aim of this work is to review and summarise existing monitoring relevant to invasive species, focusing on key components of monitoring design, namely sampling design, data collection, and dataflow and reporting. By identifying key gaps and highlighting priority recommended actions, this work contributes evidence to underpin the design of a cost effective and streamlined invasive species monitoring programme for the island of Ireland.

¹Within this report the term invasive species is used unless specific legislation and associated terms are being referred to. It is intended that the term invasive species covers all related synonyms, such as invasive non-indigenous species, and invasive non-native species.

² For the purpose of this report, the definition of invasive species excludes pathogens and parasites as pathogenic and parasitic invasive species will require very different monitoring approaches (i.e., focused on host infection and health status).

2. Methods

2.1 Identification of existing programmes

Existing monitoring programmes, which target invasive species, or that may have the potential to detect them, were initially identified through review of open-source information. Sources included search engines, resources libraries, along with the websites and reports from a variety of organisations including The Department of Agriculture, Environment and Rural Affairs (DAERA) (and associated agencies such as the Northern Ireland Environment Agency (NIEA)), National Parks and Wildlife Services (NPWS), Environmental Protection Agency (EPA), and Bord Iascaigh Mhara (BIM). (see Appendix 3 for a list of abbreviations).

Search terms used included 'invasive species', 'invasive alien species', 'non-native species', 'non-indigenous species', 'monitoring', 'surveillance', 'citizen science', 'recording', and 'reporting'. Boolean operators were applied to combine key search terms to improve focus and the relevance of outputs. Details relating to each identified programme were collated into a spreadsheet. In addition to the name of the programme, details relating to the legislative driver, timeframe, environment, spatial scope, methods, and data collection and flow were documented in the spreadsheet, where available. Programmes which had contributed invasive species data to central data repositories NBDC and the Centre for Environmental Data and Recording (CEDaR) were also identified.

To ensure all existing monitoring programmes are represented, key stakeholders across relevant public sector bodies were invited to contribute valuable information. More specifically, a spreadsheet detailing outputs from the review of open-source information was sent to stakeholders, who were then invited to verify the information for accuracy, make necessary changes, and add the names and details of any programmes known to them but not captured.

2.2 Data flow

The flow of data from invasive species-specific monitoring programmes, broader environmental monitoring programmes and citizen science initiatives was investigated. Key data sources, reporting platforms, databases, biodiversity data centres, and data and mapping portals were identified, and the flow of data between them was explored. This information was mapped into flow chart format to facilitate visualisation of data inputs, linkages and endpoints.

2.3 Evaluation and recommendations

Information relating to invasive species monitoring across the island of Ireland was evaluated in the context of spatial, temporal and priority species coverage (i.e., sampling design), the data collected and methods deployed, and data accessibility. Based on this evaluation, key recommended actions and future opportunities to enhance and harmonise invasive species monitoring across the island of Ireland are provided.

3. Current Status of Invasive Species Monitoring in Ireland

This report summarises the current status of invasive species monitoring in the island of Ireland, and provides recommendations and future directions to build on existing programmes and address identified gaps. More specific information can be found in the appendices.

3.1 Invasive species-specific monitoring programmes

Numerous existing monitoring programmes, led by many different organisations, were noted. However, only three invasive species-specific monitoring programmes (i.e., widespread ongoing programmes, targeting multiple invasive species and/or driven by invasive species-specific legislation) were identified. Two of the three invasive species-specific monitoring programmes identified target the marine environment and deploy similar approaches across NI and IE. Firstly, an invasive species monitoring programme covering marinas using the established rapid assessment survey (RAS) methodology was identified. This programme is led by NPWS and DAERA in IE and NI, respectively. Secondly, an invasive species monitoring programme covering (marine) aquaculture sites was also noted, though this programme is relatively new in NI, commencing in 2025. In IE, this monitoring of aquaculture sites for invasive species, referred to as The Shellfish Associated Species Inventory (SASI) is led by BIM. In NI, the monitoring of aquaculture site for invasive species is led by DAERA. The other invasive species-specific monitoring programme identified relates to the management of 12 Widely Spread Species (WSS) operational in NI only and led by DAERA.

3.2 Smaller scale surveys

Through engagement with stakeholders, a number of examples of localised surveys being undertaken across all environments were also uncovered. These examples include smaller surveys, primarily implemented for research purposes or to fulfil the objectives of local councils or broader environmental monitoring legislation. Such surveys focus on a single invasive species or a specific area, and as such are not considered to be invasive species monitoring programmes. Despite being ad-hoc and of narrow scope, they are a valuable source of invasive species data.

3.3 Environmental monitoring programmes and opportunities to incorporate invasive species

Invasive species monitoring requirements, or invasive species monitoring potential, was also identified for broader environmental monitoring programmes, relating to four key themes:

3.3.1 Water quality

Monitoring of various water bodies (rivers, lakes, coastal and transitional waters) is driven by the Water Framework Directive (2000/60/EC) (WFD), and associated national implementing legislation.

While invasive species monitoring is not explicitly mandated under the WFD, they are considered a pressure which impacts the ecological status of the water body and the importance of invasive species data to inform assessment of pressures and ecological status classification, is therefore recognised. However, assessment of the threat posed by invasive species often incorporates data from other statutory monitoring programmes, citizen science initiatives and historic datasets, as opposed to targeted invasive species surveys. With integration of targeted and standardised approaches to invasive species monitoring, WFD monitoring, may offer a strong foundation for spatially comprehensive invasive species monitoring within the freshwater environment, across the island of Ireland.

Marine monitoring is also required under the Marine Strategy Framework Directive (2008/56/EC) (MSFD), and associated national implementing legislation, which focusses on 11 descriptors of Good Environmental Status. Invasive species is one of these descriptors and the two aforementioned invasive species monitoring programmes in the marine environment generate data relevant to this legislation. However, monitoring related to other descriptors conducted under this driver has potential to enhance spatial coverage across the marine environment.

3.3.2 Protected habitats and species

While conservation legislation typically focuses on the conservation of natural habitats (Annex I) and wild species (Annex II), invasive species are explicitly acknowledged as a significant pressure or threat to listed habitats and species associated with designations under the EU Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC), and associated national implementing legislation. There is requirement for monitoring of designated sites to underpin condition assessment and reporting. However, the methodologies used to capture threats from invasive species may vary and, in some instances, rely on acquisition of existing invasive species records.

While potentially complicated in terms of their legislative origin, governance and often overlapping designations, the scale, coverage and diversity of the protected site network is extensive and, with standardised integration of invasive species monitoring, may offer a strong foundation for spatially comprehensive invasive monitoring across the island of Ireland.

3.3.3 Aquaculture and Fisheries

Fisheries surveys, focussing on stock assessments and sustainability, occur across IE and NI driven by a multi-layered legal framework with numerous organisations involved. Though not invasive species focussed, invasive species detection through these surveys, and the use of fisheries data to inform invasive species assessment was noted.

Driven by aquatic animal health legislation, surveillance and associated inspections of aquaculture stock is required. Though outside of any aquatic animal health legislation remit, such monitoring offers opportunity for detection of invasive species within aquaculture sites.

3.3.4 Plant pests

Monitoring for plant pests which are not native to the island of Ireland (or the EU) is well established and driven by key pest and disease legislation, and related pest classifications. While broadly considered to fall within the scope of invasive species monitoring, the pest species targeted are not priority invasive species defined under invasive species legislation (i.e., those focused on in this review). However, the pathways by which pest species are introduced, and which are consequently monitored, overlap with those pathways to which the introduction of non-pest invasive species are attributed, offering potential opportunity for extension to detect invasive in addition to the priority pest species targeted. These programmes do not constitute invasive species monitoring programmes as they have broader objectives or do not implement bespoke invasive monitoring as standard across their environment, spatial and temporal remit. However, they are included because they already report on the presence of invasive species or have the potential to detect invasive species, and therefore offer a strong platform of statutory monitoring across relevant habitats onto which standardised invasive monitoring may be added.

3.3.5 Citizen science

Eighteen examples of citizen science reporting and survey initiatives were identified. These initiatives are led by a number of different organisations including universities, societies, government agencies, local authorities and charities. Twelve (66%) are operational in both jurisdictions, four (22%) in IE only, and two in NI only (11%). Eight (44%) are relevant to the marine environment only and five (27%) to the terrestrial environment only. Only three (17%) of the identified initiatives are specific to invasive species, all of which are concerned with the reporting of terrestrial plants.

3.3.6 Border control

While of potential relevance to invasive species management more broadly, border control monitoring does not provide data on the presence of species in the wild and is therefore considered out of scope here.

3.4 Evaluation against core monitoring programme components

Below we summarise the identified programmes and initiatives in the context of their spatial, temporal and priority species coverage (i.e., sampling design), the data collected and methods deployed, and data access and flow. The status of existing monitoring within the freshwater, terrestrial and marine environment, with respect to key monitoring programme components is summarised in Table 1, Table 2 and Table 3, respectively.

3.4.1 Spatial, temporal and species coverage (sampling design)

With respect to spatial coverage, specifically monitoring at sites at high risk of invasive species introduction or spread, or vulnerable to impacts (often referred to as hotspots), existing coverage is

variable. Of the three invasive species-specific monitoring programmes identified, two cover the marine environment, more specifically marinas and aquaculture sites, both of which are considered hotspots for the introduction and spread of invasive species. No monitoring within ports was identified. This is a gap given that ports are hotspots for invasive species introduction and spread, due to their association with ballast water and biofouling pathways (e.g., Costello et al., 2022). The absence of monitoring in ports also limits the island of Ireland's ability to adhere to the requirements of the Ballast Water Management Convention (see Legislation Summary in Supplementary Material).

Broader monitoring of a range of protected sites, across the marine, freshwater and terrestrial environments to assess condition, was identified. Monitoring of a range of aquatic sites for water quality purposes was also identified. Together, this network of monitored sites is extensive with sites surveyed at least once every six years. However, invasive species are not the focus of these monitoring programmes such that selection of sites reflects the primary drivers of monitoring (i.e., water quality parameters and protected habitats and species) rather than invasive species introduction, establishment, spread or impact risk.

With respect to focus on priority invasive species, and the main taxonomic groups they represent, existing programme coverage could be improved markedly. In NI, twelve priority terrestrial and freshwater species, including an invertebrate (New Zealand flatworm), a vertebrate (grey squirrel), aquatic plants (e.g., floating pennywort) and riparian plants (e.g., Himalayan balsam) have monitoring plans as part of WSS management, though these incorporate existing monitoring rather than bespoke species-specific monitoring. Smaller scale invasive species-specific surveys in the terrestrial and freshwater environment across the island of Ireland were also noted. Coverage of marine sessile/ fouling species is also good, with methods deployed in marinas and aquaculture sites targeting this taxonomic group. Identified citizen science initiatives, particularly those being undertaken in the marine and coastal environment, support the detection and reporting of additional species, including marine mobile pelagic species (jellyfish, fish) and rafting or anchored marine plants (algae).

Broader environmental monitoring programmes have the potential to capture a range of invasive species, but as invasive species are not targeted, their reporting is likely to underrepresent the status of invasive species (see also the methods and data collection section below). Classification of particularly impactful invasive species as 'alert species' is a mechanism through which improved awareness, successful in-field ID, and an increase in ad-hoc reporting may be achieved, even in the absence of explicit monitoring programmes.

3.4.2 Methods and data collection

Capacity for detecting the range of priority invasive species within existing programmes is generally poor. Deployment of a range of different monitoring methods was identified through this review, from walk over surveys to molecular based surveys using eDNA. Different methods offer different sensitivities for different priority invasive species / species categories, environments and seasons,

thereby affecting the likelihood of invasive species detection. This is the case even for methods deployed in surveys targeting invasive species. For example, RASs conducted in marinas provide an established means by which to determine the presence and abundance of fouling species but may fail to detect planktonic species, or species which occupy soft-bottom habitats. For the broader environmental monitoring programmes identified, species survey methods, timings, seasonality were not optimised for invasive species detection, such that detection capacity and sensitivity is likely to be generally low.

The majority of programmes identified in this review recorded presence of an invasive species only (and often as a result of incidental sightings). While presence data fulfils the needs of some monitoring objectives and reporting needs (i.e., detection of new introductions), it does not allow for tracking abundance and or impacts, limiting the accuracy by which Ireland can report against targets focussed on establishment and spread (e.g., MSFD Descriptor 2, criteria 2 and 3, and Target 6 of the Kunming-Montreal Global Biodiversity Framework under the Convention on Biological Diversity - see Legislation Summary in Supplementary Material). Further the lack of species absence data limits the accuracy with which true invasive species trends can be delineated from artifacts driven by changes in monitoring effort (Stæhr et al., 2023).

3.4.3 Data access and flow

The number of programmes submitting data to the NBDC and CEDaR highlighted their realised functionality in collating biodiversity data, including that relating to invasive species. However, for some existing programmes, data are held on localised / organisation specific databases and do not reach a central repository, thereby posing potential challenges for access and contribution to invasive species reporting requirements. For a number of smaller scale species-specific survey examples, data flow was unclear.

The highly complex data flow uncovered is likely driven by the large number of organisations involved in monitoring (both specifically targeting invasive species and of relevance to invasive species), and their individual data processes and requirements. Data sensitivities were evidenced, in particular where surveys were conducted on private land, which restricted data sharing and access.

No single repository of all invasive species data within each jurisdiction was identified. As such, data required for reporting against key international objectives such as Target 6 of the Kunming-Montreal Global Biodiversity Framework under the Convention on Biological Diversity, as well as core national and regional objectives, including those covering specific environments only such as Descriptor 2 under the MSFD, need to be sought from multiple locations, with potential for data gaps as well as duplications.

Comprehensive details of the identified programmes and their data flow can be found in Appendix 1 and Appendix 2, respectively.

Table 1. The RAG status of monitoring within the freshwater environment against key monitoring programme components.

Monitoring programme components		RAG status justification and recommended key actions	RAG status
Sampling design	Spatial coverage	Invasive species-specific coverage limited to smaller scale surveys. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, water quality) would facilitate more comprehensive spatial coverage.	AMBER
	Temporal coverage	Invasive species-specific coverage limited to smaller scale surveys. Temporal frequency of sampling may not be sufficient to detect new invasive species introductions. Standardised integration of monitoring into broader environmental programmes (e.g., protected habitats and species, water quality) is unlikely to achieve temporal coverage required for early detection. ➤ More frequent invasive species monitoring and sampling is required.	RED
	High risk locations	Invasive species-specific coverage limited to smaller scale surveys which do not cover high-risk locations as standard. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, water quality) will improve high-risk location coverage, but not all high-risk locations are monitored under broader programmes. ➤ Identification and implementation of monitoring at high-risk sites in the freshwater environment is required.	RED
	Priority invasive species	Capacity to detect priority species may be limited to smaller scale invasive species-specific surveys. ➤ Integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, water quality), with invasive species-specific detection method protocols implemented, will improve priority species coverage. ➤ The implementation of bespoke monitoring for WSS will improve coverage of widely spread freshwater priority invasive species. ➤ Identification and implementation of monitoring of priority invasive species in the freshwater environment is required.	AMBER
Methods and data collection	Methods	Invasive species-specific detection methods are deployed during smaller scale invasive species-specific surveys only. ➤ Methods deployed by broader environmental monitoring programmes (e.g., protected habitats and species, water quality), may pick up invasive species, but they are not deployed solely for that purpose. Integration of invasive species monitoring into broader environmental programmes, with invasive species-specific detection method protocols implemented, will improve detection capacity. ➤ Additional methods are required to capture all taxonomic groups.	AMBER
	Data	Invasive species data are collected during smaller scale invasive species-specific surveys and potentially via broader environmental monitoring programmes (e.g., protected habitats and species, water quality). ➤ Integration of invasive species monitoring into broader environmental programmes, with standardised protocols, will improve data collection markedly. ➤ Collection of absence data and data to inform impacts will enhance understanding of trends in invasive species in the freshwater environment.	AMBER
Data access and flow		Not all data uploaded to central repository. ➤ Standardised data reporting/sharing protocols will improve data access and flow.	RED

Table 2. The RAG status of monitoring within the terrestrial environment against key monitoring programme components.

Monitoring Programme components		RAG status justification and recommended key actions	RAG status
Sampling design	Spatial coverage	Invasive species-specific coverage limited to smaller scale surveys. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species) would facilitate comprehensive spatial coverage.	AMBER
	Temporal coverage	Invasive species-specific coverage limited to smaller scale surveys. Temporal frequency of sampling may not be sufficient to detect new invasive species introductions. Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species) is unlikely to achieve temporal coverage required for early detection. ➤ More frequent invasive species monitoring and sampling is required.	RED
	High risk locations	Invasive species-specific coverage limited to smaller scale surveys which do not cover high-risk locations as standard. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species) will improve high-risk location coverage, in particular sites at high risk of impact, but not all high-risk locations are monitored under broader programmes. ➤ Identification and implementation of monitoring at high-risk sites in the terrestrial environment is required.	RED
	Priority invasive species	Capacity to detect priority species may be limited to smaller scale invasive species-specific surveys. ➤ Integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species) with invasive species-specific detection method protocols implemented, will improve priority terrestrial species coverage. ➤ The implementation of bespoke monitoring for WSS will improve coverage of widespread priority terrestrial invasive species. ➤ Identification and implementation of monitoring of priority invasive species in the terrestrial environment is required.	AMBER
Methods and data collection	Methods	Invasive species-specific detection methods are deployed during smaller scale invasive species-specific surveys only. ➤ Methods deployed by broader environmental monitoring programmes (e.g., protected habitats and species), may pick up invasive species, but they are not deployed solely for that purpose. Integration of invasive species monitoring into broader environmental programmes, with invasive species-specific detection method protocols implemented, will improve detection capacity. ➤ Additional methods are required to capture all taxonomic groups.	AMBER
	Data	Invasive species data are collected during smaller scale invasive species-specific surveys and potentially via broader environmental monitoring programmes. ➤ Integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species), with standardised protocols, will improve data collection markedly. ➤ Collection of absence data and data to inform impacts will enhance understanding of trends in invasive species in the terrestrial environment.	AMBER
Data access and flow		Not all data uploaded to central repository. ➤ Standardised data reporting/sharing protocols will improve data access and flow.	RED

Table 3. The RAG status of monitoring within the marine environment against key monitoring programme components.

Monitoring Programme components		RAG status justification and recommended key actions	RAG status
Sampling design	Spatial coverage	Invasive species-specific survey locations distributed across both jurisdictions. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, fisheries and aquaculture) would improve spatial coverage further.	GREEN
	Temporal coverage	Routine invasive species-specific monitoring programmes are currently implemented in the marine environment, but sampling frequency may not be sufficient for early detection of invasive species. Standardised integration of invasive species monitoring into broader environmental programmes (e.g., fisheries and aquaculture) unlikely to achieve temporal coverage required for early detection. ➤ Monitoring and sampling frequency needs to be increased.	AMBER
	High risk locations	Hot-spot locations are covered by invasive species-specific monitoring programmes. ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, fisheries and aquaculture) would improve coverage of high-risk locations, in particular those sites at high risk of impact. ➤ Bespoke monitoring programme is required at ports to ensure all hotspots covered and key legislation is adhered to.	AMBER
	Priority invasive species	Methods deployed by existing invasive species-specific monitoring programmes have capacity to detect some priority species (i.e., marine fouling species). ➤ Standardised integration of invasive species monitoring into broader environmental programmes (e.g., protected habitats and species, fisheries and aquaculture) may improve coverage of priority species but unlikely to cover all taxonomic groups. ➤ Deployment of additional methods is required to capture other priority species groups (e.g., marine mobile benthic species).	AMBER
Methods and data collection	Methods	Methods developed for the detection of invasive species are deployed as part of existing invasive species-specific monitoring programmes at marine hotspots. ➤ Additional methods are required to capture all taxonomic groups. E.g., trapping and eDNA approaches may supplement RASs in marinas, facilitating detection of mobile benthic priority species.	AMBER
	Data	Presence and abundance of invasive species documented by existing invasive species monitoring programmes in marinas and aquaculture sites. ➤ Collection of absence data and data to inform impacts will enhance understanding of trends in invasive species in the marine environment.	AMBER
Data access and flow		Not all data uploaded to central repository. ➤ Standardised data reporting/sharing protocols will improve data access and flow.	RED

4. Recommendations

This review has identified a fragmented approach to surveillance and monitoring for invasive species across the island of Ireland. There are different challenges apparent in the marine, freshwater and terrestrial environments.

It is recommended that:

1. Up-to-date information on all surveillance and monitoring programmes is maintained.
2. Collection and submission of invasive species occurrence data to central repositories is standardised to ensure timely reporting and compliance with legal obligations.
3. A programme is developed to enhance the capability and capacity of both jurisdictions to effectively monitor invasive species. With specific focus on:
 - I. Improved spatial, temporal and priority species coverage through standardised integration of invasive species into existing broader environmental monitoring programmes, with focus on the freshwater and terrestrial environments.
 - II. Enhancement of existing invasive species-specific programmes in the marine environment to optimise spatial, temporal and species coverage.
 - III. Development and implementation of additional bespoke invasive species monitoring programmes to address shortfalls with respect to priority site-specific legislative requirements.

5. Appendix 1 –Monitoring Across the Island of Ireland Relevant to Invasive Species

The existing monitoring programmes identified include invasive species-specific programmes, broader national environmental monitoring programmes, smaller scale surveys, research projects and citizen science initiatives, and are summarised below.

5.1 Invasive species-specific monitoring programmes

Included within the category of invasive species-specific monitoring programmes are widespread ongoing programmes, targeting multiple invasive species and driven by invasive species-specific legislation. For a summary, please see Table 4.

5.1.1 Invasive species monitoring at shellfish production sites

The Shellfish Associated Species Inventory (SASI) is part of the Shellfish Import Monitoring Protocol (SIMP) set up to meet the legislative requirements for shellfish imports into The Netherlands. These mandatory surveys commenced in 2010 and are ongoing in IE. Initially, surveys were organised by Dutch importers, but since 2018 BIM have supported this monitoring, expanding its geographical scope to include all marine shellfish growing areas and also some areas not used for aquaculture (Devine & Gittenberger, 2023).

During a SASI, multiple samples (comprising ~5kg of shellfish) are collected from the shellfish production area. These samples are screened for all species (including invasive species) that are visible to the naked eye. At least one detailed photograph is taken of each species found. Species that cannot be identified directly in the field, such as amphipods, sponges and algae, are collected for identification in the laboratory. Typically, 70 to 90 samples are collected per survey, from various locations within the designated survey area.

SASI surveys are undertaken at varying intervals, ranging from annual to every three years. Between 2010 and 2022 114 SASI surveys were conducted by GiMaRIS across 40 shellfish production areas, covering mussel, oyster and periwinkle production by four aquaculture methods, as relevant (bottom grown culture, seed fishery, rope culture and trestles) (Figure 1). In total, 45 alien (or cryptogenic) species were detected by SASIs conducted between 2010 and 2022, eight of which were first records for IE (Devine & Gittenberger, 2023), highlighting the importance of SASIs in the detection of new marine alien and invasive species introductions associated with aquaculture sites.

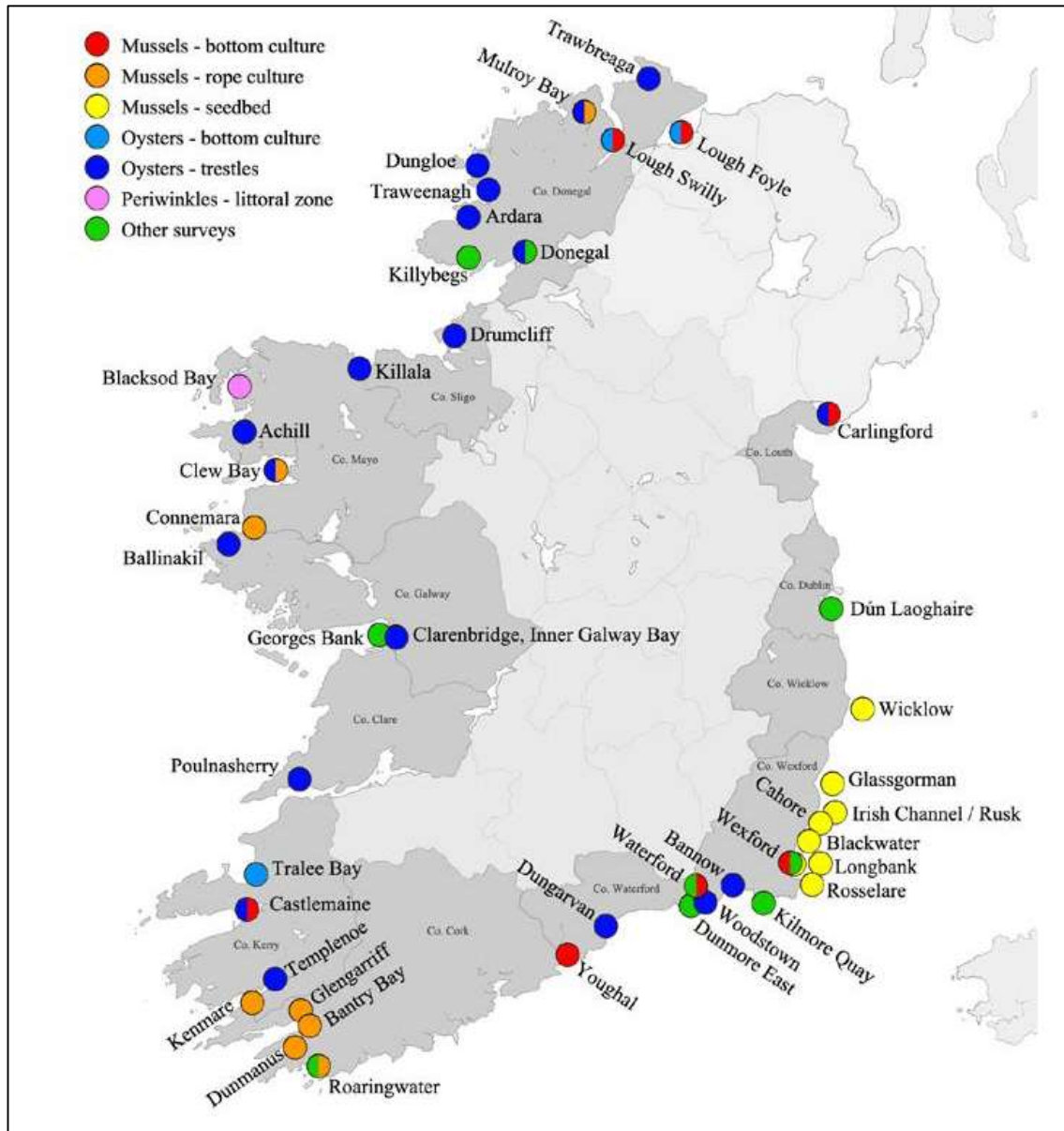


Figure 1. Location of SASI surveys conducted in IE between 2010 and 2022. The aquaculture species and method are highlighted through colour coding according to the key. Taken from Devine and Gittenberger (2023).

Though not part of the SASI, monitoring of invasive species at shellfish production sites is also conducted in NI, by DAERA. Primarily driven by the MSFD and WFD, this programme commenced in 2025 with surveys conducted at five locations: Carlingford Lough, Larne Lough, Strangford Lough, Dundrum Bay and Killough (Figure 2). Surveys are planned to be repeated at these locations every two to three years.

Invasive species monitoring coverage of aquaculture production sites across IE is good. However, inclusion of aquaculture production sites near Belfast Harbour would enhance coverage in NI. Aside from the absence of aquaculture production sites on the northeast coast of NI, aquaculture sites are generally distributed quite evenly across the coast of the island of Ireland, facilitating good spatial marine invasive species monitoring coverage.

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Water bodies containing aquaculture production sites subject to marine IS survey by DAERA.

Legend

Surveyed water body

Notes

Base map: © OpenStreetMap contributors, under the Open Data License
 Location information survey data © Crown copyright and database rights (2023), OS OpenData

Local water system: Bannagh / High Watermark

0 10 20 km

1:750000 @ A3 Date: 28/08/2025 Drawn by: HT Checked by: PS

Revised: A37 The Embankment Business Park, Southport, Southport, UK
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5.1.2 Invasive species rapid assessment surveys in marinas

The rapid assessment survey (RAS) is an established method which balances spatial coverage and time by employing a qualitative approach in which target species are recorded on an abundance scale during timed searches of specific habitats (e.g., Cohen et al. 1998, 2005; Arenas et al. 2006). RASs in marinas facilitate the collection of species abundance data over large areas of submerged and intertidal hard structure (e.g., pontoons, harbour walls), and have been used in marinas around the world to record and map presence, abundance and distribution of non-native species, as well as document new arrivals.

Most recently, in 2021, RASs were undertaken in 22 marinas across IE, funded by the NPWS, Department of Housing, Local Government and Heritage (DHLGH) (O'Shaughnessy et al., 2023). These surveys reported presence and abundance of Target invasive species, driven primarily by obligations to monitor and report on Annex I (Habitats) and Annex II (Species) under The Habitats Directive but contributing valuable data under additional legislative drivers such as the MSFD. RASs of marinas were repeated in summer 2025 (Figure 3), again commissioned by the NPWS, indicating a 4-year survey cycle. The marinas are located along the north, east, south and southwest coasts of IE. Several marinas are located in or adjacent to waterways that support international commercial vessel traffic (e.g., Dublin Bay, Cork Harbour, Shannon Estuary), while other marinas are located in less busy waters, frequented by smaller recreational boats (Figure 3). In total, 25 non-native species were recorded across the 22 marinas surveyed in 2021, four of which were not previously recorded publicly in IE: devil's *Grateloupia turuturu*, *Asterocarpa humilis*, *Botrylloides diegensis* and *Bugulina simplex* (O'Shaughnessy et al., 2023). Results from the 2025 survey are not available at the time this report was prepared.

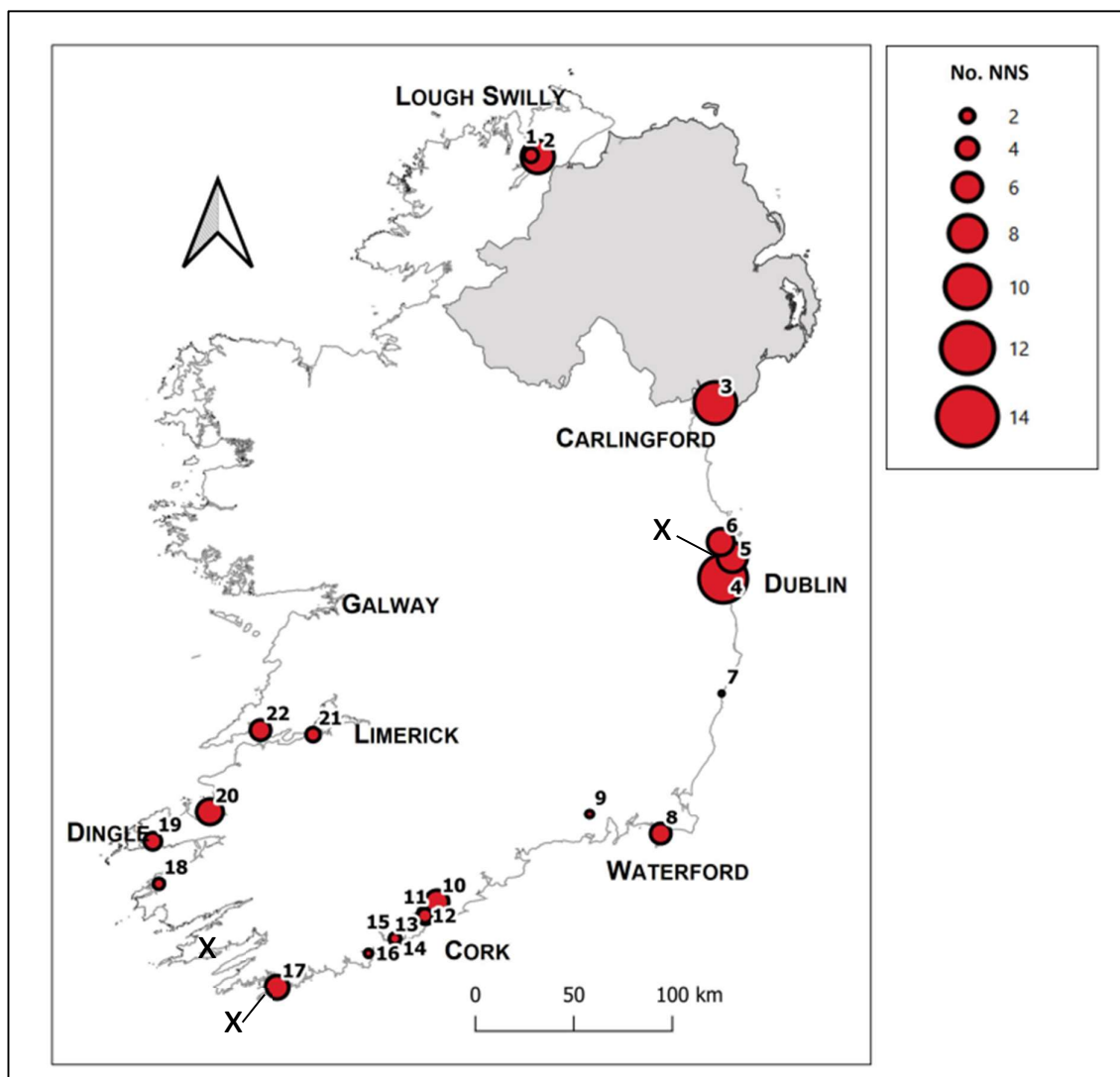


Figure 3. Total number of non-native species (NNS) recorded in 2021 using RAS at each surveyed marina. Numbers refer to individual marinas. The size of red circle indicates the number of NNS recorded. The black circle (Marina 7) denotes a survey during which no NNS were found. Crosses denote additional marinas for which RASs are planned in 2025. Adapted from O'Shaughnessy et al. (2023).

RASs of marinas in NI were undertaken in 2012 at 27 sites with the aim of providing baseline data towards UK Marine Strategy Regulations Assessments for D2 Non-Indigenous Species (NIS) (synonym: Alien Species) (Minchin & Nunn, 2013). Since 2015, RASs have been repeated annually at six large and active marinas (Bangor, Carrickfergus, Belfast, Ballycastle, Glenarm and Rathlin), led by DAERA. RASs of a further 18 marinas are also conducted regularly by DAERA (Figure 4). The

carolinensis), Himalayan balsam (*Impatiens glandulifera*), New Zealand flatworm (*Arthurdendyus triangulatus*), Nuttall's waterweed (*Elodea nuttallii*), Parrot's feather (*Myriophyllum aquaticum*) and three slider species (*Trachemys scripta scripta*, *Trachemys scripta elegans*, *Trachemys scripta troostii*). Detailed plans have been developed and are currently implemented for their management, led by The NIEA. Within the early detection and rapid response element of the plans there are notes relating to species surveillance. However, for each of the 12 WSS, a new, dedicated surveillance mechanism is documented as not necessary, rather, existing reporting schemes and broader environmental monitoring are referenced in the context of species surveillance.

Table 4. A summary of widespread, ongoing invasive species monitoring programmes which target multiple invasive species and are driven by invasive species-specific legislation, conducted across the island of Ireland.

Category	Monitoring Programme Name	Spatial scope	Monitoring programme driver	Species group/species	Timeframe	Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow	Link
Invasive species monitoring at shellfish production sites	Shellfish Associated Species Surveys (SASI).	IE, marine, aquaculture sites.	Aquaculture industry support, MSFD, Habitats Directive.	Plants and Animals.	2010 - present, supported by BIM since 2018, prior to that implemented by Dutch Government.	Surveys are typically repeated once every 3 years in most regions.	Undertaken under contract to BIM.	Shellfish sites (bottom culture, rope culture and trestles in areas of both oyster and mussel production). 40 shellfish production areas surveyed 2010-2022.	Shellfish samples searched with the naked eye and photograph. Species which cannot be identified in the field, are preserved and sent for identification in the lab, sometimes with the assistance of DNA analysis.	Invasive species Presence.	Data submitted to NBDC (at bay scale).	https://bim.ie/wp-content/uploads/2021/02/BIM-Alien-Species-Report-2024.pdf
	Aquaculture Site Non-native Species Monitoring	NI, marine, aquaculture sites.	MSFD, WFD, Windsor Framework.	Plants and Animals.	First surveys conducted in 2025.	2-3 years.	DAERA.	Aquaculture sites in Carlingford Lough, Larne Lough, Strangford Lough, Dundrum Bay and Killough.	30 locations where marine life is likely to be found (i.e., oyster bags, trestles) at each site searched. Species which cannot be identified in the field, are preserved and sent for identification in the lab, sometimes with the assistance of DNA analysis.	Presence and abundance using SACFOR scale.	Data submitted to Marine Data Recorder Online via CEDaR.	NA

Category	Monitoring Programme Name	Spatial scope	Monitoring programme driver	Species group/species	Timeframe	Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow	Link
Invasive species monitoring at marinas	Marina Non-Native Species Monitoring	NI, marine, marinas.	MSFD, WFD, Windsor Framework.	Plants and animals - fouling/in tertidal species from target species list (57 species).	2012 – present.	Six marinas surveyed annually since 2015.	NIEA, DAERA Marine & Fisheries team.	6 main marinas (annual frequency), and a further 18 marinas (every 2-3 years).	Rapid Assessment Survey - Abundance and Distribution Range method deployed (Olenin et al. 2007). Sampling undertaken at selected areas within an assessment unit which varies according to marina size and layout. For marinas with > 50 berths, 30 separate sampling positions chosen from the sides and undersides of floating structures.	Presence and abundance of target invasive species using SACFOR scale.	Data submitted to Marine Data Recorder Online via CEDaR.	https://www.daera-ni.gov.uk/sites/default/files/publications/doe/marine-report-rapid-assessment-of-marinas-for-invasive-alien-species-in-ni-2013.pdf
	Marina Rapid Assessment Surveys (RASs).	IE, marine, marinas.	Habitats Directive, MSFD, IAS Regs.	Plants and animals - fouling/in tertidal species – including target species list.	2021 & 2025.	4-year cycle (indicated by repeat survey timeframe).	NPWS.	25 marinas listed (23 surveyed into 2021).	Rapid Assessment Survey method whereby floating structures visually inspected and species present recorded. Photographs and scrape samples for laboratory analysis taken to aid identification of certain species.	Presence and abundance using SACFOR scale.	Data held by NPWS centrally, data can be shared with interested parties upon data request.	http://reabic.net/journals/mbi/2023/2/MBI_2023_OS_haughnessy_et_al.pdf

Category	Monitoring Programme Name	Spatial scope	Monitoring programme driver	Species group/species	Timeframe	Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow	Link
Widely spread species monitoring	Widely Spread Species Management Measures.	NI, terrestrial and freshwater.	Article 19 of IAS Regs requires Member States to produce effective management measures for Widely Spread Species.	Plants and animals - fouling/in ter tidal species.	2020-present.	No sampling specifically.	NIEA.	Freshwater and terrestrial sites relating to 12 WSS (no marine WSS).	Species surveillance likely to be incorporated into existing surveys and reporting initiatives using varying methodologies.	Presence.	Depending on underlying monitoring data submitted to CEDaR, (via Invasive Species Northern Ireland), or to NIEA directly via email.	https://www.daera-ni.gov.uk/publications/widely-spread-species-management-measures-publications

5.2 Localised and short-term invasive species survey examples

Through engagement with Stakeholders, examples of localised surveys relating to individual invasive species were also uncovered. These are smaller surveys, primarily implemented to fulfil the objectives of broader environmental monitoring legislation (see below for further information), with focus on a single invasive species or a specific area, and as such are not considered to be invasive species monitoring programmes. While they provide insight into the types of invasive species surveys that are undertaken across Ireland, driven by various legislation, they do not represent the full extent of such surveys.

Common cord-grass (*Spartina anglica*) surveys are ongoing (since 2006) in a subset of coastal estuaries in NI, using a combination of walkovers by landowners and drone surveys commissioned by the National Trust and funded by NIEA. These surveys are driven by multiple legislation and data are used internally to select locations for control.

Muntjac deer (*Muntiacus reevesii*) surveys have been undertaken in NI in Mount Stewart (2022-2024) and across the Ards Peninsula more broadly (2024-2025) using camera traps, led by NIEA. Given that muntjac deer are a Species of Union concern, these surveys are primarily driven by The IAS Regs, and will be used to inform a management plan for this species in the Ards Peninsula area.

Data gathered on the common cord-grass and the muntjac deer and via these surveys are not shared publicly because they relate to the condition of privately owned land.

Ongoing invasive species clearance projects in the Mourne (Cotoneaster and Rhododendron) and Killarney National Park (Rhododendron and Muntjac deer), led by Northern Ireland Water and NPWS, respectively, which include survey elements were also highlighted.

Invasive plant surveys, supported by the Survey123 App within Cloghernagor Bog and Glenveagh National Park Special Area of Conservation (SAC) are also ongoing, as well as plant surveys in SACs across Donegal, Sligo, Mayo and Galway through manual and remote sensing methodologies undertaken as part of the Wild Atlantic Nature Project, both led by NPWS.

Pacific oyster (*Magallana gigas*) surveys across IE during summer of 2024 and 2025 under a European Maritime, Fisheries and Aquaculture Fund project led by The Marine Institute. The survey is driven by the Fisheries Amendment Act 1997 (aquaculture licencing) and the Natura Regulations. The method comprised time searches and recording of oyster presence and abundance, using the SACFOR-scale, as outlined by (Kochmann et al., 2013). In total, greater than 120 coastal sites were surveyed.

Invasive species-specific surveys may also be implemented, in particular for priority species, in response to suspicion or confirmation of their presence. For example, surveys for Chinese mitten crab, a Species of Union concern under the IAS Regs, and an alert species in both IE and NI, were conducted in a number of locations across IE from 2020-2022 in response to detections in 2020 and

2021. These surveys were commissioned by BIM and NBDC and employed multiple monitoring methods, including environmental DNA (eDNA).

5.2.1 Research and local action funded projects

Although not the focus of this review, examples of invasive species surveys associated with short-term research and local action funded projects were also identified. In particular, a fixed term Evidence and Innovation project monitoring presence of zebra mussel veligers in water samples taken at the fish farms on the River Bann, running between 2024 and 2025, led by DAERA and Agri-Food and Biosciences Institute (AFBI), was identified. Further, an MSc project monitoring the invasive species *Rhododendron ponticum* in Glenveagh using machine learning, supported by NPWS, was undertaken in 2023.

Projects that deliver the objectives of Ireland's 4th National Biodiversity Action Plan (NBAP) 2023-2030 (and contribute to the implementation of the IAS Regs) are supported by the Local Biodiversity Action Fund operated by the Scientific Advice and Research Directorate of NPWS. Current projects related to invasive species monitoring include:

- Survey of the invasive alien aquatic bivalve Quagga mussel in Lough Sheelin, Cavan.
- County Invasive Species Audit & Mapping – Waterford.
- Sligo IAS programme, including survey and treatment of Giant Hogweed.
- Invasive Alien Species Database, Baseline Report and Action Plan for Monaghan County Council.
- Invasive Species Eradication Programme on West Connacht Islands 2025-2026, Mayo, including a survey and mapping exercise in 2026.
- Survey & Removal of Giant Hogweed and raising awareness of its spread on the Morningstar River Limerick.
- Survey of Invasive Alien Plant Species (IAPS) in the vicinity of An Fhairche (Clonbur) in counties Galway and Clare.

invasive species projects in NI may also be funded by a number of grant schemes and initiatives, including The Environment Fund and the Nature Recovery Challenge Fund, though live projects relevant to invasive species monitoring could not be identified.

Please note that the aforementioned projects are examples brought to the attention of the authors, and do not represent the full breadth of research and local action funded projects relevant to invasive species monitoring.

5.3 Broader environmental monitoring programmes which currently include invasive species or have potential to in the future

A number of broader statutory environmental monitoring programmes relevant to invasive species were identified as part of this review. These programmes do not constitute invasive species specific monitoring programmes as they have broader objectives or do not implement bespoke invasive

species monitoring as standard across their environment, spatial and temporal remit. However, they are documented as they already report on the presence of invasive species or have the potential to detect invasive species, and therefore offer a strong platform of statutory monitoring across relevant habitats onto which standardised invasive species monitoring may be added.

These programmes fall within four categories: Water Quality, Protected Sites, Plant Pests and Aquaculture and Fisheries. To accompany the overview below, example surveys within these categories, identified through literature search and input from stakeholders, are documented in Table 9. Please note that the example surveys are not exhaustive and are intended to provide insight into the varied surveys undertaken.

5.3.1 Water quality monitoring programmes

Water quality monitoring conducted across the island of Ireland is largely driven by WFD, and in the marine environment specifically, MSFD, implemented through their associated national legislation.

Water Framework Directive monitoring

The WFD is implemented through the European Communities (Water Policy) Regulations 2003 in IE. In NI the Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 transpose the WFD into NI law, which following EU exit, have been amended to ensure continued operability. In IE water quality monitoring falls within the remit of a number of authorities including EPA, Marine Institute, Inland Fisheries Ireland, Waterways Ireland, NPWS and local authorities. In NI, water quality monitoring is overseen by NIEA, with support from AFBI and local authorities. Water quality monitoring covers rivers, lakes, transitional and coastal waters, canals and groundwater. In total 2899 and 571 sites are monitored in IE and NI, respectively (Table 5, Figure 5). Heavily modified or artificial water bodies are also monitored, including, for example, 16 canals in IE. Biological quality monitoring elements include macroinvertebrates, aquatic plants, macroalgae, phytoplankton, phytobenthos and fish. A range of methods are typically employed for water quality monitoring, as detailed in a recent report by the EPA (Environmental Protection Agency, 2024) and summarised in Table 6. The frequency of monitoring depends on the quality element, ranging from 12 times per year (e.g., phytoplankton monitoring in coastal waters) to once every six years (e.g., saltmarsh monitoring in coastal and transitional waters). Monitoring frequency may be reactively increased, for example at high status sites at risk or with low quality status, and at sites which have declined in status significantly (Table 7).

Table 5. The number of sites, by water body type, monitored for water quality purposes in IE (2022 – 2027, Environmental Protection Agency (2023)) and NI (2024, Northern Ireland Environment Agency(2025)).

Water body Type	Number of sites monitored in IE	Number of sites monitored in NI
Rivers	2429	450
Lakes	224	21
Transitional & Coastal	125	25
Groundwater*	121	75
Total	2899	571

*Unlikely to detect invasive species, even incidentally, given focus on pollutants.

While invasive species monitoring is not explicitly mandated under the WFD, invasive species are considered a pressure which impacts the ecological status of the water body. The importance of invasive species data, to inform assessment of pressures and ecological status classification, is therefore recognised. The WFD UKTAG has created a high-risk invasive species list and detailed approaches for using invasive species data in assessing ecological status which is implemented in NI. Invasive species are also routinely explicitly referenced in River Basin Management plans as a pressure requiring mitigation action. Further, Local Catchment Assessment guidance, developed by the EPA, includes the identification of invasive species as a principal component of the assessment methodology. However, without a standardised and comprehensive and specific invasive species monitoring programme across WFD water bodies, assessment of the threat posed by invasive species often incorporates data from other statutory monitoring programmes, citizen science initiatives, historic datasets, as well as localised or short term targeted invasive species surveys. With integration of targeted and standardised approaches to invasive species monitoring, WFD monitoring may offer a strong foundation for spatially comprehensive invasive species monitoring within the freshwater environment, across the island of Ireland.

Specific examples of monitoring related to the WFD identified in this study include monitoring of canals by Waterways Ireland (though note that canal monitoring also fulfils other legislative drivers including the Habitats Directive) (see Table 9 for full list of existing programmes).

Table 6. Biological assessment methods in the IE WFD monitoring programme 2022- 2027. Taken from Environmental Protection Agency (2023). It is assumed that similar methodologies are deployed in NI given the shared origin of water quality legislation.

Quality Element	Water Category			
	Rivers	Lakes	Transitional Waters	Coastal Waters
Macroinvertebrates	Quality Rating System (Q-value)	Lake Acidification Macroinvertebrate Metric (LAMM)	Infaunal Quality Index (IQI)	Infaunal Quality Index (IQI)
	Acid Water Indicator Community Score (AWICs)			
Aquatic Plants	Mean Trophic Rank (MTR)	Free Macrophyte Index	Intertidal Seagrass tool	Intertidal Seagrass tool
	LEAFPACS		Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE)	Saltmarsh Angiosperm Assessment Tool for Ireland (SMAATIE)
Macroalgae	Mean Trophic Rank (MTR)	Not applicable	Opportunistic Green Macroalgal Abundance (OGA tool)	Opportunistic Green Macroalgal Abundance (OGA Tool)
	LEAFPACS			RSL - Rocky Shore reduced species List
Phytoplankton	Not applicable	IE Lake Phytoplankton Index	Phytoplankton biomass & composition	Phytoplankton biomass & composition
Phytobenthos	Revised form of Trophic Diatom Index (TDI)	Lake Trophic Diatom Index (IE)	Not applicable	Not applicable
Fish	Fish Classification Scheme (FCS2)	Fish in lakes 2 (FIL2)	Transitional Fish Classification Index (TFCI)	Not applicable
			Estuarine Multi-metric Fish Index (EMFI)	

Table 7. Frequency of monitoring for biological quality elements under the IE WFD monitoring programme 2022-2027. Taken from Environmental Protection Agency (2023). It is assumed that frequencies are similar in NI given the shared origin of water quality legislation.

Quality Element	Water Category			
	Rivers	Lakes	Transitional Waters	Coastal Waters
Biological				
Macroinvertebrates	Every 3 years	Every 3 years annually at selected acid lakes*	Every 3 years	Every 3 years
Aquatic Plants	Every 3 years (in canals annually)	Every 3 years	Every 3 years (seagrass) Every 6 years (saltmarsh)	Every 3 years (seagrass) Every 6 years (saltmarsh)
Macroalgae	Not applicable	Not applicable	Every year (opportunistic algae)	Every year (opportunistic algae) Every 3 years (RSL)
Phytoplankton	Not applicable	Twice per annum for taxonomic composition (SM) As per physico[1] chemical for chlorophyll a	4 times per annum	12 times per annum
Phytobenthos	Once per annum	Twice per annum every 3 years	Not applicable	Not applicable
Fish	Every 3 years	Every 3 years	Every 3 years	Not applicable

* non-acid lakes four times per annum, acid lakes six times per annum.



These Marine Strategies comprise a three-part framework relating to assessment, monitoring and programmes of measures, for each descriptor. As such monitoring for invasive species is an explicit requirement. However, currently, monitoring for invasive species in the marine environment to support marine strategies typically integrates various existing programmes, which may or may not target invasive species specifically. For example, in the UK, monitoring for invasive species is carried out under existing programmes including Groundfish Surveys, Marine Protected Area monitoring, and WFD & associated river basin monitoring plans (Defra, 2022). In IE, SASI is identified as the invasive species monitoring programme in Irish Waters, supported by the RAS undertaken in 2021 (see above) (Government of Ireland, 2021). While this approach provides a cost-effective solution, it may lead to limitations including monitoring gaps at high-risk locations and difficulty in determining monitoring effort based on methods not designed to target invasive species detection. This piggy-back type approach is not unique to MSFD implementation across the island of Ireland, and is noted at broader geographical scales, including across other OSPAR Contracting Parties (Stæhr et al., 2023).

In the UK, coastal and estuarine environmental monitoring is coordinated through the Clean Seas Environmental Monitoring Programme (CSEMP).

With extension to include targeted and standardised approaches to invasive species monitoring, MSFD monitoring, may offer a strong foundation for spatially comprehensive invasive species monitoring within the marine environment across the island of Ireland.

5.3.2 Protected habitats and species monitoring programmes

While the Habitats Directive focuses on the conservation of natural habitats (Annex I) and wild species (Annex II), invasive species are explicitly acknowledged as a significant pressure or threat to the listed habitats and species, and as such, are included within monitoring (Article 11) and reporting (Article 17) obligations. Similarly, the Birds Directive aims to protect wild birds, to which invasive species pose a significant threat and should be reported under Article 12.

The Habitats and Birds Directives are implemented directly through the European Communities (Birds and Natural Habitats) Regulations 2011 in IE, with coordination from the NPWS. In NI, The Habitats and Birds Directives are primarily implemented through The Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995, amended in 2019 to ensure operability following the UK's exit from the EU. In NI, implementation is overseen by DAERA. Despite differing national legislation and administration, the ecological purpose and conservation goals of the IE and NI Regulations are currently the same.

The primary mechanism of protection under this legislation is through the designation of sites. More specifically, designation of SACs for the protection of habitats and species (listed under Annex I and II or the EU Habitat's Directive, respectively) and designation of Special Protected Areas (SPAs) for the protection of vulnerable and migratory bird species (as defined in the EU Birds Directive). These designations are central to IE's contribution to the EU's Natura 2000 network, and NI's contribution to the UK's National Site Network.

Further designations, driven by national legislation to protect habitats and species of national importance, also exist. These include National Heritage areas in IE (which focus on protection of raised bogs, wetlands and woodlands), established under the Wildlife (Amendment) Act 2000 and managed by NPWS. In NI, designations also include Areas of Special Scientific Interest (ASSIs) under The Environment (Northern Ireland) Order 2002, and Marine Protected Areas (MPAs) (in particular, Marine Conservation Zones (MCZs), under The Marine Act (Northern Ireland) 2013 and the UK The Marine and Coastal Access Act 2009. There are also numerous designated RAMSAR sites across NI and IE which are wetlands of international importance recognised under the Ramsar Convention on Wetlands. The distribution of key protected site types across the island of Ireland is captured in Figure 6.

For designated sites there is requirement for monitoring to underpin condition assessment and reporting. For both SACs and SPAs invasive species are referenced within the threats and pressures section. The monitoring/reporting requirements for each site type are summarised in Table 8. The methodology used to detect invasive species as a threat or pressure may vary and is difficult to capture across all site types, organisations and jurisdictions. Invasive species observations or walkovers as part of broader protected site surveys were noted, with, for example, DAERA documenting their undertaking of coastal observations during on shore habitats (and WFD) surveys, which include noting non-native flora or fauna with a SACFOR abundance. In some instances, invasive species records available through relevant databases may be used to inform condition assessments, rather than data collected through specific designated site monitoring.

Table 8. A summary of protected site types, including their scale and their monitoring and reporting requirements.

Designation	Country	Legislation	Purpose	Monitoring / Reporting	Number and scale
Special Areas of Conservation (SAC)	IE	The legal basis by which SACs are selected and designated is the EU Habitats Directive which was transposed into Irish law in the European Communities (Birds and Natural Habitats) Regulations 2011.	They have been designated because of a possible threat to the special habitats or species which they contain and to provide increased protection to a variety of animals, plants, and habitats of importance to biodiversity both on a national and international scale.	Reporting every 6 years, managed by NPWS, under Article 17 of the Habitats Directive. Reporting on invasive species is under other pressures/threats: 'Invasive alien species of Union concern' (P101) and 'Other invasive alien species (other than species of Union concern' (P102) (List of pressures and threats for reporting 2019-2024 v1.1.xlsx).	441 46,178km ²
	NI	Special Areas of Conservation (SACs) are those which have been given greater protection under The Conservation (Natural Habitats, etc.) Regulations 1995 (Northern Ireland) (as amended).		DAERA is responsible for reporting every 6 years, coordinated across UK by JNCC using the Common Standards Monitoring approach. SACs (and SPAs) in NI are now part of the UK National Site Network.	58 2,462km ²
Special Protection Areas (SPA)	IE	The EU Birds Directive (2009/147/EC), which was transposed into Irish law in the European Communities (Birds and Natural Habitats) Regulations 2011, requires the designation of SPAs,	They are classified for rare and vulnerable birds (as listed on Annex I of the Birds Directive (79/409/EEC as amended), and for regularly occurring migratory species.	Reporting every 6 years managed by NPWS, under Article 12 of the Birds Directive. Reporting on invasive species is under other pressures/threats: 'Invasive alien species of Union concern' (P101) and 'Other invasive alien species (other than species of Union concern' (P102) (List of pressures and threats for reporting 2019-2024 v1.1.xlsx).	167 11,359km ²
	NI	SPAs are designated under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended). Some operability changes have been made through the Conservation (Natural Habitats, etc.)		DAERA is responsible for reporting every 6 years, coordinated across UK by JNCC using the Common Standards Monitoring approach. SPAs (and SACs) in NI are now part of the UK National Site Network	16 1,459km ²

Designation	Country	Legislation	Purpose	Monitoring / Reporting	Number and scale
		(Amendment) (Northern Ireland) (EU Exit) Regulations 2019.			
Marine Conservation Zones (MCZ) (formerly MNR)	NI	Marine Act (Northern Ireland) 2013.	To protect nationally important habitats, species and geological/geomorphological features, while fully taking into account any economic, cultural or social consequences of doing so. Also allows DAERA to make byelaws to protect MCZs from damage by unregulated activities. It is an offence to intentionally or recklessly destroy or damage a protected MCZ feature or contravene a byelaw.	Reviewed by DAERA on a 6-year monitoring and reporting program – assessment of conditions against conservation objectives. Data to substantiate assessment can be from multiple sources/methods e.g., cores, ROV, remote sensing, diving, imagery (see example for Outer Belfast Lough). MCZ Assessment Template – January 2022.PDF. Annex 3 of the assessment comprises sensitivity, exposure and vulnerability matrix. Includes the introduction and spread of NIS. For further information on NIS Strategy for MCZs see the Strategy for Marine Protected Areas in the Northern Ireland inshore region.	7 549km²
Natural Heritage Area (NHA)	IE	Under the Wildlife Amendment Act (2000), NHAs are legally protected from damage from the date they are formally proposed for designation.	This is an area considered important for the habitats present, or which holds species of plants and animals whose habitat needs protection. In an NHA, persons need to seek consent from the Minister for the Environment to carry out works (under Schedule 2 of the order).	In contrast to SPAs and SACs there is no formal, cyclical reporting requirements for NHAs. Site condition assessments made as part of the designation process consider invasive species as a pressure.	5 raised bogs (230km²) 73 blanket bogs (370km²), 630 pNHAs (650km²)
Areas of Special Scientific Interest (ASSI)	NI	First designated under the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985: New ASSIs are designated under the	To provide statutory protection for NI's flora, fauna, geological or physiographical features. The Order makes it an offence for anyone to	ASSIs are subject to regular condition assessments - the aim is to monitor and report on features every 6 years. Invasive species are considered as a pressure.	396 1,111km²

Designation	Country	Legislation	Purpose	Monitoring / Reporting	Number and scale
		Environment (Northern Ireland) Order 2002.	intentionally or recklessly damage any natural feature of an ASSI.		
RAMSAR	IE	Ramsar Convention.	Ramsar sites are wetlands of international importance, in particular, sites of importance for waterbirds.	No formal reporting to EU required but if designations overlap a single site condition assessment is performed and includes consideration of invasive species as a pressure. Ramsar site status and monitoring is captured through the Ramsar Sites Information Service.	45
	NI	Most Ramsar sites are SAC, SPA or both.			672 km ²
					20
					881km ²

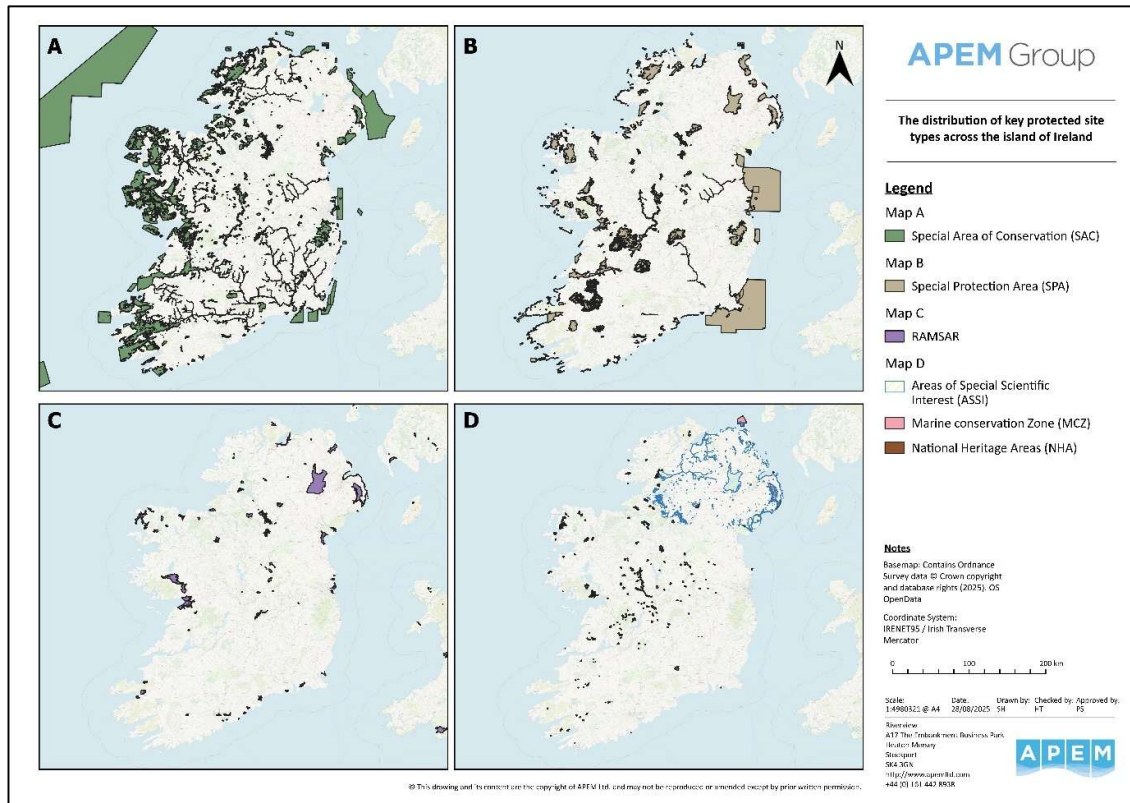


Figure 6. The distribution of key protected site types across the island of Ireland, namely Special Areas of Conservation (A), Special Protection Areas (B), RAMSAR sites (C) and Areas of Special Scientific Interest, Marine Conservation Zones and National Heritage Areas (D).

Specific examples of current and recent programmes carried out across the island of Ireland in line these obligations, and which include invasive species reporting (i.e., under threats or pressures), are included in Table 9.

Additional monitoring related to protected habitats and species

Within the context of protected sites, invasive species surveys may also be carried out as part of Habitats Regulations Assessments (HRAs), a legal requirement for consent applications to assess whether a development plan or project will harm a protected site. In particular, if invasive species are identified as a pressure within the HRA screening stage, surveys may be undertaken to further understand their distribution and abundance (though existing data may also be utilised) as relevant to the geographical scope of the plan or project.

While broader than HRAs in their remit, Environmental Impact Assessments (EIAs) are also undertaken for larger developments and projects, and include assessment of wide-ranging environmental impacts (not just in relation to protected sites). If invasive species are implicated as an ecological risk in the EIA screening stage, baseline surveys may be conducted to establish an

understanding of presence, abundance and distribution (though as with HRAs, existing data may also be utilised). Post-development invasive species monitoring may also be integrated into license conditions underpinned by the EIA. A specific example of license related monitoring in the marine environment is dredge disposal surveys under the licensing requirements of the Marine and Coastal Access Act 2009 (Table 9).

Driven by multiple legislation (including the IE Planning and Development Acts, 2000–2019) and their requirements (including HRAs and EIAs), and to facilitate sector-specific implementation and standardisation, guidance and a standard for invasive alien plant species (IAPS) management during national road planning, construction, operation and maintenance, has been created by Transport Infrastructure Ireland (TII) (Transport Infrastructure Ireland, 2020a, 2020b) (see Table 9). Implicit within the required invasive species management is invasive species surveys. Between 2016 and 2019 TII conducted 1485 IAPS surveys across 12 counties in order to support management of five IAPS (Japanese Knotweed, Giant Rhubarb, Himalayan Knotweed, Giant Knotweed and Bohemian Knotweed) with such work anticipated to be ongoing currently.

While perhaps somewhat complicated in their legislative origin, governance, and often overlapping designations, the scale, coverage and diversity of the protected site network across Ireland is extensive. A number of examples of invasive species surveys within protected sites were identified in this review (see section 4.1.4). However, variation in capacity to detect invasive species during protected area surveys / attention to invasive species within condition assessments was noted. With extension to include targeted and standardised approaches to invasive species monitoring, this protected site network may offer a strong foundation for spatially comprehensive invasive species monitoring across Ireland.

5.3.3 Aquaculture and fisheries – (excluding Shellfish Associated Species Inventory)

Fisheries surveys are undertaken in both freshwater and marine environments across Ireland. These surveys focus on stock assessments and sustainability and are driven by a multi-layered legal framework including national laws such as the Inland fisheries Act; EU water quality related directives such as the WFD and MSFD, and their associated national enacting legislation; and broader regional and international obligations associated with OSPAR and ICES. As such there are numerous organisations involved in fisheries surveys including NIEA, DAERA, BIM and Inland Fisheries Ireland. Examples of fisheries surveys identified within this project are highlighted in Table 9. Though not invasive species focussed, reference to invasive species detection and use of fisheries data to inform invasive species assessment was noted, for example, in relation to seed stock mussel surveys conducted by BIM.

Aquaculture is a key pathway to which the introduction and spread of aquatic invasive species is attributed. The aquaculture industry is heavily regulated with respect to aquatic animal disease, incorporating aquatic animal health surveillance and associated inspections by regulators, and reporting obligations for the industry. Though outside of any aquatic animal health legislation remit, such monitoring offers opportunity for detection of invasive species (as contaminants of stock) or

within aquaculture sites. Further, through national implementation of Council Regulation (EC) No. 708/ 2007 concerning the use of alien and locally absent species in aquaculture, aquaculture operators are obligated to monitor escapes into the wild of farmed alien species (assuming prior approval to farm the alien) (see Legislation Summary in Supplementary Material).

Further, shellfish safety monitoring programmes, while focussed on protecting human health, monitor harmful toxin producing micro-algal species, offer a potential monitoring foundation for extension to include invasive micro algae species.

5.3.4 Plant pest monitoring

Monitoring for plant pests which are not native to Ireland (or the EU) is well established and driven by key pest and disease legislation, and related pest classifications (EU Priority, Protected Zone and Union Quarantine). Responsibility falls to AFBI and DAERA in NI and the Department of Agriculture, Food and the Marine (DAFM) in IE. While broadly considered to fall within the scope of invasive species monitoring, the pest species targeted are not priority invasive species defined under invasive species legislation (i.e., those focused on in this review). That said, the Oak Processionary moth which is a Protected Zone pest, is considered an alert invasive species across both jurisdictions, and two EU priority pest species, the birch borer and emerald ash borer have been identified as a future risk to Ireland through a recent invasive species horizon scanning exercise (Lucy et al., 2020). Further, the pathways by which pest species are introduced, and which are consequently monitored, overlap with those pathways to which the introduction of non-pest invasive species are attributed, offering potential opportunity for extension to detect invasive species in addition to the priority pest species targeted.

5.3.5 Border control

There are numerous examples of existing monitoring initiatives undertaken at ports and airports which include, or have the potential to include, invasive species detection. For example, in the context of epizootic disease risk management, Port Health Authorities, along with Veterinary Services, are responsible for monitoring incoming animals and animal products for signs of disease. This includes surveillance for notifiable diseases, which are diseases that must be reported to authorities, and therefore covers invasive species that present an epizootic risk. While of potential relevance to invasive species management more broadly, and potentially useful to inform site prioritisation, border control monitoring does not provide data on the presence of species in the wild and is therefore considered out of scope here.

Table 9. Example surveys associated with broader statutory environmental monitoring programmes operating across the island of Ireland.

Primary category	Survey name	Spatial scope	Species group/species	Timeframe / Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow
Water Quality	Dredge disposal surveys.	NI, Marine.	Animals – Infauna.	Unknown.	AFBI / DAERA.	Dredge disposal sites.	Sediment grabs, Remote operated vehicles with video camera.	Benthic infauna abundance, biomass, habitat.	Data go to Cefas via DAERA. Some data (e.g., for Belfast Lough dredge disposal) is on DASSH.
Aquaculture & Fisheries	Fisheries Stock Management.	IE, Freshwater.	Animals – fish.	Ongoing. Annual (high frequency of sampling at specific sites).	Inland Fisheries Ireland.	Lakes.	Fyke nets, perch/pike traps, gill nets, electrofishing.	Presence.	Data held by Inland Fisheries Ireland.
Protected habitats and species	Marine Benthic & Lagoons monitoring.	IE, Marine, Freshwater.	Plants and Animals.	2010 – present. Every six years. Report due November 2025.	NPWS.	Freshwater, coastal and terrestrial.	Protected site & species- specific.	Protected site & species-specific.	Held by NPWS centrally, data can be shared with interested parties upon data request.
Aquaculture & Fisheries	Seed Mussel Stock Surveys.	IE, Marine.	Plants and Animals.	2000 (first report noted) – present Seasonal (summer) sampling Frequency - annual or every 2 years.	BIM.	Mussel beds including in Rusk Channel, Wexford, Wicklow Head, Blackwater, Glassgorman, Rosslare & Long Bank Areas, Castelemaine Harbour/Cromane, Cahore (site information taken from reports published).	Purpose built inshore survey vessel, with a full range of survey equipment including side scan sonar, underwater cameras, ROV, dredges, and a Day grab.	Mussel biomass, mussel bed extent, condition of mussel seed (size, density, distribution within the beds, predation), larval distribution. The data collected during those surveys also feed into the assessment of potential invasive species.	Unknown.
Protected Habitats & Species	Management of Invasive Alien Plant Species (IAPS)	IE, Terrestrial.	Plants	2020 – present Frequency – as required.	TII.	Road network.	Site assessment (i.e., via walkover).	Mapping of IAPS presence/coverage.	TII.

Primary category	Survey name	Spatial scope	Species group/species	Timeframe / Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow
	on National Roads.								
Protected Habitats & Species	National, White-Clawed Crayfish Surveillance programme (includes Crayfish Plague monitoring).	IE, freshwater.	Animals – crayfish.	2015 – present Frequency according to guidance (https://www.npws.ie/sites/default/files/publications/pdf/Reynolds_2006_Crayfish_Monitoring.pdf).	NPWS and the Marine Institute.	Lakes.	Guide on Crayfish monitoring exists and likely followed (https://www.npws.ie/sites/default/files/publications/pdf/Reynolds_2006_Crayfish_Monitoring.pdf).	Number and size of crayfish.	Data submitted to NBDC.
Aquaculture and Fisheries	Irish Groundfish Survey.	IE, marine.	Animals – fish.	Ongoing. Annual, six-week survey.	Marine Institute.	Shelf waters around Ireland.	Trawl with 20mm mesh to retain juvenile fish spawned that spring which will then form the basis of the fishery in years to come. Sampling efficiency is highly controlled on these surveys.	Independent estimate of abundance for commercially exploited fish stocks, in particular their reproductive success for that year.	Unknown.
Protected habitats and sites	Monitoring and Assessment of four EU Habitats Directive Annex I Woodland Habitats.	IE, Terrestrial.	Plants & deer pressure.	2011-present. Every 6 years.	NPWS.	Woodland sites.	Unknown.	Unknown.	Unknown.
Protected habitats and sites	Monitoring of vegetation change through permanent	IE (Killarney), terrestrial.	Plants.	1991-present. Every 5 years.	NPWS.	Woodland sites.	Unknown.	Unknown.	Unknown.

Primary category	Survey name	Spatial scope	Species group/species	Timeframe / Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow
	woodland plots in Killarney National Park.								
Protected habitats and sites	National Bat Monitoring Programme.	IE, terrestrial.	Bats.	Ongoing. Variable frequency.	NPWS.	Unknown.	Various.	Unknown.	Unknown.
Protected habitats and species	Natterjack toad monitoring.	IE (Kerry), freshwater.	Amphibians.	Irregular. Weekly site visits during breeding season.	NPWS.	Natterjack breeding sites.	Various.	Unknown.	Unknown.
Protected habitats and species	Otter surveys.	IE, freshwater, terrestrial.	Otters.	Irregular. ~ 10 years.	NPWS.	various rivers, lakes and coastline locations.	Visual searches.	Unknown.	Unknown.
Protected habitats and species	Monitoring and Assessment of Killarney Fern (<i>Vandenboschia speciosa</i> (Willd.) G. Kunkel) in Ireland 2019–2024.	IE (Killarney), terrestrial.	Plants.	2021–2024. Variable – survey results inform future monitoring frequency.	NPWS.	Terrestrial.	Traditional field survey methods.	The presence, abundance, distribution and impacts of invasive species at sites for <i>Vandenboschia speciosa</i> .	Data held by NPWS.
Plant Pests	Protected Zone Pests and Diseases.	Island of Ireland, Terrestrial.	23 pests (insects) and disease for which NI has protected zone status within the EU.	1990s – ongoing. Annual.	NI - AFBI/DAERA. IE – DAFM.	Mostly forests and some crops.	Trapping, observation and molecular diagnoses.	Presence/absence.	NI - AFBI report to DAERA/ DEFRA/EU IE – DAFM.
Plant Pests	EU Priority Pests.	Island of Ireland, Terrestrial.	20 plant pests and diseases of Union concern.	Ongoing. Annual.	NI - AFBI/DAERA. IE – DAFM.	Mostly forests and some crops	Trapping, observation and molecular diagnoses	Presence/absence	NI - AFBI report to DAERA to DEFRA/EU. IE – DAFM.

Primary category	Survey name	Spatial scope	Species group/species	Timeframe / Frequency of sampling	Lead Organisation	Sites covered	Method(s) used	Data collected	Data storage & onward flow
Plant Pests	Union Quarantine Pests.	Island of Ireland, Terrestrial.	Rolling programme of surveillance for >200 plant pests and diseases dependent on risk status.	Ongoing. Annual.	NI - AFBI/DAERA. IE – DAFM.	Mostly forests and some crops.	Trapping, observation and molecular diagnoses. Some species listed are not relevant to NI's climate and/or cropping so can be discounted on that basis.	Presence/absence.	NI - AFBI report to DAERA to DEFRA/EU. IE - DAFM.
Water Quality	AWB Canals (direct WFD remit) and its navigations on River and Lake Systems e.g., Shannon, Shannon Erne (River section), Erne, Bann Navigations.	Island of Ireland, Freshwater.	All aquatic species (plants, Inverts, Birds, fish, mammals), and any bird or other species using the waterways as Habitat - e.g., Otter/Bats/Badger/Fox etc.	Ongoing. Yearly for WFD reporting (Canals). Project specific for all other navigable waterway. (E.g., Erne invasive aquatic Species Control/Weed Cutting plan is every 6 years.)	Waterways Ireland.	1250km of navigable inland waterways across the island of Ireland.	Ecological Survey and Reporting.	invasive species recorded through WFD canals sampling and reporting to EPA. Waterways Ireland also notified.	Unknown.
Water Quality	NIEA/AFBI/Loughs Agency WFD fish monitoring statutory monitoring of fish.	NI, Freshwater.	Fish.	Ongoing.	NIEA/AFBI/Loughs Agency.	Unknown.	Unknown.	Unknown.	Unknown.

5.4 Citizen science initiatives

Eighteen examples of citizen science initiatives of relevance to invasive species monitoring across the island of Ireland were identified (See Table 10). These initiatives are led by a number of different organisations including universities, societies, government agencies, local authorities and charities. Nine (50%) are categorised as survey initiatives and nine are categorised as reporting initiatives. Twelve (66%) are operational in both IE and NI, four (22%) in IE only, and two in NI only (11%). Eight (44%) are relevant to the marine environment only and five (27%) to the terrestrial environment only. Of the remaining initiatives, one (6%) covers both the marine and freshwater algae (The British Phycological Society Seaweed and Freshwater Algae Recording Site), one covers freshwater and coastal birds (the Irish Wetland Bird Survey), and two (11%) cover all environments (BioBlitz, Biodiversity Data Capture). Only three (17%) of the identified initiatives are specific to invasive species, all of which are for the reporting of terrestrial plants: Plant Alert, Report Invasive Plants, and SuirCan. The remaining initiatives either do not specify which species should be recorded or include invasive species in the survey list of species to be recorded. Eight of the initiatives allow for the reporting of both plants and animals, six are for the reporting of plants or algae (marine and freshwater) only, and four initiatives are for recording data on squirrels, jellyfish, angling catch or birds specifically.

All reporting initiatives operate on an ad hoc basis with citizen scientists uploading their sightings as they are made. Of the survey initiatives, four are undertaken annually and one is undertaken seasonally (i.e., four times per year). Three survey initiatives, BioBlitz, Seasearch NI and Seasearch Ireland, are activities/events that are organised on an ad hoc basis by scientists and/or environmental groups to engage the help of volunteer citizen scientists to collect data through structured or semi-structured surveys.

Citizen science data may vary in accuracy and be prone to strong biases in terms of the locations, ecosystems or taxa surveyed (Thompson et al., 2023). However, validation mechanisms are in place across the island of Ireland to improve confidence in citizen science data.

Table 10. Example citizen science initiatives of relevance to invasive species monitoring across the island of Ireland.

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland, terrestrial	Plant Alert	Reporting initiative.	Project aimed at discovering garden plants with the potential to become invasive in the future.	Yes	Plants	Since 2015.	Ad Hoc.	Centre for Agroecology, Water and Resilience at Coventry University & Botanical Society of Britain and Ireland (BSBI).	Survey form (Plant Alert survey form).	Location, species other useful info like life-history stage.	Data submitted to the BSBI.	https://plantalert.org/
IE, all environments	Biodiversity Data Capture	Reporting initiative	App /reporting platform designed for recording and submitting observations of species in the field, contributing to biodiversity conservation efforts.	No	All	Since 2023.	NA	NBDC	Citizen science.	Location, species.	Data submitted to NBDC.	https://docs.biodiversityireland.ie/biodiversity-data-capture
NI, marine	Seasearch NI	Survey initiative (an Irish Marine Biodiversity Citizen Science Survey).	Seasearch NI is a project for volunteer scuba divers and snorkellers interested in underwater habitats and protection of the marine environment.	No	Plants and Animals.	Since 2009.	Ad Hoc.	DiveNI.	Diver surveys.	Habitats and Species.	Surveyors directed to CEDaR or iRecord.	https://www.dive-ni.com/record-species/#record_species_2
IE, marine	Seasearch Ireland	Survey initiative (an Irish Marine Biodiversity Citizen Science Survey).	Seasearch Ireland is a project for volunteer scuba divers and snorkellers interested in underwater habitats and protection of the marine environment.	No.	Plants and Animals.	Since 2009.	Ad Hoc.	Seasearch is run by Marine Conservation Society. CFT (trading as Diving Ireland) teamed up with Seasearch in 2009.	Diver surveys.	Habitats and Species.	NBDC.	https://seasearchireland.ie/

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/ species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland, marine (shoreline/intertidal)	All Ireland Coastwatch Survey, part of Coastwatch Europe	Survey initiative (an Irish Marine Biodiversity Citizen Science Survey).	The Goal is protection and sustainable use of coastal resources, and informed public participation in environmental planning and management.	No.	Plants and Animals.	Since 1980.	Annual survey.	Coastwatch Europe, supported by the Marine Environment Section of DHLGH in IE. Ulster Wildlife Trust in NI.	Volunteers checking their chosen 500m stretch of coast (survey unit) once around low tide, and noting observations on marine litter, water quality and biodiversity on a survey questionnaire while on the shore.	General presence of invasive species and two species (<i>M. gigas</i> , <i>C. fornicata</i>) presence specifically. For specific species request reference to size of population.	Coastwatch data is provided to CEDaR. Coastwatch NI data is uploaded onto the NBN Atlas via CEDaR.	https://www.coastwatch.org/about
Ireland, marine (angling sites)	Irish Marine Recreational Angling Diary & Surveys	Reporting initiative.	Provides vital information on fishing effort and catches of marine species in coastal waters. The goal is to gather data on how many people fish, how often they fish and what they catch.	No.	Fish (and shellfish).	Ongoing.	Ad Hoc - summer months.	Inland Fisheries Ireland.	Anglers submit data via angler diary or survey.	Catch species.	Submitted to Inland Fisheries Ireland (IFI).	https://exploreyourshor.e.ie/marine-surveys/imrec/ https://www.fisheriesireland.ie/sites/default/files/2022-01/ifi-ba-survey-of-irish-sea-anglers_final-210122.pdf https://www.fisheriesireland.ie/sites/default/files/2023-07/imrec-diary-report-2022.pdf https://imrec-iframe.hub.arcgis.com/
Ireland, marine	The Big Jellyfish Hunt	Reporting initiative (an Irish Marine Biodiversity Citizen Science Survey).	For the interest of UCC School of Biological, Earth and Environmental Sciences.	No.	Jellyfish specific.	Ongoing.	Ad Hoc.	University College Cork, Ireland.	Surveys by divers and snorkelers.	Jellyfish observations - guided by simple ABCDEF categories - A=aggregations B=Barrel etc. Resolution of information collected may not allow distinction between native and non-native jellyfish species.	Jellyfish hunt webpage reporting tab goes to NBDC.	https://exploreyourshor.e.ie/marine-surveys/the-big-jellyfish-hunt/

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland, marine (shoreline)	Seashore Spotter	Reporting initiative.	The goal is to monitor changes in the distribution and occurrence of marine species linked to climate change and water quality change to help us understand their impact on marine species and habitats.	No.	Plants and Animals.	Ongoing.	Ad Hoc.	NBDC.	Seashore Spotter is a Citizen Science survey allowing you to record any marine species (even if you don't know what it is!), anytime, anywhere.	Submit photo and location.	Uploaded to NBDC following expert validation Records are also shared on the European Ocean Biodiversity Information System and on the Global Biodiversity Information Facility. Data contributed to Explore Your Shore! also forms part of UNESCO monitoring of Essential Ocean Variables.	https://exploreyourshore.ie/surveys/seashore-spotter/
Ireland, marine (shoreline)	The Big Beach Biodiversity Survey	Reporting initiative.	The goal is to monitor changes in the distribution and occurrence of marine species linked to climate change and water quality.	No.	Plants and Animals.	Ongoing.	Ad Hoc.	NBDC.	Citizen scientists record marine species found cast up on Irish beaches.	Submit photo and location.	As for Seashore Spotter.	https://exploreyourshore.ie/surveys/the-big-beach-biodiversity-survey/
Ireland, marine (rock pools)	Adopt-a-Rockpool!	Survey initiative.	The goal is to identify changes in marine species in your rockpool by season and over time.	No.	Plants and Animals.	Ongoing.	4 times per year (Spring, Summer, Autumn, Winter).	NBDC, Irish Wildlife Trust.	Citizen scientists survey (photograph) their adopted rock pool four times a year.	Submit photo of whole rockpool.	As for Seashore Spotter.	https://exploreyourshore.ie/surveys/adopt-a-rockpool/
Ireland, terrestrial	National Plant Monitoring Scheme (NPMS)	Survey initiative.	NPMS is a habitat-based plant monitoring scheme which provides data on changes in wild plants and their habitats.	No, but invasive species listed on submission site (e.g., <i>Buddleja davidii</i>)	Plants.	Since 2015.	Annual.	Centre for Environment and Hydrology, Joint Nature Conservation Committee, Plantlife (see above).	Citizen scientists sign up and get allocated a 1km square close to them.	Species names and abundance based on dominance scale (for specifically selected indicator species).	Records entered online at www.npms.org.uk and are held by CEH. Data are also available on NBN Atlas.	https://bsbi.org/npms

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/ species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland, Freshwater & marine	British Phycological Society Seaweed and Freshwater Algae Recording Site	Reporting initiative.	Encourage upload of your seaweed records to inform assessment of changes to the seaweed flora due to climate change, increases in invasive species and a range of other factors.	No.	Plants – Algae.	Since 2003.	Ad Hoc.	British Phycological Society.	Citizen science.	Name, date, location, habitat, identification of species and confidence, (option to upload photos).	Submitted to NBN Atlas following expert validation.	https://www.bpsalgalrecords.com/
NI, terrestrial (woodland)	Red Squirrel Conservation Strategy for Northern Ireland	Survey initiative.	Landowners, local communities and local red squirrel groups are managing red squirrel habitat, undertaking education and awareness activities, monitoring squirrel populations, and carrying out targeted control of grey squirrels.	Yes.	Mammals.	Since 2014 The official funded monitoring programme (Red Squirrels United project) ran from 2014 - 2022. However, efforts are still being made annually by Ulster Wildlife to monitor populations	Annual presence/absence surveys for red and grey squirrels.	Ulster Wildlife.	Presence absence surveys (checking squirrel boxes and camera trapping) and humane control of grey squirrels.	Squirrel population metrics.	Unknown.	Ulster Wildlife - Squirrel and Pine Marten 2022 Survey Report.pdf

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland freshwater & terrestrial	Report Invasive Plants	Reporting initiative.	Limerick County Council driven initiative.	Yes.	Plants.	Since 2017.	Ad Hoc.	Limerick City and County Council.	Sightings of invasive plants in your area. Identify invasive species by comparing sightings with images and a detailed description. Focus is on County Limerick but possible to submit data outside this region.	Sighting location, images and notes.	Data appear on the platform's mapping function, with locations presented as open data. Data submitted to NBDC also, though this is seemingly infrequent.	https://invasivespecies.limerick.ie/
IE, freshwater & coastal	Irish Wetland Bird Survey (IWeBS)	Survey initiative.	Monitoring in support of protected wetland sites in Ireland.	No.	Birds (Ruddy duck).	Since 1994.	Annual winter monitoring.	NPWS (also Bird Watch Ireland).	Telescope/binoculars.	Species, counts/estimated counts. Potential for inclusion of invasive species considerations within the "Other useful information" section (see 'Counter manual').	Stored by IWeBS and submitted to International Waterbird Census (IWC).	https://birdwatchireland.ie/publications/i-webs-counter-manual/

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
Ireland, terrestrial	Botanical Society of Britain and Ireland (BSBI) plant recording	Reporting initiative.	Contribute information to build a clearer picture of the distribution of species" (native and non-native) growing wild in Britain and Ireland.	No.	Plants.	Ongoing.	Ad hoc.	Botanical Society of Britain and Ireland.	Record-a-plant is only for single records of plants growing in the wild. It is possible to submit your record if you are not sure on identification. Multiple records are requested to be sent directly to the BSBI County Recorder.	Plant species (and notes about ID), date and location of record, additional field notes/commence.	Submitted to BSBI County Recorder (either directly or via 'Record-a-plant'), then uploaded onto the main BSBI distribution database.	Record a plant – Botanical Society of Britain & Ireland
Ireland, all environments	BioBlitz	Survey initiative.	Wildlife survey events. Examples from IE/NI include: - The Great Rocky Shore BioBlitz (goal is to monitor changes in the distribution and occurrence of marine species linked to climate change and water quality) - Grand Canal Dublin BioBlitz - Delamont BioBlitz (in a country park, day and night surveys).	No.	Plants and Animals.	Since 2010.	Ad Hoc, Ireland event held annually since 2010.	There is a national BioBlitz network for the UK led by the Bristol Natural History Consortium. NBDC lead the IE element.	Methods will be dependent on the environment and the participants. Scientists, students, naturalists and members of the public work together to survey a set location over a defined time period (usually 24 or 48hrs) aiming to record as many species of plant, animal and fungus as possible. Primarily consists of walkovers in a	All species present (plant, animal, fungus), photo and location.	Records should be submitted by either the participant or the event organiser within 4 weeks of the event to the chosen reporting platform (e.g., NBDC, NBN, iNaturalist, etc).	National BioBlitz Network : Bristol Natural History Consortium https://biodiversityireland.ie/surveys/bioblitz/ https://exploreyourshor.e.ie/surveys/the-great-rocky-shore-bioblitz/ bioblitz-guide.pdf

Spatial scope	Name	Type	Overview	Invasive species specific	Species group/species	Timeframe	Frequency of sampling	Organisation	Method(s) used	Data collected	Data storage & onward flow	Link
									set location over a set time period. ID experts/guidance are on hand to assist, and photos taken.			
Ireland, Terrestrial (riverbank)	River Siur Project.	Survey initiative.	Citizen science" program to try and map invasive plant species along the river.	Yes.	Plants – Giant Hogweed, Himalayan Balsam, Japanese Knotweed.	Since 2022.	Annual – summer months.	SiurCan Environmental Forum.	Training provided.	Species coverage (mapping).	NBDC.	https://www.suircanenvironmental.ie/what-we-do/river-suir/invasive-species

6. Appendix 2 - Data Flow

Robust, timely and accurate reporting on invasive species by the island of Ireland requires access to relevant data. The flow of data from invasive species specific monitoring programmes (Figure 7), broader environmental monitoring programmes (Figure 8), and citizen science initiatives (Figure 9) was mapped to facilitate visualisation of data inputs, linkages and endpoints.

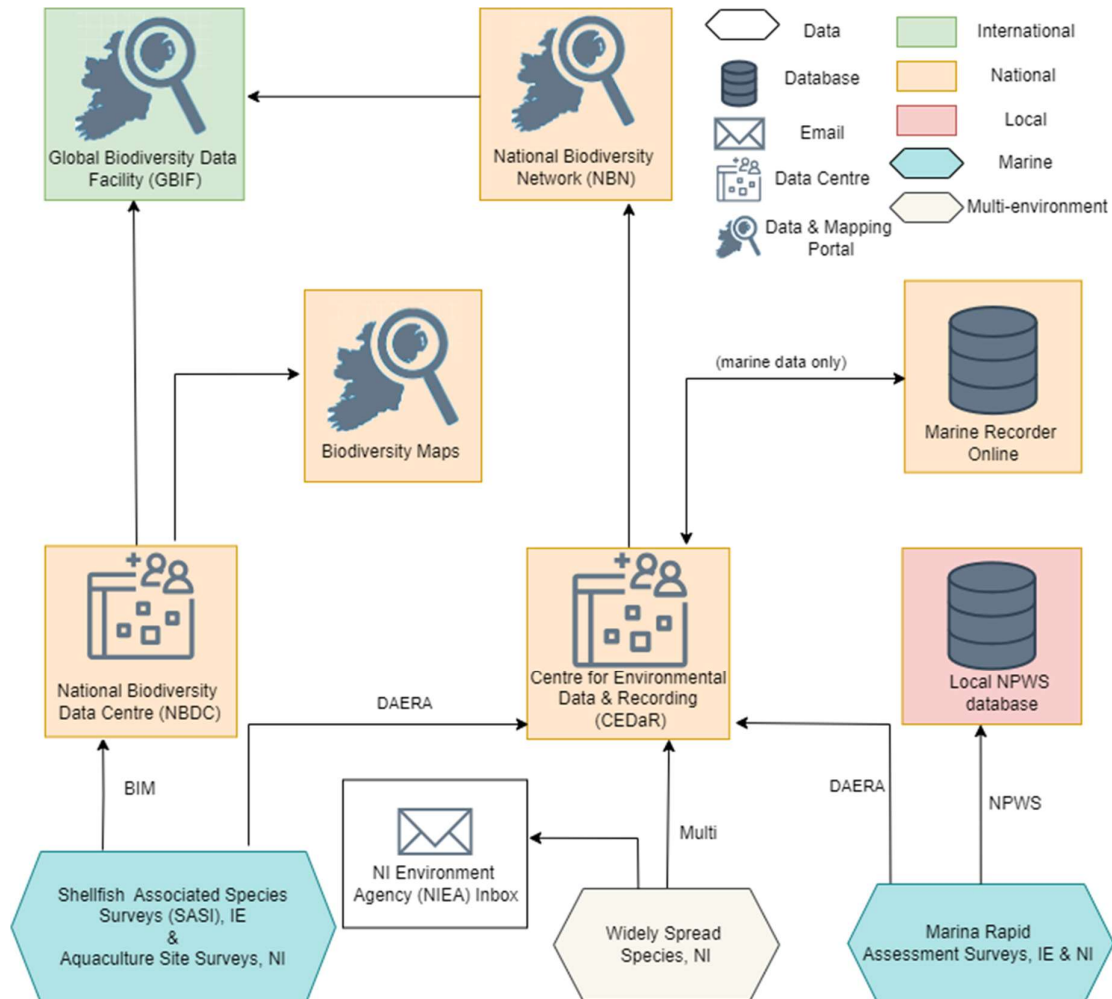


Figure 7. Data flow diagram for invasive species-specific monitoring programmes where shapes indicate data or data repositories, lines indicate linkages or partial linkages (dotted line) and shading indicates the environment or spatial scale, as indicated by the key.

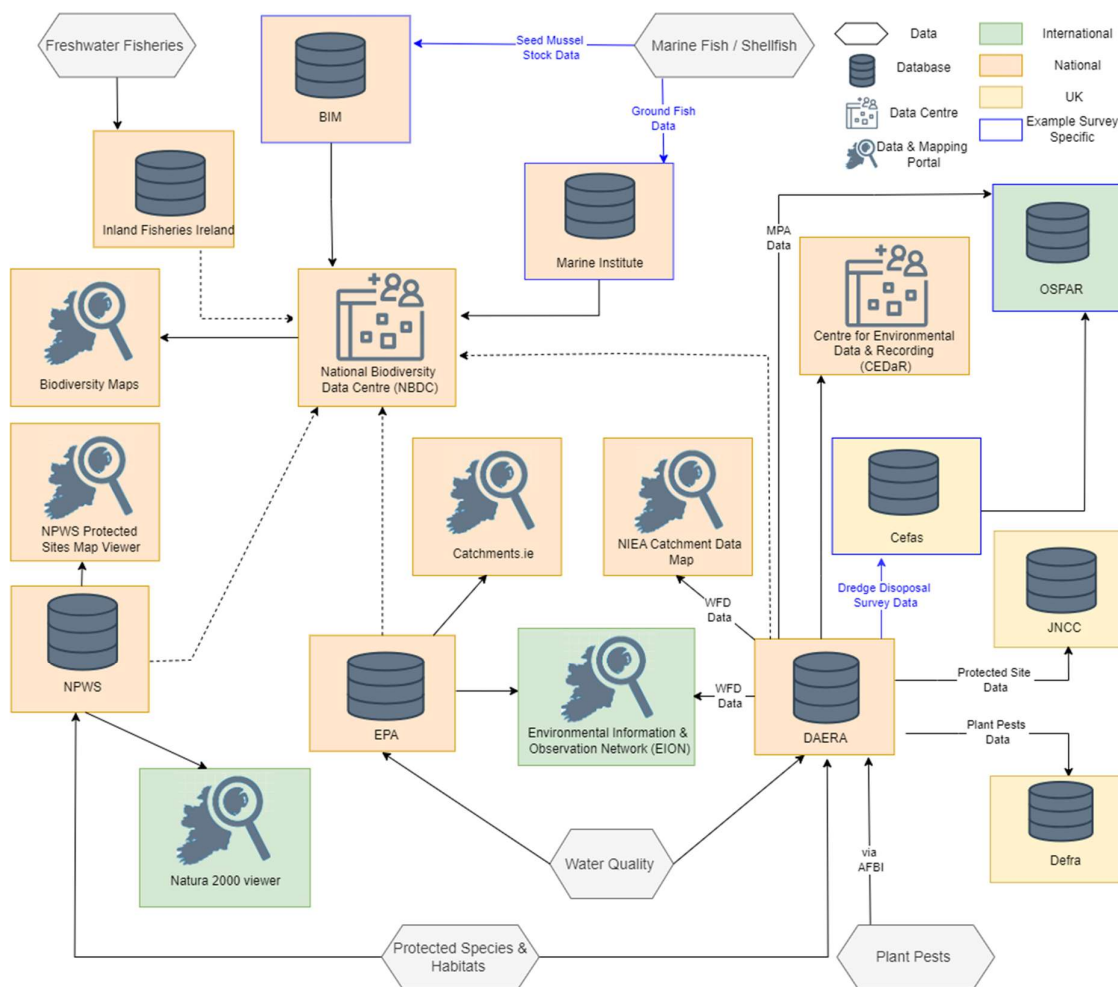


Figure 8. Data flow diagram for broader environmental monitoring programmes where shapes indicate data or data repositories, lines indicate linkages or partial linkages (dotted line) and shading indicates the spatial scale, as indicated by the key. Where only specific data flow from a repository which receives multiple data, the data is noted on the link. Note that the links from CEDaR to NBN, and from NBN and NBDC to GBIF (as portrayed in Figure 7) are not shown in this diagram to avoid overcrowding.

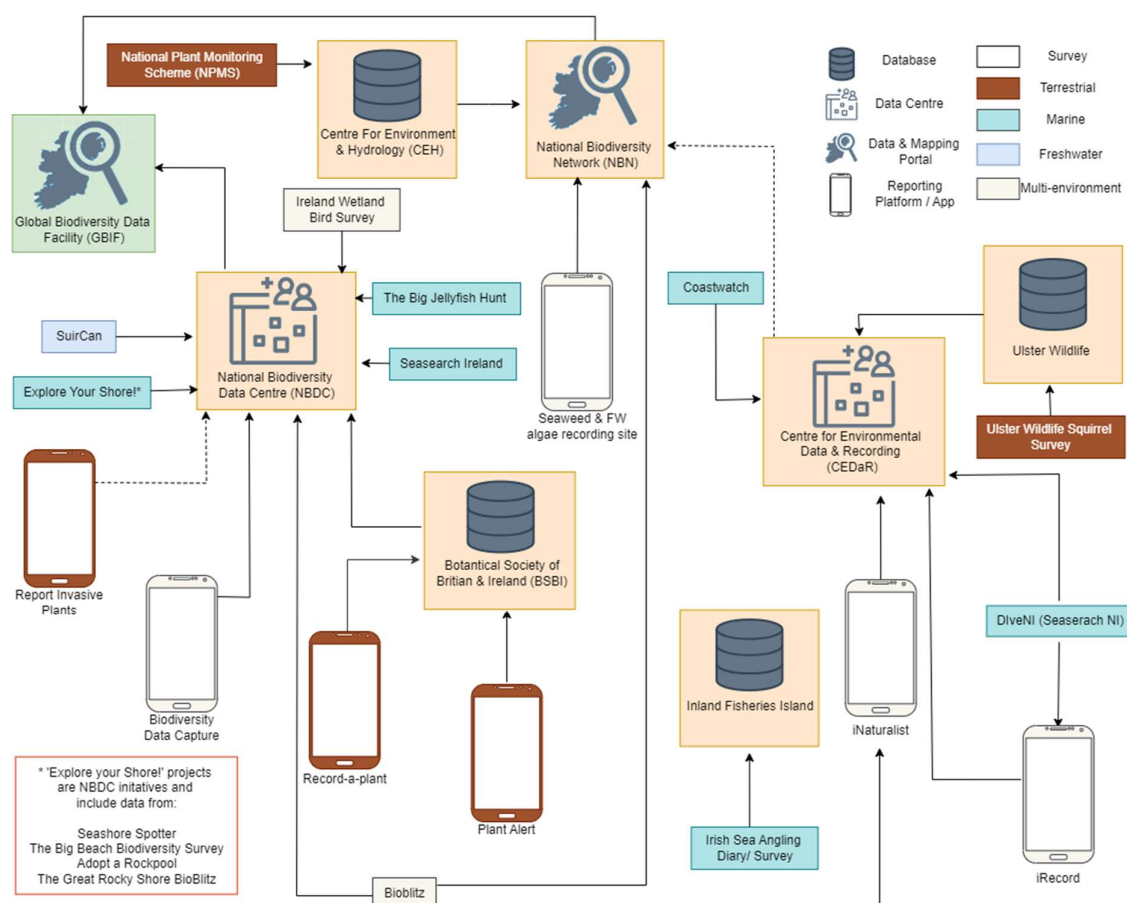


Figure 9. Data flow diagram for citizen science initiatives, where shapes indicate data, reporting platforms or data repositories, lines indicate linkages or partial linkages (dotted line) and shading indicates the relevant environment, as indicated by the key.

Though information on data flow may be missing in some instances, through examination of available data flow information, the following important points are noted:

- Data flow is complex and multifaceted, reflecting the number of organisations involved and the number routes by which invasive species data may enter the system.
- A number of portals with mapping functionality exist to facilitate visualisation of key data and data products.
- NBDC and CEDaR act as key hubs for data acquired through multiple routes (statutory and citizen science) across the island of Ireland, in accordance with their remit. However, not all invasive species data go to NBDC or CEDaR.
- Some important data may be held in local or organisation-level repositories making them difficult and more time consuming to access (data requests required) for invasive species

reporting. For example, information acquired suggests that data from marina surveys and fisheries stock assessments in IE, are held locally and not submitted to NBDC.

- Linkages to platforms with broader spatial scope than the island of Ireland exist, e.g., GBIF, facilitating data sharing at broader geographical scales.
- Many citizen science reporting platforms exist, tailored to their intended use and the organisation responsible for the initiative. The number of platforms may result in confusion among stakeholders on how and where to report invasive species and may complicate data flow and the collation of data into a single repository.
- Data sharing constraints highlighted were primarily around the collection of data on the status of invasive species on private land.
- Resources (including both time and expertise) for data validation also constrain the speed at which data enter the system.

No single repository of all invasive species data within each jurisdiction was identified. As such, data required for reporting against key international objectives such as Target 6 of the Kunming-Montreal Global Biodiversity Framework under the Convention on Biological Diversity, as well as core national and regional objectives, including those covering specific environments only such as Descriptor 2 under the MSFD need to be sought from multiple locations, with potential for data gaps as well as duplications.

7. Appendix 3 - List of Abbreviations

Abbreviation	Definition
AFBI	Agri-Food and Biosciences Institute
BIM	Bord Iascaigh Mhara
BSBI	Botanical Society of Britain and Ireland
CEDaR	Centre for Environmental Data and Recording
Cefas	Centre for Fisheries Environment and Aquaculture Science
CEH	Centre for Environment and Hydrology
DAERA	Department of Agriculture, Environment and Rural Affairs
DAFM	Department of Agriculture, Food and the Marine
Defra	Department for Environment, Food and Rural Affairs
eDNA	Environmental DNA
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
GBIF	Global Biodiversity Information Framework
GDPR	General Data Protection Regulation
HRA	Habitats regulations assessment
IAPS	Invasive alien plant species
IAS	Invasive Alien Species
IE	Ireland
JNCC	Joint Nature Conservation Committee
MCZ	Marine Conservation Zone
MSFD	Marine Strategy Framework Directive
NBAP	National Biodiversity Action Plan
NBDC	National Biodiversity Data Centre
NBN	National Biodiversity Network
NI	Northern Ireland
NIEA	Northern Ireland Environment Agency

Abbreviation	Definition
NIS	Non-indigenous Species
NPMS	National Plant Monitoring Scheme
NPWS	National Parks and Wildlife Services
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic.
RAS	Rapid assessment survey
SAC	Special area of conservation
SACFOR	Superabundant, Abundant, Common, Frequent, Occasional, and Rare abundance scale.
SASI	Shellfish associated species inventory
SPA	Special protection area
TII	Transport Infrastructure Ireland
WFD	Water Framework Directive
WSS	Widely Spread Species

8. References

- Costello, K. E., Lynch, S. A., McAllen, R., O'Riordan, R. M., & Culloty, S. C. (2022). Assessing the potential for invasive species introductions and secondary spread using vessel movements in maritime ports. *Marine Pollution Bulletin*, 177, 113496-113496. <https://doi.org/10.1016/J.MARPOLBUL.2022.113496>
- Defra. (2022). Marine Strategy Part Two: UK updated monitoring programmes.
- Devine, G., & Gittenberger, A. (2023). Alien Species and Aquaculture. A summary of work to support the aquaculture sector in understanding, preventing and managing IAS risks. BIM Report.
- Environmental Protection Agency. (2023). Ireland's National Water Quality Monitoring Programme 2022-2027.
- Environmental Protection Agency. (2024). Methods used to assess the status of monitored surface water and groundwater in Ireland for the purposes of implementing the EU Water Framework Directive.
- Government of Ireland. (2021). Marine Strategy Framework Directive 2008/56/EC. Article 17 update to Ireland's Marine Strategy Part 2: Monitoring Programme (Article 11). Prepared by the Department of Housing, Local Government and Heritage.
- IPBES. (2023). Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Roy, H. E., Pauchard, A., Stoett, P., Renard Truong, T., Bacher, S., Galil, B. S., Hulme, P. E., Ikeda, T., Sankaran, K. V., McGeoch, M. A., Meyerson, L. A., Nuñez, M. A., Ordonez, A., Rahlao, S. J., Schwindt, E., Seebens, H., Sheppard, A. W., and Vandvik, V. (eds.). IPBES secretariat, Bonn, Germany.
- Kelly, J., Tosh, D., Dale, K., & Jackson, A. (2013). The economic cost of invasive and non-native species in Ireland and Northern Ireland. The Northern Ireland Environment Agency and the National Parks and Wildlife Service.
- Kochmann, J., O'Beirn, F. X., Yearsley, J., & Crowe, T. P. (2013). Environmental factors associated with invasion: modeling occurrence data from a coordinated sampling programme for Pacific oysters. *Biological invasions*, 15(10), 2265-2279.
- Lucy, F., Davis, E., Anderson, R., Booy, O., Bradley, K., Britton, J.,...W, T. (2020). Horizon scan of invasive alien species for the island of Ireland. *Management of Biological Invasions*, 11(2), 155-177. <https://doi.org/https://doi.org/10.3391/mbi.2020.11.2.01>
- Minchin, D. M., & Nunn, J. D. (2013). Rapid assessment of marinas for invasive alien species in Northern Ireland. Northern Ireland Environment Agency Research and Development Series No. 13/06.
- Northern Ireland Environment Agency. (2025). Water Classification Statistics Report 2024.
- O'Shaughnessy, K. A., Lyons, D., Ashelby, C. W., Counihan, R., Pears, S., Taylor, E.,...Stebbing, P. D. (2023). Rapid assessment of marine non-native species in Irish marinas. *Management of Biological Invasions*, 14(2), 245-267.
- Stæhr, P. A. U., Carbonell, A., Guerin, L., Kabuta, S. H., Tidbury, H., & Viard, F. (2023). Trends in New Records of Non-Indigenous Species (NIS) Introduced by Human Activities. In OSPAR, 2023: The 2023 Quality Status Report for the Northeast Atlantic. OSPAR Commission, London.

- Thompson, M. M., Moon, K., Woods, A., Rowley, J. J. L., Poore, A. G. B., Kingsford, R. T., & Callaghan, C. T. (2023). Citizen science participant motivations and behaviour: Implications for biodiversity data coverage. *Biological Conservation*, 282.
<https://doi.org/10.1016/j.biocon.2023.110079>
- Tidbury, H., Bullen, C., Lintott, L., Rees, J., Atkinson, S., & Stebbing, P. (2026). An Invasive Species Surveillance and Monitoring Framework for the Island of Ireland. A report commissioned by the National Biodiversity Data Centre and completed by APEM Ltd.
- Transport Infrastructure Ireland. (2020a). The Management of Invasive Alien Plant Species on National Roads – Standard.
- Transport Infrastructure Ireland. (2020b). The Management of Invasive Alien Plant Species on National Roads – Technical Guidance. TII Publication Number: GE-ENV-01105.