Improvement Programme for England's Natura 2000 Sites (IPENS) – Planning for the Future IPENS 046

Understanding the impacts of invasive non-native species on protected sites

Report covers all Special Area of Conservation (SAC) and Special Protection Area (SPA) within England

www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens

This project is part of the IPENS programme (LIFE11NAT/UK/000384IPENS) which is financially supported by LIFE, a financial instrument of the European Community.

Foreword

The Improvement Programme for England's Natura 2000 sites (IPENS), supported by European Union LIFE+ funding, is a new strategic approach to managing England's Natura 2000 sites. It is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when they will target their efforts on Natura 2000 sites and areas surrounding them.

As part of the programme we identified gaps in our knowledge and have commissioned a range of projects to help us fill these gaps. The project findings are being used to help develop our Theme Plans and Site Improvement Plans. This report is one of the project studies we commissioned.

Invasive non-native species (INNS) are considered the second biggest threat to global biodiversity - following habitat loss - causing impacts through consumption, resource competition, introduction of diseases, interbreeding and disturbance. They can have economic, agricultural and health impacts, with an estimated cost to the English economy of at least £1.3 billion per year. They also present a significant risk to the favourable condition of England's protected sites.

To date we have lacked a complete picture of the current extent and scale of this pressure on the protected sites network. Records are collected by many different organisations and individuals and are spread across a range of databases. Therefore, the aims of this project were to:

1. Create a baseline snapshot of INNS in protected sites through an audit of available records so that we can start to develop a strategic programme of work and more effectively direct resources to tackle INNS issues.
2. Review the recording, systems and data flow processes within Natural England and identify recommendations for improving data flow in the future.

The key audience for this work are Natural England staff, who will use the data as evidence to assist in identifying threats and issues on sites. Recommendations from the report will be used to inform our ongoing work to improve data flow within Natural England, both to ensure staff have access to the most up to date information, and in mobilising INNS records to help inform national reporting.

Please note: the datasets produced as part of this project have not been published as not all the data has been made publicly available by the record owners.

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Understanding the impacts of invasive non-native species on protected sites

Final report

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Disclaimer

The recommendations made and any opinions expressed in this report are those of the authors. They are based upon the available information and what was considered most appropriate, but may not reflect the views of Natural England, or its invasive non-native species or data strategy.

Executive Summary

Invasive non-native species (INNS) are considered the second biggest threat to global biodiversity - following habitat loss - causing impacts through consumption, resource competition, introduction of diseases, interbreeding and disturbance (Wittenberg et al. 2001). They can have economic, agricultural and health impacts, with an estimated cost to the English economy of at least £1.3 billion per year (Williams et al. 2010). They also present a significant risk to the favourable condition of England's protected sites.

The distribution of non-native species on protected sites in England was investigated, in order to help develop a programme of work to tackle INNS. The first stage was the development of a master list of 3,687 non-native species (NNS), which was created by combining existing lists (Hill et al. 2005; Parrott et al. 2009; Thomas 2010; Roy et al. 2012; and the GB Non-native Organism Risk Assessments).

Nearly five million records for the listed NNS were collated, 99% of which were downloaded from the National Biodiversity Network (NBN) Gateway. Other records were drawn from the Joint Nature Conservation Council Marine Recorder snapshot, Natural England's Environmental Monitoring Database (EMD) and Integrated Site Assessment Tool (ISAT), and data on National Nature Reserves in England, 88% of which did not correspond to records on the NBN Gateway. The distribution of these NNS data were analysed against English Special Area of Conservation (SAC), Special Protection Area (SPA) and Site of Special Interest (SSSI) boundaries. Two types of coincidence were considered where the spatial extent of the record:

- fell entirely within the protected site and was considered to be a record from the site; or
- intersected the boundary of the site and may have been a record from the within or outside of the site.

The very detailed results were presented in a Microsoft Excel workbook, showing the NNS that had been recorded either intersecting or within each site, the number of times each species had been recorded, the dates of the recent records and an indication of the best available risk assessment for the species. Each spreadsheet could be filtered, allowing only the data within a specific site or region to be displayed.

This work showed that 98% of SACs, 99% of SPAs and 87% of SSSIs intersected with records of NNS. Higher risk NNS, or potential INNS, were found to intersect with 90% of SACs, 96% of SPAs and 75% of SSSIs. A lower level of recording was thought to account for the differences between SSSIs and the other protected sites.

The following limitations in the analysis were identified, which meant that careful interpretation of the results was required:

- the NNS list used was created uncritically and included species that would not be regarded as invasive;
- some of records that intersected with a site will have been from the surrounding area, not within the site;
- some low resolution records were excluded from the analysis, due to the poor likelihood that they would relate to a specific site, but these could have included valid site records;
- the quality of the data varied, which could mean that some records were incorrect;
- some data were old, so the species could be no longer present;
- the spatial accuracy of the data was not checked, but may affect the validity of the results; and
- records of some highly mobile species may not have been resident on the site.

The results for seven sites were reviewed against on the ground knowledge by Natural England site staff to determine any differences and demonstrate the case for increased data flow. A comparison against data in Natural England's ENSIS database was also undertaken. This demonstrated that:

- staff were aware of 50% of the NNS for their sites on average, with a greater awareness of higher risk species;
- records were not available for some NNS known to be present on the sites;
- all sites had targeted action against one or more higher risk NNS, but no action had resulted in eradication of the species;
- knowledge of the presence of a NNS was unlikely to lead to action, but the likelihood was greater for higher risk NNS;
- 65% of SACs/SPAs and 88% of SSSIs with NNS records from within their boundaries had no recorded pressure or threat in ENSIS; and
- similar proportions of protected sites containing higher risk NNS records also had no recorded pressure or threat in ENSIS.

Improving data flow to site staff will make them more aware of INNS present on their sites and those that present a future threat. Mobilising INNS records made by site staff will assist with national reporting and statistics, as well as helping to ensure a nationally consistent approach to managing INNS.

A review of the recording, systems and data flow processes within Natural England was subsequently undertaken, with a view to ensuring INNS data are available to those that require them. This covered the utilisation of:

- the NBN Gateway as a data repository and for viewing INNS records;
- CMSi, the basis for Natural England's Designated Sites Management Tool, as an INNS recording and data interrogation tool;
- Natural England's WebMap for viewing INNS records;
- online recording tools as a means of collecting INNS records from Natural England staff;
- Recorder and Marine Recorder for INNS recording;
- the EMD and ISAT for INNS recording; and
- bespoke tools for recording INNS and data interrogation.

From these available options the use of the NBN Gateway as the data repository is recommended, as well as the implementation of suitable functionality within CMSi, WebMap and the online recording website iRecord in order to maximise opportunities for Natural England staff to record and interrogate INNS presence on their sites. The costs of implementing these were considered to be minimal, requiring little development and staff training, but required the addition of some functionality to the NBN Gateway.

Additional recommendations include:

- the addition of species record export functionality to the EMD and ISAT;
- mobilisation of Natural England species data through the NBN Gateway
- the development and implementation of INNS recording and record use policies within Natural England; and
- the creation of an accepted list of potential INNS.

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Contents

1 Background and objectives

1.1 Background

Non-native species (NNS) are those that have established themselves outside their past or present natural range, with the intentional or unintentional assistance of man. The introduction of NNS has intensified due to the increase in trade, transport, travel and tourism, which provides new vectors and increased opportunities for introduction to new areas. Whilst most NNS are benign or sometimes beneficial, a small proportion can cause biodiversity impacts and have significant environmental, economic and public health implications (Natural England 2014b). These are considered to be invasive non-native species (INNS).

INNS are considered the second biggest threat to global biodiversity following habitat loss and the greatest threat to island ecosystems. They impact biodiversity and ecosystems through consumption, resource competition, introduction of diseases, interbreeding and disturbance (Wittenberg et al. 2001). This can result in major economic, agricultural and health impacts. Since 1850 there has been a dramatic increase in the number of non-native species arriving in Britain and becoming established (Roy et al. 2012). The cost of INNS to the English economy is at least £1.3 billion per year (Williams et al. 2010).

INNS are a present and increasing risk to the favourable condition of England's protected sites and have been identified by Natural England as a key issue to be addressed as part of the IPENS project (Rae 2013; see Section 1.2). The Convention on Biological Diversity (1992) suggests a three-stage hierarchical approach to managing INNS, which has been followed in the Invasive Non-Native Species Framework Strategy for Great Britain (Defra 2008):

1. Prevention.
2. Early containment and rapid eradication.
3. Control and or containment.

Managing INNS requires a current and comprehensive understanding of their distribution through the availability of records of the taxa concerned, though no definitive list of INNS exists, meaning that some lower risk NNS must inevitably be considered. Records of NNS are collected by many different organisations and individuals and are spread across a range of databases. The NBN Gateway is the desired final repository for all species records, including those of NNS. Natural England relies on these records, and data collected by and on behalf of the organisation, to help with site condition assessments to inform its programme of work to tackle the pressure and threat of INNS on protected sites (National Biodiversity Network 2014a). A major constraint on Natural England's ability to make sound decisions is the lack of a comprehensive baseline of the extent and scale of NNS presence on the protected sites network and the pressure from higher risk INNS.

1.2 The IPENS project

The Improvement Programme for England's Natura 2000 Sites (IPENS), supported by EU LIFE+, is a new strategic approach to managing England's Natura 2000 sites. It will enable Natural England, the Environment Agency, and other key partners to plan what, how, where and when they will target their efforts on Natura 2000 sites and areas surrounding them.

This project is part of the IPENS programme (LIFE11NAT/UK/000384IPENS) which is financially supported by LIFE, a financial instrument of the European Community.

The IPENS glossary defines two types of issue that may relate to INNS on Natura 2000 sites:

- *'Pressure – Factors which are currently causing adverse impacts on Natura 2000 interest features.*
- *Threat – Potential factors which may in the future cause adverse impacts on Natura 2000 interest features'* (Natural England 2014a).

This report is focused upon INNS that are a pressure upon protected Natura 2000 sites and Sites of Special Scientific Interest (SSSIs). In order to cause adverse impacts on a site an INNS would need to be on or within the immediate vicinity of the site. INNS that present a threat to protected sites are equally important, as they may cause adverse impacts to the sites in the future, but are not the focus of this report.

1.3 Objectives

Natural England required an audit of the availability of NNS records and baseline data on the presence of NNS on protected sites in England. This would be used to facilitate development of a strategic programme of work to tackle higher risk INNS pressure on those sites and more effectively direct and justify resources.

A review of recording and data dissemination systems and data flow processes within Natural England was also required, to ensure that INNS records were made available to genuine users, both within and outside of the organisation. This sought to improve access to data in line with the NBN Data Exchange Principles (National Biodiversity Network 2014b).

The specific aims for this project were:

- to create a master list of NNS based on previous work;
- to collate available data on NNS from the NBN Gateway and Natural England;
- to use the collated data to assess the current presence of NNS on protected Natura 2000 sites and SSSIs;
- to compare NNS distribution on protected sites with on the ground knowledge, to determine the extent to which site managers were aware of invasive species reported on their site; and
- to review existing Natural England systems for collecting and distributing INNS records and provide recommendations on how to improve the data flow.

2 Assessing the current pressure of non-native species on protected sites

2.1 Creation of a master list of non-native species

The following sources containing lists of non-native species (NNS) were compiled:

- The Audit of non-native species in England (Hill et al. 2005). This study provided a complete audit of non-native species known to be present in the wild. The result was a list of 2,721 species and hybrids, of which 1,413 were considered to be of highest significance.

- The horizon scanning exercise for invasive non-native animals in England (Parrott et al. 2009). This study assessed the potential of non-native animal species to become invasive, including species that were not present within the UK. Each species identified in the resulting list of 161 species was given a risk category of high, medium or low.

- The horizon scanning exercise for invasive non-native plants in Great Britain (Thomas 2010). This study assessed the potential of non-native plant species to become invasive, focusing primarily upon those species that were already present within the UK. Each species identified in the resulting list of 599 species was given a risk category of critical, urgent, moderate or low.

- The work undertaken to populate the GB Non-native Species Information Portal (Roy et al. 2012; Roy et al. 2014). This study created a register of 3,758 non-native species either known to be invasive, established in the UK, present in the UK or likely to enter the UK in the future. Of these, 2,104 were listed as being established in the UK, 150 of which were considered to have a negative ecological impact[1].

- The GB Non-native Organism Risk Assessments from the GB Non-native Species Information Portal. These were published and draft assessments made following the GB Non-native Species Risk Analysis Mechanism and covered 60 species.

A master database of non-native taxa was developed from these datasets. To help identify whether any assessment of risk had been undertaken a number of fields were populated to record, for each taxon, whether it was included in:

- the full or short list of Hill et al. (2005);
- the risk categories from Parrot et al. (2009) and Thomas (2010);
- the full and ecological impacts lists from Roy et al. (2012); or
- the overall risk assessment category from the GB Non-native Species Risk Assessments.

Hill et al. (2005) also identified species with conservation statuses, so this information was included in the database.

Duplicates were removed from the database and synonyms were resolved, ensuring that the entries in the resulting database still linked to the relevant sources. This resulted in a combined list of 3,687 taxa.

Relevant Taxon Version Keys (TVKs; Box 2.1) were then identified for each taxon where they existed. This used a combination of computerised name matching to the NBN Species Dictionary, which identified the

[1] Roy et al. (2012) included a much larger number of species than Parrott et al. (2009) and Thomas (2010), primarily owing to the wider remit of the study. Note that these figures are higher than those given in Roy et al. (2012), as additional species had been added to the list in the intervening period.

majority of TVKs, followed by manual name matching where computerised matching had failed. During this process misspelt names were identified and corrected. The TVKs were then used to populate the database with the preferred names for each taxon, drawing this information from the NBN Species dictionary.

TVKs and preferred names were identified for a total of 3,176 taxa, which formed the basis for the data collation and analysis (Appendix A). Those species without TVKs had no records in the NBN Gateway or any of the other datasets collated and so could not be included in the subsequent analysis. The lack of records provided a good indication that they were either not established or poorly established in the UK. Appendix B provides a full list of species without TVKs.

Box 2.1 – Taxon Version Keys explained

A Taxon Version Key (TVK) is a code used by the NBN that refers to an individual species name. Because species have been given multiple names over time a single species can have multiple TVKs. For example, *Azolla filiculoides* has a TVK of NBNSYS0000002090 and in the UK is considered synonymous with:

- the incorrect name *A. caroliniana* (NHMSYS0100000739)
- the misapplied name *A. pinnata* (NHMSYS0100000740)
- the common name water fern (NBNSYS0000171630)

Because the TVKs are linked to the preferred name, in this instance *A. filiculoides*, through its TVK it allows the NBN Gateway to present all records for the species, regardless of the name used in the original record. Thus, a request for records of *A. filiculoides* using the TVK NBNSYS0000002090 also includes records of *A. caroliniana*, *A. pinnata* and water fern.

Another advantage of using TVKs is that the taxonomic hierarchy is implied and child taxa are included in records of the parent taxon. Thus a request for records of *Azolla* (NHMSYS0000456383) includes all records of *A. filiculoides* and a request for records of *A. filiculoides* also includes records of *A. filiculoides* var. *filiculoides* (NBNSYS0100009641).

Note that the Water Framework Directive (WFD) impact list was not incorporated into the database, as it was assumed that all species would be covered by the other sources. This was incorrect, as five taxon names were found to be missing from the database. One of these, the seaweed *Grateloupia doryphora*, actually related to a misidentification of *G. turuturu*, though these names had not been linked by the UK species inventory. As a result, records relating to the name *G. turuturu* were included in this work, but thirteen records of *G. doryphora* from the south coast of England in the NBN Gateway were not included. The absence of the other four species from the list will have had no impact on the results, as no records were available from the NBN or within any of the other data sources. These species were subsequently added to the list, but were not included in any of the analysis.

2.2 Collation and review of available data

The following section describes the process used to collate and reviews the quality and standard of the datasets used. Table 2.1 summarises the resolution of the available data within each collated dataset. Where relevant datasets are compared with the data available via the NBN Gateway as an indication of the value of data mobilisation and difficulties in making the data more widely available are identified.

The recording undertaken by Natural England was targeted towards the higher risk INNS, as these were generally negative indicator species and a pressure upon protected sites. As a result, most of the relevant data within Natural England databases (Sections 2.2.3 to 2.2.6) related to INNS.

Note that no assessment of the confidence in the data was made. Most datasets contained records from multiple recorders of varying levels of ability, so it was potentially misleading to assess the overall confidence in the data. Confidence would need to be assessed on an individual record basis, which was not possible as the available information was insufficient.

Table 2.1 – Breakdown of the resolution of the records within the datasets used in this study. † The data from the NBN Gateway comprised many datasets that have not been separately detailed. A similar breakdown of data resolution was visible on the Geographical tab of the dataset summary on the NBN Gateway. The NBN Gateway data shown here only covers those records in British National Grid. ‡ The precise resolution of the Marine Recorder data varied due to the format of the data (see Section 2.2.2). As a result, line lengths were rounded up to the nearest multiple of 10, so 11m and 99m both fall within the 100m resolution class. The square root was taken for all polygon areas, making the assumption that they were square, and the results were treated as per lines.

Resolution	Dataset					
	Data from the NBN Gateway†	Marine Recorder data‡	Environmental Monitoring Database	Integrated Site Assessment Tool data	National Nature Reserve data	Total
1,000 km	0	4	0			4
100 km	0	13	0			13
10km (hectad)	1,212,160	74	1			1,212,235
2km (tetrad)	1,368,513		0			1,368,513
1km (monad)	1,039,553	499	261			1,040,313
100 m	1,336,519	327	2,895			1,339,741
10 m	0	22	15,932			15,954
1 m	0	0	4,410			4,410
Point		11,401				11,401
Site based				203	33	236
Total	**4,956,745**	**12,340**	**23,499**	**203**	**33**	**4,992,820**

2.2.1 Data available via the NBN Gateway

The data available from the NBN Gateway represented the standard for biodiversity data. Natural England's aim should be to ensure that wherever possible its data is made available via the NBN Gateway and to the same high standards.

A custom download of records was requested from the NBN Gateway team, using the list of TVKs as the basis. This was conducted through Natural England, which as an organisation had access to higher resolution data with a greater number of attributes, due to agreements with the relevant data holders (details of the datasets and the effective resolution for each is provided in Appendix C). This ensured that the most precise and most useful data available were used during the analysis. The custom download included all synonyms and child taxa (see Box 2.1).

Approximately 5.1 million records of NNS were supplied by the NBN team. These included data from 490 separate datasets, originating from 123 organisations. Of these datasets, 243 allowed public access to 1km resolution data or better. Natural England had enhanced access to 183 datasets, which ensured that 1km resolution or better access was available for 406 datasets in total.

The data were too large to be loaded into most database or Geographical Information Systems (GIS), so were imported into the relational database management system Microsoft SQL Server, where they could be

manipulated and spatially analysed. All records based upon the Irish National Grid and European Datum 1950[2] were removed, stripping out any records from Ireland (Republic and North) and any from the Channel islands, leaving just under 5 million UK records based upon the British National Grid.

Geometries were automatically created for the UK records, mapping them according to the grid references. A square polygon was created for each, correctly located and sized based upon the resolution of the grid reference (see Figure 2.1).

A further SQL Server view was created on the data. This included only the approximately 2.4 million UK records that were monad (1km × 1km square) resolution or higher, and excluded all lower resolution records (Table 2.1). This more precise subset was used during analysis.

2.2.2 Marine Recorder data

Marine Recorder was the standard database package for managing data from marine surveys, including all marine species records. It had been designed to meet NBN requirements, so all data met minimum validation standards (James 2011). Most of the data were collected by professionals, so the accuracy of species identification and location information was expected to be relatively high.

Marine NNS records were obtained via a Marine Recorder snapshot downloaded from the JNCC website (http://jncc.defra.gov.uk/page-1599). This was more up to date than the data generally available via the NBN Gateway, being dated the 6th February 2014. All data within the snapshot used were available at the original recorded resolution.

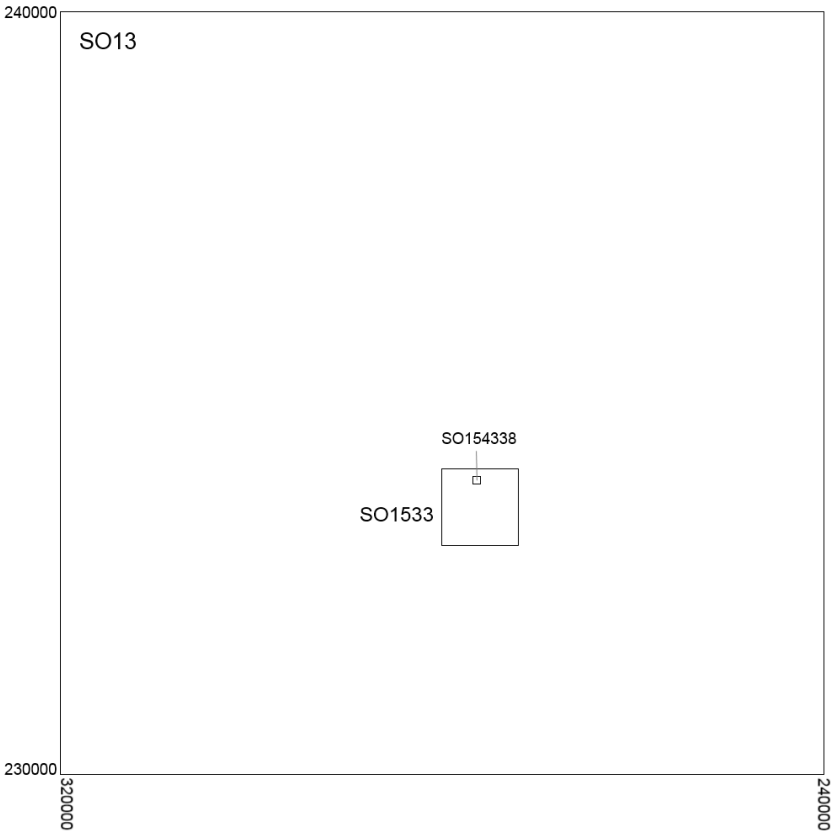

Figure 2.1 – Example of squares created for various precision grid references for the same location.

[2] European Datum 1950 (ED50) refers to the coordinate system in use in the Channel Isles.

The snapshot contained 12,340 records of species on the NNS list, excluding all negative records as these were not thought to be records of absence. The species, date, location information and other attributes were extracted from the snapshot and imported as a table into SQL Server. Wherever possible the date of the species record was taken in preference to the survey date, and the sample location was taken in preference to the survey location.

The location information included points, lines and polygons, depending upon the type of survey, and was in latitude and longitude based on WGS84 rather than the British National Grid. As a result a different approach was taken to creating geometries in SQL Server to that used for the data from the NBN Gateway. Each line or polygon contained both start and end coordinates, which meant that the start and end of a line or the south west and north east corner of a polygon could be defined. Points only had start coordinates, by which they were defined. Appropriate geometries were created for each record using the coordinates. These were then converted to British National Grid using the OSGB 1936 to WGS 1984 Petroleum transformation in ArcGIS, to allow spatial analysis to be performed against the protected site boundaries.

Some of the resulting records were low resolution (Table 2.1), with one appearing to cover most of the England and Wales (Figure 2.2). All records for areas larger than 1km² or 1km in length were excluded from further analysis, to correspond with the approach used for the data from the NBN Gateway. This left 12,249 NNS records that were taken forward to the analysis.

8,236 (67%) out of the 12,249 higher resolution records contained in the Marine Recorder snapshot did not correspond with high resolution records from the same time periods in the data from the NBN Gateway. Most of these records (7,336) had no corresponding records from any date within the data from the NBN Gateway. This was surprising, since Marine Recorder had been designed to allow export to NBN Data Exchange Format, but might have been due to recent updates to the data that had not yet been made available through the NBN Gateway. Most statutory agency data entered into Marine Recorder would have been part of the NBN Gateway 'DASSH Data Archive Centre Statutory Agency and commercial marine surveys' dataset managed by the Marine Biological Association, which had not been updated since 2008.

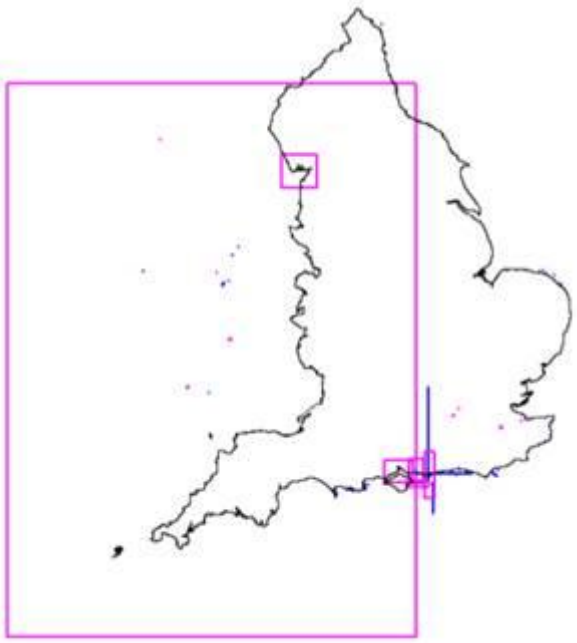

Figure 2.2 – Location and resolution of records in Marine Recorder. Contains Ordnance Survey data © Crown copyright and database right 2014.

2.2.3 Environmental Monitoring Database

Natural England's Environmental Monitoring Database (EMD) is a Microsoft Access database used for the storage of data from agri-environment scheme monitoring and a range of other very specific surveys. The species data it contained included all the minimum attributes required for valid species records according to NBN guidelines (James 2011). The data were generally collected by professional ecologists, so the accuracy of the species identification was expected to be relatively high. All data were available at the recorded resolution, but significant issues with the accuracy of the grid references had been previously identified (Lush and Lush 2014), so the data could not be regarded as accurate.

The EMD was supplied by Natural England so that all NNS records could be extracted. This was achieved by extracting all species records, dates and location details and matching against the master list of NNS. In total over 1.5 million species records were extracted from the EMD, of which 23,499 were of NNS.

The NNS records were imported into SQL Server and geometries were created. Whilst the spatial referencing system used was the British National Grid only coordinates were provided for each record, with

no indication of the resolution of the record. Since mapping the areas as points would lead to false precision and might have meant that records that intersected with protected sites would not be identified as such, simple rules were used to convert the coordinates into area geometries (Table 2.2). This risked representing some records as lower precision than intended by the original recorder, but this was likely to affect less than 1% of records purely by chance. Only one record was mapped as less than 1km² resolution (Table 2.1) and was excluded from subsequent analysis.

Table 2.2 – Rules used to convert coordinates (easting and northing) from Natural England's Environmental Monitoring Database to appropriately sized geometries (squares). The size of the squares was determined by the divisibility of both sets of coordinates by factors of 10.

Easting and northing divisible by:	Size of mapped square
100,000	100km × 100 km
10,000	10km × 10 km
1,000	1km × 1 km
100	100m × 100 m
10	10m × 10 m
1	1m × 1 m

Only 108 out of the 23,498 higher resolution records contained in the EMD had corresponding high resolution records from the same time periods in the data from the NBN Gateway. Of the remainder, 15,919 records had no corresponding records from any date within the data from the NBN Gateway. This suggested that none of the data contained within the EMD had been made available through the NBN Gateway, as less than 0.5% of records in the EMD could have identical records in other datasets purely by chance.

The absence of EMD records from the NBN Gateway was likely to be partly due to the difficulty in exporting species records from the EMD. For this project it was necessary to extract all survey attributes from eleven tables, extract the species records, link them to location information from either the Field Survey Unit or Primary Sampling Unit[3] and filter against the NNS list to build a single table. This was a time consuming process that could not be completed without some expertise in Microsoft Access.

2.2.4 Integrated Site Assessment Tool database

Records from Natural England's Integrated Site Assessment Tool (ISAT) database were provided. This was a new database and was in the process of being populated, but the aim was for it to contain all Integrated Site Assessment data collected by Natural England and contactors. At the date of supply one full year of SSSI condition assessment and HLS indictor of success assessment data had been entered into ISAT. It contained a mixture of environmental records and 72,274 records of taxa, but recording was targeted at the capture of specific information and so could not be treated as a comprehensive survey of NNS within the sites covered.

In total 203 records of NNS, including the survey date and site code, were extracted from ISAT, excluding a much larger number of apparently negative records as these were not considered to be records of absence. These data comprised entirely of species recorded during SSSI condition assessments, which were conducted by Natural England staff and contractors, and were targeted towards certain indicator species only, generally higher risk INNS. Only nineteen NNS were covered by the data, most of which were readily identifiable.

[3] The Primary Sampling Unit (PSU) is the unit that is sampled, such as a field or grid square. The Field Survey Unit (FSU) is the spatial unit used to collect data on the ground, entirely within the PSU, such as a quadrat or transect.

Box 2.2 – NNS recorded in Natural England's ISAT database

The data used to populate Natural England's ISAT database consisted of SSSI condition assessment surveys and HLS indicator of success assessments. Both used targeted approaches to record only key indicator species, rather than complete species recording. Only the SSSI condition assessment data included records of NNS, covering the following species:

- *Acer pseudoplatanus*
- *Campylopus introflexus*
- *Crassula helmsii*
- *Crocosmia pottsii* × *aurea* = *C.* × *crocosmiiflora*
- *Disphyma crassifolium*
- *Elodea canadensis*
- *Elodea nuttallii*
- *Galeopsis angustifolia*
- *Hydrocotyle ranunculoides*
- *Impatiens glandulifera*
- *Lemna minuta*
- *Myriophyllum aquaticum*
- *Picris echioides*
- *Pinus sylvestris*
- *Rhododendron ponticum*
- *Ribes nigrum*
- *Ribes uva-crispa*
- *Salix viminalis*
- *Spartina anglica*

The extracted NNS data were imported into SQL Server and linked to SSSI Unit boundaries, as these were the locations for all the relevant records (Table 2.1). Some SSSI units were split into two separate areas, which resulted in multiple records in SQL Server and brought the effective number of records up to 253, though it was not clear which areas the records actually related to. The SSSI Unit boundaries were used as the spatial information for the record; since these data related to the sites being reported on it was not necessary to consider the spatial precision of the records.

140 (55%) out of the 253 effective records extracted from ISAT did not correspond with high resolution records from the same time periods in the data from the NBN Gateway. This included 99 records with no corresponding records from any date within the data from the NBN Gateway. This was surprising, given that all records are of common NNS that should be well recorded, but may have been because recorders tend focus on unusual species and do not always record common species. Though some of the discrepancy may be due to the spatial imprecision of the records, where a record for one part of a SSSI unit was also assigned to a separate part of the same unit where the species did not occur, the impact of this was thought to be limited. It suggests that data flow from ISAT to the NBN was deficient and it would be beneficial to disseminate more widely even the moderate amount of data that ISAT contained.

2.2.5 ENSIS

Outputs from Natural England's ENSIS database were made available, so an investigation was made of the NNS records it contained, which were primarily restricted to INNS as it was not Natural England's intention to undertake action on lower risk NNS. Any data on NNS was held in a text field relating to the adverse condition reason or 'threat' category of 'invasive species'. Automated searching was considered, but since there was no control over what could be entered into these text fields:

- Not every mention of an invasive species meant that it was actually present. For example, mink was mentioned for Calthorpe Broad NNR, but only in the context of protecting water voles if mink appeared. Uncritically selecting all mention of invasive species would therefore falsely inflate the number of records.
- There was no standardisation in species names used. In some cases the NBN preferred Latin name was used, but in order to capture all information it would be necessary to search for all synonyms, both scientific and common. There were also cases where the species could only be inferred based upon the context, such as 'balsam' at Goss Moor NNR and 'Rhododendron' at Dersingham Bog NNR.
- Some records were not specific. Issues with deer could relate to native and non-native species. 'Non-native conifer' was likely to relate to species on the master list, but it was not possible to say which.

Manual interpretation of the records was considered the more accurate alternative. This would have been very time consuming, as there were over 800 records in ENSIS that would need to be manually checked for the presence of over 3,500 species names and synonyms. A smaller dataset from the system that was being set up as a replacement for ENSIS was interpreted manually (Section 2.2.6), which demonstrated that only a relatively small amount of data was likely to be extracted.

Given the issues with automated interpretation and the time required to extract what was likely to be a relatively small number of records from ENSIS by manual interpretation it was decided not to use these data.

2.2.6 Natural Nature Reserves data

Data on NNS projects within Natural Nature Reserves (NNR) were extracted from the Countryside Management System (CMSi) where the project was tagged as NNS. This system was in the early stages of use by NNR staff, so there were limited numbers of records available. For each project there were two text fields containing details about the project: description and qualifying phrase.

Since they were text fields there were no restrictions on how the data was entered. Some projects mentioned non-native species but did not include a species name. Many species names were also incomplete, for example just Rhododendron. As a result, automatic searches were not possible and the data had to be reviewed manually to identify the species name and whether the species was present.

Each of the resulting records was then checked to determine whether the species was present on the NNS list for this project and assigned the relevant NBN Taxon Version Key. Where species names were incomplete, these species were assumed to be the most widespread and abundant NNS species within that genus. The 33 records identified were linked to the site boundary, which was used as the spatial information for the record, as with the ISAT data (Table 2.1).

Because utilising the data from CMSi required manual matching of non-standard species names to NBN TVKs the confidence in the species determination must be regarded as low. The extracted data were also undated and therefore were not valid records, though dates were applied based upon the associated project in CMSi. Though the data were not used during this contract, this appraisal was true of the data contained within ENSIS, as these data were approximately identical to that within CMSi.

14 (42%) out of the 33 records extracted from CMSi did not correspond with high resolution records in the data from the NBN Gateway. Note that because the data did not have accurate dates, it was impossible to assess whether the 19 remaining records included more recent records than those in the data from the NBN Gateway. This suggests that there may be value in wider mobilisation in data held within ENSIS and CMSi. It also suggests that Natural England site managers can play a key role in identifying the presence of NNS, and in particular the higher risk INNS, that are not recorded in other datasets.

2.3 Production of non-native species lists for protected sites

Due to the very large volumes of data (see Section 2.2.1) SQL Server was used for data analysis. The following additional data were therefore loaded into SQL Server:

- The NNS data described in Section 0
- Protected site boundary data for:
    - SACs (dated 19/08/2013)
    - SPAs (dated 05/07/2013)
    - Offshore SACs (dated 29/10/2012)
    - SSSIs (dated 01/04/2014)
    - SSSI Units (dated 01/04/2014)

Where required, the datasets were converted to British National Grid using the relevant transformations in ArcGIS. As described in Section 2.2, minimum resolution thresholds of 1 km² or 1km in length were applied to the data to exclude low resolution data from the analysis. Box 2.3 provides a justification for this approach.

Only those protected sites that were within England were considered for analysis. Offshore SACs were included where they were within English inshore or offshore marine plan areas. Protected sites that straddled the boundaries between countries were included in their entirety.

SQL scripts were created to analyse the coincidence of each NNS record from all of the datasets used with the protected site boundaries, which was broadly equivalent to the process used to produce a list for a site by the NBN Gateway. Two types of spatial coincidence were considered as shown in Figure 2.4: NNS records that were entirely **within** the protected site; and those that **intersected** but were not completely contained within the protected site.

A results table was produced for the two types of coincidence, which contained the following calculated values for each site and dataset:

- Species name
- No of records within site
- Latest StartDate within site
- Latest EndDate within site
- No of records intersecting site
- Latest StartDate intersecting site
- Latest EndDate intersecting site

The latest StartDate and EndDate were used to identify the most recent occurrence of each species on the site. In many cases StartDate and EndDate were the same, to indicate that the record was made on a single, known date. In other cases the precise date of the record was not known, so StartDate and EndDate referred to the earliest and latest possible dates for the record delimiting a date range, the 'vague date' (see French 2012). Selecting the most recent StartDate and EndDate for each species gave an indication of the currency of the record and the likelihood of the species still being present on the site.

This table was summarised to produce an Excel spreadsheet containing the processed data.

Note that spatial coincidence was used to reflect the requirement to assess pressure on protected sites (see Section 1.2). INNS not occurring within the immediate vicinity of a protected site are of equal interest, but would clearly be defined in the IPENS glossary as a threat (Natural England 2014a). In addition, the assessment of INNS outside of protected sites would require a consideration of the mobility of the species, as well as any potential vectors.

Box 2.3 – Determining non-native species records that could constitute a threat to protected sites

The resolution of the data is an important consideration when determining whether an invasive non-native species (INNS) should be considered a pressure on a protected site. INNS pressure can be defined as the species occurring on or within the immediate vicinity of a site (Section 1.2). Monad or higher resolution species records that intersect a site boundary were likely to have been present within the site or the immediate vicinity. In contrast, hectad or tetrad species records that intersect may have applied to the site, but it is more likely that they applied to a location some distance from the site (see Figure 2.3).

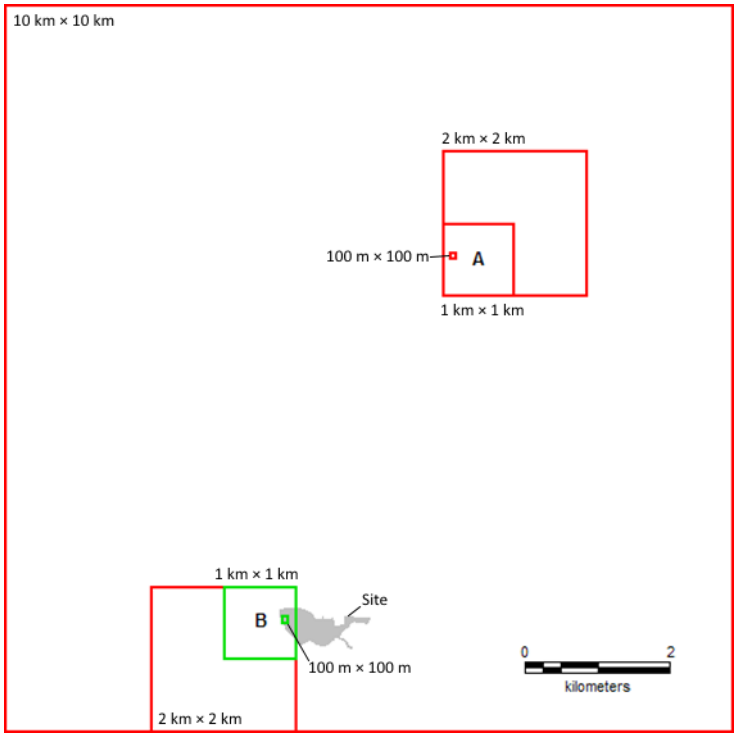

Figure 2.3 – Intersection of different resolution species records with a SAC (Calf Hill and Cragg Woods, in grey). The lowest resolution record is represented by a 10×10km square (SD56) and could represent record A or B, but the likelihood is that it does not relate to the SAC. Record A is also represented as a tetrad (SD56T), 1×1km square (SD5666) and 100×100m square (SD561665), none of which intersect the SAC and are not regarded as relevant to this study. Record B is similarly represented in different resolutions, but only the 1×1km (SD5361) and 100×100m (SD538615) resolutions are considered relevant (in green), as they intersect the SAC and are likely to constitute a pressure to the site. The tetrad resolution of record B (SD56F) is not treated as relevant, as it is likely that the true location of the species recorded falls well outside of the SAC boundary.

A more nuanced approach would have been to determine the proportion of each mapped record that overlapped with the site, as this would provide an indication of the relevance of the record to the site. This might show that 99% of a record at 100m resolution overlaps with the site, but only 1% of a similar record at hectad resolution does, providing greater confidence that the higher resolution record was relevant. This was not undertaken in this project, due to the increased processing overhead implicit in this type of analysis.

For example, an aquatic INNS is likely to have greater mobility when travelling downstream than upstream and may have varying amounts of mobility overland. Such information may not be readily available for all INNS. As a result of the fact that an assessment of threats was not required and due to the extreme difficulty

of making an accurate assessment no assessment of INNS outside of but threatening protected sites was made.

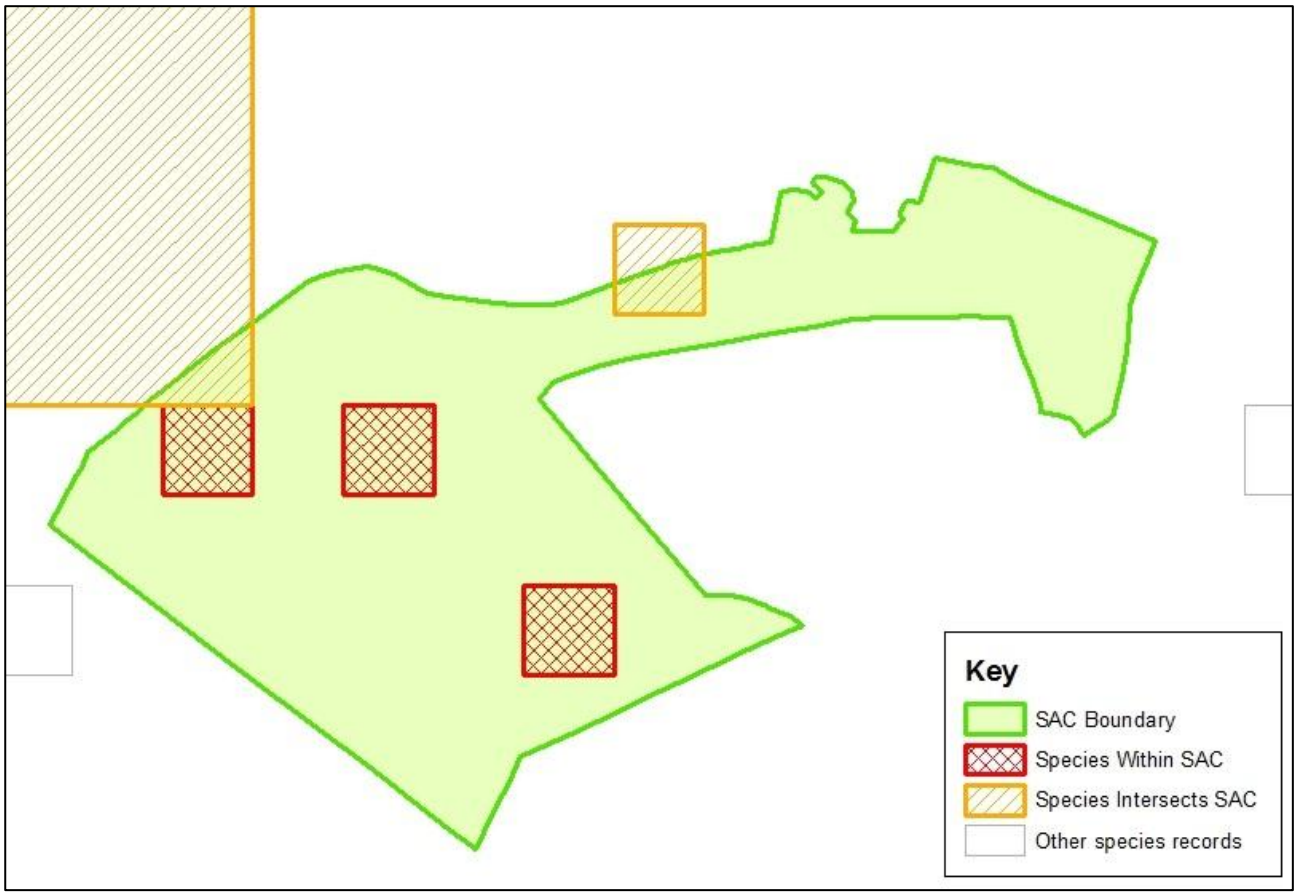

Figure 2.4 - Diagram showing the spatial relationship between the SAC boundary and non-native species records attributed as Within (red cross-hatch) and Intersects (orange diagonal hatch)

The processed data was split into the following tables:

- Spp_Site_Dataset, which contained:
  - Taxon Version Key
  - Scientific Name
  - Common Name (where available)
  - Species Group
  - Site Code and Name
  - Natural England Region
  - Dataset Key – short name or code identifying the dataset
  - For NBN datasets, the following additional fields were populated:
    - DatasetName – full name of the dataset on the NBN Gateway
    - DatasetProvider – name of the organisation that supplied the data
    - URL – hyperlink to the online dataset description
  - Count

- Spp_Site, which contained:
  - Taxon Version Key
  - Scientific Name
  - Common Name (where available)

- Species Group
- Primary Risk Assessment (Box 2.4)
- Site Code and Name
- Natural England Region
- Within/Intersects
- Count and latest dates

Common name and species group were taken from the NBN Gateway. In two instances the common name on the NBN Gateway was replaced with the common name in more frequent usage. These replacements were:

- *Ludwigia grandiflora* - Creeping Water Primrose
- *Impatiens glandulifera* – Himalayan Balsam

Box 2.4 – Determining the Primary Risk Assessment

The Primary Risk Assessment was determined subjectively, based upon the perceived reliability and usability of the risk assessments in the previous studies. This was done with the aim of identifying the most significant and/or reliable risk assessment available. The risk assessments and lists were prioritised in the following order:

1. The NNSS Risk Assessments, which rated the risk as high, medium or low
2. Species listed as having ecological impact in 'Non-Native Species in Great Britain: establishment, detection and reporting to inform effective decision making' (Roy et al. 2012)
3. The risk ratings given in 'Horizon-scanning for invasive non-native plants in Great Britain' (Thomas 2010), which rated the risk as critical, urgent, moderate or low
4. The risk ratings given in 'Horizon scanning for new invasive non-native animal species in England' (Parrott et al. 2009), which rated the risk as high, medium or low
5. Species listed in Roy et al. (2012), excluding those listed as having ecological impact
6. The main species listed in the 'Audit of non-native species in England' (Hill et al. 2005)
7. The other species listed in the Hill et al. (2005)

For inland sites the Natural England Region was derived from a spatial query using regional boundaries supplied by Natural England. Where a site crossed regional boundaries the data was duplicated for each region. For marine and offshore sites the Natural England Region was assigned using a list supplied by the project team.

Filtering was enabled in the spreadsheets, allowing only the data within a specified site or Natural England Region to be displayed.

2.4 Results

Table 2.3 to Table 2.6 indicate the number of species assigned to each Primary Risk Assessment category for each type of protected site. It is worth noting that some NNS records that intersect with a site may represent records of the NNS occurring within the site, the uncertainty resulting from the accuracy and resolution of the grid reference quoted by the recorder.

Table 2.3 and Table 2.4 show that 98.8% of onshore and 71.4% of offshore SACs in England intersected with NNS. All of the NNS records for offshore SACs were from within the site, whilst 74.6% of onshore SACs contained NNS. 231 onshore (91.7%) and 3 offshore SACs (42.9%) intersected NNS given a risk rating of medium/moderate and higher or as having ecological impact, which were more likely to be higher risk INNS.

Table 2.3 - Summary for onshore SACs (n=252) of the number of sites with NNS recorded, number of NNS species and number of Within and Intersect records by Primary Risk Assessment.

			Total no. of sites with NNS records	No. of sites with NNS within	No. of NNS	No. of NNS records within	No. of NNS records intersecting
Primary Risk Assessment	NNSS Risk Assessment	High	158	88	16	2,165	3,929
		Medium	177	100	13	2,700	13,280
		Low	71	32	7	404	1,698
	Roy et al (2012)	Having ecological impact	224	136	112	4,210	31,828
	Thomas (2010)	Critical	83	18	29	77	579
		Urgent	79	24	24	133	393
		Moderate	47	7	15	46	197
		Low	93	35	96	133	723
	Parrott et al (2009)	High	22	4	4	5	107
		Medium	60	17	14	96	2,687
		Low	77	29	13	473	1,966
	Hill et al (2005)	Main species	210	124	182	4,775	21,958
	Listed in Roy et al		246	177	1,087	23,473	93,451
	Listed in Hill et al		118	38	170	475	1,222
Total			249	188	1,782	39,165	17,4018

Table 2.5 shows that 98.8% of SPAs in England intersected with NNS and 97.6% contained NNS. 82 SPAs (96.5%) intersected NNS given a risk rating of medium/moderate and higher or as having ecological impact.

Table 2.6 shows that 88.6% of SSSIs in England intersected with NNS and 39.2% contained NNS. 3,081 SSSIs (74.6%) intersected NNS given a risk rating of medium/moderate and higher or as having ecological impact. The differences in the figures between Natura 2000 sites and SSSIs were probably due to higher levels of recording on Natura 2000 sites than SSSIs. In addition the difference in the number of records within sites was partially due to the fact that the area covered by a SSSI was generally smaller than the area covered by a Natura 2000 site.

Table 2.4 - Summary for Offshore SACs (n=7) of the number of sites with NNS recorded, number of NNS species and number of Within and Intersect records by Primary Risk Assessment. Note that some risk assessments are omitted because no NNS in these Primary Risk Assessment categories were within or intersected with offshore SACs.

			Total no. of sites with NNS records	No. of sites with NNS within	No. of NNS	No. of NNS records within	No. of NNS records intersecting
Primary Risk Assessment	NNSS Risk Assessment	High	3	3	1	7	0
		Medium	1	1	1	1	0
	Roy et al (2012)	Having ecological impact	1	1	2	3	0
	Parrott et al (2009)	Low	1	1	1	2	0
	Hill et al (2005)	Main species	2	2	4	8	0
	Listed in Roy et al		5	5	6	49	0
Total			5	5	15	70	0

Table 2.5 - Summary for SPAs (n=85) of the number of sites with NNS recorded, number of NNS species and number of Within and Intersect records by Primary Risk Assessment.

			Total no. of sites with NNS records	No. of sites with NNS within	No. of NNS	No. of NNS records within	No. of NNS records intersecting
Primary Risk Assessment	NNSS Risk Assessment	High	74	55	14	1,584	2,942
		Medium	81	68	16	4,205	14,039
		Low	53	36	7	379	1564
	Roy et al (2012)	Having ecological impact	81	70	109	5,483	25,354
	Thomas (2010)	Critical	43	15	28	64	398
		Urgent	54	22	22	122	498
		Moderate	29	11	14	58	192
		Low	51	31	92	119	901
	Parrott et al (2009)	High	21	4	3	5	129
		Medium	45	22	11	517	3,075
		Low	52	29	16	354	1,763
	Hill et al (2005)	Main species	82	72	153	7,621	23,270
	Listed in Roy et al		82	80	1,018	27,290	84,547
	Listed in Hill et al		64	37	171	262	1,217
Total			84	83	1,675	48,063	159,891

Table 2.6 - Summary for SSSIs (n=4,129) of the number of sites with NNS recorded, number of NNS species and number of Within and Intersect records by Primary Risk Assessment.

			Total no. of sites with NNS records	No. of sites with NNS within	No. of NNS	No. of NNS records within	No. of NNS records intersecting
Primary Risk Assessment	NNSS Risk Assessment	High	1,193	381	17	2,597	7,892
		Medium	1,462	496	16	7,557	32,168
		Low	410	137	8	991	3,899
	Roy et al (2012)	Having ecological impact	2,890	958	117	14,147	83,129
	Thomas (2010)	Critical	548	87	34	242	1,527
		Urgent	380	80	24	253	1,135
		Moderate	176	31	15	95	475
		Low	515	104	116	272	2,260
	Parrott et al (2009)	High	70	9	4	27	152
		Medium	244	61	16	824	5,625
		Low	354	93	17	737	6,115
	Hill et al (2005)	Main species	2,409	835	213	14,007	44,564
	Listed in Roy et al		3,413	1,352	1,259	53,017	244,434
	Listed in Hill et al		781	1,352	242	866	3,386
Total			3,659	1,619	2,098	95,632	436,761

2.4.1 Limitations

Data were collated from several datasets so the quality of the data varied. Some of the data was over 10 years old, so the NNS may no longer be present, whilst other data were known to be incorrect. Resurvey of sites for NNS is the surest method to determine their presence, impact and whether any control is required.

The spatial accuracy of the source data was not checked due to the volume of data, but errors in grid references may affect the validity of the results.

The results of the spatial analysis indicated whether a species record was within or intersected a protected site boundary. As discussed in Section 2.2, low resolution data over 1 km^2 or 1km in length were excluded to minimise the inclusion of species records that were unlikely to be related to the site. Even within this higher resolution dataset records that intersected the site boundary may or may not relate to the site. No assessment was made of the degree of overlap between the record and the site in these instances.

Records of highly mobile NNS may be less relevant to sites they are within or intersect. These species may have been recorded whilst passing through and may not be a periodical or permanent resident on the site, such as migrant bird and casual plant species. Conversely, records of highly mobile INNS, such as *Phytophthora* or *Chalara* spp., are very important, as they are much more likely to represent a pressure on the sites they are within or intersect.

The list of NNS was created uncritically based upon NNS lists created during previous projects. Some of the NNS may be seen as a positive contribution to a site, for example cornfield annuals such as poppy *Papaver* species, whilst the non-native status of others may be questionable or incorrect. Other species, including the majority or non-native vascular plant species, may not have a significant impact on site ecology.

Overall the results provided an indication of the non-native species that may be present based upon available records. This should be interpreted critically in conjunction with specialist and local knowledge and an assessment of actual or potential risk associated with each NNS present should be made on a site by site basis in order to develop an appropriate management plan.

3 Comparing non-native species distribution against on the ground knowledge

An understanding of on the ground knowledge of the non-native species (NNS) present on a sample of sites was considered likely to demonstrate the case for increased data flow, both to and from Natural England site staff, and to determine the extent to which the results described in Section 2.4 reflect on the ground knowledge. As a result, a comparison of the results of the work described in Section 2 against on the ground knowledge was undertaken.

3.1 Selection of sites

The sites that were used to compare the results of the analysis described in Section 2 with on the ground knowledge were selected by the Natural England project officers in consultation with site staff. The selection specifically targeted:

- Experienced naturalists who were familiar with invasive non-native species (INNS), could review the lists accurately and identify species that were missing from the list
- Wide geographical coverage, to account for variability in recording effort
- Terrestrial and marine sites, to ensure that marine NNS were well covered by the review.

Table 3.1 – Sites selected for 'ground truthing' by Natural England project managers. Region refers to the Natural England region that the site is within. The Thanet Coast SAC and Thanet Coast and Sandwich Bay SPA overlap but have completely different boundaries, and were therefore treated as entirely separate sites.

Site	Region	Site staff
Roydon Common & Dersingham Bog SAC	Norfolk, Suffolk	Ash Murray
Hatfield Moor SAC	Yorkshire & Northern Lincolnshire	Julian Small
Thorne Moor SAC		
The Stiperstones and Hollies SAC	North Mercia	Simon Cooter
Thanet Coast SAC	Sussex and Kent	Ingrid Chudleigh
Thanet Coast and Sandwich Bay SPA		
South Solway Mosses SAC	Cumbria	Alisdair Brock

3.2 Creation and review of lists

An Excel spreadsheet was created for each site that was populated with details of the NNS recorded from it, including:

- Latin name, common name and higher taxon group
- the risk status of the species based upon the most reliable assessment
- the total number of records and date range of the most recent record

Species that had been recorded *within* the site were distinguished from those that merely *intersected*, with those recorded within the site given the greatest importance as they definitely related to the site assuming the grid reference was correct.

Further to these columns, additional columns were added to the spreadsheet to allow answers to specific questions for each species. The answers to these questions were standardised through the use of drop down options in each cell in the spreadsheet, which was protected to prevent non-standard answers (Table 3.2). A further spreadsheet was included that allowed respondents to list any other NNS on the site that were not included in the main spreadsheet.

Table 3.2 – Questions asked to Natural England site staff to check the known distribution of non-native species against on the ground knowledge.

Question	Drop down options
Were you aware that the species had been recorded on the site?	Yes No
Do you know that the species definitely isn't present?	Yes No
Is there or has there been any management actions targeted at the species?	Yes No Don't know
If so, have these management actions resulted in the eradication of the species?	Yes No Uncertain Actions ongoing N/A
Is the knowledge that the species has been recorded likely to lead to actions, e.g. surveys for the species or management?	Definitely Probably Unsure Unlikely

Each spreadsheet was supplied to the relevant Natural England site staff along with a covering email explaining the requirement. This included an outline of the project, its aims and progress to date, and the objectives of the review were carefully explained (Appendix D).

3.3 'Ground truthing' results

Completed 'ground truthing' spreadsheets were received from site staff for all seven Natura 2000 sites. The spreadsheets were collated and analysed for trends. Summary results for the number of NNS intersecting and within the sites are shown in Table 3.3. The results for terrestrial NNS records on the two marine sites were excluded from the analysis as the staff member reporting on these sites was not familiar with terrestrial species.

Table 3.3 – Non-native species (NNS) recorded at monad resolution or better for the ground truthing sites.

Site Name	No. of NNS recorded at monad resolution or better		
	'Intersecting' site	'Within' site	Total
South Solway Mosses SAC	14	23	37
Stiperstones SAC	64	17	81
Roydon Common and Dersingham Bog SAC	23	6	29
Thorne Moor SAC	30	7	37
Hatfield Moor SAC	46	4	50
Thanet Coast SAC	1	15	15
Thanet Coast and Sandwich Bay SPA	1	17	18

3.3.1 Awareness of non-native species on Natura 2000 sites

The results indicate that on average site staff were aware of 50% of the NNS for which records (at monad accuracy or better) were supplied to them for their sites (Table 3.4). Awareness varied between staff from 32% to 80%. 'Within' records were more likely to be confirmed by site staff (average 65%) than 'Intersect' records (average 46%), though this was a weak trend as four sites showed the opposite result. As shown in Table 3.4 site staff had a high level of awareness of medium and high risk NNS. Site staff awareness of NNS with a Non-Native Species Secretariat risk assessment of high was complete within the data analysed, but not if terrestrial species on the two marine site were included.

Sites were selected for this exercise where the site staff were known to have a good knowledge of the species present. An average 65% awareness of NNS recorded 'Within' suggests that, even for these more experienced site staff, better data on NNS will improve understanding of the potential threats to site condition. 'Within' records may have been higher precision and therefore more recent, reflecting modern recording technology such as GPS, with site managers being more likely to be aware of more recent records.

Table 3.4 – Natura 2000 site staff awareness of non-native species (NNS) recorded for their sites.

Site Name	Site staff awareness of				No. of NNS definitely not present on site
	All NNS	'Within NNS'	'Intersecting NNS'	Medium and high risk NNS	
South Solway Mosses SAC	38%	35%	43%	50%	Blank
Stiperstones SAC	53%	82%	45%	40%	9
Roydon Common and Dersingham Bog SAC	62%	50%	65%	75%	6
Thorne Moor SAC	32%	57%	27%	50%	0
Hatfield Moor SAC	48%	25%	50%	100%	1
Thanet Coast SAC	80%	73%	100%	86%	0
Thanet Coast and Sandwich Bay SPA	56%	100%	0%	67%	0

Three site staff gave information on NNS that they knew were not presently in the site (Table 3.4), though this was too small a data set to draw any clear conclusions. In every case where the site staff knew the NNS was not present on the site it referred to 'Intersecting' records. This supports the view that a proportion of the 'Intersect' records will refer to locations outside the site boundary.

3.3.2 Management actions on non-native species

All seven sites had targeted action against at least one of the NNS recorded, with the action on six NNS at the Stiperstones SAC being the highest (Table 3.5). Almost all NNS targeted for action had a higher risk rating so, as would be expected, risk rating has a strong influence on the commitment of resources for control. Japanese knotweed *Fallopia japonica* and Rhododendron *Rhododendron ponticum* were the most frequently targeted species.

No sites reported successful eradication of any NNS targeted (Table 3.5). Complete eradication of NNS from a site is rare and some species can, at best, only be controlled to manage the level of impact. Re-invasion from adjacent ground where Natural England has no control under current legislation is likely to be a factor preventing successful eradication.

Table 3.5 – Number of non-native species (NNS) targeted for action and successfully eradicated at each Natura 2000 site covered by the ground truthing.

Site Name	No. of NNS with targeted action	No. of targeted NNS successfully eradicated
South Solway Mosses SAC	4	0
Stiperstones SAC	6	0
Roydon Common and Dersingham Bog SAC	2	0
Thorne Moor SAC	1	0
Hatfield Moor SAC	2	0
Thanet Coast SAC	4	0
Thanet Coast and Sandwich Bay SPA	3	0

3.3.3 The presence of a non-native species and its influence on action

The results show that the knowledge of the presence of a NNS on a site was highly unlikely to lead to further action (Table 3.6). One respondent suggested that the logistics and cost would be a concern for any action to control NNS. Species that were indicated for definite or probable action were generally higher risk NNS (Figure 3.1). This suggests that site staff saw the highest risk and highest impact INNS as a priority, and that lower risk NNS were tolerated.

Table 3.6 – Likelihood of non-native species (NNS) records leading to action.

Site Name	Will records of an NNS lead to actions?			
	Definitely	Probably	Unlikely	Unsure
South Solway Mosses SAC	Blank	Blank	Blank	Blank
Stiperstones SAC	0	4	71	6
Roydon Common and Dersingham Bog SAC	1	4	2	22
Thorne Moor SAC	1	0	36	0
Hatfield Moor SAC	1	1	46	2
Thanet Coast SAC	3	1	10	1
Thanet Coast and Sandwich Bay SPA	3	1	12	2

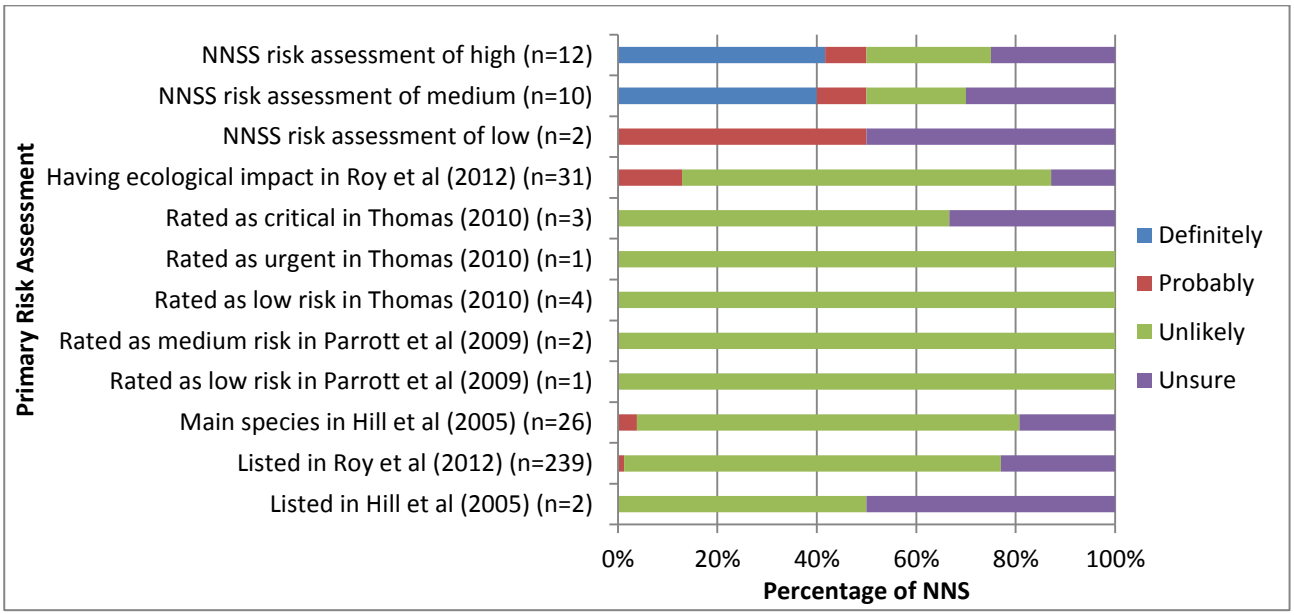

Figure 3.1 – The likelihood that the knowledge of a non-native species (NNS) would lead to action by the number of species within each Primary Risk Assessment.

3.3.4 Additional non-native species

Additional NNS were reported from four sites (Table 3.7). The majority of these species were medium and high risk. Several factors may have influenced this.

- The high alert status of some species, such as carpet seasquirt *Didemnum vexillum*, had prompted more intensive and targeted surveys leading to new discoveries.
- Species that have exhibited rapid expansion such as the muntjac *Muntiacus reevesi* and the harlequin ladybird *Harmonia axyridis* were more likely to have been observed recently on the site for the first time.

- Species such as ostrich fern *Matteuccia struthiopteris* may have been overlooked by previous recorders.
- Common and ubiquitous species such as the European rabbit *Oryctolagus cuniculus* may simply have not been recorded during previous surveys.
- Delays in mobilisation of data may have meant that species were recorded but not disseminated through the NBN Gateway or the other data sources used during this study.

Table 3.7 – Additional non-native species (NNS) known to be present on selected Natura 2000 sites that were not included in the higher resolution records intersecting or within the site. * = immediately adjacent to the site.

Site	NNS	Primary Risk Assessment
Roydon Common & Dersingham Bog SAC	Ostrich fern *Matteuccia struthiopteris*	Listed in Roy et al (2012)
	Parrot feather *Myriophyllum aquaticum*	NNSS risk assessment of high
	Mink *Neovison vison*	Listed as having ecological impact in Roy et al (2012)
	Muntjac *Muntiacus reevesi*	NNSS risk assessment of medium
	Water deer *Hydropotes inermis*	NNSS risk assessment of low
	Guinea pig *Cavia porcellus*	Not on NNS master list
	The bee *Bombus hypnorum*	Listed in Roy et al (2012)
Hatfield Moor SAC	American water fern *Azolla filiculoides**	NNSS risk assessment of high
	Mink *Neovison vison*	Listed as having ecological impact in Roy et al (2012)
	Grey Squirrel *Sciurus carolinensis*	Listed as having ecological impact in Roy et al (2012)
	European rabbit *Oryctolagus cuniculus*	Listed in Roy et al (2012)
	Harlequin Ladybird *Harmonia axyridis*	Listed as having ecological impact in Roy et al (2012)
	Brown china mark *Elophila nymphaeata*	Listed in Roy et al (2012)
Thorne Moor SAC	American water fern *Azolla filiculoides*	NNSS risk assessment of high
	Mink *Neovison vison*	Listed as having ecological impact in Roy et al (2012)
Thanet Coast SAC	Carpet seasquirt *Didemnum vexillum*	NNSS risk assessment of high
Thanet Coast and Sandwich Bay SPA	Carpet seasquirt *Didemnum vexillum*	NNSS risk assessment of high

3.4 Comparison of NNS listed for each site against actions in ENSIS

Lists of site units with a pressure or threat of invasive species for Natura 2000 sites and Sites of Special Scientific Interest (SSSIs) were extracted from ENSIS and provided by Natural England. The ENSIS invasive species threat category was used:

> '*Where a notified feature is under demonstrable threat from an invasive non-native species (INNS) - either because it is elsewhere on the SSSI or on nearby land/SSSI. Invasive species may either be alien or translocated natives in origin. Effects include competitive displacement and direct predation.'* (M. Ellershaw, pers. comm.)

The invasive species threat or pressure categories related to non-native species considered to be invasive; invasive native species were covered by other categories. This was used as an indication that the presence of NNS was known about and compared with the results of this work.

336 Natura 2000 sites and 3,623 SSSIs had records of the NNS included in this project. 274 of the Natura 2000 sites had NNS recorded within the site boundary, of which 177 had no recorded pressure or threat of invasive species. 1,595 of the SSSIs had NNS recorded within the site boundary, of which 1,405 had no recorded pressure or threat of invasive species.

In many cases, the NNS recorded on Natura 2000 sites and SSSIs with no recorded pressure or threat were likely to be considered benign and had not had any observed impacts on species, habitats or ecosystem function. The analysis nevertheless shows that a significant number of Natura 2000 sites and SSSIs with records of high risk INNS had no recognised pressure or threat associated with that species (Table 3.8 and Table 3.9). For example, 63% of Natura 2000 sites and 80.8% of SSSIs with records of species assessed as high by the NNSS risk assessments had no pressure or threat.

Understanding the mismatch between higher risk INNS records and the recognition of an associated threat or pressure requires further work. It may be due to the fact that ENSIS was originally populated before the impact of INNS was widely known or may simply be that site managers were not aware that the INNS was present.

Table 3.8 – Natura 2000 sites entirely containing records of non-native species (NNS) that also had a pressure or threat recorded in ENSIS, broken down by the primary risk assessment. Note that the figures for All Assessments are not the sum of the figures for the Primary risk assessments, as it is a sum of the sites rather than a sum of the number of species.

Primary risk assessment	**Number of Natura 2000 sites with NNS records within**	
	Total sites	**Sites with pressure or threat recorded**
NNSS risk assessment of high	145	54
NNSS risk assessment of medium	167	66
NNSS risk assessment of low	67	26
Listed as having ecological impact in Roy et al (2012)	205	76
Listed in Roy et al (2012)	259	91
Rated as critical in Thomas (2010)	32	19
Rated as urgent in Thomas (2010)	46	22
Rated as moderate risk in Thomas (2010)	17	9
Rated as low risk in Thomas (2010)	64	27
Rated as high risk in Parrott et al (2009)	8	5
Rated as medium risk in Parrott et al (2009)	38	17
Rated as low risk in Parrott et al (2009)	54	21
Main species in Hill et al (2005)	183	67
Listed in Hill et al (2005)	54	29
All Assessments	**274**	**97**

Table 3.9 – Sites of Special Scientific Interest (SSSI) entirely containing records of non-native species (NNS) that also had a pressure or threat recorded in ENSIS, broken down by the primary risk assessment. Note that the figures for All Assessments are not the sum of the figures for the Primary risk assessments, as it is a sum of the sites rather than a sum of the number of species.

Primary risk assessment	Number of SSSIs with NNS records within	
	Total SSSIs	SSSIs with pressure or threat recorded
NNSS risk assessment of high	381	73
NNSS risk assessment of medium	496	79
NNSS risk assessment of low	137	25
Listed as having ecological impact in Roy et al (2012)	947	118
Listed in Roy et al (2012)	1,326	156
Rated as critical in Thomas (2010)	87	11
Rated as urgent in Thomas (2010)	80	18
Rated as moderate risk in Thomas (2010)	30	7
Rated as low risk in Thomas (2010)	102	17
Rated as high risk in Parrott et al (2009)	9	3
Rated as medium risk in Parrott et al (2009)	61	10
Rated as low risk in Parrott et al (2009)	82	16
Main species in Hill et al (2005)	765	107
Listed in Hill et al (2005)	106	13
All Assessments	**1,595**	**190**

3.5 Wider benefits of enhanced INNS data flow

The results of both the 'ground truthing' of the NNS distribution data and the comparison against ENSIS provides strong evidence that the presence of some important NNS was not known on some protected sites. In other cases their presence was likely to be known by site staff, but there was no associated pressure or threat recorded in ENSIS.

The incomplete awareness of higher risk INNS recorded on sites, even records entirely within the selected sample sites with knowledgeable site staff, confirms the need for the flow of INNS records to site staff. Additionally, a proportion of INNS records intersecting the sites clearly refer to species occurring within the site and nearby INNS records may present a threat to the site, so these data are also relevant.

Improved data flow to site staff will make them more aware of INNS records. Alertness to the potential presence of the NNS within the site, although unlikely to generate action as the majority are low risk species, should in time confirm their presence or absence on the site.

Site staff also reported a range of INNS present on their sites that were not included in the record set supplied to them. Records for these species may have been submitted but not yet made available via the NBN Gateway, but this may indicate that the data is not flowing from local staff to a national level. Increasing the flow of records from site managers should assist with national reporting and statistics, and help to ensure a nationally consistent approach to managing INNS. There may be issues with the clarity of guidance regarding responsibilities for recording, reporting and data flow, which would need to be resolved.

4 Review of data management systems

4.1 NBN Gateway

There are two main options for a repository for invasive non-native species (INNS) data relating to protected sites in England, either an internal Natural England data hub or the NBN Gateway. Of these, the NBN Gateway is clearly the best choice:

- The NBN team have the expertise and capacity to manage large amounts of species data, which may not be available within Natural England.
- The NBN Gateway utilises well-established national standards for data flow, including the upload and download of species data.
- Data made available to the NBN Gateway would be widely available to potential users outside of Natural England. This may be an issue where there are sensitivities over the data collected, but there are unlikely to be any real sensitivities regarding data on INNS.
- All available INNS data could be gathered from a single source, rather than having to combine data from the NBN Gateway and an internal data hub.
- Data could be retrieved from the NBN Gateway using the web services, ensuring that the most up to date information available is used by Natural England staff.
- Natural England is a member of the NBN Trust and wider use of the NBN Gateway helps to realise the Trust's objectives.
- The NBN Gateway is Natural England's default source of species data and thus is where they would look for data on any species group or theme.

Ensuring all Natural England data on INNS were made available via the NBN Gateway would also have a significant impact upon the data on the Gateway. Section 2.2 suggests that non-native species (NNS) data held by Natural England and within Marine Recorder could add over 30,000 records to the NBN Gateway. If data on all species held within Natural England databases and Marine Recorder were added to the NBN Gateway the impact would be much greater.

It is also possible for users to view INNS records on the NBN Gateway, though the functionality for doing this at present is limited: although multiple species can be added to the interactive map they must currently be added one at a time. This is impractical even for the relatively small number of high risk INNS, so a mechanism for adding groups of taxonomically unrelated species must be found.

The simplest approach to viewing all INNS records on the NBN Gateway may be to add a list of INNS as an Organisation List on the NBN Gateway, alongside the JNCC collation of taxon designations and protected and invasive species pertinent to Environment Agency work. It would also be necessary to allow whole organisation lists to be displayed on the interactive map and selected through the general Gateway search. In the same way that higher taxa can be used to view all records relating to child taxa, this would allow users to view and interrogate all records of INNS species.

Direct use of the NBN Gateway by Natural England staff was thought to be limited, with the majority of NBN services being used through the WebMap (Section 4.3). Nevertheless, increasing the accessibility of INNS information through the NBN Gateway would have benefits for site managers and other users outside of Natural England.

4.2 CMSi

CMSi is the basis for Natural England's new Designated Sites Management Tool, which was set to replace ENSIS as the main repository for management information on protected sites. It also includes existing functionality to allow INNS to be recorded for specific sites.

The Designated Sites Management Tool has two forms of issue that could represent an INNS:

- Adverse condition reasons, which describe why any site is in a poorer than unfavourable recovering condition. These have associated remedies, which are the activities required to resolve the issue and thus improve condition.
- Condition threats, which are other issues that may be potential reasons for future decline in condition. These have associated actions, which are actions required to resolve the threat.

Whilst both adverse condition reasons and threats may relate to INNS, it is not possible to record which species is present (
Figure 2.3). Remedies and actions have text boxes within which species can be named, but these are unstructured and therefore suffer the same issues as described in Section 2.2.5.

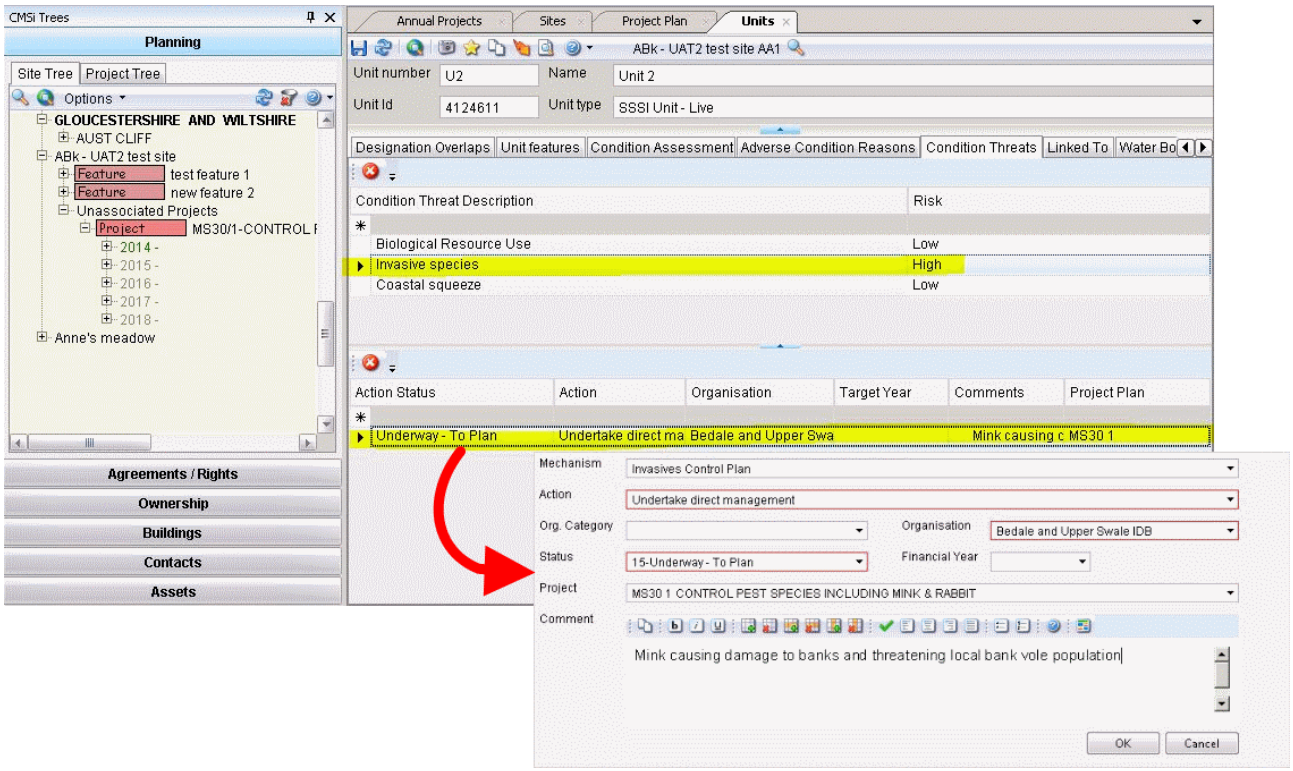

Figure 4.1 – Condition Threat and Action recording in Natural England's Designated Sites Management Tool CMSi.

Nevertheless, it is possible to link both adverse condition reasons and threats to annual projects, which then have the option to enter valid species records (
Figure 4.2). These are available to Natural England through the Designated Sites Management Tool, but are not generally used outside of the National Nature Reserve management team. Annual projects would provide a very suitable method of recording and storing INNS records.

The simplest approach would be to establish an annual project for all INNS recording on each site, under which all Natural England local advisers could easily record any INNS encountered on the site[4]. Species recording is based upon a species dictionary, which is based upon the NBN Species Dictionary but may need updating to include the full list of INNS species.

Species records can be exported from CMSi in Recorder format, thus allowing ready supply of the INNS records to the NBN Gateway. This would initially need to be done manually, though future enhancements to the software could allow the data to be automatically exported and sent to the NBN Gateway in Data Exchange Format on a regular basis.

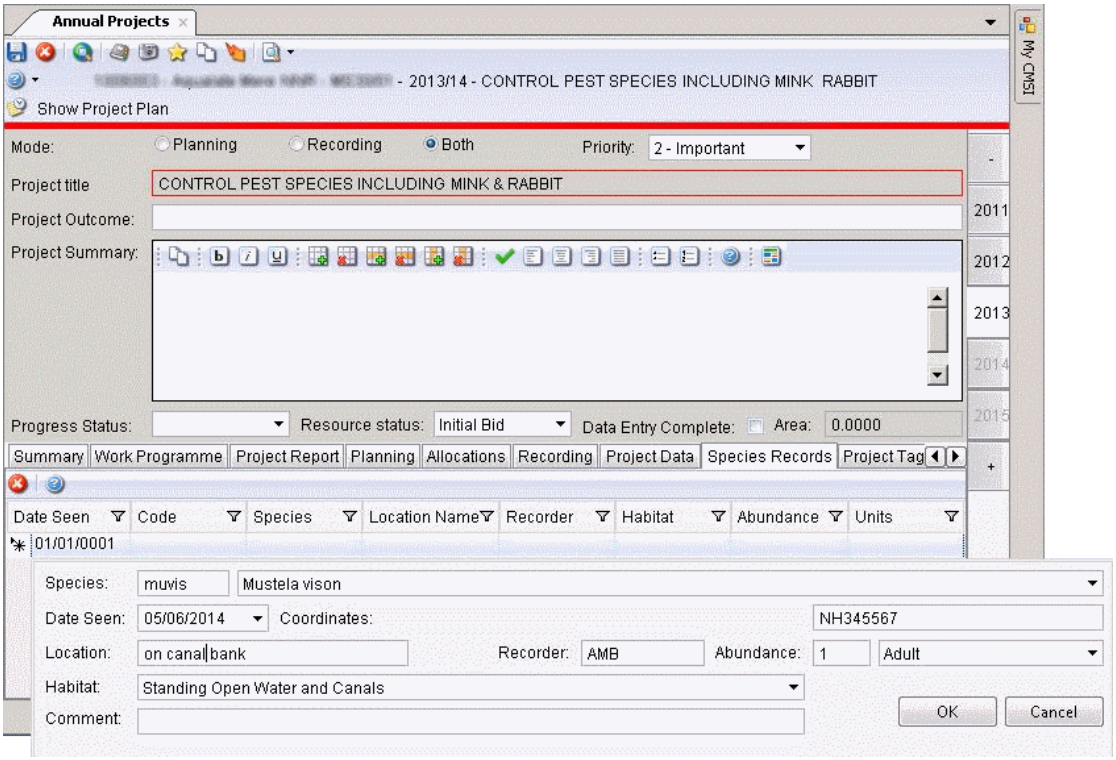

Figure 4.2 – Recording an invasive species under an annual project in Natural England's Designated Sites Management Tool CMSi.

CMSi also has a built in mapping system, which is available to Natural England users and provides basic GIS functionality. The map can be configured to include Web Map Service (WMS) layers, such as those provided by the NBN web services, that can then be loaded and viewed. This provides a mechanism by which Natural England local advisers could obtain information about the sites that they cover.

Using the NBN web services through CMSi in this way would require a list of INNS to be added as an Organisation List on the NBN Gateway (Section 4.1). It should then be possible to request all records of species on the list through the NBN web services to produce a layer that can be added to the map in CMSi.

[4] This could be extended by establishing a single annual project under which all species records could be added, rather than specifying INNS only. Natural England local advisers could still be encouraged to record any INNS encountered, but recording any and all species would have wider benefits, as described in Section 4.1.

It is not possible to interrogate the NBN WMS layer to give the species name or full record details, but the provision of this information through a Web Feature Service (WFS) may be developed in the future (NBN team pers. comm.). In the short term it may be necessary to develop a tool to instead use the full record details available using the NBN Application Programming Interface (API) to generate geometries with their associated record data on the fly (Section 5.4).

By combining species recording and retrieval of existing records, from both within and outside of Natural England, the Designated Sites Management Tool can already provide all the functionality required for INNS data flow at a local level. Future enhancements could improve functionality, for example:

- The ability to add species records in CMSi to the map. This is not a standard layer in the map, but should be easily achievable.
- Adding the ability to record species through the built in map, by clicking the location and adding the other record details.
- Regular automated exports of species data that are then sent directly to the NBN Gateway. These could be regularly run by the cloud server.
- Further utilisation of the NBN Gateway web services to provide a formatted list of INNS or INNS records based upon a site boundary. Most of the functionality for this exists, but methods for formatting and presenting the results through the CMSi interface would be needed.

4.3 WebMap

The Natural England WebMap has not been seen by the authors, so this section is based upon information from third parties. It is an internal GIS available only to Natural England staff that allows them to view spatial information without the need for a full desktop GIS. For example, Natural England staff can use it to screen wind energy schemes to determine potential risk, based on the scale of the development and distance from the protected landscape.

Use of the Natural England WebMap is widespread within the organisation, with all staff having access, though staff awareness is incomplete. WebMap allows spatial data to be displayed and interrogated; it is not a recording or data input tool. A particularly useful function is the ability for users to define an area and use it to produce a list of species records for the area, which could be used to create lists of INNS for a site. Display of INNS data held on the NBN Gateway through the Natural England WebMap would be possible, but would have the same requirements as display of the data in the CMSi:

- The addition of a list of INNS as an Organisation List on the NBN Gateway.
- Either the development of tool to add geometries to the records available through the NBN web services or the implementation of full record details through a NBN WFS layer.

The main advantage of using the WebMap would be that it is already widely used by Natural England staff, with frequency of use over the coming years expected to be higher than CMSi. It also presents a simple interface through which records could be presented.

The WebMap does not provide an interface through which new INNS records can be added. The addition of an interface to the WebMap for entering species records is technically possible, but would require development. For example, it would be possible to embed an Indicia-based INNS recording form in the WebMap. This is considered unlikely until the need for and use of online recording is demonstrated (Oliver Grafton pers. comm.).

Despite its shortcomings as a data entry tool, there is no reason why the WebMap could not be used to display INNS records from the NBN Gateway. This could also occur alongside other ways of displaying the data. For example, some of the development options to display INNS data in CMSi would mean very little additional work would be required to display the same data through the WebMap (Section 5.4).

4.4 Online recording

Online recording is already in use within Natural England, mainly by National Nature Reserve managers and contractors. It would therefore be fairly easy to implement recording on INNS species through an online recording form.

The main advantages of online recording would be the widespread availability to Natural England staff, the ease of use and the fact that it would be relatively easy to ensure that all records were received by the NBN Gateway.

The disadvantages are the development costs for a bespoke interface and the fact that it would not provide an interface for interrogating existing records. Both these issues could be overcome. Use of an existing interface, such as that used by the Non Native Species Secretariat (www.brc.ac.uk/irecord/enter-non-native-records), would negate the need for a bespoke tool[5]. The latter issue could easily be overcome by its use in combination with the Natural England web map.

4.5 Recorder and Marine Recorder

All marine species data collected by Natural England staff or contractors should eventually end up in Marine Recorder, as data supplied to the Marine Biological Association (MBA) is entered into Marine Recorder (see Box 4.1). Additionally, some Natural England contractors will collect and supply records in Marine Recorder. Though data supplied to the MBA should be disseminated through the NBN Gateway, under the DASSH Statutory Agency and commercial marine surveys dataset for example, updates had not occurred regularly and large amounts of recent data on NNS was not included in the NBN Gateway, thus demonstrating the time lag inherent in the use of the system.

In order to add incidental species records to Marine Recorder it was necessary to create a survey specifically for incidental records. It was possible to share Marine Recorder databases over a network, though it was still necessary to install some files locally. It was theoretically possible to install Marine Recorder on a remote server into which users log in. Marine Recorder therefore had potential for collecting and storing records of marine INNS.

The main disadvantage of Marine Recorder for recording INNS was its inability to store terrestrial records, which would mean that multiple systems for collecting records would be required, leading to less than ideal management overhead. There are also issues with Marine Recorder being over-complicated for simple ad hoc records and the training that would be required for Natural England staff to use it.

Box 4.1 - Natural England guidance on recording Marine Species

The following guidance applies to Natural England staff making incidental records of marine species whilst on site:

Sighting information should be uploaded to the MBA website as they are data custodians for marine species http://www.mba.ac.uk/recording.

If you are unsure about a particular sighting - email the sighting with the date, location (lat/long in WGS84 or grid ref preferable), recorder, species, any other notes of interest and any photos to recording@mba.ac.uk.

There is currently one marine ALERT species; the carpet sea squirt, Didemnum vexillum*, which should be recorded with images here http://www.brc.ac.uk/risc/alert.php?species=carpet_seasquirt.*

[5] Note that the existing Natural England tool for National Nature Reserve surveillance (http://www.brc.ac.uk/irecord/ne-nnr-sighting) contains 218 records of 24 species, but is very specific to particular survey methodologies and would not be suited to ad hoc recording of INNS.

The following guidance applies to Natural England contractors making records of invasive species:

The contractor should report any records of INNS observed on site to the Marine Biological Association http://www.mba.ac.uk/recording and to the Natural England project officer. More information and guidance including ID guides can be found at www.nonnativespecies.org and the Marine Aliens Project.

In contrast, Recorder 6 or earlier versions were not in widespread use within Natural England. It allowed users to collect incidental species records, focussed mainly on terrestrial and freshwater species, and allowed network installs. Recorder also shared the disadvantages of Marine Recorder, being over-complicated for ad hoc records, requiring significant staff training and having a lag between data entry and its appearance on the NBN Gateway, with the addition of license costs. Support for Recorder was also due to end soon.

Overall, Recorder and Marine Recorder were not considered to be sensible options for ad hoc recording of INNS.

4.6 EMD/ISAT

The two other main tools used by Natural England for collecting and managing species records and archiving survey data were the Environmental Monitoring Database (EMD) and ISAT. Both are very heavily focused on servicing specific protocols or tasks.

The EMD is a Microsoft Access application that has been designed and enhanced over many years to store data from agri-environment scheme monitoring and a range of other very specific surveys. It is not designed for storing incidental species records and attempting to do so would most likely require a 'survey' to be set up. This would be complicated for users.

In addition, extracting species data from the EMD is currently difficult. As described in Section 2.2.3, the obvious solution is to extract all species records, dates and location details, which must then be combined and reformatted subsequently. This is not a straightforward process and would make supply of INNS data recorded in the EMD to the NBN Gateway difficult and time consuming.

The authors had no experience of ISAT, but knowledge of the ISA and the extracted data provided by Natural England has been used to draw inferences about the database. It is used for common standards monitoring of SSSIs and HLS indictor of success assessment data. As such it set up to record only a very specific set of information, which may include some INNS, but not all. The addition of INNS recording to the database would require the development of new functionality for ad hoc species records and the addition of many INNS species to the database. There is currently no functionality for exporting data from ISAT, but the addition of such functionality was being discussed within Natural England (Keith Porter *pers. comm.*).

Because of their very specific focus, both the EMD and ISAT are not considered suitable for general INNS data entry and interrogation. They nevertheless both have the capacity to store some INNS data, which are not generally available to Natural England site managers and advisers. These data should be made more widely available both within and outside Natural England.

4.7 Bespoke tool

The alternative to using an existing system for recording INNS and disseminating INNS data on protected sites is the development of a bespoke tool. This would require:

- an interface for INNS record data entry
- the ability to manage and edit data

- functionality to allow data to flow to the NBN Gateway, such as the ability to export to NBN Data Exchange Format
- tools to display data from the NBN Gateway and elsewhere, through a map and/or site specific species lists

The development of such a tool would be costly compared with the other options, namely using CMSi, the webmap and/or online recording tools. These other options provide all the required functionality, most of it available with minimal cost implications. The development of a bespoke tool is therefore not recommended.

5 Recommended non-native species data flow system

This work identified a need for Natural England site managers to be better informed and aware of the higher risk invasive non-native species (INNS) recorded on the sites they manage. INNS are the primary target for action, since these are more likely to have management implications for protected sites, but wider recording of non-native species (NNS) may help to identify emerging problem species. This section addresses the recommendations for increasing awareness of INNS through increased and more effective data flow.

In order to maximise opportunities for INNS recording on protected sites, increase accessibility to INNS data and make use of existing systems three main approaches to data flow are recommended:

- The use of CMSi for INNS recording and as an interface for viewing INNS records
- Online recording for INNS recording
- The Natural England WebMap as an interface for viewing NNS records

The core component that ties these approaches together is the use of the NBN Gateway as the central data repository. This avoids many of the overheads for managing data that Natural England would otherwise have to cover and benefits from the economy of scale of storing the data alongside a large number of other datasets and the ready accessibility of these other datasets.

Data from each Natural England recording system should be uploaded to the NBN Gateway as separate datasets, allowing them to be made available to all Natural England staff, and external users. By keeping the data from different systems in separate datasets it allows different access restrictions to be placed on the data, as it may not be appropriate for general users to have access to original resolution fully detailed data from the EMD or ISAT.

The data from the NBN, including data from third parties, are then available to Natural England staff. In order to improve accessibility to the data they should be added to existing Natural England systems using the NBN web services.

A simple data flow diagram is shown in
Figure 5.1, showing all systems and the direction of and mechanisms enabling the flow of data.

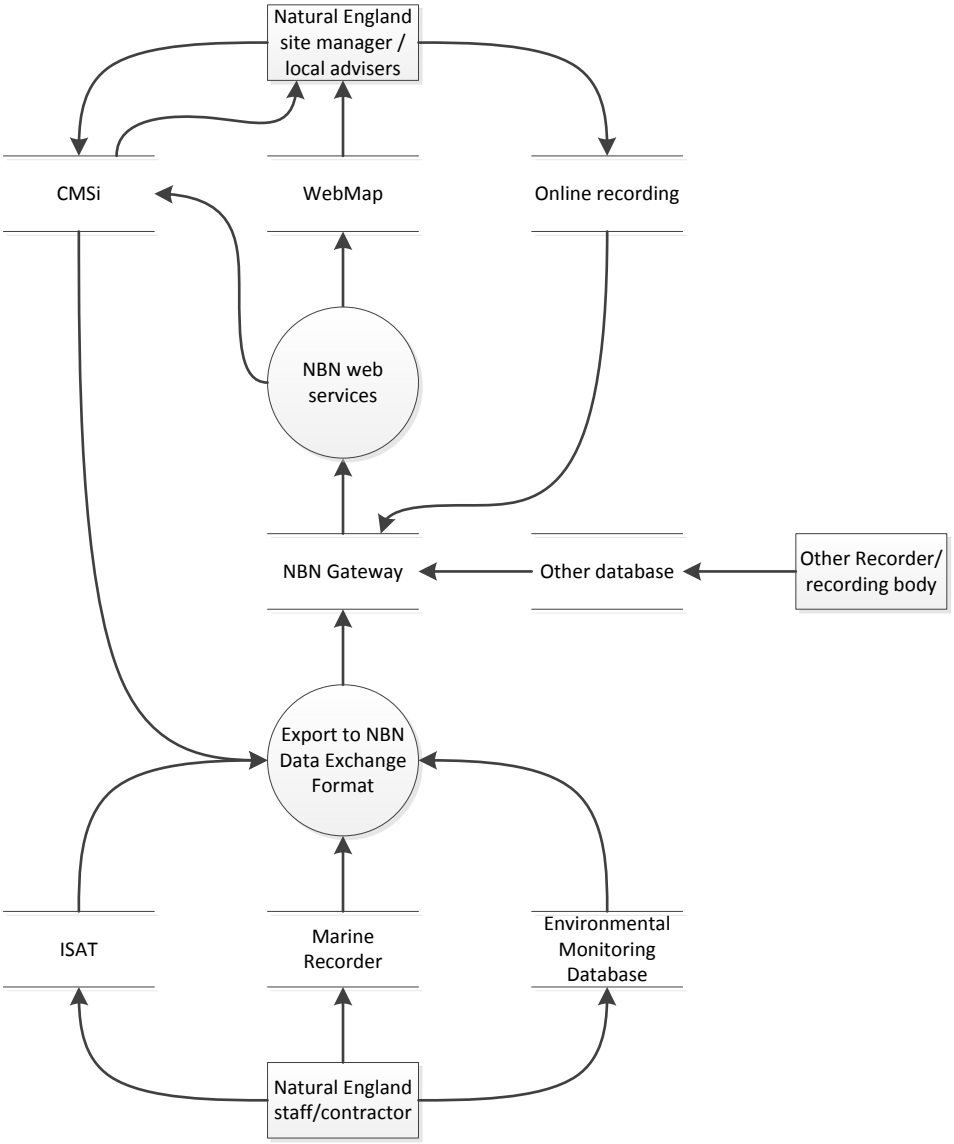

Figure 5.1 – Proposed non-native species data flow diagram for Natural England. = data store; = user of the software or the data (external interactor); = data process. Note that the webmap and CMSi would display live, not stored, data from the NBN web services, but since they both store other data they are regarded as data stores in this diagram.

Alongside the recommendations for these systems are other recommendations that should help to improve data flow and accessibility, both within and external to Natural England (Section 5.7). These recommendations include a review of the NNS list, to make it more exclusive through the removal of NNS that are known to pose no threat to protected sites.

5.1 Use of CMSi for non-native species data entry and display

CMSi should be used for both recording INNS and display of the records. Its use as the Designated Sites Management Tool will ensure that many staff within Natural England are familiar with it, so the limited amount of extra training required to use it for INNS data should not present great challenges.

Users of the designated sites tool should be encouraged to record INNS records from the site under an annual project for species recording. This will take a very small amount of time to set up, at which point making simple records of INNS is relatively straightforward. Because CMSi is hosted on a central server all INNS and other species records would also be stored centrally, from where they can be exported to Recorder format. In the short term these can be converted to NBN Data Exchange Format by the NBN Record Cleaner, which will also undertake semi-automated validation and verification of the records.

In the longer term it may be sensible to develop additional functionality for CMSi to allow species records to be exported directly into NBN Data Exchange Format, as this will reduce the time required to prepare the data for the NBN Gateway. Further development could include:

- Update of the CMSi species list to include rarer INNS. Whilst the species list in CMSi will include all commonly encountered INNS, some of those currently encountered very rarely may be missing.
- Enhancement of the species recording functionality in CMSi, to allow more detail and flexibility.
- Use of the built in map in CMSi to record species, e.g. by using a 'record species here' option on the right click context menu to place the record in the correct location[6].
- Regular automated supply of data to the NBN Gateway in Data Exchange Format.

CMSi should also be used to display records for a site on the built in map. In order for this to occur the NBN will need to be supplied with a list of relevant NNS to be added as an Organisation List. This may be the list developed by this project, another existing list or a list generated by Natural England that includes TVKs, though production of an entirely new list is likely to be time consuming. The use of an existing list is recommended, to avoid duplication of effort both in terms of creation and subsequent updates.

Additional development will be required to allow data from the NBN Gateway to be interrogated through the CMSi map (Section 5.4).

5.2 Use of online recording for non-native species data entry

Online recording of INNS should be used alongside CMSi. It is not clear whether all Natural England staff will be users of CMSi, either due to access restrictions or lack of familiarity, so it is important to allow options for data entry. It may also be necessary for Natural England contractors who are likely not to have access to CMSi to record INNS, for which online recording will be useful.

In addition, providing different options for data entry allows users to use those with which they are most comfortable. Regular users of CMSi may like having a single point through which species records and management decisions are added and viewed. Those that are not regular users of CMSi will undoubtedly prefer a different system.

To avoid the need for a bespoke development, use of iRecord (www.brc.ac.uk/irecord/home) is recommended. This could use the interface set up for the Non Native Species Secretariat (www.brc.ac.uk/irecord/enter-non-native-records), but it might be beneficial for users to add casual or list of records through the normal interface, as this will encourage the recording of species other than INNS.

5.3 Use of the Natural England WebMap for non-native species data display

The Natural England WebMap should be used alongside CMSi for display and interrogation of INNS records, for the reasons stated in Section 5.2. The WebMap will not be used by contractors, who would still be able to

[6] The CMSi Vegetation and Species Module already allows species recording through the map in CMSi, but a UK-targeted version is not currently available and would require development. In addition, since it is designed for more complex data (relevés), the Vegetation and Species Module may introduce unnecessary complexity.

access the data through the NBN Gateway, but will provide a mechanism for Natural England staff that do not use CMSi to view INNS data.

As with CMSi, displaying INNS records through the Natural England WebMap will require the addition of an approved list of INNS to the NBN Gateway as an Organisation list. Only one list is required, which would serve the needs of CMSi and the WebMap.

Also as with CMSi, additional development will be required to allow data from the NBN Gateway to be interrogated through the WebMap (Section 5.4). Once created it should be possible to add the data as a layer in the WebMap in the normal way.

As stated in Section 4.3, it would be possible to add a tool for species recording to the Natural England WebMap. Whilst this is not necessary whilst iRecord is being used, it is recommended that the use of iRecord and the potential benefits of having a species recording tool in the WebMap be investigated. This investigation should be undertaken at a period following the update of policies and guidance on INNS recording (Section 5.5), to allow for uptake of online recording where it is not already occurring.

5.4 Development of additional functionality for use of the NBN web services

Additional functionality must be added to the NBN web services to allow INNS data to be interrogated through the CMSi map and Natural England WebMap, or any other mapping system. This requires full record details to be associated with the geometries representing the record locations, which can be achieved through the following options, listed in order of preference.

Applicable to CMSi and the Natural England WebMap:

1. The NBN team can implement the supply of records details using a new WFS layer available through the NBN web services. This will require some time for the NBN team to set up and support subsequently. There are also authentication and authorisation issues around users seeing record details according to the NBN Gateway rules. The advantage of this approach is that the WFS would be available to everyone for any application, not just for Natural England or INNS. This would also avoid the need for any development of CMSi or the Natural England WebMap, as they could simply be configured to use the new WFS.

2. A proxy WMS solution can be developed, which would be independent of CMSi or the WebMap. When the proxy receives a WMS request, it would make a request to the NBN RESTful API, process the spatial information in the JSON response and return the relevant geometry based upon the grid reference and precision. Given that it should not be necessary to use this tool outside of the mainland UK, it will not be necessary to consider different coordinate systems, so all geometries can be created in British National Grid. The proxy could be hosted on the Natural England servers, including the servers hosting CMSi and the WebMap. This avoids the issues regarding authorisation of record details, as the record details available through this system would only be available to Natural England. As for option 1, CMSi and the WebMap could simply be configured to use the proxy WMS, but this potentially service would not be available to users outside of Natural England.

Applicable to CMSi only, and therefore have the disadvantage that they cannot be used to display species records through the Natural England WebMap:

3. The Natural England designated sites module for CMSi could be extended to make the request directly to the NBN web services from a form or the map, based upon the current map extent or site boundary. It would then undertake the same process as the proxy WMS described in option 2. The main advantage of this is the potential additional functionality then possible within CMSi, such as the ability to view species records for a site in a table. Also, because it would be a new feature on an existing CMSi module there would be no overheads in creating a new plugin.

4. CMSi comes with a Windows Action Service that could be set up to periodically query the NBN API and keep some tables in the CMSi database up-to-date. This would create geometries for the records in the same way as options 2 and 3. This would then be made available to CMSi mapping through configuration in a similar way to a WMS. Due to the large volume of data involved it may be difficult to get the mapping in CMSi performant.

5. It is also possible to develop a 'mini-module' for CMSi that does the same thing as option 3 but can be used without the designated sites module. Creation of this new module would have a significant overhead, such as the development on an installer.

The preferred solution would be for the NBN team to implement the functionality in a WFS. Given the uncertainties about implementing this in the short term it may be necessary to develop the tool to create geometries, in which case the proxy WMS suggested in option 2 is recommended. For options 2-4, a proof of concept phase of development is recommended, followed by further development guided by feature requests and user feedback. The development of a detailed functional and/or technical specification is also recommended. It is estimated that the delivery of the tool will require 10 days' work.

Option 5 is not recommended, as the time required would be significantly greater than the other options, given the need for additional development not directly related to the core functionality of the tool.

5.5 Policies and protocols for Natural England staff and contractors

If investment is made in promoting or creating tools for INNS data recording and presentation, it is important that appropriate policies and protocols are in place to encourage Natural England staff and contractors to use them (see Section 3.5).

Guidance on recording marine INNS already exists for staff and contractors (Box 4.1). Similar guidance should be created for recording terrestrial INNS. These instructions should promote the use of online recording or CMSi for Natural England staff, and online recording for contractors, and aim to ensure that all species data is made available via the NBN Gateway. For larger contracted projects it may be appropriate to specify that all data must be made available via the NBN Gateway directly, which could be as a dataset managed by the contractor or Natural England, or as an update to an existing dataset where appropriate.

The guidance should also cover the need for and use of negative (absence) records. For example, where an INNS has been eradicated or is known not to be present its absence should be recorded. This record should be made available via the NBN Gateway, along with the others, because if there are no records for the same area for subsequent years it can be used to show that the species is no longer present. The technical implications of this for the NBN Gateway are discussed in Section 5.7.4.

Mobilisation of historic species data is also recommended. Much of this will be achieved through the mobilisation of data in the EMD, ISAT and that held by Natural England on National Nature Reserves (Sections 5.6 and 5.7.2), though the cost benefit of the mobilisation of other collections of records should be assessed.

Additional guidance should be provided on using species data to inform decisions about site management made by Natural England. This should specify the use of CMSi and the Natural England WebMap for viewing and interrogating INNS records, as well as more generic guidance on utilising records of native species and NSS not considered to be invasive on the NBN Gateway. Ideally all Natural England staff should be able to access data on the NBN Gateway at the resolution available to the organisation as a whole.

The guidance should also cover the interpretation of INNS data provided through CMSi or the WebMap, or direct from the NBN Gateway. This should include:

- Consideration of the mobility of the species. For example, a bird may be recorded from a site that is not resident and may simply have been passing overhead. See also Section 5.7.1 regarding categorisation of INNS species based upon mobility.

- A warning that not all records will be accurate. This was demonstrated by the review described in Section 3.
- Clarification that action will not be required for every instance of an INNS on a protected site. In each case, an assessment of the local situation should be undertaken and the actual risk evaluated.

There may also be value in generating better species specific advice on management. This advice would need to written in general terms, as it will not be possible to anticipate every situation, and it would need to be made clear that it would not be universally applicable.

All guidance produced, including the existing guidance on INNS in marine situations, should be made readily available and widely promoted within Natural England, so that all relevant staff know of their existence. Staff training on INNS data flow and interpretation should be used to raise the profile of the guidance, ensure it is understood and encourage its application.

5.6 Development of export functionality for existing systems

The data extracted from the EMD during this project included 741,597 unique species records, which amounts to a substantial sized dataset. The one years' worth of ISAT data supplied as part of this project included 72,274 species records, generally of species targeted by ISA surveys. Clearly ISAT is likely to accumulate very large numbers of species records as its use continues.

The EMD and ISAT do not have the ability to export species data (Section 4.6). Given the large quantity of data contained within these databases the contribution they could make to the NBN Gateway is significant. Mobilisation of these data should therefore be considered a priority and is already being discussed within Natural England.

Data export routines for the EMD and ISAT should be developed. These should ideally export all species records to NBN Data Exchange Format (French 2012), so that they can be directly uploaded to the NBN Gateway.

It is acknowledged that some records, especially those contained within the EMD, may be sensitive. Publishing these data through the NBN Gateway should be no problem if access to these data is limited by setting public access to low resolution and preventing access to the record details. Alternatively, confidential records can be flagged as sensitive in the NBN Gateway and therefore not displayed or can simply not be included in the export.

5.7 Other recommendations to improve data flow

5.7.1 Creation of an accepted invasive non-native species (i.e. significant risk) list

It was recognised during the course of this project that the list of NNS created included some unexpected species. These included:

- Species that are native to parts of the country but may have been introduced elsewhere or established feral populations from escapes from captive collections. Examples included the red kite *Milvus milvus*, whooper swan *Cygnus cygnus* and grey partridge *Perdix perdix.*
- Species of archaeophyte plants that were introduced through human activity before 1500 AD, many going back to the Bronze Age or before. This list includes many cornfield annuals such as poppy *Papaver* species, cornflower *Centaurea cyanus* and red dead-nettle *Lamium purpureum*. These plants are frequently mistaken to be full natives or seen as honorary natives.

This was due to the inclusive way in which species were added to the list, as if they were contained within one of the source lists they were included uncritically. This reduced the applicability of the list, as it included species that were not generally a threat to protected site condition.

The creation of an accepted list of invasive non-native species (INNS) that excludes species that are unlikely to pose a threat would resolve this issue, but presents issues of its own. Because there are so many ways in which the risk of a NNS can be assessed, any list of INNS will be open to criticism.

The practical alternative is to create a shortlist of potential INNS based upon published lists along with their associated risk assessments, which would be more acceptable as it would require interpretation. This is therefore recommended, but would need to be titled carefully to ensure that it is clear that interpretation is required. It is suggested that the first step towards this would be list containing only NNS with the following primary risk assessments:

- Non Native Species Secretariat Risk Assessment of High or Medium
- Having ecological impact according to Roy et al (2012)
- Critical, Urgent or Moderate according to Thomas (2010)
- High or Medium according to Parrott et al (2009)

In addition, it was recognised that the lists lacked some important species. The following species should be added to the list, along with any others as they are identified as being a threat:

- Expected or likely invaders, such as those on the Water Framework Directive red list.
- Recent records of new NNS species, such as the Asian shore crab *Hemigrapsus sanguineus*, which was found in Kent and Barry Island in 2014 (National Biodiversity Network 2014c) and the ant *Hypoponera ergatandria* (Seifert 2013).

Once complete, a review of the list should be undertaken to gain acceptance and raise its profile among Natural England staff.

The updated list should be added as an Organisation List on the NBN Gateway, so that it can be used to filter INNS records from the Gateway (Sections 5.1 and 5.3). Any species listed that are not recognised by the NBN should be added to the NBN Species Dictionary, so that they can be assigned TVKs and can be recorded if they are found.

Ongoing management of the list should ensure that any additional INNS identified should be added, either from existing NNS present within the UK or INNS occurring outside of the UK that nevertheless present a threat. In particular, species added in the future to the list created by Roy et al. (2012) should also be added to the Organisation List on the NBN Gateway.

It may also be useful to categorise the species on the list by their ability to spread, such as their mobility and vector types, and the broad habitats that they occupy. This information could then be used to undertake more advanced analysis of risks to sites based upon sound ecological theory. This information could be used to assess threats in the vicinity of protected sites but not directly intersecting, such as INNS upstream of riparian sites, and determine whether the INNS is likely to establish and compete effectively.

5.7.2 Capture of data on National Nature Reserves

There are a number of species records held in National Nature Reserve (NNR) site files within Natural England that have not been mobilised. A metadata survey has been completed for all NNRs to determine the data holdings and a programme of data capture has commenced (K. Porter, pers. comm.). It is recommended that this programme is continued and well supported, and that the resulting data is made available via the NBN Gateway.

5.7.3 Allocation of SSSI units by region

A list allocating SSSI units to each Natural England team was provided to assist with the creation of the NNS lists for protected sites (Section 2.3). This was found to contain issues, with a number of sites clearly allocated to the wrong region. These errors were not quantified, as the decision was made to allocate sites spatially instead, based upon the Natural England region boundaries, but it is recommended that the list is reviewed for errors to assist with Natural England's operations.

5.7.4 Site based records on the NBN Gateway

Ideally it would be possible to associate INNS records with the site boundary, rather than specific grid references. This is particularly true of negative records, where the absence of a species from a site might be known, but its status in adjacent areas might be unknown.

The NBN Data Exchange Format allows records to be linked to site boundaries (using the FeatureKey element; French 2012), these are currently related to the central site grid reference and displayed as such. Whilst there are no issues with reducing positive site records to the central grid reference for the site, this does present problems for negative records, which will relate to a very specific area (as shown in Figure 5.2).

It is therefore recommended that the NBN team develop this area further to allow site records to be mapped as site boundaries. This will inevitably involve an investigation into how this would function with regard to access controls and record visibility.

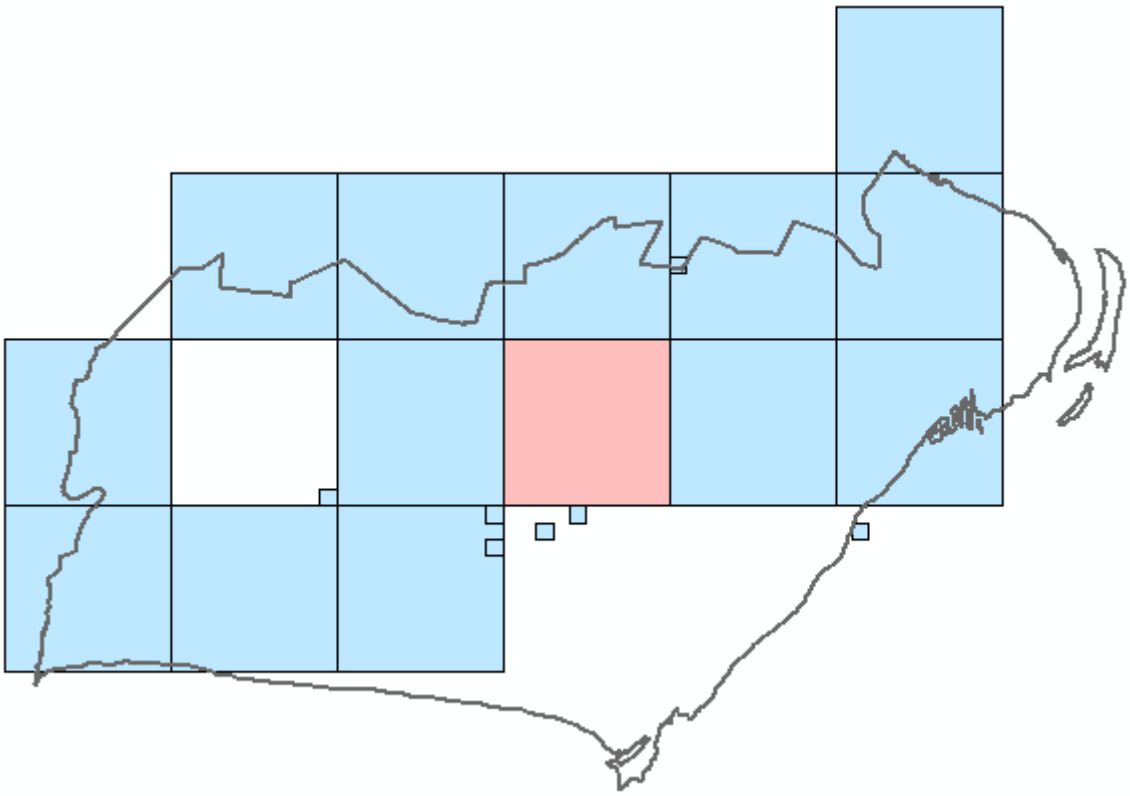

Figure 5.2 – An example of how site based negative records are implemented by the NBN Gateway. A site manager eliminates an INNS from a site and submits a negative record that should negate all previous records for the same area. The negative record applies only to the area within the site boundary (shown as a grey line). The NBN Gateway interprets the site record as the central grid reference for the site, displaying the negative record as covering the central square only (in red). This means that it appears as though the negative record only applies to the central area of the site, incorrectly suggesting that previous positive records of the species (in blue) still apply.

5.7.5 Making the NNSS risk assessments more accessible

The Risk Assessments on the GB Non-native Species Secretariat website were available as pdf documents only, so it was necessary to manually review each to determine the results of each assessment (Section 2.1). It would be more useful for future users of the data to have the results of the assessments summarised in a single table. Since the assessment scheme uses a Microsoft Access based template (JH/JDM 2009) it should be possible to export the results of all assessments into a single table, though older assessments may need to be added manually. These summary results should then be made publically available, alongside and possibly with links to the full risk assessments.

5.7.6 Improvements to grid references in the Environmental Monitoring Database

A full check of the accuracy of the grid references used in the EMD has previously been recommended (Lush and Lush 2014). The known issues with accuracy will have had a significant effect on the reliability of this work and would affect the reliability of the data on the NBN Gateway if it were submitted. The recommendation that the data is reviewed and positional errors either corrected or the erroneous data removed is therefore repeated.

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Appendix A Non-native species included in this study

This appendix is provided separately as a Microsoft Excel workbook, available from: [Insert link].

Appendix B Non-native species without TVKs that were excluded from further analysis

The following non-native species (NNS) were not included in the NBN Species Dictionary and therefore did not have a TVK. As a result these species were excluded from further analysis.

Scientific Name	Primary Risk Assessment
Acorus gramineus 'Pusillus'	Rated as moderate risk in Thomas (2010)
Acyrthosiphon primulae	Listed in Roy et al (2012)
Adelges viridana	Listed in Roy et al (2012)
Aerococcus viridans	Listed in Roy et al (2012)
Agrilus planipennis	Rated as high risk in Parrott et al (2009)
Alisma parviflora	Rated as moderate risk in Thomas (2010)
Alocasia × amazonica	Rated as low risk in Thomas (2010)
Alocasia cucullata	Rated as moderate risk in Thomas (2010)
Alocasia odora	Rated as low risk in Thomas (2010)
Alocasia plumbea	Rated as low risk in Thomas (2010)
Aloephagus myersi	Listed in Roy et al (2012)
Alpinia zerumbet 'Variegata' (v)	Rated as low risk in Thomas (2010)
Alternanthera reineckii	Rated as low risk in Thomas (2010)
Alternanthera 'Sunset'	Rated as low risk in Thomas (2010)
Alternanthera tenella	Rated as low risk in Thomas (2010)
Ambulia aromatica	Rated as low risk in Thomas (2010)
Ammania gracilis	Rated as low risk in Thomas (2010)
Ammania senegalensis	Rated as low risk in Thomas (2010)
Ampelodesmos pliniana	Rated as urgent in Thomas (2010)
Amphorophora tuberculata	Main species in Hill et al (2005)
Amsonia hubrichtii	Rated as low risk in Thomas (2010)
Amsonia orientalis	Rated as low risk in Thomas (2010)
Amsonia tabernaemontana	Rated as low risk in Thomas (2010)
Anemopsis californica	Rated as low risk in Thomas (2010)
Antiponemertes pantini	Listed in Hill et al (2005)
Anubias afzelii	Rated as low risk in Thomas (2010)
Anubias angustifolia	Rated as low risk in Thomas (2010)
Anubias barteri	Rated as low risk in Thomas (2010)
Anubias caladifolia	Rated as low risk in Thomas (2010)
Anubias callos	Rated as low risk in Thomas (2010)
Anubias coffeefolia	Rated as low risk in Thomas (2010)
Anubias congensis	Rated as low risk in Thomas (2010)
Anubias gigantea	Rated as low risk in Thomas (2010)
Anubias gracilis	Rated as low risk in Thomas (2010)
Anubias hastifolia	Rated as low risk in Thomas (2010)
Anubias heterophylia	Rated as low risk in Thomas (2010)
Anubias lanceolata	Rated as low risk in Thomas (2010)
Anubias nana	Rated as low risk in Thomas (2010)
Aonidia lauri	Listed in Hill et al (2005)
Aony × cinerea	Rated as medium risk in Parrott et al (2009)
Aphis balloticola	Listed in Roy et al (2012)
Aphis cytisorum	Listed in Roy et al (2012)
Aphis gossypii	Listed in Roy et al (2012)
Aphis oenotherae	Listed in Roy et al (2012)
Aphis thalictri	Listed in Roy et al (2012)
Aponogeton capuronii	Rated as low risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Aponogeton crispus	Rated as low risk in Thomas (2010)
Aponogeton elongatus	Rated as low risk in Thomas (2010)
Aponogeton fenestralis	Rated as low risk in Thomas (2010)
Aponogeton henkelianus	Rated as low risk in Thomas (2010)
Aponogeton krauseanus	Rated as low risk in Thomas (2010)
Aponogeton longiplumulosus	Rated as low risk in Thomas (2010)
Aponogeton madagascarensis	Rated as low risk in Thomas (2010)
Aponogeton natans	Rated as low risk in Thomas (2010)
Aponogeton rigidifolius	Rated as low risk in Thomas (2010)
Aponogeton siamensis	Rated as low risk in Thomas (2010)
Aponogeton ulvaceus	Rated as low risk in Thomas (2010)
Aponogeton undulatus	Rated as low risk in Thomas (2010)
Appendiseta robiniae	Main species in Hill et al (2005)
Aristichthys nobilis	Rated as low risk in Parrott et al (2009)
Arocatus longiceps	Listed in Roy et al (2012)
Aspidiotus nerii	Listed in Roy et al (2012)
Asteroe rubra	Main species in Hill et al (2005)
Atelerix albiventris	Rated as medium risk in Parrott et al (2009)
Aulacaspis rosae	Listed in Roy et al (2012)
Australopacifica coxii	Main species in Hill et al (2005)
Bacillius rossius	Listed in Roy et al (2012)
Bacopa caroliniana	Rated as moderate risk in Thomas (2010)
Bacopa lanigera	Rated as low risk in Thomas (2010)
Bacopa monnieri	Rated as low risk in Thomas (2010)
Bacopa myrophylloides	Rated as low risk in Thomas (2010)
Bacopa rotundifolia	Rated as moderate risk in Thomas (2010)
Balanococcus diminutus	Listed in Roy et al (2012)
Barclaya longifolia	Rated as low risk in Thomas (2010)
Barley mild mosaic virus	Main species in Hill et al (2005)
Barley yellow mosaic virus	Main species in Hill et al (2005)
Baumea Rubiginosa 'var'	Rated as low risk in Thomas (2010)
Beet necrotic yellow vein virus	Main species in Hill et al (2005)
Bemisia afer	Listed in Roy et al (2012)
Blastobasis vittata	Main species in Hill et al (2005)
Blyxa aubertii	Rated as moderate risk in Thomas (2010)
Blyxa japonica	Rated as low risk in Thomas (2010)
Boa constrictor imperator	Rated as high risk in Parrott et al (2009)
Bolbitis heteroclita	Rated as low risk in Thomas (2010)
Bolbitis heudelotii	Rated as low risk in Thomas (2010)
Bombus terrestris dalmatinus	NNSS risk assessment of medium
Brachycaudus amygdalinus	Listed in Hill et al (2005)
Brachynotocoris punctipennis	Listed in Roy et al (2012)
Bufo marinus	Rated as high risk in Parrott et al (2009)
Bursaphelenchus xylophilus	Rated as high risk in Parrott et al (2009)
Cabomba aquatica	Rated as low risk in Thomas (2010)
Cabomba furcata	Rated as low risk in Thomas (2010)
Callidiellum rufipenne	Rated as low risk in Parrott et al (2009)
Callithrix spp	Rated as low risk in Parrott et al (2009)
Caltha introloba	Rated as low risk in Thomas (2010)
Caltha leptosepala	Rated as moderate risk in Thomas (2010)
Caltha natans	Rated as low risk in Thomas (2010)
Caltha palustris subsp. *Polypetala*	Rated as moderate risk in Thomas (2010)
Caltha palustris var. *barthei*	Rated as moderate risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Caltha sagittata	Rated as low risk in Thomas (2010)
Canna tuerckheimii	Rated as low risk in Thomas (2010)
Carassius gibelio	Main species in Hill et al (2005)
Cardamine lyrata	Rated as moderate risk in Thomas (2010)
Cardamine macrophylla	Rated as moderate risk in Thomas (2010)
Carex muskingumensis	Rated as moderate risk in Thomas (2010)
Castor canadensis	Rated as high risk in Parrott et al (2009)
Catostomus commersoni	Rated as low risk in Parrott et al (2009)
Cebus spp	Rated as low risk in Parrott et al (2009)
Cecidophyopsus grossulariae	Listed in Roy et al (2012)
Cecidophyopsus ribis	Listed in Roy et al (2012)
Cerataphis lataniae	Listed in Roy et al (2012)
Cerataphis orchidearum	Listed in Roy et al (2012)
Ceratopteris cornuta	Rated as low risk in Thomas (2010)
Ceratopteris thalicroides	Rated as low risk in Thomas (2010)
Ceresa alta	Rated as low risk in Parrott et al (2009)
Chinchilla spp	Rated as low risk in Parrott et al (2009)
Chladophora aegagrophila	Rated as low risk in Thomas (2010)
Chlorophytum bechettii	Rated as low risk in Thomas (2010)
Chlorophytum 'Pongol Sword'	Rated as low risk in Thomas (2010)
Chymomyza amoena	Listed in Roy et al (2012)
Cinara cedri	Listed in Hill et al (2005)
Cinara curvipes	Listed in Hill et al (2005)
Cinara escherichi	Main species in Hill et al (2005)
Cinara fresai	Listed in Roy et al (2012)
Cinara stroyani	Main species in Hill et al (2005)
Cinara tujafilina	Listed in Roy et al (2012)
Cinara viridescens	Listed in Roy et al (2012)
Clarias batrachus	Main species in Hill et al (2005)
Closterotomus trivialis	Listed in Roy et al (2012)
Collybia biformis	Listed in Hill et al (2005)
Coregonus clupeaformis	Main species in Hill et al (2005)
Corvus splendens	NNSS risk assessment of medium
Corythucha arcuata	Rated as low risk in Parrott et al (2009)
Corythucha ciliata	Listed in Roy et al (2012)
Crinum calamistratum	Rated as low risk in Thomas (2010)
Crinum erubescens	Rated as low risk in Thomas (2010)
Crinum natans	Rated as low risk in Thomas (2010)
Crinum thaianum	Rated as low risk in Thomas (2010)
Cryptocoryne × *willisii*	Rated as low risk in Thomas (2010)
Cryptocoryne affinis	Rated as low risk in Thomas (2010)
Cryptocoryne albida	Rated as low risk in Thomas (2010)
Cryptocoryne aponogetifolia	Rated as low risk in Thomas (2010)
Cryptocoryne balansae	Rated as low risk in Thomas (2010)
Cryptocoryne beckettii	Rated as low risk in Thomas (2010)
Cryptocoryne bullosa	Rated as low risk in Thomas (2010)
Cryptocoryne ciliata	Rated as low risk in Thomas (2010)
Cryptocoryne cordata	Rated as low risk in Thomas (2010)
Cryptocoryne cordata var. *cordata* 'Blassii'	Rated as low risk in Thomas (2010)
Cryptocoryne crispatula var. *tonkinensis*	Rated as low risk in Thomas (2010)
Cryptocoryne crispulata var. *balansae*	Rated as low risk in Thomas (2010)
Cryptocoryne griffithii	Rated as low risk in Thomas (2010)
Cryptocoryne griffithii × *C. cordata* var.*cordata*	Rated as low risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Cryptocoryne hudoroi	Rated as low risk in Thomas (2010)
Cryptocoryne lingua	Rated as low risk in Thomas (2010)
Cryptocoryne longicauda	Rated as low risk in Thomas (2010)
Cryptocoryne minima	Rated as low risk in Thomas (2010)
Cryptocoryne moehlmanni	Rated as low risk in Thomas (2010)
Cryptocoryne nurii	Rated as low risk in Thomas (2010)
Cryptocoryne parva	Rated as low risk in Thomas (2010)
Cryptocoryne pontederiifolia	Rated as low risk in Thomas (2010)
Cryptocoryne pygmaea	Rated as low risk in Thomas (2010)
Cryptocoryne retrospiralis	Rated as low risk in Thomas (2010)
Cryptocoryne scurillis	Rated as low risk in Thomas (2010)
Cryptocoryne striolata	Rated as low risk in Thomas (2010)
Cryptocoryne thwaitesii	Rated as low risk in Thomas (2010)
Cryptocoryne undulata	Rated as low risk in Thomas (2010)
Cryptocoryne usteriana	Rated as low risk in Thomas (2010)
Cryptocoryne walkerii	Rated as low risk in Thomas (2010)
Cryptocoryne wendtii (red, green, tropica, brown, 'mi Ova', 'Green Gecko')	Rated as low risk in Thomas (2010)
Cynomys ludovicianus	Rated as medium risk in Parrott et al (2009)
Cyperus albostriatus 'Variegatus'	Rated as urgent in Thomas (2010)
Cyperus alternifolius L.	Rated as low risk in Thomas (2010)
Cyperus haspan L.	Rated as moderate risk in Thomas (2010)
Cyperus helferi	Rated as low risk in Thomas (2010)
Cyperus papyrus	Rated as low risk in Thomas (2010)
Cyperus prolifer	Rated as low risk in Thomas (2010)
Cyprinella lutrensis	Rated as low risk in Parrott et al (2009)
Dactylogyrus anchoratus	Main species in Hill et al (2005)
Dasineura oleae	Listed in Roy et al (2012)
Dasineura oxycoccana	Rated as low risk in Parrott et al (2009)
Dialeurodes chittendeni	Listed in Roy et al (2012)
Diaspidiotus perniciosus	Rated as low risk in Parrott et al (2009)
Dickeya dianthicola	Main species in Hill et al (2005)
Dicyphus escalerae	Listed in Roy et al (2012)
Didactylomyia longimana	Listed in Roy et al (2012)
Didiplis diandra	Rated as low risk in Thomas (2010)
Dryocosmus kuriphilus	Rated as medium risk in Parrott et al (2009)
Dulichium arundinaceum	Rated as low risk in Thomas (2010)
Dysaphis tulipae	Listed in Roy et al (2012)
Echinodorus × barthii	Rated as low risk in Thomas (2010)
Echinodorus amazonicus	Rated as low risk in Thomas (2010)
Echinodorus andreuxii	Rated as low risk in Thomas (2010)
Echinodorus argentinesis	Rated as moderate risk in Thomas (2010)
Echinodorus berteroi	Rated as moderate risk in Thomas (2010)
Echinodorus bleheri	Rated as low risk in Thomas (2010)
Echinodorus bolivianus	Rated as low risk in Thomas (2010)
Echinodorus chrileni	Rated as low risk in Thomas (2010)
Echinodorus compacta	Rated as low risk in Thomas (2010)
Echinodorus cordifolius	Rated as moderate risk in Thomas (2010)
Echinodorus grisebachii	Rated as low risk in Thomas (2010)
Echinodorus harbich	Rated as low risk in Thomas (2010)
Echinodorus harbii	Rated as low risk in Thomas (2010)
Echinodorus horemanii	Rated as low risk in Thomas (2010)
Echinodorus horizontalis	Rated as low risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Echinodorus Imperial	Rated as low risk in Thomas (2010)
Echinodorus ipica	Rated as low risk in Thomas (2010)
Echinodorus Kleiner Bar	Rated as low risk in Thomas (2010)
Echinodorus latifolius	Rated as low risk in Thomas (2010)
Echinodorus magdalensis	Rated as low risk in Thomas (2010)
Echinodorus Marble Queen	Rated as low risk in Thomas (2010)
Echinodorus marttii (major)	Rated as low risk in Thomas (2010)
Echinodorus midi fleur	Rated as low risk in Thomas (2010)
Echinodorus mitchii	Rated as low risk in Thomas (2010)
Echinodorus oriental	Rated as low risk in Thomas (2010)
Echinodorus ozelot	Rated as low risk in Thomas (2010)
Echinodorus paniculatus	Rated as low risk in Thomas (2010)
Echinodorus parviflorus	Rated as moderate risk in Thomas (2010)
Echinodorus quadricostata	Rated as low risk in Thomas (2010)
Echinodorus 'Red Flame'	Rated as low risk in Thomas (2010)
Echinodorus 'Red Rubin'	Rated as low risk in Thomas (2010)
Echinodorus 'Red Vein'	Rated as low risk in Thomas (2010)
Echinodorus 'Rose'	Rated as low risk in Thomas (2010)
Echinodorus scaber	Rated as low risk in Thomas (2010)
Echinodorus schlueteri	Rated as low risk in Thomas (2010)
Echinodorus schlueteri Leopard	Rated as low risk in Thomas (2010)
Echinodorus tenellus	Rated as moderate risk in Thomas (2010)
Echinodorus tricolor	Rated as low risk in Thomas (2010)
Echinodorus uruguayensis	Rated as moderate risk in Thomas (2010)
Echinodorus uruguayensis × *E. portoalegrensis*	Rated as low risk in Thomas (2010)
Eichhornia azurea	Rated as low risk in Thomas (2010)
Eichhornia diversifolia	Rated as low risk in Thomas (2010)
Eleocharis dulcis variegated (v)	Rated as moderate risk in Thomas (2010)
Eleocharis vivipara	Rated as low risk in Thomas (2010)
Eleutherodactylus coqui	Rated as medium risk in Parrott et al (2009)
Enapholodes rufulus	Rated as low risk in Parrott et al (2009)
Epitrimerus pyrifoliae	Listed in Roy et al (2012)
Equisetum camtschatcense	Rated as low risk in Thomas (2010)
Equisetum hyemale robustum	Rated as low risk in Thomas (2010)
Equisetum hyemale var. *affine*	Rated as moderate risk in Thomas (2010)
Equisetum japonicum	Rated as moderate risk in Thomas (2010)
Equisetum ramosissimum var. *japonicum*	Rated as moderate risk in Thomas (2010)
Equisetum scirpoides	Rated as critical in Thomas (2010)
Ericaphis scammelli	Listed in Roy et al (2012)
Ericaphis wakibae	Listed in Roy et al (2012)
Eriocaulon cinereum	Rated as moderate risk in Thomas (2010)
Eriocaulon 'Guangzhou'	Rated as low risk in Thomas (2010)
Eriocaulon setaceum	Rated as low risk in Thomas (2010)
Erwinia amylovora	Main species in Hill et al (2005)
Eucalyptus glaucescens	NNSS risk assessment of low
Eucalyptus nitens	NNSS risk assessment of low
Eulachnus bluncki	Listed in Roy et al (2012)
Eulepidosaphes pyriformis	Listed in Roy et al (2012)
Eupulvinaria hydrangea	Listed in Hill et al (2005)
Eusteralis stellata	Rated as moderate risk in Thomas (2010)
Farsonia cincta	Listed in Roy et al (2012)
Felis bengalensis	Rated as high risk in Parrott et al (2009)
Gambusia holbrooki	Rated as medium risk in Parrott et al (2009)

Scientific Name	Primary Risk Assessment
geophilid sp.	Listed in Roy et al (2012)
Glischrochilus quadrisignatus	Listed in Roy et al (2012)
Glossostigma diandrum	Rated as critical in Thomas (2010)
Glossostigma elatinoides	Rated as moderate risk in Thomas (2010)
Gymnocoronis spilanthoides	Rated as moderate risk in Thomas (2010)
Gymnodinium mikimotoi	Main species in Hill et al (2005)
Hemianthus callitrichoides	Rated as low risk in Thomas (2010)
Hemianthus micranthemoides	Rated as low risk in Thomas (2010)
Hemigraphis colorata	Rated as low risk in Thomas (2010)
Hemigraphis exotica	Rated as low risk in Thomas (2010)
Heteranthera bettzinckiana	Rated as low risk in Thomas (2010)
Heteranthera dubia	Rated as low risk in Thomas (2010)
Heteranthera zosterifolia	Rated as low risk in Thomas (2010)
Horidiplosis ficifolii	Listed in Roy et al (2012)
Hottonia inflata	Rated as low risk in Thomas (2010)
Hydrochoerus hydrochoaeris	Rated as high risk in Parrott et al (2009)
Hydrocotyle leucocephala	Rated as low risk in Thomas (2010)
Hydrocotyle variegata	Rated as low risk in Thomas (2010)
Hydrocotyle verticillata	Rated as moderate risk in Thomas (2010)
Hydrotriche hottoniiflora	Rated as low risk in Thomas (2010)
Hygrophila angustifolia	Rated as low risk in Thomas (2010)
Hygrophila corymbosa	Rated as low risk in Thomas (2010)
Hygrophila costata	Rated as low risk in Thomas (2010)
Hygrophila difformis	Rated as low risk in Thomas (2010)
Hygrophila lacustris	Rated as moderate risk in Thomas (2010)
Hygrophila polysperma	Rated as low risk in Thomas (2010)
Hygrophila rosae australis	Rated as low risk in Thomas (2010)
Hygrophila rosanervis	Rated as low risk in Thomas (2010)
Hygrophila salicifolia	Rated as low risk in Thomas (2010)
Hygrophila thailand stricta	Rated as low risk in Thomas (2010)
Hygroryza aristata	Rated as moderate risk in Thomas (2010)
Hypophthalamichthys moitrix	Main species in Hill et al (2005)
Icerya purchasi	Listed in Roy et al (2012)
Idiopterus nephrelepidis	Listed in Roy et al (2012)
Iguanidae	Rated as low risk in Parrott et al (2009)
Illinoia rhododendri	Listed in Roy et al (2012)
Isoetes japonica	Rated as low risk in Thomas (2010)
Isoetes velata	Rated as low risk in Thomas (2010)
Juncus 'Curly Gold Strike' (v)	Rated as low risk in Thomas (2010)
Juncus decipiens 'Curly-wurly'	Rated as low risk in Thomas (2010)
Juncus 'Goldstrike'	Rated as low risk in Thomas (2010)
Juncus repens	Rated as low risk in Thomas (2010)
Juncus xiphioides	Rated as urgent in Thomas (2010)
Labyrinthula zosterae	Listed in Roy et al (2012)
Lagenandra ovata	Rated as low risk in Thomas (2010)
Lagenandra thwaitesii	Rated as low risk in Thomas (2010)
Lampropeltis spp	Rated as medium risk in Parrott et al (2009)
Leia arsona	Listed in Hill et al (2005)
Leucaspis podocarpi	Listed in Hill et al (2005)
Lilaeopsis brasiliensis	Rated as low risk in Thomas (2010)
Lilaeopsis mauritiana	Rated as low risk in Thomas (2010)
Lilaeopsis novaezelandiae	Rated as low risk in Thomas (2010)
Limnobium laevigatum	Rated as low risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Limnobium spongia	Rated as critical in Thomas (2010)
Limnophila aquatica	Rated as low risk in Thomas (2010)
Limnophila aromatica	Rated as low risk in Thomas (2010)
Limnophila conferta	Rated as low risk in Thomas (2010)
Limnophila gigantea	Rated as low risk in Thomas (2010)
Limnophila heterophylla	Rated as low risk in Thomas (2010)
Limnophila hippuroides	Rated as low risk in Thomas (2010)
Limnophila sessiliflora	Rated as low risk in Thomas (2010)
Lindernia grandiflora	Rated as moderate risk in Thomas (2010)
Lindernia rotundiflora	Rated as low risk in Thomas (2010)
Liriomyza chinensis	Rated as low risk in Parrott et al (2009)
Lissorhoptrus oryzophilus	Rated as medium risk in Parrott et al (2009)
Listrodes difficilis	Rated as low risk in Parrott et al (2009)
Loxosomella antedonis	Listed in Roy et al (2012)
Ludwigia arcuata	Rated as low risk in Thomas (2010)
Ludwigia brevipes	Rated as low risk in Thomas (2010)
Ludwigia glandulosa	Rated as low risk in Thomas (2010)
Ludwigia helminthorrhiza	Rated as low risk in Thomas (2010)
Ludwigia inclinata	Rated as low risk in Thomas (2010)
Ludwigia inclinata verticillata 'Pantanale'	Rated as low risk in Thomas (2010)
Ludwigia latifolia	Rated as low risk in Thomas (2010)
Ludwigia ovalis	Rated as moderate risk in Thomas (2010)
Ludwigia perennis	Rated as low risk in Thomas (2010)
Ludwigia repens	Rated as critical in Thomas (2010)
Lythrum virgatum 'Dropmore Purple'	Rated as moderate risk in Thomas (2010)
Macrolabis aquilegiae	Listed in Roy et al (2012)
Macrosiphoniella sanborni	Listed in Roy et al (2012)
Macrosiphum ptericolens	Listed in Roy et al (2012)
Marsilea crenata	Rated as low risk in Thomas (2010)
Marsilia hirsuta	Rated as moderate risk in Thomas (2010)
Masculinium traversum	Rated as low risk in Parrott et al (2009)
Matsucoccus feytaudi	Rated as low risk in Parrott et al (2009)
Mayaca fluviatilis	Rated as moderate risk in Thomas (2010)
Mayaca sellowiana	Rated as low risk in Thomas (2010)
Mayaca vandelli	Rated as low risk in Thomas (2010)
Maylandia (Metriaclima) sp.	Main species in Hill et al (2005)
Medetera grisescens	Listed in Roy et al (2012)
Megadytes costalis	Main species in Hill et al (2005)
Megastigmus nigrovariegatus	Rated as low risk in Parrott et al (2009)
Mentha cervina	Rated as low risk in Thomas (2010)
Mephitis mephitis	NNSS risk assessment of low
Mesocricetus auratus	Rated as low risk in Parrott et al (2009)
Metcalfa pruinosa	Rated as low risk in Parrott et al (2009)
Micranthemum umbrosum	Rated as critical in Thomas (2010)
Micropterus dolomieui	Main species in Hill et al (2005)
Microsorum latifolius	Rated as low risk in Thomas (2010)
Microsorum pteropus	Rated as low risk in Thomas (2010)
Mindarus obliquus	Listed in Roy et al (2012)
Misgurnus mizolepis	Main species in Hill et al (2005)
Monema flavescens	Rated as low risk in Parrott et al (2009)
Monochamus alternatus	Rated as low risk in Parrott et al (2009)
Monochoria hastata	Rated as low risk in Thomas (2010)
Monosolenium tenerum	Rated as low risk in Thomas (2010)

Scientific Name	Primary Risk Assessment
Moritziella corticalis	Main species in Hill et al (2005)
Myriophyllum elatinoides	Rated as critical in Thomas (2010)
Myriophyllum hippuroides	Rated as urgent in Thomas (2010)
Myriophyllum matogrossense	Rated as low risk in Thomas (2010)
Myriophyllum pinnatum	Rated as urgent in Thomas (2010)
Myriophyllum propinquum	Rated as urgent in Thomas (2010)
Myriophyllum propium	Rated as urgent in Thomas (2010)
Myriophyllum 'Red Stem'	Rated as urgent in Thomas (2010)
Myriophyllum tuberculatum	Rated as low risk in Thomas (2010)
Myxobolus artus	Main species in Hill et al (2005)
Myzaphis turanica	Listed in Roy et al (2012)
Myzocallis schreiberi	Listed in Roy et al (2012)
Nasua nasua	NNSS risk assessment of low
Naupactus leucoloma	Rated as low risk in Parrott et al (2009)
Nelumbo nucifera	Rated as low risk in Thomas (2010)
Neobeckia aquatica	Rated as low risk in Thomas (2010)
Neogobius melanostomus	Rated as high risk in Parrott et al (2009)
Neoseiulus californicus	Main species in Hill et al (2005)
Nereis succinea	Listed in Roy et al (2012)
Nesaea crassicaulis	Rated as low risk in Thomas (2010)
Nomaphila siamensis	Rated as low risk in Thomas (2010)
Nomaphila stricta	Rated as low risk in Thomas (2010)
Nomaphila variegata	Rated as low risk in Thomas (2010)
Nuphar japonicum	Rated as moderate risk in Thomas (2010)
Nyctereutes procyonoides	Rated as high risk in Parrott et al (2009)
Nymphaea mexicana	Rated as low risk in Thomas (2010)
Nymphaea odorata subsp. *tuberosa* (H)	Rated as moderate risk in Thomas (2010)
Nymphaea odorata var. *minor* (H)	Rated as low risk in Thomas (2010)
Nymphaea pubescens	Rated as moderate risk in Thomas (2010)
Nymphaea tetragona (H)	Rated as urgent in Thomas (2010)
Nymphaea zenkeri	Rated as low risk in Thomas (2010)
Nymphoides aquatica	Rated as moderate risk in Thomas (2010)
Nysius huttoni	Rated as low risk in Parrott et al (2009)
Oenanthe javanica 'Flamingo' (v)	Rated as critical in Thomas (2010)
Oidium subsp. *pseudoideum*	Main species in Hill et al (2005)
Olisthodiscus luteus	Listed in Roy et al (2012)
Oncorhynchus clarki	Main species in Hill et al (2005)
Orchonectes limosus	Rated as high risk in Parrott et al (2009)
Osteopilus septentrionalis	Rated as medium risk in Parrott et al (2009)
Ottelia ulvifolia	Rated as low risk in Thomas (2010)
Paracolopha morrisoni	Listed in Hill et al (2005)
Paratrichodorus renifer	Listed in Hill et al (2005)
Pealius azaleae	Listed in Roy et al (2012)
Pellucidhaptor pricei	Main species in Hill et al (2005)
Peltandra sagittifolia	Rated as low risk in Thomas (2010)
Peltandra virginica	Rated as critical in Thomas (2010)
Pemphigus populitransversus	Listed in Roy et al (2012)
Periphyllus xanthomelas	Listed in Roy et al (2012)
Petaurus breviceps	Rated as low risk in Parrott et al (2009)
Philometroides sanguinea	Listed in Roy et al (2012)
Phyllanthus fluitans	Rated as low risk in Thomas (2010)
Phytomyza astrantiae	Listed in Roy et al (2012)
Phytomyza gymnostoma	Listed in Roy et al (2012)

Scientific Name	Primary Risk Assessment
Phytophthora alni	Main species in Hill et al (2005)
Pimepales promelas	Listed in Roy et al (2012)
Pimephales promelas	Rated as low risk in Parrott et al (2009)
Pineus orientalis	Listed in Roy et al (2012)
Pineus pineoides	Listed in Roy et al (2012)
Pineus strobi	Listed in Roy et al (2012)
Planococcus vovae	Listed in Hill et al (2005)
Plum pox virus	Main species in Hill et al (2005)
Poecilia reticulata	Main species in Hill et al (2005)
Pogostemon helferi	Rated as low risk in Thomas (2010)
Pontederia lanceolata	Rated as low risk in Thomas (2010)
Popillia japonica	Rated as medium risk in Parrott et al (2009)
Pratylenchus bolivianus	Listed in Roy et al (2012)
Procyon lotor	NNSS risk assessment of medium
Proserpinaca palustris	Rated as moderate risk in Thomas (2010)
Pseudaulacaspis pentagona	Rated as low risk in Parrott et al (2009)
Pseudococcus calceolariae	Listed in Hill et al (2005)
Pseudomonas syringe pv. pisi	Main species in Hill et al (2005)
Psyllaephagus pilosus	Main species in Hill et al (2005)
Puccinia pazchkei var. *pazchkei*	Listed in Hill et al (2005)
Pulvinariella mesembryanthemi	Listed in Roy et al (2012)
Python molurus bivittatus	Rated as high risk in Parrott et al (2009)
Ralstonia solanacearum race 3 biovar 2	Main species in Hill et al (2005)
Ranunculus limosella	Rated as low risk in Thomas (2010)
Resseliella skuhravyorum	Listed in Roy et al (2012)
Reticulitermes lucifugus	Listed in Roy et al (2012)
Reticulitermes lucifugus ssp. *grassei*	Main species in Hill et al (2005)
Rhynchospora colorata	Rated as low risk in Thomas (2010)
Rotala indica	Rated as low risk in Thomas (2010)
Rotala macrandra	Rated as low risk in Thomas (2010)
Rotala rotundifolia	Rated as critical in Thomas (2010)
Rotala wallichii	Rated as low risk in Thomas (2010)
Sagittaria 'Bloomin Babe'	Rated as low risk in Thomas (2010)
Sagittaria filiformis	Rated as low risk in Thomas (2010)
Sagittaria lileopterus	Rated as low risk in Thomas (2010)
Sagittaria platyphylla	Rated as moderate risk in Thomas (2010)
Sagittaria sagittifolia ssp. *leucopetala*	Rated as critical in Thomas (2010)
Sagittaria teres	Rated as urgent in Thomas (2010)
Saissetia oleae	Listed in Hill et al (2005)
Salmo salar sebago	Main species in Hill et al (2005)
Salvelinus malma	Main species in Hill et al (2005)
Salvelinus namaycush	Main species in Hill et al (2005)
Salvinia auriculata	Rated as low risk in Thomas (2010)
Salvinia cucullata	Rated as low risk in Thomas (2010)
Salvinia oblongifolia	Rated as low risk in Thomas (2010)
Samolus valerandi ssp. *Parvifloras*	Rated as moderate risk in Thomas (2010)
Saururus cernuus	Rated as critical in Thomas (2010)
Saururus chinensis	Rated as moderate risk in Thomas (2010)
Scaptomyza adusta	Listed in Roy et al (2012)
Schoenus pauciflorus	Rated as moderate risk in Thomas (2010)
Sciophila fractinervis	Listed in Roy et al (2012)
Selaginella wildenowii	Rated as low risk in Thomas (2010)
Semanotus russicus	Listed in Roy et al (2012)

Scientific Name	Primary Risk Assessment
Sitona discoideus	Rated as low risk in Parrott et al (2009)
Soil-borne cereal mosaic virus	Main species in Hill et al (2005)
Stenotaphryum secundatum variegatus	Rated as low risk in Thomas (2010)
Stephanitis oberti	Rated as low risk in Parrott et al (2009)
Stephanitis takeyai	Listed in Roy et al (2012)
Syngonium podophyllum	Rated as low risk in Thomas (2010)
Syngonium Red Knight	Rated as low risk in Thomas (2010)
Takecallis taiwanus	Listed in Roy et al (2012)
Tamias sibiricus	NNSS risk assessment of medium
Tamias striatus	Rated as medium risk in Parrott et al (2009)
Tetrastichus setifer	Listed in Roy et al (2012)
Thalia dealbata	Rated as moderate risk in Thomas (2010)
Thalia geniculata	Rated as urgent in Thomas (2010)
Thamnophis spp	Rated as medium risk in Parrott et al (2009)
Threskionis aethiopicus	Rated as high risk in Parrott et al (2009)
Tinocallis nevskyi	Main species in Hill et al (2005)
Tinocallis takachihoensis	Rated as low risk in Parrott et al (2009)
Tinocallis ulmiparvifoliae	Listed in Roy et al (2012)
Tinocallis zelkowae	Listed in Roy et al (2012)
Tomato spotted wilt virus	Main species in Hill et al (2005)
Tonina fluviatilis	Rated as low risk in Thomas (2010)
Trichocoronis rivularis	Rated as moderate risk in Thomas (2010)
Trichomanes javinicum	Rated as low risk in Thomas (2010)
Trichosiphonaphis polygonifoliae	Listed in Hill et al (2005)
Trionymus diminutus	Listed in Hill et al (2005)
Tylenchorhynchus claytoni	Listed in Hill et al (2005)
Typha gracilis	Rated as critical in Thomas (2010)
Typhonodorum lindleyanum	Rated as low risk in Thomas (2010)
Urocleidus principalis	Listed in Hill et al (2005)
Uroleucon erigeronensis	Listed in Roy et al (2012)
Utricularia gibba	Rated as urgent in Thomas (2010)
Utricularia sandersonii	Rated as moderate risk in Thomas (2010)
Vallisneria americana	Rated as urgent in Thomas (2010)
Vallisneria asiatica	Rated as urgent in Thomas (2010)
Vallisneria natans var. *natans*	Rated as moderate risk in Thomas (2010)
Vallisneria rubra	Rated as low risk in Thomas (2010)
Vallisneria tortifolia	Rated as moderate risk in Thomas (2010)
Vesicularia dubyana	Rated as low risk in Thomas (2010)
Vesicularia ferriei	Rated as low risk in Thomas (2010)
Vesicularia montaignei	Rated as low risk in Thomas (2010)
Wasabia japonica	NNSS risk assessment of low
Zamenis longissimus	Listed in Roy et al (2012)

Appendix C Datasets contributing to the list of non-native species on Natura 2000 sites

The following table summarises the data providers and datasets that contributed records to the list of non-native species (NNS) for each Natura 2000 site. The effective resolution refers to the highest resolution for relevant species records; the best available resolution for the entire dataset may be higher. Equally, each dataset may also contain lower resolution records, details of which were visible on the Geographical tab of the dataset summary on the NBN Gateway. The number of records refers to the number of records that intersected one or more Natura 2000 site.

Organisation name	Dataset name	Effective resolution	Number of Records
Aggregate Industries	Ecological surveys from Bardon Hill undertaken in the period 2000 to 2007	1km	45
	Wildlife Observations Bardon Hill 31.5.09	1km	8
Amphibian and Reptile Conservation	NARRS Data 2007 – 2011	1km	1
	The ARC Rare Species Database	100m	214
Bedfordshire and Luton Biodiversity Recording and Monitoring Centre	Bedfordshire Bumblebees (BNHS) - 2006-2012	100m	33
	Bedfordshire Coleoptera (BNHS) - 1986-2012	100m	79
	Bedfordshire Fish (BNHS) - 1800-2011	100m	6
	Bedfordshire Flora (BNHS/BSBI) - 1904-2012	100m	6,350
	Bedfordshire Herpetofauna (BNHS/BRAG) - 1973-2013	100m	4
	Bedfordshire Hymenoptera (BNHS) - 1930-2009	100m	3
	Bedfordshire Lacewings and Allies (BNHS) - 1942-2009	100m	1
	Bedfordshire Mammals (BNHS) - 1987-2012	100m	251
	Bedfordshire Micro Moths (BNHS) - 1820-2013	100m	184
Berkshire Reptile and Amphibian Group	BRAG - Berkshire Reptile and Amphibian Records	1km	1
Biodiversity Information Service for Powys and Brecon Beacons National Park	Natural Resources Wales Regional Data : Mid-Wales	100m	33
Biological Records Centre	Atomariine Beetle (Coleoptera) records for Britain and Ireland to 1992	10km	1
	Cerambycidae Dataset	100m	10
	Coccinellidae Data	100m	14
	Crayfish (Crustacea; Astacura) data for Britain and Ireland to 2003	100m	116
	Database for the Atlas of Freshwater Fishes	100m	1,188
	Derek Lott Coleoptera Dataset	100m	211
	Grasshopper and Cricket (Orthoptera) and related species records from Britain and Ireland to 2007	100m	61
	Lacewings and allied insects records from Britain and Ireland to 1999	100m	1
	Ladybird Survey of the UK	100m	2,361

Organisation name	Dataset name	Effective resolution	Number of Records
	Mammal records from Britain from the Atlas of Mammals (1993), with some subsequent records	100m	2,538
	Millipede (Diplopoda) records for Britain and Ireland to 2005	100m	4
	Mosquito Recording Scheme	100m	2
	Moths - John Heath Lepidoptera recording scheme macro-moth data from BRC	100m	264
	Opiliones (Harvestman) Dataset	100m	61
	Reptiles and Amphibians Dataset	100m	12
	RISC Non-Native Species Records for Muntjac	100m	3
	RISC Non-Native Species Records for Rhododendron Leafhopper	100m	3
	Soldier Beetle and Jewel Beetle (Coleoptera; Cantharoidea and Buprestoidea) records for Britain and Ireland to 2000	100m	10
	Ticks (Ixodidea) distribution for the British Isles	100m	21
	UK Ladybird Survey data from iRecord	100m	3
Botanical Society of the British Isles	RISC Botanical Non-Native Species Records	100m	26
	Vascular Plants Database	100m	37,504
	Vascular Plants Database additions since 2000	100m	48,210
Bristol Regional Environmental Records Centre	BRERC April 2013	100m	27,278
British Bryological Society	Bryophyte data for Great Britain from the British Bryological Society held by BRC	100m	3,099
British Phycological Society	Seaweed data for Great Britain and Ireland	100m	147
British Trust for Ornithology	Non-native-bird records from WeBS and BBS	10km	11,590
Buckinghamshire and Milton Keynes Environmental Records Centre	Amphibians and Reptiles in Buckinghamshire	100m	3
	Birds in Buckinghamshire	100m	1,893
	Bryophytes in Buckinghamshire	100m	35
	Crustaceans in Buckinghamshire	100m	5
	Freshwater Fish in Buckinghamshire	100m	5
	Mammals in Buckinghamshire	100m	531
	Molluscs in Buckinghamshire	100m	199
	Vascular Plants in VC24	100m	2,708
Butterfly Conservation	Butterfly distributions for Great Britain for the period 1690-1999 from Butterfly Conservation and the Biological Records Centre	100m	16

Organisation name	Dataset name	Effective resolution	Number of Records
	Macro-moth provisional distribution for the British Isles (excluding the Republic of Ireland) from the National Moth Recording Scheme	100m	7,928
Cambridgeshire & Peterborough Environmental Records Centre	Chippenham Fen Moth surveillance project	100m	11
	Orthoptera dataset held by CPERC	100m	2
Cofnod (North Wales Environmental Information Service)	NRW Regional Data: North Wales	100m	112
Conchological Society of Great Britain & Ireland	Mollusc (marine) data for Great Britain and Ireland	100m	488
	Mollusc (non-marine) data for Great Britain and Ireland	100m	3,244
	Mollusc (non-marine): 1999 Atlas Dataset for Great Britain and Ireland	100m	114
	Mollusc (non-marine): Compilation of records of rare and scarce species for Great Britain and Northern Ireland	100m	157
Cumbria Biodiversity Data Centre	Additional species observations for Cumbria Biodiversity Data Centre Partners ONLY containing species observations for Cumbria for the period 1000 to 2013	100m	2,438
	CBDC: Cumbria Wildlife Trust: survey records from 1970 - 2007 of County Wildlife Sites.	100m	26
	Cumbria Biodiversity Data Centre fungi and lower plant species observations for Cumbria for the period 1845 to 2011	100m	80
	Cumbria Biodiversity Data Centre invertebrate species observations for Cumbria for the period 1500 to 2011	100m	878
	Cumbria Biodiversity Data Centre vertebrate species observations for Cumbria for the period 1512 to 2011	100m	1,293
	Norman and Florence Hammond records. Seawatch and coastal survey records.	100m	22
	Norman and Florence Hammond records. Seawatch and coastal survey records.	100m	22
	Wildwatch North Pennines AONB project records for Cumbria 2012	100m	4
Derbyshire Biological Records Centre	Derbyshire HYMENOPTERA records - Casual records collated by Derby Museum.	100m	9
	Derbyshire & Peak District Protected Species Database (Summary of available records 1970- 2008)	100m	2
	Derbyshire Invasive Vascular Plants (INNS) 1900 - 2011	100m	1,141
	Hemiptera Records 1969 - 2011	100m	9
Devon Biodiversity Records Centre	Dartmoor National Park survey data (1910-1970)	100m	36
	Devon incidental species records 1950-2002	100m	502
Dipterists Forum	Dipterists Forum - Field Week 1999 (North West England)	1km	5

Organisation name	Dataset name	Effective resolution	Number of Records
	Dipterists Forum - Field Weeks 2000 & 2001 (Cornwall & Devon)	1km	5
Dorset Environmental Records Centre	Bryophyte Survey of the Poole Basin Mires - NBN South West Pilot Project Case Studies	100m	32
	Dorset Argiope - NBN South West Pilot Project Case Studies	100m	95
	Dorset Hygromia cinctella - NBN South West Pilot Project Case Studies	100m	2
	Dorset Important Species 2013 for statutory agencies only	100m	6,242
	Dorset Invasive Alien Plants - NBN South West Pilot Project Case Studies	100m	310
	Dorset Sites of Nature Conservation Interest (SNCI) species records 2000-2008	100m	206
	Dorset Sites of Nature Conservation Interest (SNCI) species records pre 2000	100m	417
	Dorset SSSI Species Records 1952 - 2004 (Natural England)	100m	1,257
	Dorset Wildlife Trust Reserve Records	100m	41
Dr Francis Rose Field Notebook Project	Field Notebook Records of Dr Francis Rose 1950's to 1990's	100m	1,338
Environment Agency (Biodiversity staff)	Crayfish data update for Environment Agency Thames Region March 2009	100m	13
	Environment Agency Non-native Species records v1	100m	5,308
Environmental Records Centre for Cornwall and the Isles of Scilly	Bannister Beetle distribution dataset from 1922 to 1976 for Cornwall and the Isles of Scilly.	1km	19
	Bird species distribution dataset for Cornwall from various sources, records from 1991 to 2010.	100m	1,011
	Carnivora records for Cornwall and the Isles of Scilly	100m	123
	Coleoptera species distribution dataset from 1900 to 2008 for Cornwall and the Isles of Scilly	100m	3
	Fungi species distribution dataset from 1847 to 2009 for Cornwall and the Isles of Scilly.	100m	28
	Hoverfly species distribution dataset from 1997 to 2009 for Cornwall and the Isles of Scilly.	100m	13
	Insectivora records for Cornwall and the Isles of Scilly	100m	6
	Invasives (Fresh water plants) distribution dataset from 2004 to 2011 for Cornwall and the Isles of Scilly (The Pond Check Project)	100m	14
	Invasives (Himalayan Balsam) distribution dataset from 2006 to 2010 for Cornwall and the Isles of Scilly	100m	42

Organisation name	Dataset name	Effective resolution	Number of Records
	Invasives (Japanese Knotweed) distribution dataset from 1979 to 2011 for Cornwall and the Isles of Scilly	100m	283
	Lagomorpha and Artiodactyla records for Cornwall and the Isles of Scilly	100m	263
	Lepidoptera species distribution dataset from 1981 to 2008 for Cornwall and the Isles of Scilly	100m	365
	Orthoptera records from 1850 to 2009 for Cornwall and the Isles of Scilly	100m	31
	Rodentia records for Cornwall and the Isles of Scilly	100m	108
Environmental Records Information Centre North East	ERIC North East non-sensitive species records	100m	10,153
	ERIC North East sensitive species records	100m	350
Flea (Siphonaptera) Recording Scheme	Flea (Siphonaptera) Distributions in Britain and Ireland: pre 1975, 1975 onwards	100m	59
Greater Lincolnshire Nature Partnership	Lincolnshire Beetles	100m	176
	Lincolnshire Harvestmen	100m	1
	Lincolnshire Mammals (excluding bats)	100m	817
	Lincolnshire Moths	100m	305
	Lincolnshire Sawflies	10km	2
	Lincolnshire Spiders	100m	96
	Lincolnshire True Bugs (terrestrial)	100m	2
	Lincolnshire Vascular Plants (north)	100m	5,818
Greater Manchester Ecology Unit	Bird Records held by Greater Manchester Ecology Unit	100m	83
	Distribution of Hares in Greater Manchester	100m	16
	Distribution of Higher Plants in Greater Manchester	100m	221
	Distribution of Invasive and Non-Native Species in Greater Manchester	100m	74
	Distribution of Species of Conservation Interest in Greater Manchester	100m	1
Ground Beetle Recording Scheme	Carabid data for Great Britain from the Ground Beetle Recording Scheme held by BRC	100m	162
Hampshire Biodiversity Information Centre	HBIC and partners species records	100m	2,301
	HBIC Non-Native Invasive Species.	100m	24,772
	HBIC Protected and notable species	100m	14,837
Herefordshire Biological Records Centre	Herefordshire Biological Records Centre Species Records	100m	2,918
Hertfordshire Natural History Society Flora Group	Hertfordshire Flora Survey Records 1987-2005	1km	1,165

Organisation name	Dataset name	Effective resolution	Number of Records
Herts Environmental Records Centre	Birds, records for Hertfordshire, 2008 - 2011	100m	14
	Hertfordshire Habitat Survey 1995 - 1997	100m	23
	Hertfordshire Local Wildlife Site Surveys	100m	18
	Hertfordshire Lowland Meadow Inventory Survey 2010	100m	5
	Hertfordshire Miscellaneous records	100m	1
	Hertfordshire Pond Survey 1986	100m	1
	Hertfordshire Wet Woodland Project 2007	100m	14
	South Herts Phase 1 Survey 1984-1989 (Hertfordshire)	100m	64
Highland Biological Recording Group	HBRG Insects Dataset	100m	2
Hoverfly Recording Scheme	Hoverfly Recording Scheme database for Great Britain	100m	1,119
Isle of Wight Local Records Centre	IOW Natural History & Archaeological Society Marine Invertebrate Records 1853- 2011	100m	2
	Reptiles and amphibians of the Isle of Wight Trial data set	1km	2
Joint Nature Conservation Committee	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by JNCC	100m	1,517
	Vegetation surveys of coastal shingle in Great Britain	100m	268
Kent & Medway Biological Records Centre	Fish: Records for Kent.	100m	2
	Orthoptera & Allies: Records for Kent	100m	1
Leicestershire and Rutland Environmental Records Centre	Leicestershire & Rutland Coleoptera	100m	177
	Leicestershire Bryophyte Data	100m	145
	Leicestershire Gastropod Records	100m	22
	Leicestershire Mammal Records to end of 2009	100m	19
	Leicestershire Spider Records	100m	153
Marine Biological Association	2005-Ongoing United Kingdom MarLIN Shore Thing timed search results	100m	97
	DASSH Data Archive Centre academic surveys	100m	8
	DASSH Data Archive Centre expert sightings records	100m	15
	DASSH Data Archive Centre Statutory Agency and commercial marine surveys	100m	150
	DASSH Data Archive Centre volunteer sightings records	100m	30
	DASSH Data Archive Centre volunteer survey data	100m	60
	RISC and ALERT Marine Non-Native Species (Chinese Mitten Crab, Wakame and Carpet Sea Squirt) Records	100m	31
Marine Conservation Society	Seasearch Marine Surveys	100m	227

Organisation name	Dataset name	Effective resolution	Number of Records
Merseyside BioBank	Merseyside BioBank Active Naturalists (unverified)	100m	34
	Merseyside BioBank Active Naturalists (unverified)	100m	34
	Merseyside BioBank NBN Frequently Updated Taxa	100m	32
	Merseyside BioBank NBN Frequently Updated Taxa	100m	32
	North Merseyside Birds (unverified)	100m	451
	North Merseyside Birds (unverified)	100m	451
	North Merseyside Birds (unverified)	100m	451
	North Merseyside Birds (verified)	100m	336
	North Merseyside Birds (verified)	100m	336
	North Merseyside Flowering Plants (unverified)	100m	891
	North Merseyside Flowering Plants (unverified)	100m	891
	North Merseyside Flowering Plants (verified)	100m	418
	North Merseyside Flowering Plants (verified)	100m	418
	North Merseyside Insects (unverified)	100m	14
	North Merseyside Insects (unverified)	100m	14
	North Merseyside Insects (verified)	1km	1
	North Merseyside Insects (verified)	1km	1
	North Merseyside Mammals (unverified)	100m	3
	North Merseyside Mammals (unverified)	100m	3
	North Merseyside Mammals (verified)	100m	102
	North Merseyside Mammals (verified)	100m	102
	North Merseyside Other Taxa (unverified)	100m	46
	North Merseyside Other Taxa (unverified)	100m	46
	North Merseyside Other Taxa (verified)	100m	12
	North Merseyside Other Taxa (verified)	100m	12
National Barkfly Recording Scheme	Outdoor Psocoptera (barkfly) records for Britain & Ireland, 1850 to present.	100m	15
National Trust	Hatfield Forest species data held by The National Trust.	100m	608
	Heigham Holmes species data held by The National Trust	100m	172
	Sutton Hoo species data held by The National Trust.	100m	60
	Wicken Fen nature reserve species data held by The National Trust	100m	1,074
Natural England	Invertebrate Site Register - England (1738-2005).	100m	1,547

Organisation name	Dataset name	Effective resolution	Number of Records
	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by English Nature	100m	60
	Species Surveillance Project - In-House Pilots records for 2012	100m	2
Natural Resources Wales	Marine Intertidal Phase 1 species dataset from the Countryside Council for Wales 1996-2005	100m	4
	Marine Sightings & Miscellaneous species records from Natural resources Wales (NRW), 2008 onwards	100m	4
	Rare Flowering Plant and Fern Data	100m	1
	Welsh Invertebrate Database (WID)	100m	135
	Welsh Peatland Invertebrate Survey (WPIS)	100m	2
Nature Locator	PlantTracker data from 2012 onwards	100m	336
NBN Gateway Demonstration	Demonstration dataset for record commenting on the NBN Gateway	1km	4
Norfolk Biodiversity Information Service	Norfolk Species of Conservation Concern	100m	11,194
Northamptonshire Biodiversity Records Centre	Data on a range of alien invasive species (as listed under Schedule 9 of the Wildlife and Countryside Act)specified by Natural England for Northamptonshire for dates up to November 2011	100m	94
	Data on a range of protected and notable species specified by Natural England for Northamptonshire for dates up to September 2013.	100m	105
Northumberland Wildlife Trust	Red squirrel (*Sciurus vulgaris*) and grey squirrel (*Sciurus carolinensis*) distribution for Northern England for the period August 2006 to May 2009	1km	570
Nottinghamshire Biological and Geological Records Centre	NBGRC Crayfish Dataset	100m	5
	Nottinghamshire Biodiversity Action Group Himalayan Balsam Survey	100m	15
	Nottinghamshire Biodiversity Action Group Japanese Knotweed Survey	100m	17
	UK abstract from Nottingham City Museums & Galleries (NCMG) Insect Collection Baseline database	100m	23
People's Trust for Endangered Species	*Living with Mammals* survey: sightings from 2003 to 2011	1km	6,403
Plantlife International	Back from the Brink vascular plant species abundance and distribution for Great Britain for the period 2002-2009	100m	112
Pond Conservation	National Pond Monitoring Network collated pond survey data for Great Britain 1972 to 2007	100m	280
Porcupine Marine Natural History Society	Marine flora and fauna records from the North-east Atlantic	100m	6
Record, the Biodiversity Information System for Cheshire, Halton, Warrington and the Wirral	RECORD Aculeate Hymenoptera Data up to current day	100m	107
	RECORD Aves Data up to current day	100m	4,130
	RECORD Bryopsida Data up to current day	100m	81

Organisation name	Dataset name	Effective resolution	Number of Records
	RECORD Coccinellidae Data up to current day	100m	47
Royal Horticultural Society	European Pear Rust (*Gymnosporangium sabinae*) monitoring	1km	45
	Nezara viridula records held by the Royal Horticultural Society	10km	6
	Pittosporum sucker (*Trioza vitreoradiata*) records acquired by the Royal Horticultural Society	10km	6
	Records from the RHS insect reference collection	10km	47
	RHS berberis sawfly (*Arge berberidis*) monitoring	10km	117
	RHS Hemerocallis midge survey	10km	50
	RHS lily beetle (*Lilioceris lilii*) monitoring	10km	742
	RHS monitoring of native and naturalised plants and animals at its gardens and surrounding areas	100m	2,109
	RHS rosemary beetle (*Chrysolina americana*) monitoring.	10km	250
	Wisteria scale (*Eulecanium excrescens*) records acquired by the Royal Horticultural Society	10km	3
RSPB	Bringing Reedbeds to Life Amphibian Survey of two key reedbed sites in England in 2010	100m	45
	Bringing Reedbeds to Life Invertebrate Survey of three key reedbed sites in England in 2009, 2010	100m	97
	Bringing Reedbeds to Life Water Vole and Mink Survey of five key reedbed sites in England in 2009, 2010	100m	24
	House Sparrow Parks Project, London, 2009-2010	100m	15
	RSPB Big Garden Birdwatch winter sightings in the UK in 2009	100m	298
	RSPB Reserves breeding bird surveys	100m	215
Scottish Natural Heritage	Marine species data for Scottish waters held and managed by Scottish Natural Heritage, derived from benthic surveys 1993 to 2012	100m	1
	Reports of New Zealand Flatworms in Scotland, 1989 - 2005	1km	17
	Standing Waters Database - Scotland	100m	126
Scottish Wildlife Trust	The Scottish Squirrel Database	100m	9
Seed and Leaf Beetle Recording Scheme	Bruchid and Chrysomelid Distributions in Britain and Ireland: pre 1900, 1900-1979, 1980 onwards	100m	172
Shire Group of Internal Drainage Boards	Shire Group IDB species data 2004 to present	100m	37
Shropshire Ecological Data Network	Shropshire Ecological Data Network Database	100m	4,235
Somerset Environmental Records Centre	Species Recorded in Somerset	100m	6,379
Spider Recording Scheme	British Arachnological Society/Spider Recording Scheme's Provisional Atlas of British Spiders dataset	100m	2,052

Organisation name	Dataset name	Effective resolution	Number of Records
St Helens Wildlife Recording Group	St Helens Wildlife Dataset	1km	60
Staffordshire Ecological Record	Mollusc records for specimens held at the Stoke-on-Trent Potteries Museum	100m	9
	SER Site-based Surveys	100m	948
	SER Species-based Surveys	100m	1,424
	Staffordshire Wildlife Trust Nature Reserves Inventory	100m	118
	Stoke-on-Trent Environmental Survey results (1982-1984)	100m	44
Suffolk Biological Records Centre	Suffolk Biological Records Centre (SBRC) dataset	100m	24,068
Surrey Biodiversity Information Centre	Surrey Mammals Records (General)	100m	490
	Surrey Wildlife Trust Nature Reserves - Tranche 1 Species Records	100m	1,078
Sussex Biodiversity Record Centre	Patrick Roper's Notebooks	100m	34
	SxBRC Full dataset for Environment Agency and Natural England use only	100m	45,996
Sylva Foundation	European Pear Rust (*Gymnosporangium sabinae*) monitoring	1km	44
Tachinid Recording Scheme	Tachinid Recording Scheme - GB and Ireland records	100m	102
Terrestrial Heteroptera Recording Scheme (Shieldbugs & allied species)	Flickr (01) Shieldbugs & allied species	100m	7
	iSpot (2008-2010): Shieldbugs & allied species	100m	1
	RISC Heteroptera Non-Native Species Records	100m	17
Thames Valley Environmental Records Centre	BBOWT Local Wildlife Sites Surveys 1994-2003	100m	155
	English Nature and NCC Oxfordshire Surveys	100m	57
	English Nature Berkshire SSSI Records	100m	15
	English Nature Grassland Survey 1995	100m	1
	English Nature Oxford City Surveys	100m	7
	English Nature Oxfordshire Chalk Grassland Survey	100m	44
	English Nature Oxfordshire Fen Survey 1990-1991 (A Comparative Survey of Rich Calcareous Fens of Oxfordshire) (as held by Thames Valley Environmental Records Centre)	100m	3
	English Nature Oxfordshire Invertebrate Surveys	100m	12
	Local Wildlife Site Surveys Berkshire	100m	103
	Local Wildlife Site Surveys Oxfordshire	100m	127
	Nature Conservancy Council Berkshire Meadows Survey 1984-87 (as held by Thames Valley Environmental Records Centre)	100m	6
	Nature Conservancy Council Oxfordshire Fen Survey 1983 (as held by Thames Valley Environmental Records Centre)	100m	18

Organisation name	Dataset name	Effective resolution	Number of Records
	Nature Conservancy Council Survey of Ancient Woodlands in Berkshire.	100m	50
	NCC Berkshire Grassland Survey 1984-1987	100m	6
The Bat Conservation Trust	The BCT/MTUK Bats & Roadside Mammals Survey	100m	26
The Mammal Society	National Mammal Atlas Project, online recording	100m	91
Tullie House Museum	Tullie House Museum Natural History Collections	100m	133
Warwickshire Biological Records Centre	Warwickshire Rare Plants	100m	27
	Warwickshire Veteran Trees	100m	3
Wiltshire and Swindon Biological Records Centre	Wiltshire & Swindon Incidental Species Records	100m	19,531
	Wiltshire & Swindon Site-based Survey Records	100m	5,212
Worcestershire Biological Records Centre	Natural England species data for SSSI within Worcestershire from date of notification to present	100m	2,587
	Species data for Special Wildlife Sites within Worcestershire from date of notification to present.	100m	95
	WBRC Species data for Worcestershire collated by date.	100m	1,307
	WBRC Species data for Worcestershire collated by species group	100m	697
	Worcestershire Wildlife Trust species data for owned and managed Reserves within Worcestershire from date of first acquisition to present.	100m	849
Yorkshire Naturalists' Union Marine and Coastal Section	Yorkshire Naturalists Union Marine and Coastal Section Records	100m	6
Yorkshire Wildlife Trust	Yorkshire Wildlife Trust Shoresearch	100m	2

Appendix D Email sent to Natural England site managers

The following generic email was sent to each Natural England site manager involved in the comparison of non-native species (NNS) distribution against their on the ground knowledge.

Dear ContactName,

We are working on an IPENS funded Natural England project looking at the impact of Invasive Non-Native Species (INNS) on Natura 2000 (N2K) sites. I understand that you have spoken to Megan Ellershaw or Jan Maclennan at Natural England and have kindly agreed to 'ground truth' the data we have collated.

The project aims to address the impact on INNS on favourable condition of N2K sites in England. It has two main objectives:

1. *To audit the existing information available and create a baseline of INNS pressure on N2K sites. This has now also been extended to cover all SSSIs in England as well. These baseline data will be made available to Natural England site managers in order to help them make management decisions.*
2. *To identify appropriate tools and infrastructure to ensure data flow from on the ground staff to a centralised database (i.e. the NBN Gateway) and vice versa. This will hopefully ensure that Natural England site managers will have the most up to date information on INNS available and will help them add to the national picture to inform policy and strategy.*

So far in this project we have created a master list of 3,689 NNS, drawn entirely from existing lists. We have used this list to obtain records of these species from the NBN Gateway and extract records from Natural England's larger systems (primarily Marine Recorder, EMD and ISAT). We then used spatial analysis to work out which records were relevant to each N2K site, considering only those records that were 1km resolution or better, to create individual site lists. It is the list for SiteName that we would like you to check, as understanding your knowledge of the NNS present on that site will help us to demonstrate the case for increased data flow, both to and from Natural England site managers.

Please note that we do not expect you to visit the site to check whether the species listed are present, as we want to understand your current knowledge and confirming the presence of some species may be difficult or impossible. This is also not a test of your knowledge of the species on the list, as we're not expecting anyone to know every species on the full list, some of which are quite obscure. What we would like you to do is look through the attached list and answer the following questions by selecting from the drop down list in the relevant column:

- *Were you aware that the species had been recorded on the site?*
- *Do you know that the species definitely isn't present?*
- *Is there or has there been any management actions targeted at the species?*
- *If so, have these management actions resulted in the eradication of the species?*
- *Is the knowledge that the species has been recorded likely to lead to actions, e.g. surveys for the species or management?*
- *Are you aware of any other NNS on site that are not included in the list? There is a separate spreadsheet for this question.*

The list includes: the Latin and common name; the higher taxon group; the status of the species based upon the most reliable assessment; and the total number of records and date range of the most recent record, which is some cases may not have been accurately recorded. Note that there are two types of records: records that are completely within the site boundary, and were therefore definitely present assuming the grid reference was accurate; and those that intersect with the boundary and may therefore be on site or nearby.

Please could you complete and return the attached spreadsheet by the 6th June. Apologies for the short timescale – we are working to a tight timetable and would ideally like to allow you more time, but this simply isn't possible. You'll note that the spreadsheets are protected, but you should be able to select the options in the relevant cells.

We will be acknowledging the people that help with this project in the project report. Please could you also let me know if you would prefer to remain anonymous?

Many thanks in advance for your assistance. If you have any problems, please don't hesitate to contact me using the details below.