Non-Native Species in Great Britain: establishment, detection and reporting to inform effective decision making

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Summary

Here we report on a three-year Defra-funded study to enhance the ability to detect and report non-native species in GB. The specific aims of the project were:

- to document the distribution of non-native species in Great Britain;
- to assess whether there are changes in the rates of these processes;
- to document the impact of non-native species introductions to Great Britain; and
- to make this information available to key data users via web-based media.

The collation of data was coordinated by the Centre for Ecology & Hydrology (CEH) in collaboration with the British Trust for Ornithology, the Marine Biological Association and the Non-Native Species Secretariat. Additional experts, nominated by the Biological Records Centre (within CEH) volunteer schemes and societies, provided further information on many of the species. Of particular note was the involvement of the Botanical Society of the British Isles who provided information for 1873 species.

The project involved populating a database of non-native species (hereafter called "the species register") with additional information provided in the form of factsheets for 300 of the species. Both these components are delivered through the GB Non-Native Species Information Portal (GB-NNSIP) hosted by the Non-Native Species Secretariat. An on-line system (alongside an e-mail account) for rapid-reporting capability, whereby particularly important new arrivals (so called "alert species") can be immediately notified to the relevant bodies, was developed as an integral component of the GB-NNSIP. This was linked to an additional on-line recording site called Recording Invasive Species Counts (RISC), primarily designed for public participation.

There are 3758 species included within the species register. Information has been completed for 3204 species which constitutes 85.3% of the total list. The 554 species with incomplete information include 239 insects, 222 fungi (26 other microorganisms), 40 non-insect invertebrates, 24 lower plants, 2 higher plants and 1 alga. Information for the majority of these will be completed by early 2012.

The majority of species (2482 species) within the species register are categorised simply as non-native, that is they are species introduced by human action outside their natural past or present distribution. However, there are a number of other categories of non-nativeness which are relevant to the species register: for the purposes of this report all categories of non-nativeness are included but those designated with certainty as "unknown" (9.7%) are excluded. Therefore, there is a total of 2889 non-native species within the species register with completed information.

Each species occupies a row within the database with information on aspects of the species' biology such as environment (marine, freshwater, terrestrial etc), functional type (predator, parasite etc), habitats occupied in the invaded range (using EUNIS classification), invasion pathways, establishment status in GB and impacts.

The data compiled within this project are indicative of current knowledge collated by many recognised experts. However, a database such as the species register will be incomplete both because of the number of new species arriving within GB annually and the species which remain cryptic particularly for groups considered to be difficult, such as parasites. Additionally it is difficult to determine the status of some species with respect to whether they are native or non-native, established and the impact that they may have within the invaded range. The involvement of so many experts has undoubtedly minimised the number of omissions and errors.

There are 1875 established non-native species in GB in total. The majority are higher plants (1377 species). Insects are the next most numerous group (278 species) followed by non-insect invertebrates (141 species), vertebrates (50 species), lower plants (25 species) and four other species. It should be noted that the information for 26 established non-native species within the species register is incomplete and so the summaries within this report are based on the 1849 established non-native species for which the information is complete.

Most (1684 species) of the documented established non-native species are found within the terrestrial environment of which higher plants (1350 species) are the largest group within the terrestrial environment. Within the freshwater environment higher plants (23 species) and non-insect invertebrates (23 species) dominate the established species. Non-insect invertebrates (50 species) are also the most numerous of the established non-native species within the marine environment.

There has been a dramatic increase over time in the number of non-native species arriving in Britain and those becoming established. 528 species arrived during 1950-1999 compared to 417 species during 1900-1949 and 250 species during 1850-1899. The majority are not invasive but those that do cause ecological &/or socio-economic impacts generally become permanent burdens if they become established. There have been at least a further 125 new arrivals since 2000 but only 40 of these are known to have established for many of the others information on establishment status is not yet available. Most of the non-native species that are established within Britain originate from Europe. However, in recent decades the rate of new arrivals originating from Europe is slowing and temperate Asia and North America are both becoming major contributors to the non-native fauna and flora of GB.

The majority (1024 species) of non-native species arriving and establishing in terrestrial environments do so as ornamental introductions. The dominant pathways for non-native species in freshwater environments are ornamental (21 species) and aquaculture (23 species). In the marine environment the arrival pathway for many non-native species is unknown but stowaways (40 species) and aquaculture (19 species) are both dominant pathways.

From a preliminary assessment of the 1849 established non-native species in GB, 282 species were found to have either a negative ecological or human impact. 147 species (8.0% of the total number of established non-native species) are considered to have a negative ecological impact and 188 species (10.2% of the total number of established non-native species)

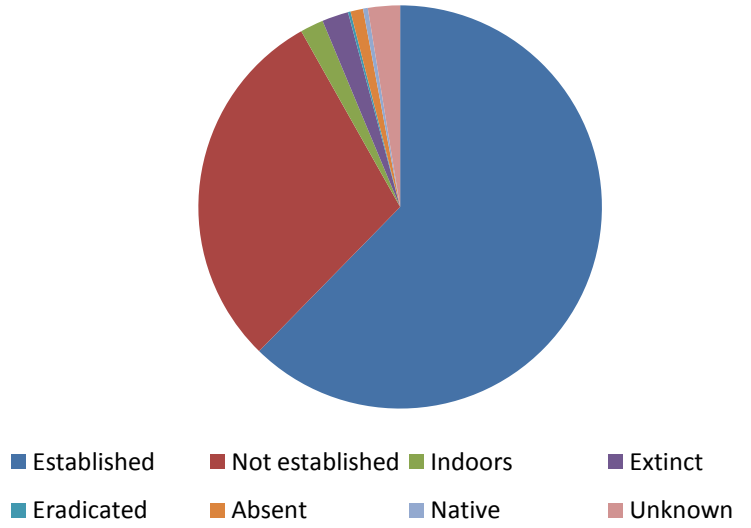
a negative human impact, with 53 species (2.9% of the total number of established non-native species) designated as having both a negative human and ecological impact. There are 108 established non-native plants and 173 established non-native animals (and one other species *Coscinodiscus wailesii*, a marine alga) considered to have a negative ecological or human impact.

A number of key recommendations are provided but particular attention should be given to further enhancement of flow of non-native species distribution data from the many (and diverse) data providers. The on-line systems developed within this project should facilitate data flow but additional development will be required for a comprehensive approach.

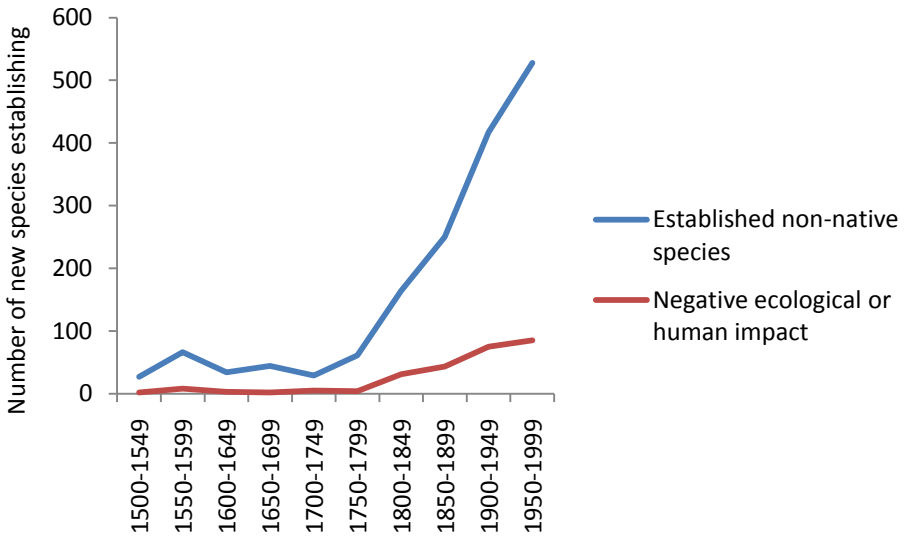
GB Non-Native Species Report Card 2011

Confidence assessment: High confidence, medium confidence and low confidence

- More than 2889 non-native species
- 1875 established (self-sustaining populations) non-native species comprising 1402 established non-native plants and 469 established non-native animals and 4 other species
- Total of 7 non-native species are known to have been eradicated from GB
- 282 established non-native species have been designated as having a negative ecological or human impact: 173 established non-native animals, 108 established non-native plants and 1 other species

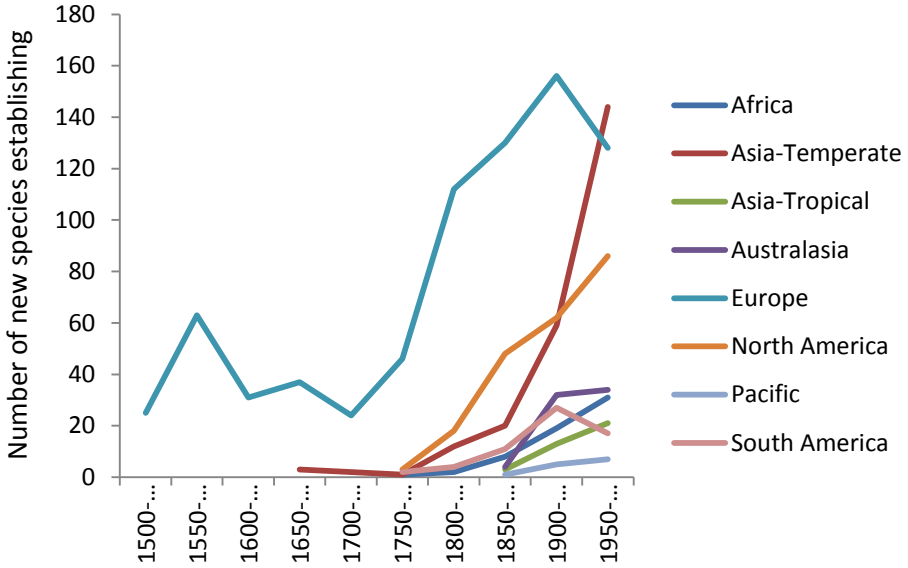


Establishment status of the species within the GB-NNSIP



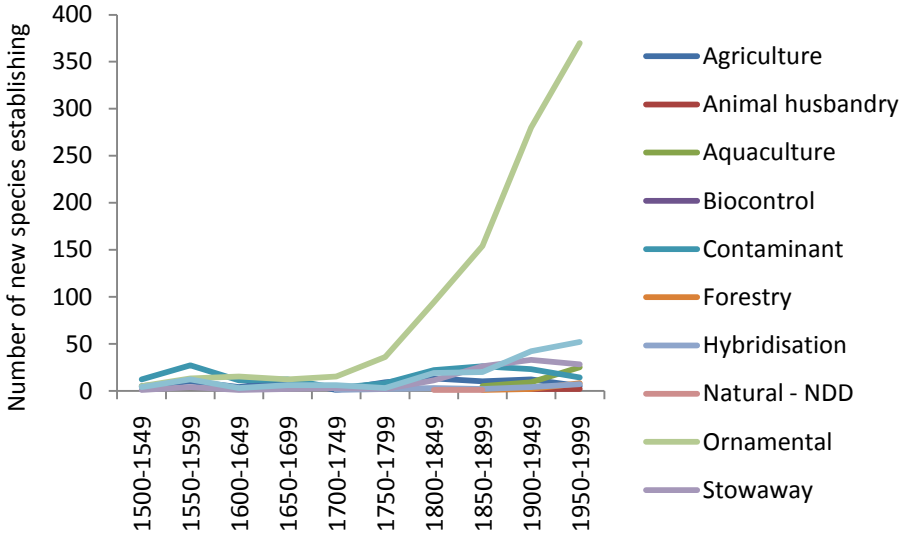
Number of established non-native species and the number that are designated as having a negative ecological or human impact against date of first arrival

There has been a dramatic increase in the number of species arriving and those becoming established over the last 400 years and there is no indication of this trend slowing. Indeed over the last 200 years there have been 6.8 additional non-native species arriving and establishing per year in contrast to 0.8 additional non-native species arriving and establishing per year from 1600-1799. The number of established non-native species designated as having a negative ecological or human impact is also increasing with 1.2 of the new species per year causing an impact.



Number of established non-native species originating from different regions against date of first arrival

Most of the non-native species that are established within GB originate from Europe. However, in recent decades the rate of new arrivals originating from Europe is slowing and temperate Asia and North America are becoming both major contributors to the non-native fauna and flora of GB.



Number of established non-native species arriving through different pathways against date of first arrival

Most established non-native species in GB have arrived for ornamental purposes usually as garden plants but also for landscape planting and through the introduction of exotic animals. There has been a dramatic increase in species arriving through this pathway since 1800. There are an increasing number of non-native species for which the pathway of arrival is unknown.

In terrestrial environments 1024 of the established non-native species arrived through ornamental introductions. The dominant pathways for non-native species in freshwater environments are both ornamental (21 species) and aquaculture (23 species). In the marine environment the arrival pathway for many non-native species is unknown but stowaways (40 species) and aquaculture (19 species) are both dominant pathways. Across all environments, biological control, forestry and animal husbandry are very minor pathways with only one, 11 and 13 species arriving and establishing through these methods respectively.

Footnote: The data compiled within this project are indicative of current knowledge collated by many recognised experts. However, a database such as the species register will be incomplete both because of the number of new species arriving within GB annually and the species which remain cryptic particularly for groups considered to be difficult, such as parasites. Additionally it is difficult to determine the status of some species with respect to whether they are native or non-native, established and the impact that they may have within the invaded range. The involvement of so many experts has undoubtedly minimised the number of omissions and errors.

1. Introduction

The Millennium Ecosystem Assessment (Anonymous, 2005) designated invasive non-native (=alien) species, alongside climate change, habitat destruction, pollution and overexploitation, as one of the main drivers of biodiversity loss. Over the last century there has been a dramatic increase in the movement of non-native species around the world, as a consequence of international trade and travel (Hulme *et al.*, 2009). The Convention on Biological Diversity (CBD) suggests a three-stage hierarchical approach to invasive non-native species: prevention, detection/surveillance and rapid response, control and eradication. This approach has been followed in the Invasive Non-Native Species Framework Strategy for Great Britain (Defra, 2008), which outlined nine specific aims including the requirement for improved detection and monitoring capabilities coupled with an effective decision-making framework. Maintaining a list of non-native species within Britain is essential for underpinning decision-making concerning control, mitigation and eradication of invasive non-native species.

An audit, published in 2005, of non-native species in England concluded that there were 2721 non-native species in England (Hill *et al.*, 2005). The total for Britain is estimated to be in excess of 3500 species (Hill *et al.*, 2009). The audit represented a major step towards fulfilling this requirement. Here we report on a three-year Defra-funded study to enhance the ability to detect and report invasive non-native species in GB.

The GB-Non-Native Species Information Portal (GB-NNSIP) has been developed, with funding from Defra, by the Centre for Ecology & Hydrology (CEH) in collaboration with the British Trust for Ornithology, the Marine Biological Association, Non-Native Species Secretariat and the volunteer schemes and societies. The main purpose of the GB-NNSIP is to provide a central point of information about non-native species in Great Britain including: origins, ecology and impacts. It consists of a number of components including an inventory of non-native species called the “species register”, 300 species factsheets, an on-line system for reporting so called “alert species” (species for which the Non-Native Species Programme Board has recommended particular attention in terms of surveillance and reporting) and information to encourage wider participation particularly on-line recording of non-native species through the project Recording Invasive Species Counts (RISC) led by the NBN Trust and CEH. The RISC project has been developed to increase participation in recording non-native species (NNS) and to improve awareness of non-native species.

This report summarises the work, to date, on the ongoing development of the GB-NNSIP, RISC and the on-line Alert system.

2. Aims

The project aims to enhance our ability to detect and report invasive non-native species, and thereby to enable more effective decision-making. The results will be used by the GB Non-native Species Programme Board to determine how its information needs relating to invasive species populations and distributions can be met in the long term.

Specifically, the aims of the project are:

1. to document the arrival and spread of non-native species in Great Britain;
2. to assess whether there are changes in the rates of these processes;
3. to document the impact of non-native species introductions to Great Britain; and
4. to make this information available to key data users via web-based media.

In pursuit of the overall aims, we recognize the following approaches, specified in the invitation to tender:

1. Collate existing data on the introduction, distribution and impact of non-native species.
2. Analyse trends in the rate of non-native species introduction, spread and impact.
3. Summarise and report significant changes in the distribution or abundance of non-native species.
4. Establish a system of alerts for the interception of new introductions.
5. Identify data gaps and instigate additional biological recording.
6. Horizon scan for emerging threats.
7. Compile species profiles for key invasive species.
8. Make species profiles available on web-pages hosted by the Non-native Species Secretariat, alongside information on interceptions, introductions and distribution of non-native species.
9. Assess the scope for participation by the general public in the process of data collection for a number of species.

3. GB-Non-native Species Information Portal (GB-NNSIP)

The GB-NNSIP is an on-line information system involving a network of organisations engaged in monitoring and surveillance of non-native species (Figure 1a and 1b). Key components of the GB-NNSIP are the list of non-native species and associated summary information (database called the "species register") and nearly 300 factsheets providing detailed information for a selection of species.

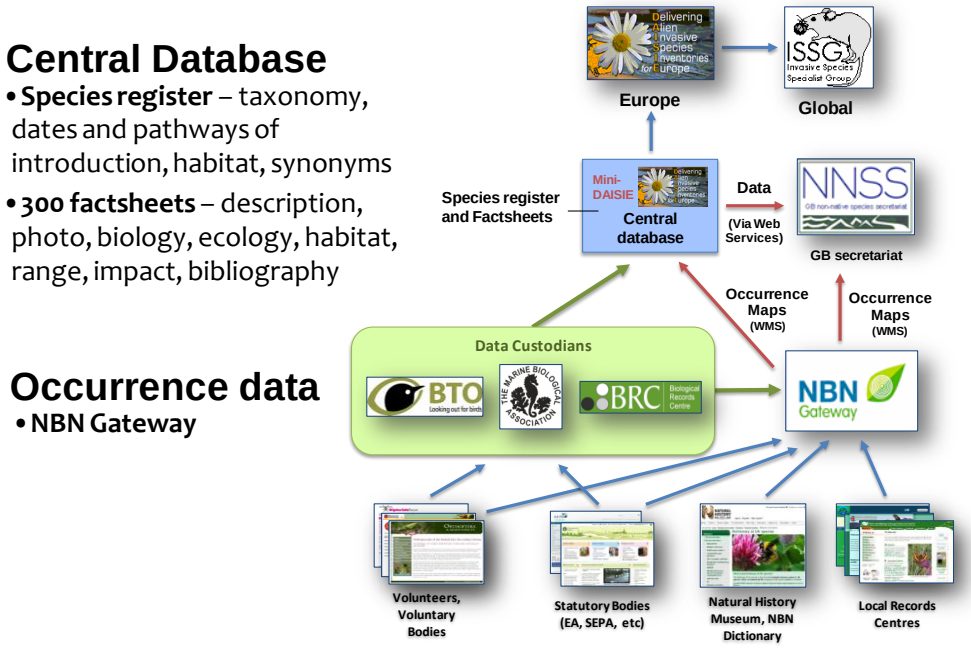


Figure 1a. Interactions between the GB-NNSIP and the wider community engaged in monitoring and surveillance of non-native species. Distributional data are collated from various organisations and bodies (statutory bodies, Local Records Centres and national schemes and societies including project collaborators MBA and BTO) through the NBN Gateway. Other information on non-native species is collated in the species register within the Biological Records Centre (Centre for Ecology & Hydrology). Data from the species register and the NBN Gateway are delivered to the GB-NNSIP and from here they can be exchanged with European (such as DAISIE) and Global initiatives such as the Global Invasive Species Database (within ISSG) and Global Invasive Species Information Network (GISIN).

Figure 1b. Structure of the GB-NNSIP illustrating links between databases and web services which provide information to the GB-NNSIP within the Non-Native Species Secretariat (NNSS) website.

3.1 Species register

The species register is the basic list of non-native species, together with supporting information such as habitat, country of origin, arrival pathway, ecofunctional type, establishment status in England, Scotland and Wales, first record, human impact and ecological impact. The species register is dynamically linked to the NBN Gateway (http://www.searchnbn.net/) which provides maps of the distribution of the non-native species within Britain. It also contains summary information on aspects of the species biology such as environment (marine, freshwater, terrestrial etc), functional type (predator, parasite etc), habitats occupied in the invaded range (using EUNIS classification: http://eunis.eea.europa.eu/about.jsp), invasion pathways, establishment status in Britain and impacts.

The non-native species list compiled by Hill *et al*. (2005) formed the basis of the species register with additional species extracted from Delivering Alien Species Inventory in Europe (DAISIE). This list was transferred to an Access database called the "species register". The list excluded pests of stored crops, human parasites and pests of human habitation unless they were thought likely to be found in the wild). Microorganisms (with the exception of a small number of marine phytoplankton) were also generally not included. The greatest deficiency in the species register was freshwater non-native species but a list of British freshwater non-native species compiled by Philip Lambdon (Centre for Ecology & Hydrology) was added. The list is summarised in Table 1.

Table 1. Numbers of non-native species in environmental groups and species lists derived from the feasibility study. Columns correspond to species lists, or (the last column) to species added but that were not found in any of the lists (taken from Hill *et al*., 2008).

TAXON_GROUP	All	DAISIE	NBN	BRC	DAISIE not in NBN or BRC	EN audit only	No list
Marine	150	135	97	36	43	2	3
Freshwater	89	4	76	45	1	8	0
Terrestrial	3239	2853	2579	2570	243	33	82
Fungi and microbes	209	0	122	121	0	50	0
Total	3687	2992	2874	2772	287	93	85

Methods of data collation

The project was led and managed initially by Mark Hill (Biological Records Centre (BRC) within Centre for Ecology & Hydrology) and by Helen Roy from July 2010 (also BRC). The main project partners were the British Trust for Ornithology (BTO), Marine Biological Association and the Botanical Society of the British Isles (BSBI); however, the volunteer zoological schemes and societies (hosted through the Biological Records Centre) nominated experts to participate in the project (Appendix 2). BRC supplied an excel template of the species register along with a set of guidelines containing coding information for each column to the numerous experts.

Information contained within the species register

Each species within the species register is assigned a BRC concept code which provides a reference within the BRC database that remains with the species despite changes to taxonomic nomenclature. Where NBN Gateway codes (Taxon Version Keys) were available these were also included within the species register enabling distribution data to be retrieved from the NBN Gateway.

Information was collated for each species under the following categories: informal grouping (such as higher plant, insect etc), phylum, environment (terrestrial, freshwater and marine etc), functional group (predator, herbivore etc), non-native status (non-native, colonist etc), native

range (using Taxonomic Database Working Group (TDWG http://www.tdwg.org/standards/104/) categories or country-level data where TDWG provided insufficient resolution), habitats occupied within GB (using Eunis (http://eunis.eea.europa.eu/about.jsp) categories), major pathways (stowaway etc), method of introduction (accidental, intentional etc), establishment status in GB, England, Scotland and Wales, ecological and human impact, place and year of first record in GB and key references (Table 2). TDWG and EUNIS are international organisations promoting standards in biodiversity data collection/storage and, therefore, the use of their categorical systems increases the probablility of compatability between GB-NNSIP and other databases such as DAISIE.

Descriptions of the codes used within the species register are summarised in Table 2 with further detail provided for status of non-native species and pathways of introduction in Tables 3 and 4.

Table 2. Main fields within the species register with comments provided to domain experts (additional fields are required to acknowledge the author, date updated and key references).

Field	Notes	Codes
idspecies	DAISIE code	
TVK	the NBN code	
Concept	i.e. the new BRC number	
Scientific name	Binomial aligning with the NBN Dictionary	
English_name	Preferred name	
Informal group	Informal group	
Phylum		
Env	Environment	
Fnct	Functional type	Ph = phytoplankton, Alg = algae, LP = land plant, Pr = predator, H = herbivores, O = omnivore, Par = parasite, D = detritivore, F = filter-feeder
Factsheet	Factsheet supplied to GB-NNSIP	Supplied by BRC
Notes on name, ecofunction or native range		
Status	Native status	Details within Table 3
Nat	Native range	TDWG categories or country-level data provided (up to 4 regions can be specified in fields Nat_1, Nat_2, Nat_3 and Nat_4)
Hab	Habitat occupied in GB	EUNIS categories provided (up to 4 habitats can be specified in fields Hab_1, Hab_2, Hab_3 and Hab_4)
Path	Invasion pathway	Arrival pathways (pathway to Europe is provided if natural spread to GB from Europe). Details within Table 4 (up to 2 pathways can be specified in fields path1 and path2.
Meth1	Human intention	GISIN terminology of "method" is used (up to 2 methods can be specified in fields Meth1 and Meth2)
GB	Establishment status - GB	
EN	Establishment status - England	
SC	Establishment status - Scotland	
WA	Establishment status - Wales	
Ec_imp	Ecological impact	Based on expert opinion
Hum_imp	Human impact	Based on expert opinion
Place where first found		Place where first found
VC	Vice-county	
current_distribution		Link to NBN Gateway distribution data
Year	Date first reported in the wild	

Defining non-native species within the species register

The CBD definition of a non-native species is clear, however within the species register there are a number of sub-categories employed (Table 3). A few of the species appearing in the species register are considered native in GB but appear as artefacts from previous audits. These are not included within this report but remain in the species register with comments to ensure clarity in the future.

Table 3. Status of non-native species including codes used in the species register, terms and notes based on Hill *et al.* (2005). Species designated as native (N) or Unknown (U) are not included within this report.

Code	Term	Notes
NN	Non-native	Species known to be non-native, including non-native species on the horizon but not yet in GB
NN-N	Non-native/Native	Probably non-native
N-NN	Native/Non-native	Probably native
C	Colonist	Colonist 2000 or later, probably or certainly by natural spread
D	Dependent	With trophic dependence on cultivated or non-native species, arrived possibly naturally before 2000
DNN	Dependent non-native species	With trophic dependence on cultivated or non-native species
DC	Dependent colonist	With trophic dependence on cultivated or non-native species, arrived naturally 2000 or later
HGB	Hybrid GB	GB hybrid origin with non-native parent
NN-S	NN subspecies	Native species that have non-native subspecies within GB
U	Unknown	Origins unknown

Pathways of arrival

The pathway by which a non-native species arrives within a country is particularly relevant to implementing prevention measures. For a minority of species the exact pathway of arrival is unknown but in most cases there is evidence for a specific introduction pathway. The species register uses a detailed set of codes for defining pathways (Table 4) but for the purposes of summarising the data these have been collapsed into broad pathway categories (Table 5).

Table 4. Introduction pathways for non-native species including codes used in the species register, terms and notes based on Hill *et al.* (2005).

Code	Term	Notes
Agr	Agriculture	Not a contaminant e.g. an intended introduction such as a crop or feral goat
AgrS	Agricultural seed contaminant or pest	Such as corncockle
Aq	Aquaculture	Such as crayfish but also aquarium plants but not pond plants which are designated as ornamental.
Bio	Biocontrol	Introduction as a biological control agent or arrival from another region in which it was introduced as a biological control agent
FLG	Fur/lab/greenhouse	Similar to agriculture but with containment e.g. mink but not ornamental plant trade which is Orn
For	Forestry	Not a contaminant e.g. an intended introduction
HF	Hunting/fishing	Such as pheasant, rainbow trout
Hyb	Hybridization	
L	Landscape	Planted into landscape such as pheasant cover or releases of muntjac
Med	Medicinal	Only plants introduced for medicinal reasons
Nat	Natural	Organisms dependent on a non-native species such as rhododendron leafhopper but also natural colonisation from a previously invaded range such as harlequin ladybird
Orn	Ornamental	Garden plant or trade in garden plants, zoo animal, pet
OrnS	Ornamental seed contaminant or component	
P	Produce	Such as harlequin ladybird on flowers, vegetables etc
PS	Seed produce contaminant or component	Such as bird seed contaminant
RM	Raw material	Such as Citrus longhorn beetle on timber
SA	Stowaway – air	Mainly animals
SL	Stowaway – land	Mainly animals
SW	Stowaway – water	Ballast water and hull fouling – mainly animals such as killer shrimp but also algae
U	Unknown	

For the purposes of summarising information in this report the pathways were grouped (Table 5).

Table 5. Grouping of specific pathways into broad pathways

Specific pathway	Broad pathway
Agr – Agriculture	Agriculture
AgrS – Agricultural seed contaminant or pest	Contaminant
Aq – Aquaculture	Aquaculture
Bio – Biocontrol	Biocontrol
FLG – Fur/lab/greenhouse (but not ornamental plant trade which is Orn)	Animal husbandry
For – Forestry	Forestry
HF – Hunting/fishing	Animal husbandry
Hyb – Hybridization	Hybridisation
L – Landscape	Ornamental
Med – Medicinal	Agricultural
Nat – Natural (dependent organisms only)	Natural – Non-Native Dependent
Orn – Ornamental, i.e. garden plant or trade in garden plants, zoo animal, pet	Ornamental
OrnS – Ornamental seed contaminant or component	Contaminant
P – Produce	Contaminant
PS – Seed produce contaminant or component	Contaminant
RM – Raw material	Stowaway
SA – Stowaway – air	Stowaway
SL – Stowaway – land	Stowaway
SM – Stowaway – marine	Stowaway
U – Unknown	Unknown

Transfer of data from designated experts to the species register

Completed templates were collated in excel and uploaded into an Access database at BRC (Figure 1b). A copy of the updated species register entry was then exported and used to update the species register table within the MySQL GBNN database schema on the BRC webserver (WLBRCWEB1). A webservice on the BRC webserver allows for information from this database to be displayed on the Non-Native Species Secretariat website where a flag to display is present. Maps displaying the native range of a species are delivered via an ARCIMS map service on the BRC webserver using information stored within the GBNN database schema.

Limitations of the species register

The data compiled within this project are indicative of current knowledge collated by many recognised experts. However, a database such as the species register will be incomplete both because of the number of new species arriving within GB annually and the species which remain cryptic particularly for groups considered to be difficult, such as parasites. Additionally it is difficult to determine the status of some species with respect to whether they are native or non-native. Many ancient introductions are likely to have been omitted. It is also difficult to

determine whether or not a species is self-sustaining (established). Categorising the impact of species is extremely difficult and, without thorough and systematic assessment of risks, remains subjective for many species. The involvement of so many experts has undoubtedly minimised the number of omissions and errors. Additionally the information for all the "factsheet species" (refer to section 3.2) has been subject to additional external review and conforms to the information provided within the risk assessments and identification sheets available through the Non-Native Species Secretariat website. Finally, it should be noted that some categories for some species were left blank by the designated experts and, therefore, the numbers do not always tally to an expected total.

3.2 Factsheets

The species register contains basic information on a large proportion of the non-native species found in GB. However, detailed information is provided for 294 non-native species (Appendix 3).

Selection of species for factsheets and methods for collation of information

The information was collated by the experts as described above (also see Appendix 2) and the species were selected on the basis of the following criteria:

- DAISIE 100 worst (Europe)
- Horizon Scanning list (Parrott *et al.*, 2009)
- Factsheet prepared for the GB-NNSIP feasibility study (Hill *et al.*, 2008)
- Illustrated in the ID sheets of the GB Non-native Species Secretariat
- Species subject to legal bans or controls
- Species selected for full risk assessment by the Non-Native Species Secretariat
- Species with strong environmental or other impacts
- Suggestions from GB-NNSIP steering group, project team and others

Collation of the factsheet information from the designated experts

The BRC webserver hosts the database driven website content management system which can be found at http://www.brc.ac.uk/gbnn_admin/. A number of species experts were asked to complete the factsheets and allocated a personal log-in for the factsheet editor allowing them to create and edit the factsheets within a second database schema, drupal_gbnn, on the BRCwebserver. Once complete, BRC staff (Helen Roy, Björn Beckmann and Steph Rorke) checked and edited the factsheets within the factsheet editor ultimately publishing them to the GBNN database schema. At this stage the factsheets were exposed through a webservice to the Non-Native Species Secretariat website (Figure 2). The factsheets can be accessed via this website as pdf files and the generation of the pdf occurs on the Non-Native Species Secretariat webserver. Additionally, a number of images displayed on the website are also stored on this webserver.

It should be noted that Defra will be checking the information provided on control methods and additionally standardising the information on legislation.

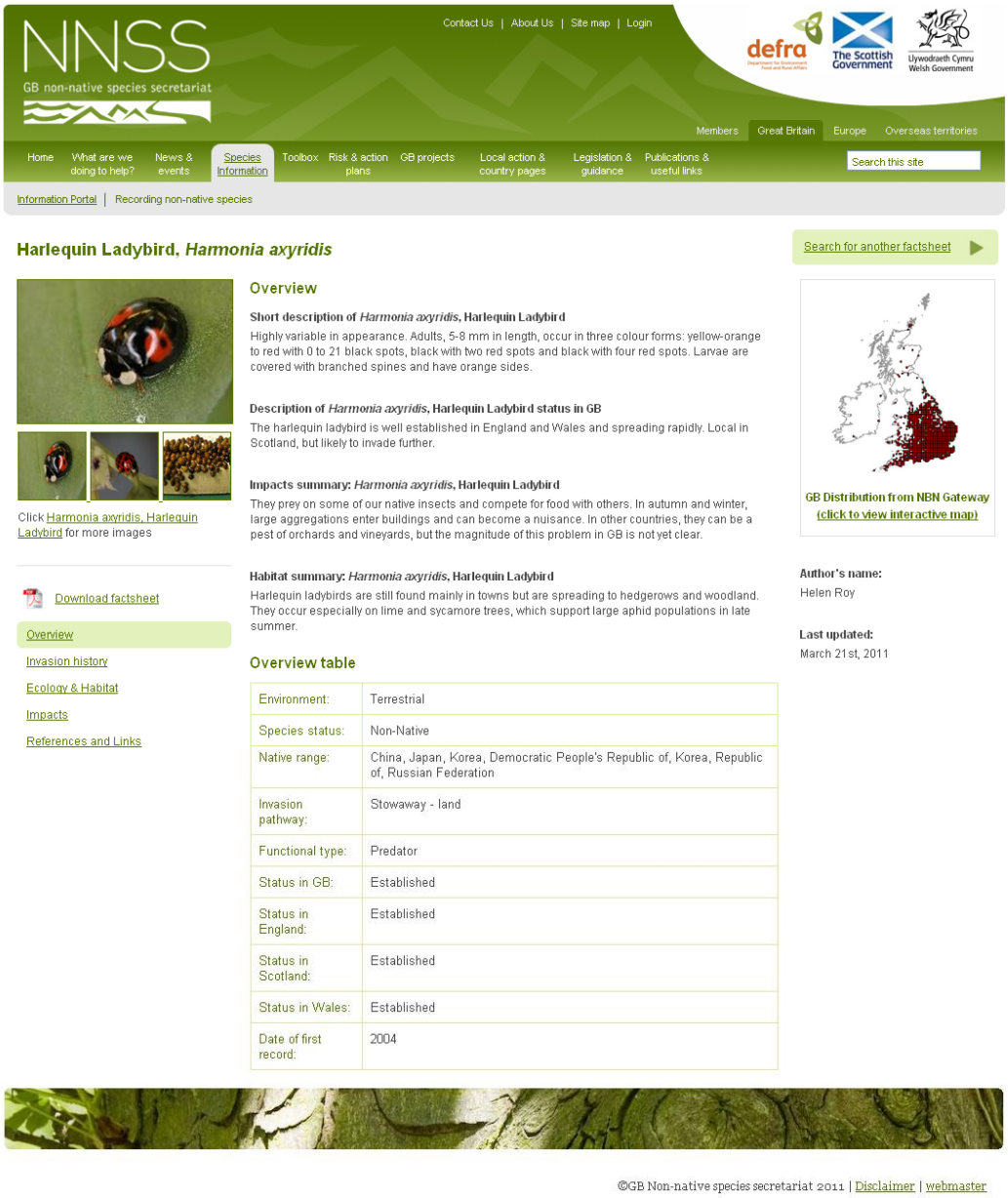


Figure 2. Example factsheet on the GB-NNSIP within the GB Non-Native Species Secretariat website.

4. Summarising the information within the species register

The species register represents a resource of detailed information on non-native species. The use of defined codes for each attribute ensures there is considerable potential for detailed analysis. In this report we have summarised the species register in terms of the total numbers

of species but the majority of the summary tables include only the species designated as established in GB.

4.1 Summary of information within the Species Register

Totals in major categories

There are 3758 species included within the species register. Information has been completed for 3204 species which constitutes 85.3% of the total list. The 554 species with incomplete information include 239 insects, 222 fungi (26 other microorganisms), 40 non-insect invertebrates, 24 lower plants, 2 higher plants and 1 alga.

Species and establishment status of the 554 species with incomplete information

There are 250 microorganisms within the species register (Table 6). Micro-organisms (including Oomycete, Mycetozoa, fungi (Ascomycota, Basidiomycota and other fungi), Haplosporea and other micro-organisms) were not included within the project specification and are consequently not well represented within the species register (in terms of species lists and information provided). There are 222 species of fungi (Ascomycota, Basidiomycota and other fungi) listed within the register alongside 28 microorganisms from other taxa (Table 6 and Appendix 4). However, information has only been provided for two species of micro-organism.

The species status (non-nativeness) of many of the remaining 304 species with incomplete information has been designated as "unknown". Indeed there are only 42 species for which the species status has been ascertained. Of these 31 are considered to be non-native, 4 non-native dependents, 6 are designated as native species and 1 is probably native. The establishment status is documented for the 35 species designated within one of the non-native species categories and 26 are considered to be established.

Table 6. Number of microbial species (total = 250) in the species register within broad taxonomic groups and the number of species with updated information.

	Number of species in species register	Number with updated information
Ascomycota	125	0
Basidiomycota	91	0
Fungi (other)	6	0
Haplosporea	1	1
Mycetozoa	1	0
Oomycete	14	0
Other Microorganisms	12	1

Species status - categories of non-nativeness

The majority of species (2482 species) within the species register are categorised simply as non-native (Table 7). However, there are a number of other categories of non-nativeness which are relevant to the species register. Approximately 7.0% of non-native species in GB are the consequence of hybridisation (Hybrid GB). It has been difficult to assign 4.4% of the species in the species register to a non-native category with complete certainty (non-native/native and native/non-native). However, for the purposes of this report all categories of non-nativeness (outlined in Table 7) are included but those designated with certainty as "unknown" (9.7%) are excluded. Therefore, there is a total of 2889 non-native species within the species register with completed information.

Table 7. Numbers of species (established and non-established but excluding microorganisms) within different environments (T=Terrestrial, F=Freshwater, M=Marine, M(E)=Marine (estuarine), TF=Terrestrial-Freshwater, MF=Marine-Freshwater, TM=Terrestrial-Marine) and subdivided into different categories of non-nativeness (non-native, hybrid within GB, probably non-native, probably native, dependent, new arrival, dependent colonist, dependent non-native and unknown).

	T	F	M	M (E)	TF	MF	TM	Total
Non-native	2194	102	98	1	69	13	5	2482
Hybrid GB	222						1	223
Probably non-native	55		3		8			66
Probably native	43		5		25	1	1	75
Dependent	27							27
New arrival	7		1					8
Dependent colonist	4							4
Dependent non-native	3		1					4
Unknown	263	17	30		1			311
Total	2818	119	138	1	103	14	7	3200

Only a fraction of new arrivals within a country will establish as self-sustaining populations. Of the non-native species, for which we have complete information within the species register, 1795 species are considered to be established in the wild in GB (Table 8). A further 54 non-native species are established indoors. A further 26 species (13 insects, 5 lower plants, 4 mites, 3 platyhelminths, 1 higher plant hybrid) are established non-native species but currently the information within the species register for these is incomplete. Therefore, in total 1875 of the documented species are established. In all subsequent summary tables only established non-native species with complete information (1849 species) will be included unless otherwise stated.

England has more established non-native species than either Scotland or Wales (Table 8). A small proportion (1.5-2.1%) of all non-native species are currently considered extinct (no longer

established) in GB. A total of 7 non-native species have been contained (only present in quarantine or other contained facilities) or exterminated in GB over the last 100 years (Table 9). Musk rat (*Ondatra zibethicus*) and tobacco whitefly (*Bemisia tabaci*) are the only species eradicated from all constituent countries within GB. A number of non-native species listed in the GB-NNSIP are absent from GB. These may enter GB in the future and should be considered 'horizon scanning species'. Similar lists are provided for each individual country.

Table 8. Establishment status of the non-native species in GB, England, Scotland and Wales. Native is included as a category because a species can be non-native in one country within GB but native in another.

	GB	England	Scotland	Wales
Established	1795	1737	1005	1013
Indoors	54	29	14	13
Not established	850	818	605	471
Native	11	10	2	3
Extinct	61	51	49	47
Eradicated	7	6	1	1
Absent	29	63	773	915
Unknown	74	64	89	86

Table 9. Non-native species eradicated.

Scientific name	English name	Notes
Hystrix brachyura	Hodgson's Porcupine	Small colony was briefly established in Devon but successfully eradicated.
Leptinotarsa decemlineata	Colorado Beetle	Probably introduced with potato (or other) shipments, though possibly an immigrant from continental Europe.
Mesocricetus auratus	Golden Hamster	First record from Bath in 1958.
Misgurnus mizolepis	Chinese Weatherfish	A reproducing loach population in a pond in Essex (since eradicated) was found to be *M. mizolepis*.
Myocastor coypus	Coypu	First brought to England to stock fur farms in 1929. Escapes occurred mainly in the 1930s.
Ondatra zibethicus	Musk Rat	Escaped from fur farms
Bemisia tabaci	Tobacco Whitefly	First reported on *Poinsettia* cuttings, which have since been main source of interceptions / outbreaks.

The majority (1377 species) of established non-native species are higher plants (Table 10). Insects are the next most numerous group (278 species) followed by non-insect invertebrates (141 species), vertebrates (50 species), and lower plants (25 species).

Table 10. Number of established non-native species within broad taxonomic groups (includes non-native species for which only establishment status is completed within the species register and also the number for which the species registry includes complete information. The latter being a subset of the former).

Broad group	Number of established non-native species	Number of species with complete information in the species register
Higher plants	1377	1376
Lower plants	25	20
Insects	278	265
Non-insect invertebrates	141	134
Vertebrates	50	50
Other	4	4
Total	1875	1849

Established non-native species within broad environmental categories

The majority of established non-native species are terrestrial (Table 11). Indeed there are only 60 freshwater species and 74 marine species. Higher plants are the largest group of established non-native species within the terrestrial environment (Table 11). Within the freshwater environment higher plants and non-insect invertebrates dominate. Non-insect invertebrates also form a high proportion of the established non-native species within the marine environment.

Table 11. Total number of established non-native species in broad taxonomic groups (includes only species designated as non-native) for different environments (T=Terrestrial, F=Freshwater, M=Marine, M(E)=Marine (estuarine), TF=Terrestrial-Freshwater, MF=Marine-Freshwater, T-M=Terrestrial-Marine).

	T	F	M	M (E)	TF	MF	TM	Total
Higher plants	1350	23	0	0	0	0	3	1376
Lower plants	0	0	20	0	0	0	0	20
Insects	255	8	0	0	0	0	2	265
Non-insect invertebrates	52	23	50	1	0	8	0	134
Vertebrates	27	6	0	0	16	1	0	50
Other	0	0	4	0	0	0	0	4
Total	1684	60	74	1	16	9	5	1849

Established non-native species within taxonomic groups

The established non-native species in GB are taxonomically diverse (Table 12). Flowering plants represent the most numerous taxonomic category of established non-native species (1336 species). Birds (15 species) and terrestrial mammals (17 species) are the most species-rich vertebrate taxa. Insects are the most numerous of all the established non-native species of invertebrate with Hemiptera (bugs) and Coleoptera (beetles) dominating. There are a further 239 species of insect to update in the species register and a high proportion of these are beetles. In marine environments algae (20 species) and crustacea (15 species) are the most numerous of all established non-native species. There is also a reasonable number of established non-native crustacean (12 species) within freshwater environments.

Examples of recent new arrivals

There have been 125 new arrivals since 2000 (only 40 of these are known to have established and for many of the others information on establishment status is not yet available). The list of non-native species arriving over the last decade has been dominated by insects and other invertebrates (78 species). A number of these species have received considerable interest from the media and consequently a high profile primarily because of their potentially negative impacts on the environment.

Harmonia axyridis, harlequin ladybird, is native to Asia. The harlequin ladybird was first recorded in England (Essex) in 2004, however assessment of the Rothamsted Aphid Trap archives revealed a specimen from 2003. The spread of this generalist predator has been monitored by people who send their sightings into an on-line survey (www.ladybird-survey.org). This species is known to have spread at 100 km yr^{-1} and is one of the most abundant species of ladybird through England and Wales.

Dikerogammarus villosus, killer shrimp, was discovered in England (Grafham Water, Cambridgeshire) in 2010. This species, native to the Ponto-Caspian region, has the potential to disrupt freshwater communities and is considered to be an invasive non-native species. There have only been two further records of this species both in Wales (Cardiff Bay and Eglwys Nunydd, Wales). Rapid response to *D. villosus*, including the launch of a campaign (Stop the spread – check, clean, dry) and an on-line system for recording sightings of this species, should provide effective surveillance and rapid response.

In 2008 *Didemnum vexillum*, carpet sea-squirt (native to the north-west Pacific), was recorded in Devon. This species has now been recorded from nine marinas in GB (North Wales, the Clyde, Devon and the Solent). Rapid growth of this species can result in the smothering of habitat and disruption of resident communities.

Pimepales promelas, fathead minnow, is a species which has been reported sporadically across England since 2003 following release from private collections. It is native to North America and Mexico. There are no known impacts of this species in GB but it is a predatory fish which could affect resident communities and additionally it is associated with the spread of enteric red-mouth disease (ERM) to wild and cultured trout and eel in continental Europe.

Two species of crayfish have arrived and established over the last ten years: *Orconectes limosus*, spinycheek crayfish (2001), and *Orconectes virilis*, virile crayfish (2004). Both species are native to North America. The arrival of these two crayfish brings the total number of

established non-native crayfish in GB to seven. *Pacifastacus leniusculus*, signal crayfish, which was first recorded in GB in 1975 is a major threat to the native *Austropotamobius pallipes*, white-clawed crayfish, and is causing declines in diversity and richness of aquatic communities.

Lemna turionifera, red duckweed, was first recorded in 2007 in Stoborough, England. It is spreading rapidly through England and Wales.

Table 12. Numbers of established non-native species in taxonomic groups within different environments (T=Terrestrial, F=Freshwater, M=Marine, M(E)=Marine (estuarine), TF=Terrestrial-Freshwater, TM=Terrestrial-Marine, MF=Marine-Freshwater).

	T	F	M	M (E)	TF	TM	MF	Total
Plants								
Alga			20					20
Clubmoss	1							1
Conifer	29							29
Diatom			4					4
Fern	8	1						9
flowering plant	1311	22				3		1336
Horsetail	1							1
Vertebrates								
Amphibian					8			8
Bird	7				8			15
bony fish (Actinopterygii)		6					1	7
Reptile	3							3
terrestrial mammal	17							17
Insects								
insect - beetle (Coleoptera)	95	1						96
insect - cockroach (Dictyoptera)	1							1
insect - hymenopteran	4							4
insect - moth	44	7						51
insect - stick insect (Phasmida)	3							3
insect - thrips (Thysanoptera)	1							1
insect - true bug (Hemiptera)	103							103
insect - true fly (Diptera)	4					2		6
Non-insect invertebrate								
Annelid		2	11	1				14
Bryozoans			4				1	5
Centipede	3							3
coelenterate (=cnidarian)			2				1	3
Crustacean	2	12	15				3	32
Entoproct			1					1
flatworm (Turbellaria)		1						1
Millipede	2							2
Mollusc	23	8	10				2	43
roundworm (Nematoda)	1						1	2
sea spider (Pycnogonida)			1					1
spider (Araneae)	20							20
springtail (Collembola)	1							1
tunicate (Urochordata)			6					6
Total	1684	60	74	1	16	5	9	1849

Established non-native herbivorous species are prevalent within terrestrial and freshwater systems but appear to be lacking in the marine environment (Table 13). Primary producers (alga and land plants) represent the majority of established non-native species, followed by primary consumers (filter-feeders, herbivores and omnivores) with secondary consumers (parasites and predators) occuring in low proportions in all systems.

Table 13. Number of established species within different functional groups for different environments (T=Terrestrial, F=Freshwater, M=Marine, M(E)=Marine (estuarine), TF=Terrestrial-Freshwater, TM=Terrestrial-Marine, MF=Marine-Freshwater).

	T	F	M	M(E)	TF	TM	MF	Total
No data	9	2	1					12
Detritivore	6	1	3					10
Alga			25					25
Land plant	1350	23				3		1376
Filter-feeder		4	35	1			4	44
Herbivore	217	14			7	2		240
Omnivore	56	5	2		1		2	66
Parasite	1	5	2				1	9
Predator	45	6	6		8		2	67

Established non-native species within functional groups

Marine species are distributed reasonably evenly between littoral rocks, sediment and infralittoral rock habitats (Table 14). This could be an indication of ease of sampling and species could remain largely undiscovered in pelagic zones.

Terrestrial and freshwater non-native species also occupy diverse habitats (Table 14). More than 40% (821 species) of terrestrial established non-native species are found within grassland habitats; a consequence of the high number of plants which occur in ruderal tall-herb communities (categorised by EUNIS as grasslands) (Table 14). Woodlands and forest habitats have 123 established non-native species. Inland surface waters also have a high number of non-native species (140 species) spread across the different environments. Domestic habitats including cultivated gardens and parks also have a high number of non-native species (153 species), as do constructed, industrial habitats (158 species). This reflects the dominance of plants within the species register. Mires and bogs have a very low number of non-native species (7 species).

Table 14. Number of established non-native species occurring in different habitats (EUNIS categories) across different environments (T=Terrestrial, F=Freshwater, M=Marine, M(E)=Marine (estuarine), TF=Terrestrial-Freshwater, TM=Terrestrial-Marine, MF=Marine-Freshwater).

Habitat	T	F	M	M (E)	TF	TM	MF	Total
No data	13							13
Marine			35				3	38
Littoral rock & hard substrate			8					8
Littoral sediment	7		2			2	1	12
Infralittoral rock			19					19
Circalittoral rock			1					1
Sublittoral sediment			2					2
Pelagic water column							1	1
Coastal habitats	196		3	1		2		202
Inland surface waters	67	53	1		16	1	2	140
Mires, bogs & fens	7							7
Grasslands etc	821							821
Heathland, hedgerow & scrub	81							81
Woodland & Forest	123							123
Inland unveg. or sparsely veg.	48							48
Domestic habitats	153							153
Constructed, industrial etc	158	7						165
Unknown	7							7
Estuarine and brackish habitats	3		3				2	8
Total								1849

Date of introduction of established non-native species

There has been a dramatic increase in the number of species arriving and those becoming established since 1800 and there is no indication of this trend slowing (Figure 3). The number of established non-native species designated as having a negative ecological or human impact is also increasing.

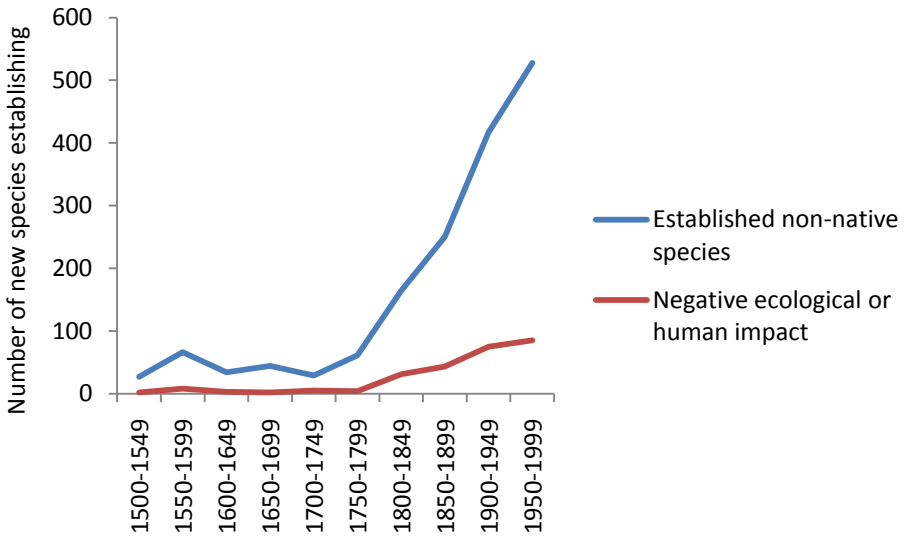


Figure 3. Number of established non-native species and the number that are designated as having a negative ecological or human impact against date of first record. It should be noted that a further 125 species have arrived (only 40 of these are known to have established) between 2000 and 2010 and 14 of these are considered to have a negative impact. There are 170 established non-native species for which there is no date within the species register.

Geographic origin of established non-native species

Most of the non-native species that are established within GB originate from Europe (Figure 4). However, temperate Asia and North America are both major contributors to the non-native fauna and flora of GB.

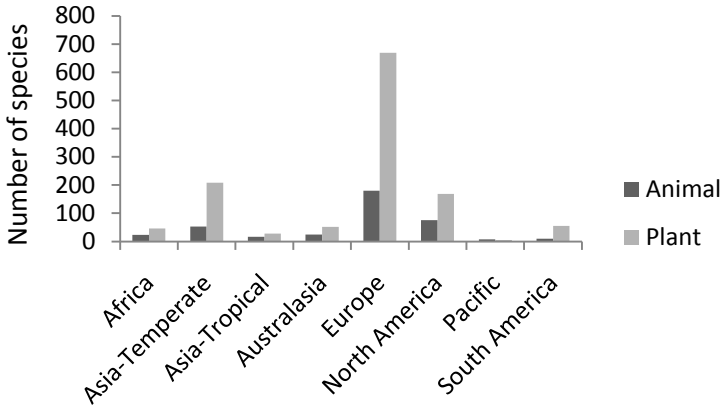


Figure 4. Number of established non-native species (animals and plants) in GB originating from different regions.

It is interesting to note that non-native species originating from Europe began to arrive and establish in high numbers from the 1700s, whereas non-native species originating from temperate Asia and North America have seen a rapid escalation since the 1800s (Figure 5). The peak in number of species arriving from Europe from 1500 to 1600 is almost certainly a consequence of an increase in human movement from 1500 onwards. It is intuitive that species in close proximity to Britain would arrive earlier than those from greater distances. The patterns in date of first arrival for non-species originating from different regions are entirely consistent with the increase in long-distance transport subsequent to the discovery of the Americas. It is apparent the rate of new species arriving from Europe to Britain is slowing particularly in contrast to the dramatic rate of new arrivals from temperate Asia.

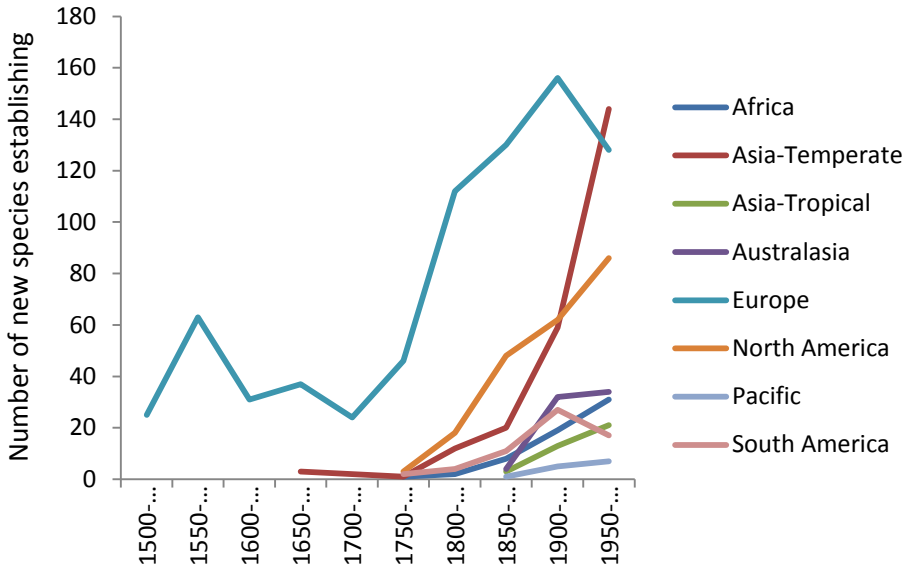


Figure 5. Number of established non-native species originating from different regions and arriving in Britain against date of first record.

In the terrestrial environment most of the non-native species (822 species) within GB have originated from Europe (Table 15). This is dominated by the number of higher plants that have arrived to GB from Europe (666 species) but also the high number of insects arriving from Europe (107 species). In contrast North America is a major contributor of non-native species (29 species), particularly plants (13 species), to GB freshwater environments (Table 15) although a reasonably high number of invertebrates arrive in the freshwater environment from Europe and temperate Asia. Interestingly, within the marine environment the non-native species originate much more evenly from a number of regions with Asia (temperate), North America and the Pacific region dominating (Table 15).

Table 15. Number of established non-native species, within broad taxonomic groups, originating from different regions and environments.

	Africa	Asia-Temperate	Asia-Tropical	Australasia	Europe	North America	Pacific	South America	No data	Total
Terrestrial										
Higher plants	44	197	28	49	666	153		52	161	1350
Vertebrates	1	6	2	1	12	2			4	27
Insects	15	28	9	15	107	32		8	41	255
Other inverts	2		1	2	37	4		2	4	52
Total	62	231	40	67	822	190		62	210	1684
Freshwater										
Higher plants	2	2		1	2	13		3		23
Vertebrates						6				6
Insects		1	5			2				8
Invertebrates		4		1	7	8			3	23
Total	2	7	5	2	9	29		3	3	60
Marine										
Lower plants		9		2	1	1	5		2	20
Invertebrates	4	9		5	5	15	7		5	50
other		1					1		2	4
Total	4	19		7	6	16	13		9	74
Marine (estuarine)										
Invertebrates									1	1
Marine-Freshwater										
Vertebrates					1					1
Invertebrates		3			2	2			1	8
Total		3			3	2			1	9
Terrestrial-Freshwater										
Vertebrates	1	2			9	4				16
Terrestrial-Marine										
Higher plants						2			1	3
Insects						2				2
Total						4			1	5

Pathways of introduction for established non-native species

A very high proportion of the non-native species arriving and establishing in terrestrial environments do so as ornamental introductions (Figure 6, Table 16). The dominant pathways for non-native species in freshwater environments are ornamental and aquaculture (Table 16). In the marine environment the arrival pathway for many non-native species is unknown but stowaways and aquaculture are both dominant pathways (Table 16). Higher plants are the most numerous of all non-native species within terrestrial and freshwater environments and so it is not surprising that the ornamental pathway is the most common because many of the non-native plants arrive through horticulture. However, a high proportion of terrestrial animals have also arrived through this pathway particularly as exotic pets for domestic and zoological collections. There has been a dramatic increase in species arriving through the ornamental pathway since 1800. However, there are an increasing number of non-native species for which the pathway of arrival is unknown (20 species: 1850-1899, 42 species: 1900-1949 and 52 species: 1950-1999).

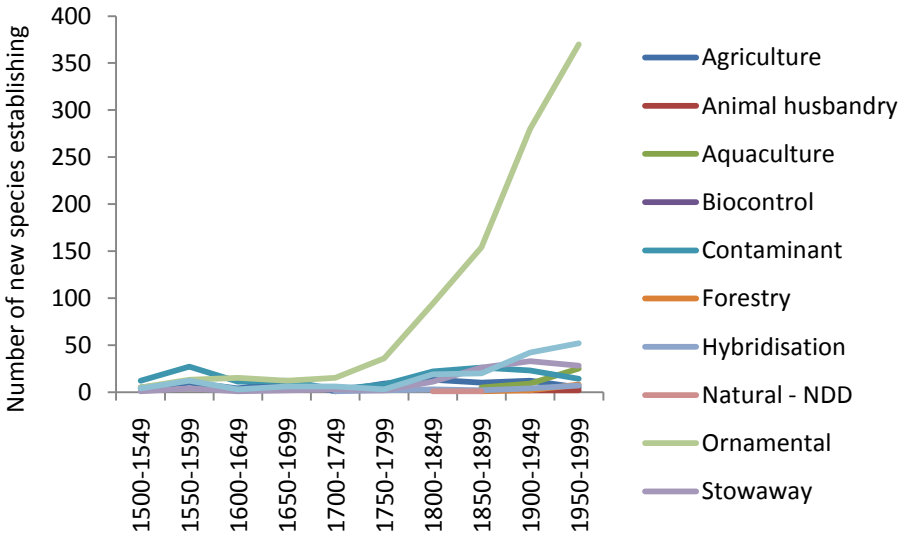


Figure 6. Number of established non-native species arriving in GB through different pathways against date of first record.

Table 16. Number of non-native species, within broad taxonomic groups, arriving by different pathways (Agr. = agricultural, Anim. husb. = animal husbandry, Aqua. = aquaculture, Bio. = biocontrol, Con. = contamination, For. = forestry, Hyb. = hybridisation, Natural-NND = Natural non-native dependent, Orn. = ornamental, Stow. = stowaway and U = Unknown) into different environments.

	No data	Agr.	Anim. husb.	Aqua.	Bio.	Con.	For.	Hyb.	Natural - NND	Orn.	Stow.	U
Terrestrial												
Higher plants		88	1			145	11	29		955	54	67
Vertebrates			8		1					14	4	
Insects	167	2	1			40			20	51	23	114
Invertebrates			2							4	2	71
Other												
Total	167	90	12		1	185	11	29	20	1024	83	252
Freshwater												
Higher plants				7						14		2
Vertebrates	6		1							6		
Insects				7						1		
Invertebrates	2			9		2					8	4
Total	8		1	23		2				21	8	6
Marine												
Lower plants				7							7	10
Invertebrates				12					1		32	12
Other											1	4
Total				19					1		40	26
M (estuarine)												
Invertebrates											1	
Total											1	
TF												
Vertebrates			1							15		
Total			1							15		
TM												
Higher plants								1		2		
Insects	2											
Total	2							1		2		
MF												
Invertebrates				3							4	
Total				3							4	

Ecological and human impacts of established non-native species

Of the 1849 established non-native species in GB, 282 species (15.3%) are designated as having some negative impact of which 147 species (8.0%) are considered to have a negative ecological impact and 188 species (10.2%) a negative human impact with 53 species (2.9%) designated as having both a negative human and ecological impact. There are 108 (7.7%) established non-native plants and 173 (39.2%) established non-native animals considered to have a negative ecological or human impact (Table 17). The majority of the human impacts are linked to plant health (pests and diseases). Higher plants dominate the list of established non-native species with ecological impacts (Appendix 5) however, a high proportion (48.0%) of the total number of established non-native vertebrates have an ecological impact (24 species). The impact for 106 established non-native species is designated as unknown (Appendix 6) and critical assessment of these species should be a high priority.

Table 17. Number of established non-native species, within broad taxonomic groups, designated as having a **negative ecological or human impact** arriving through each introduction pathway.

	Higher plants	Lower plants	Total plants	Insects	Invertebrates	Vertebrates	Total animals	Other	Total
Agriculture	4		4	1			1		5
Animal husbandry			0			7	7		7
Aquaculture	3	3	6		11		11		17
Biocontrol			0			1	1		1
Contaminant	10		10	38			38		48
Forestry	3		3				0		3
Hybridisation	1		1				0		1
Ornamental	79		79	22	1	13	36		115
Stowaway	3	2	5	12	16	3	31		36
Unknown			0	18	9		27	1	28
No data			0	21			21		21
Total	103	5	108	112	37	24		1	282

Pathways and negative impacts of established non-native species

The ornamental pathway contributes the highest number of non-native species considered to have a negative ecological impact (Table 18). The majority of these are higher plants. A high number of non-native vertebrates arrive through the ornamental pathway and exert a negative ecological impact.

Table 18. Number of established non-native species, arriving by different pathways, within broad taxonomic groupings considered to have a **negative ecological impact**.

	Higher plants	Lower plants	**Total plants**	Insects	Invertebrates	Vertebrates	**Total animals**	**Total**
Agriculture	1		**1**					**1**
Animal husbandry						5	**5**	**5**
Aquaculture	3	3	**6**		10		**10**	**16**
Biocontrol						1	**1**	**1**
Contaminant	1		**1**					**1**
Forestry	3		**3**					**3**
Hybridisation	1		**1**					**1**
Ornamental	76		**76**	4		12	**16**	**92**
Stowaway	2	2	**4**	3	10	3	**16**	**20**
Unknown				1	4		**5**	**5**
No data				2			**2**	**2**
Total	**87**	**5**	**92**	**10**	**24**	**21**	**55**	**147**

The two dominant pathways of arrival for non-native species considered to have a negative human impact are ornamental and contaminant (Table 19). However, there are a large number of established non-native species exerting a negative human impact and for which the introduction pathway is unknown. This is largely a consequence of the paucity of information available for insects and further work is required to elucidate the exact pathways. However, it is apparent that the ornamental pathway is a major contributor of non-native insects and higher plants with a negative impact on humans.

Table 19. Number of established non-native species, arriving by different pathways, within broad taxonomic groupings considered to have a **negative human impact**.

	Higher plants	Lower plants	**Total plants**	Insects	Invertebrates	Vertebrates	**Total animals**	Other	**Total**
Agriculture	3		**3**	1			**1**		**4**
Animal husbandry			**0**			4	**4**		**4**
Aquaculture		2	**2**		10		**10**		**12**
Contaminant	9		**9**	38			**38**		**47**
Ornamental	15		**15**	22	1	11	**34**		**49**
Stowaway	1	1	**2**	10	12	3	**25**		**27**
Unknown			**0**	17	7		**24**	1	**25**
No data			**0**	20			**20**		**20**
Total	**28**	**3**	**31**	**108**	**30**	**18**	**156**	**1**	**188**

Approximately a third of the established non-native species considered to have a negative ecological or human impact within the terrestrial environment originate from Europe (Table 20a). In contrast North America is the major region of origin for established non-native species considered to have a negative ecological or human impact within the freshwater environment (Table 20b). Established non-native species, considered to have a negative ecological or human impact, arriving within the marine environment originate relatively evenly from temperate Asia, North America and the Pacific (Table 20c). It is apparent that the number of non-native species arriving from temperate Asia has been increasing in recent years while the number of new arrivals from Europe has been decreasing. Clearly temperate Asia is a becoming a major contributor of established non-native species to all environments.

Table 20. Number of established non-native species, arriving by different pathways and regions of origin, within broad taxonomic groups considered to have a negative ecological or human impact. Subdivided into species from the terrestrial environment (a), freshwater environment (b) and marine environment (c).

a. Terrestrial

	Africa	Asia-Temperate	Asia-Tropical	Australasia	Europe	North America	Pacific	South America	No data	Total
Higher plants										
Agriculture					4					4
Contaminant					10					10
Forestry					3					3
Ornamental	3	14	4	1	23	12		4	10	71
Stowaway		1		1	1					3
Insects										
No data		8	2		3	7			1	21
Agriculture					1					1
Contaminant	7	3	3	2	5	1		3	14	38
Ornamental	2	5		3	3	2		1	6	22
Stowaway		1		3	3	3			2	12
Unknown	4		1		4	3		2	4	18
Invertebrates										
Ornamental					1					1
Unknown					4					4
Vertebrates										
Animal husbandry		1			2				3	6
Biocontrol									1	1
Ornamental	1	3	1		2	1				8
Stowaway		1	1		1					3
Total	17	37	12	10	70	29	0	10	41	226

b. Freshwater

	Africa	Asia-Temperate	Asia-Tropical	Australasia	Europe	North America	Pacific	South America	No data	Total
Higher plants										
Aquaculture						1		2		3
Ornamental	1			1		6				8
Invertebrates										
Aquaculture		2			4	1				7
Stowaway		1		1		1				3
Unknown		1			1					2
Vertebrates										
Animal husbandry						1				1
Marine										0
Total	1	4	0	2	5	10	0	2	0	24

c. Marine

	Africa	Asia-Temperate	Asia-Tropical	Australasia	Europe	North America	Pacific	South America	No data	Total
Lower plants										
Aquaculture		2					1			3
Stowaway		2								2
Invertebrates										
Aquaculture					1	1				2
Stowaway		2		1		3	1		2	9
Unknown	1					1	1			3
Other										
Unknown							1			1
Total	1	6	0	1	1	5	4	0	2	20

5. System for on-line recording of alert species including the outreach component "Recording Invasive Species Counts" (RISC)

An on-line system for reporting occurrences of species that require highlighting so called "alert species" has been developed (https://www.nonnativespecies/alerts/index.cfm; Figure 9). The open-access software system Indicia has been used to construct an on-line system, including photo upload and interactive maps, linked to the content management system Drupal for verification of records submitted (Figure 10). The same system is used for species within the RISC project.

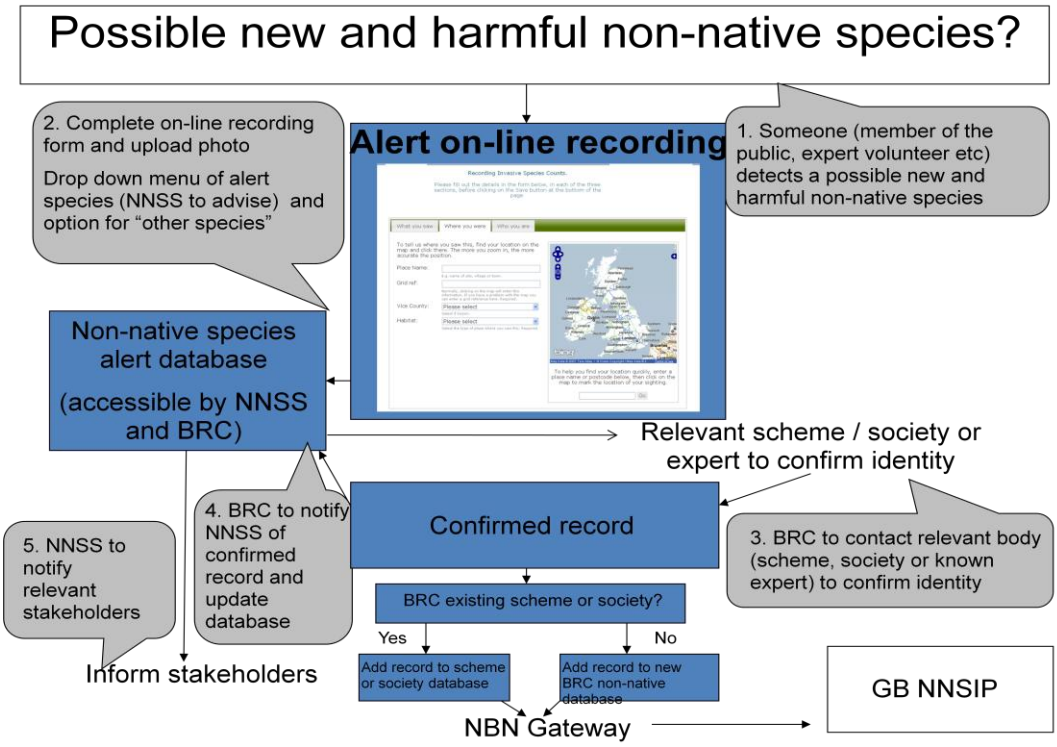


Figure 9. Details of mechanism for reporting alert species through an on-line recording system.

There is an e-mail address (alert_nonnative@ceh.ac.uk) that can be used for enquiries on non-native species or for reporting alert species if this is preferable to the on-line mechanism. This e-mail system receives approximately six e-mails a month and these have mainly been in relation to the killer shrimp, *Dikerogammarus villosus*, and the Asian hornet, *Vespa velutina*. In all cases the information has been rapidly disseminated to the Non-Native Species Secretariat. *Dikerogammarus villosus* enquiries are simultaneously relayed to the Environment Agency and David Aldridge (domain expert). *Vespa velutina* enquiries are simultaneously relayed to FERA and the Bees, Wasps and Ants Recording Society.

The on-line Alert system includes the capacity to add a new arrival of any species but there are specific forms for carpet sea-squirt, African clawed frog, Citrus longhorn beetle, emerald ash borer, Indian house crow, oak processionary moth, sacred ibis, Siberian chipmunk, topmouth gudgeon, monk parakeet, prairie dog, eagle owl and killer shrimp.

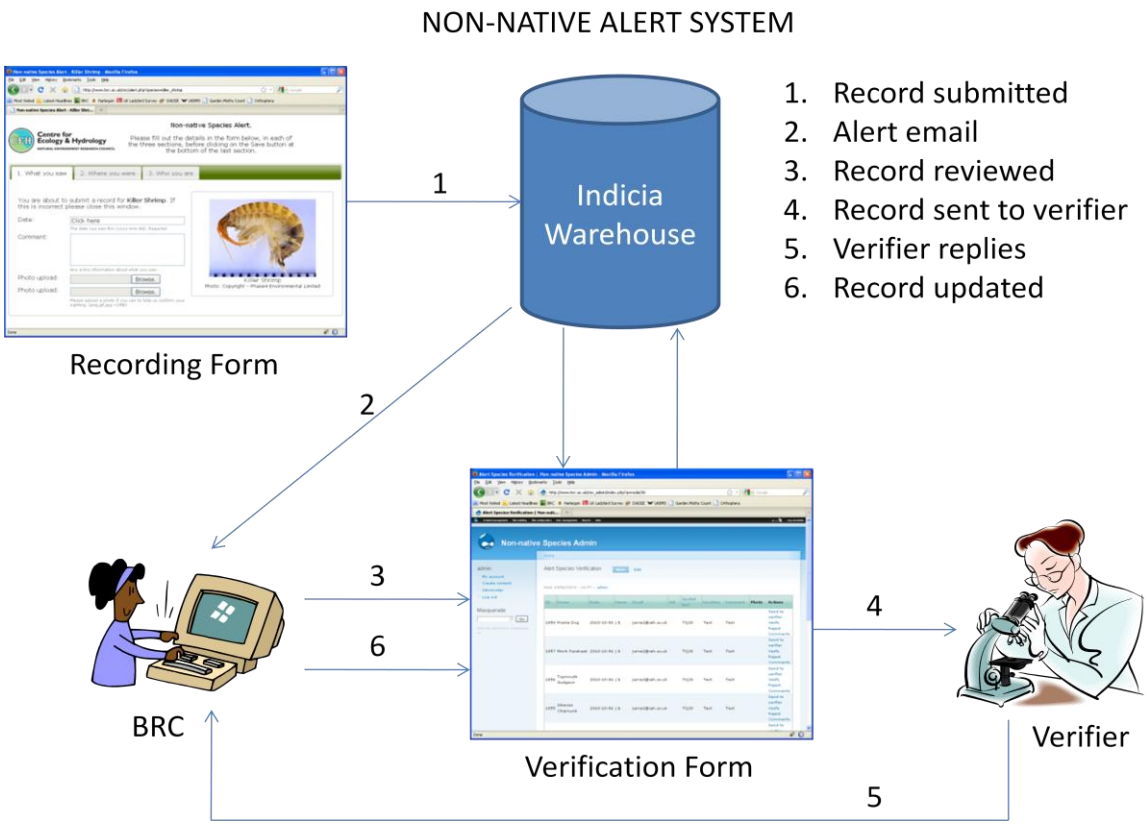


Figure 10. Summary of the alert on-line recording system that has been developed using the open-access Indicia software.

The outreach component of the non-native species on-line recording (RISC) was launched in spring 2010 and received considerable attention from the media. Each of the non-native species (Table 23) is linked to a domain expert mainly through the schemes and societies. Some of the species (muntjac and American skunk cabbage) have received reasonable numbers of records. For others the response has been expectedly low (Citrus longhorn beetle and Water primrose). However, for others the response has been disappointing and further promotion is required. Additional non-native species have been added to the RISC project for recording in 2012 and beyond.

Table 21. Non-native species included within RISC with number of records received on-line and the number verified as correct species identification. Verification is only possible if a photograph or specimen is provided.

Species	No. records	No. verified records	Scheme or society involved
			Mammal Society
Muntjac deer	512	46	People's Trust for Endangered Species
American skunk cabbage	96	47	BSBI
Tree of heaven	15	4	BSBI
Floating pennywort	1	0	BSBI
Water fern	4	1	BSBI
Water primrose	0	0	BSBI
Citrus longhorn beetle	5	0	FERA
Western conifer seed bug	5	0	Heteroptera Recording Scheme
Southern green shieldbug	1	0	Heteroptera Recording Scheme
Rhododendron leafhopper	0	0	Auchenorrhyncha Recording Scheme
Zebra mussel	4	1	Conchological Society
Wakame	2	0	MBA
Chinese mitten crab	2	0	MBA
American bullfrog	0	0	Amphibian and Reptile Recording Group

6. Key recommendations

i. Maintain and develop the database of non-native species (Species Register) to include the non-native species that have arrived since the onset of this project, for example more than 200 species of birds that were recorded in the bird reports data set for NBN Gateway do not yet have an entry in the GB-NNSIP species register.

ii. Develop factsheets for new species designated as a priority for additional information.

iii. Increase the flow of distribution data on non-native species particularly developing methods for uploading spreadsheets of non-native species through Indicia.

iv. Continue to deliver the information from the species register, factsheets and NBN Gateway to the GB-NNSIP through the Non-Native Species Secretariat and enhance search functionality.

v. Maintain the on-line system of alerts coupled with a mechanism for enquiries through e-mail.

vi. Develop a system for non-native species information to be disseminated to relevant personnel within other organisations both on the basis of regional locality and environment (freshwater, marine and terrestrial).

vii. Ensure that mechanisms to enhance data flow will support the development of automated trends and analysis particularly in the context of the indicator of non-native species.

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Appendix 1. Glossary

Alert species (see also sleeper species)

A species which the Non-native Species Programme Board has recommended requires particular attention in terms of surveillance and reporting. Examples of situations in which the Programme Board might recommend an alert species include:

- A high-risk invasive species not yet present in GB but which might enter in the future and cause environmental, economic or social harm.
- A sleeper species considered to be high risk and which might cause environmental, economic or social harm in the future.
- An invasive non-native species for which there is a special concerted effort to provide better-quality distribution information.
- An invasive non-native species against which action is being taken and reporting is required to help facilitate action.

Alert species can be reported using the alert e-mail (alert_nonnative@ceh.ac.uk) or the on-line recording system which results in a cascade of information to relevant stakeholders.

Alien species

See non-native species.

Database (see also species register)

An integrated collection of logically related records and files on non-native species consolidated into a network that provides data for multiple uses. The species register forms the central database of the GB-NNSIP. The NBN Gateway is the central database for species distribution data.

Daisie

Delivering Alien Invasive Species Inventory for Europe - http://www.europe-aliens.org/

This website provides a 'one-stop shop' for information on biological invasions in Europe. It is the result of the DAISIE project, funded by the European Commission under the Sixth Framework Programme. CEH maintains the DAISIE database and website.

Content management system (CMS)

A computer system used to edit, track and store electronic documents. The GB-NNSIP uses a CMS called Drupal. Drupal is a Content Management System (CMS) which is an online system for maintaining website content.

Factsheet

In the case of the GB-NNSIP a factsheet refers to the detailed information for each species delivered through the website. The factsheets will be downloadable as a PDF. The information is written for a wide audience but principally stakeholders such as government employees, scientists and volunteer contributors to biological recording schemes. Factsheets within the

GB-NNSIP contain the following information: Invasion History, Ecology and Habitat, Distribution, Impact, Management, Legislation, References and Links.

See for example:

http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets.cfm

ID sheet

In the case of the GB-NNSIP the ID sheets are a series of PDFs (focussed purely on providing species identification guidance) that have been produced for the Non-Native Species Secretariat which users can access through the GB-NNSIP. An ID sheet provides information on a species in a structured format which is downloadable as a PDF from the Non-native Species Secretariat website: (http://www.nonnativespecies.org/02_Identification%20Sheets.cfm

The information is written for a broader audience than the factsheets and includes images and text written for a non-expert audience.

Invasive non-native species (INNS) (= invasive alien species or IAS)

An invasive non-native species is a non-native species that has the ability to spread causing damage to the environment, the economy, our health or the way we live.

Non-native species (= alien species)

A non-native species (= alien species) is a species introduced (i.e. by human action) outside its natural past or present distribution; including any part, gametes, seeds, eggs or propagules of such species that might survive and subsequently reproduce as defined by the Convention on Biological Diversity (CBD). Non-native species covered by the GB-NNSIP include all fauna and flora with the exception of genetically modified organisms (GMOs), fungi, bacteria and viruses. Lower taxonomic ranks such as subspecies, varieties, races or provenances can also be non-native.

Portal

GB-NNSIP. Web-based platform providing a gateway to information, including other websites, factsheets, species nomenclature, and species distribution.

Sleeper species (see also alert species)

Sleeper species are non-native species that have arrived in Great Britain and have currently established only small populations but that have the potential to spread widely and threaten biological diversity.

Species established and persisting in the wild

The term “in the wild” is widely used and generally encompasses both natural and semi-natural habitats in both rural and urban environments. However, this and preceding projects (Hill *et al.*, 2005, Hill *et al.*, 2008) have not attempted to define the term “in the wild” but have only included species that occur outside buildings, captivity or cultivation. In this report we align with the definition provided by Natural England with respect to “the wild” (http://www.defra.gov.uk/publications/2011/05/26/pb13535wildlife-countryside-act/):

"The diverse range of natural and semi-natural habitats and their associated wild native flora and fauna in the rural and urban environments in general. This can also be broadly described as the general open environment."

The term "established" is used for self-sustaining (reproducing) populations. A species is deemed to be "established" if it occurs as a self-sustaining population, persisting for more than four years, not dependent on repeated reintroduction. However, it is useful to include the term "persisting" for species, such as forest trees, that persist for more than four years but are not successfully reproducing.

Species register

Relational database (= central store) containing a list of all non-native species in Great Britain and associated information (excluding distribution information). Principal tables in the database include: Species, Synonyms, Common names, Native range, Habitats, Species in region (invasion information by geographical region), Pathways, Vectors, Donor areas, Date of Introduction etc.

Web services

Web services are web-based software applications that exchange data with other web-based applications. The NBN Gateway maps are a web service to the GB-NNSIP. For more information see:

http://www.nbn.org.uk/getdoc/4db9ded1-6469-4e2d-a901-87b3686b064f/Web-services.aspx

Appendix 2. Summary of participation by experts, nominated by volunteer zoological scheme and society organisers (and other relevant bodies), to complete the species register entries associated with different informal (species) groups. The environment relates to the main environment of the informal group: terrestrial (T), terrestrial-freshwater (TF) or freshwater (F). The number of non-native species for each informal group is listed alongside the scheme, society or other organisation (and a named individual) contributing information.

Informal group	Environment	Number of species	Scheme participation
higher plants	All	1873	**Botanical Society of the British Isles**
Bryophytes	All		**British Bryological Society**
acarine (Acari)	T	9	**Health Protection Agency - Jolyon Medlock**
Amphibian	TF	12	**Amphibian and Reptile Conservation - John Wilkinson**
Annelid	F	6	**Earthworm Recording Scheme – Emma Sherlock**
Bird	T	119	**BTO**
bony fish (Actinopterygii)	F	35	**CEFAS and ecological consultant Dave Hubble**
bryozoan	F	1	**To complete**
centipede	T	7	**British Myriapod and Isopod Group (BMIG) – Tony Barber**
coelenterate (=cnidarian)	F	1	**Freshwater invertebrate expert - David Aldridge**
crustacean	F	15	**Freshwater invertebrate expert - David Aldridge**
crustacean	T	3	**BMIG – Tony Barber**
flatworm (Turbellaria)	F	4	**Terrestrial Flatworm Recording Scheme - Brian Boag and Hugh Jones**
flatworm (Turbellaria)	T	2	**Terrestrial Flatworm Recording Scheme - Brian Boag and Hugh Jones**
harvestman (Opiliones)	T	2	**To complete**
insect - beetle (Coleoptera)	F	2	**To complete**
insect - beetle (Coleoptera)	T	348	**Coleoptera Recording Scheme Organisers - Darren Mann, Dave Hubble, Helen Roy, Peter Brown**
insect - beetle (Coleoptera)	TF	1	**To complete**
insect - booklouse (Psocoptera)	T	38	**To complete - consulting scheme organiser - Keith Alexander**
insect - butterfly	T	3	**Lepidoptera expert - David Green**
insect - cockroach (Dictyoptera)	T	4	**To complete**
insect - earwig (Dermaptera)	T	5	**Orthoptera Recording Scheme - Björn Beckmann**
insect - flea	T	7	**To complete**

(Siphonaptera)			
insect - hymenopteran (ant)	T	16	**Bees Wasp and Ants Recording Society - Mike Fox**
insect - hymenopteran (chalcid wasp)	T	16	**Parasitic Wasp Recording Scheme Organiser - Gavin Broad**
insect - hymenopteran (cynipid wasp)	T	6	**Parasitic Wasp Recording Scheme Organiser - Gavin Broad**
insect - hymenopteran (ichneumon)	T	1	**Parasitic Wasp Recording Scheme Organiser - Gavin Broad**
insect - hymenopteran (sawfly)	T	39	**Royal Horticultural Society – Andrew Halstead**
insect - lacewing (Neuroptera)	T	2	**To complete**
insect - moth (macro)	T	29	**Lepidoptera expert - David Green**
insect - moth (micro)	T	108	**Lepidoptera expert - David Green**
insect - orthopteran	T	4	**Orthoptera Recording Scheme - Björn Beckmann**
insect - silverfish (Thysanura)	T	1	**To complete**
insect - stick insect (Phasmida)	T	6	**Orthoptera Recording Scheme - Björn Beckmann**
insect - termite	T	1	**To complete**
insect - thrips (Thysanoptera)	T	19	**Consulting FERA**
insect - true bug (Hemiptera)	T	236	**Auchenorrhyncha Scheme Organiser (Alan Stewart), Terrestrial heteroptera scheme organisers (Tristan Bantock with Bernard Nau), Psyllids and Coccids (RHS), Aphids (Rothamsted Research)**
insect - true fly (Diptera - fruitfly)	T	6	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera - fungus gnat)	T	1	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera - gallfly)	T	5	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera - gall-midge)	T	16	**Royal Horticultural Society – Andrew Halstead**
insect - true fly (Diptera - hoverfly)	T	9	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera - leaf-miner fly)	T	1	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera - lesser dungfly)	T	1	**Dipterists Forum - Ian McLean**

insect - true fly (Diptera - mosquito or gnat)	T	2	**Mosquito Recording Scheme - Jolyon Medlock**
insect - true fly (Diptera - parasite-fly)	T	5	**Dipterists Forum - Ian McLean**
insect - true fly (Diptera)	T	64	**Dipterists Forum - Ian McLean**
millipede	T	2	**BMIG – Tony Barber**
mollusc	F	8	**Freshwater invertebrate expert - David Aldridge**
mollusc	T	30	**Ecological consultant - Dave Hubble**
reptile	T	5	**Amphibian and Reptile Conservation - John Wilkinson**
reptile	TF	1	**Amphibian and Reptile Conservation - John Wilkinson**
ribbon worm (Nemertinea)	T	1	**To complete**
roundworm (Nematoda)	F	1	**To complete**
roundworm (Nematoda)	T	4	**To complete**
spider (Araneae)	T	44	**Ecological consultant - Dave Hubble**
springtail (Collembola)	T	7	**Collembola Scheme Organser - Peter Shaw**
terrestrial mammal	T	41	**BTO**

Appendix 3. List of species selected for factsheets within the GB-NNSIP (294 species)

Species	Common name	Informal group	Phylum	Environment
Acaena novae-zelandiae	Pirri-Pirri Bur	flowering plant	Anthophyta	T
Acer pseudoplatanus	Sycamore	flowering plant	Anthophyta	T
Achatina fulica	Giant African Land Snail	mollusc	Mollusca	T
Aedes albopictus	Asian Tiger Mosquito	insect - true fly (Diptera)	Arthropoda	T
Aegopodium podagraria	Ground-elder	flowering plant	Anthophyta	T
Agapornis roseicollis	Rosy-faced lovebird	bird	Chordata	T
Agrilus planipennis	Emerald Ash Borer	insect - beetle (Coleoptera)	Arthropoda	T
Ailanthus altissima	Tree of heaven	flowering plant	Anthophyta	T
Aix galericulata	Mandarin	bird	Chordata	T
Aix sponsa	Carolina Wood Duck	bird	Chordata	T
Alectoris chukar	Chukar	bird	Chordata	T
Alectoris graeca	Rock Partridge	bird	Chordata	T
Alexandrium catenella		alga	Dinophyta	M
Allium paradoxum	Few-flowered Garlic	flowering plant	Anthophyta	T
Allium triquetrum	Three-Cornered Garlic	flowering plant	Anthophyta	T
Alopochen aegyptiacus	Egyptian Goose	bird	Chordata	T
Alytes obstetricans	Midwife Toad	amphibian	Chordata	TF
Ambloplites rupestris	Rock Bass	bony fish (Actinopterygii)	Chordata	F
Ambrosia artemisiifolia	Ragweed	flowering plant	Anthophyta	T
Ameiurus melas	Black Bullhead	bony fish (Actinopterygii)	Chordata	F
Amelanchier lamarckii	Juneberry	flowering plant	Anthophyta	T
Ammothea hilgendorfi	Japanese sea spider			M
Anguillicola crassus	Swimbladder Nematode	roundworm (Nematoda)	Nematoda	MF
Anoplophora chinensis	Citrus longhorn beetle	insect - beetle (Coleoptera)	Arthropoda	T
Anoplophora glabripennis	Asian Longhorned Beetle	insect - beetle (Coleoptera)	Arthropoda	T
Anser caerulescens	Snow Goose	bird	Chordata	T
Anser canagica	Emperor Goose	bird	Chordata	T
Anser indicus	Bar-headed Goose	bird	Chordata	T
Antithamnion nipponicum		alga	Rhodophyta	M
Aphis gossypii	Cotton aphid	insect - true bug (Hemiptera)	Arthropoda	T
Aratinga acuticaudata	Blue-crowned Parakeet	bird	Chordata	T
Arcitalitrus dorrieni		crustacean	Arthropoda	T
Arge berberidis	Berberis Sawfly	insect - hymenopteran	Arthropoda	T
Arion lusitanicus agg.	Lusitanian Slug	mollusc	Mollusca	T
Arthurdendyus triangulata	New Zealand	flatworm (Turbellaria)	Platyhelminthes	T

	Flatworm			
Arundo donax	Giant Reed	flowering plant	Anthophyta	F
Asparagopsis armata	Harpoon weed	alga	Rhodophyta	M
Astacus astacus	Noble Crayfish	crustacean	Arthropoda	F
Astacus leptodactylus	Turkish Crayfish	crustacean	Arthropoda	F
Australoplana sanguinea	Australian Flatworm	flatworm (Turbellaria)	Platyhelminthes	T
Azolla caroliniana	Carolina Mosquito Fern	fern	Pteridophyta	F
Azolla filiculoides	Water Fern	fern	Pteridophyta	F
Balanus improvisus	Barnacle	crustacean	Arthropoda	M
Bemisia tabaci	Tobacco Whitefly	insect - true bug (Hemiptera)	Arthropoda	T
Blatta orientalis	Oriental Cockroach	insect - cockroach (Dictyoptera)	Arthropoda	T
Blattella germanica	German Cockroach	insect - cockroach (Dictyoptera)	Arthropoda	T
Bombina variegata	Yellow-bellied Toad	amphibian	Chordata	TF
Bonnemaisonia hamifera		alga	Rhodophyta	M
Botrylloides cf.diegense				M
Botrylloides violaceus		tunicate (Urochordata)	Chordata	M
Branta canadensis	Canada Goose	bird	Chordata	T
Bubo bubo	Eagle Owl	bird	Chordata	T
Buddleja davidii	Buddleia	flowering plant	Anthophyta	T
Bugula neritina	Brown Bryozoan	bryozoan		M
Bursaphelenchus xylophilus	Pine Wood Nematode	roundworm (Nematoda)	Nematoda	T
Cabomba caroliniana	Carolina Water-shield	flowering plant	Anthophyta	F
Cairina moschata	Muscovy Duck	bird	Chordata	T
Cameraria ohridella	Horse chestnut leaf miner	insect - moth	Arthropoda	T
Campanula rapunculoides	Creeping Bellflower	flowering plant	Anthophyta	T
Campylopus introflexus	Heath Star Moss	moss	Bryophyta	T
Capra hircus	Feral Goat	terrestrial mammal	Chordata	T
Caprella mutica	Japanese skeleton shrimp	crustacean	Arthropoda	M
Carassius auratus	Goldfish	bony fish (Actinopterygii)	Chordata	F
Carpobrotus edulis	Hottentot-Fig	flowering plant	Anthophyta	T
Caulerpa racemosa	Grape Alga	alga	Chlorophyta	M
Caulerpa taxifolia	Killer Alga	alga	Chlorophyta	M
Ceratitis capitata	Medfly	insect - true fly (Diptera)	Arthropoda	T
Cervus nippon	Sika Deer	terrestrial mammal	Chordata	T
Chrysolina americana	Rosemary Beetle	insect - beetle (Coleoptera)	Arthropoda	T
Chrysolophus amherstiae	Lady Amherst's Pheasant	bird	Chordata	T
Chrysolophus pictus	Golden Pheasant	bird	Chordata	T

Cicerbita macrophylla	Blue Sow-Thistle	flowering plant	Anthophyta	T
Cinara cupressi	Cypress Aphid	insect - true bug (Hemiptera)	Arthropoda	T
Claytonia sibirica	Pink Purslane	flowering plant	Anthophyta	T
Codium fragile (fragile)	Green sea fingers	alga	Chlorophyta	M
Contarinia quinquenotata	Hemerocallis gall midge	insect - true fly (Diptera)	Arthropoda	T
Corbicula fluminea	Asiatic Clam	mollusc	Mollusca	F
Cordylophora caspia		coelenterate (=cnidarian)	Cnidaria	M
Corella eumyota		tunicate (Urochordata)	Chordata	M
Cornus sericea	Red-Osier Dogwood	flowering plant	Anthophyta	T
Corophium sextonae		crustacean	Arthropoda	M
Cortaderia selloana	Pampas Grass	flowering plant	Anthophyta	T
Corvus splendens	Indian house crow	bird	Chordata	T
Coscinodiscus wailesii		diatom	Chromista	M
Cotoneaster horizontalis	Wall Cotoneaster	flowering plant	Anthophyta	T
Cotoneaster microphyllus s.str.	Small-leaved Cotoneaster	flowering plant	Anthophyta	T
Cotoneaster simonsii	Himalayan Cotoneaster	flowering plant	Anthophyta	T
Crangonyx pseudogracilis	Northern River Crangonyctid	crustacean	Arthropoda	F
Crassostrea gigas	Pacific oyster	mollusc	Mollusca	M
Crassula helmsii	New Zealand Pigmyweed	flowering plant	Anthophyta	F
Crepidula fornicata	Slipper limpet	mollusc	Mollusca	M
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia	flowering plant	Anthophyta	T
Ctenopharyngodon idellus	Chinese Grass Carp	bony fish (Actinopterygii)	Chordata	F
Cygnus atratus	Black Swan	bird	Chordata	T
Cynomys ludovicianus	Black-tailed Prairie Dog	terrestrial mammal	Chordata	T
Cyprinus carpio	Carp	bony fish (Actinopterygii)	Chordata	F
Dama dama	Fallow Deer	terrestrial mammal	Chordata	T
Datura stramonium	Thorn-Apple	flowering plant	Anthophyta	T
Diabrotica virgifera	Western Corn Rootworm	insect - beetle (Coleoptera)	Arthropoda	T
Didemnum vexillum	Carpet Sea-squirt	tunicate (Urochordata)	Chordata	M
Dikerogammarus villosus	Killer Shrimp	crustacean	Arthropoda	F
Disphyma crassifolium	Purple Dewplant	flowering plant	Anthophyta	T
Doronicum pardalianches	Leopard's-bane	flowering plant	Anthophyta	T
Dreissena bugensis	Quagga Mussel	mollusc	Mollusca	F
Dreissena polymorpha	Zebra Mussel	mollusc	Mollusca	F
Echinocystis lobata	Wild Cucumber	flowering plant	Anthophyta	T
Egeria densa	Large-Flowered	flowering plant	Anthophyta	F

	Waterweed			
Eichhornia crassipes	Water Hyacinth	flowering plant	Anthophyta	F
Eliomys quercinus	Garden Dormouse	terrestrial mammal	Chordata	T
Elminius modestus		crustacean	Arthropoda	M
Elodea canadensis	Canadian Pondweed	flowering plant	Anthophyta	F
Elodea nuttallii	Esthwaite Water-Weed	flowering plant	Anthophyta	F
Emys orbicularis	European Pond Terrapin	reptile	Chordata	T
Ensis americanus	American jack knife clam	mollusc	Mollusca	M
Epilobium brunnescens	New Zealand Willowherb	flowering plant	Anthophyta	T
Eriocheir sinensis	Chinese Mitten Crab	crustacean	Arthropoda	M
Eucalyptus (genus)	Gum Tree	flowering plant	Anthophyta	T
Fallopia baldschuanica	Russian Vine	flowering plant	Anthophyta	T
Fallopia japonica	Janapese Knotweed	flowering plant	Anthophyta	T
Fallopia japonica x sachalinensis = F. x bohemica		flowering plant	Anthophyta	T
Fallopia sachalinensis	Giant Knotweed	flowering plant	Anthophyta	T
Ficopomatus enigmaticus		annelid	Annelida	M
Frankliniella occidentalis		insect - thrips (Thysanoptera)	Arthropoda	T
Gammarus tigrinus	Sideswimmer	crustacean	Arthropoda	MF
Gaultheria shallon	Shallon	flowering plant	Anthophyta	T
Glis glis	Edible Dormouse	terrestrial mammal	Chordata	T
Graphocephala fennahi	Rhododendron leafhopper	insect - true bug (Hemiptera)	Arthropoda	T
Grateloupia filicina subsp. luxurians		alga	Rhodophyta	M
Grateloupia turuturu	Devil's tongue weed	alga	Rhodophyta	M
Gunnera manicata	Brazilian Giant Rhubarb	flowering plant	Anthophyta	T
Gunnera tinctoria	Giant Rhubarb	flowering plant	Anthophyta	T
Gyrodactylus salaris	Salmon fluke	trematode	Platyhelminthes	F
Harmonia axyridis	Harlequin Ladybird	insect - beetle (Coleoptera)	Arthropoda	T
Helianthus tuberosus	Jerusalem Artichoke	flowering plant	Anthophyta	T
Hemigrapsus sanguineus	Japanese shore crab	crustacean	Arthropoda	M
Hemigrapsus takanoi	Brush-clawed shore crab	crustacean	Arthropoda	M
Hemimysis anomala	Bloody-red Mysid	crustacean	Arthropoda	F
Heracleum mantegazzianum	Giant Hogweed	flowering plant	Anthophyta	T
Hyacinthoides hispanica	Garden Bluebell	flowering plant	Anthophyta	T

Hydrocotyle ranunculoides	Floating Pennywort	flowering plant	Anthophyta	F
Hydropotes inermis	Chinese Water Deer	terrestrial mammal	Chordata	T
Hyla arborea	Common Tree Frog	amphibian	Chordata	TF
Hystrix brachyura	Hodgson's Porcupine	terrestrial mammal	Chordata	T
Hystrix cristata	European Porcupine	terrestrial mammal	Chordata	T
Impatiens glandulifera	Himalayan Balsam	flowering plant	Anthophyta	T
Kontikia andersoni		flatworm (Turbellaria)	Platyhelminthes	T
Kontikia ventrolineata		flatworm (Turbellaria)	Platyhelminthes	T
Lacerta bilineata	Western Green Lizard	reptile	Chordata	T
Lagarosiphon major	Curly Waterweed	flowering plant	Anthophyta	F
Lamiastrum galeobdolon subsp. argentatum		flowering plant	Anthophyta	T
Lasius neglectus	Asian Super Ant	insect - hymenopteran	Arthropoda	T
Lemna minuta	Least Duckweed	flowering plant	Anthophyta	F
Lepomis gibbosus	Pond-Perch	bony fish (Actinopterygii)	Chordata	F
Leptinotarsa decemlineata	Colorado Beetle	insect - beetle (Coleoptera)	Arthropoda	T
Leptoglossus occidentalis	Western conifer seed bug	insect - true bug (Hemiptera)	Arthropoda	T
Leucaspius delineatus	Belica	bony fish (Actinopterygii)	Chordata	F
Leuciscus idus	Ide	bony fish (Actinopterygii)	Chordata	F
Lilioceris lilii	Lily Beetle	insect - beetle (Coleoptera)	Arthropoda	T
Linepithema humile	Argentine ant	insect - hymenopteran	Arthropoda	T
Liriomyza huidobrensis	Pea leaf miner	insect - true fly (Diptera)	Arthropoda	T
Lithobates catesbeianus	American Bullfrog	amphibian	Chordata	TF
Lonicera japonica	Japanese Honeysuckle	flowering plant	Anthophyta	T
Lophocolea semiteres	Liverwort			
Ludwigia peploides	Creeping Water-primrose	flowering plant	Anthophyta	F
Lymantria dispar	Gypsy Moth	insect - moth	Arthropoda	T
Lysichiton americanus	American Skunk-cabbage	flowering plant	Anthophyta	T
Macropus rufogriseus	Red-necked Wallaby	terrestrial mammal	Chordata	T
Mahonia aquifolium	Oregon-grape	flowering plant	Anthophyta	T
Marenzelleria neglecta	Red-gilled Mud Worm	annelid	Annelida	M
Marenzelleria viridis	Red-gilled Mud Worm	annelid	Annelida	M
Marsupenaeus japonicus	Caribbean mud crab	crustacean	Arthropoda	M
Melopsittacus undulatus	Budgerigar	bird	Chordata	T
Mercenaria mercenaria	American hard-shelled clam	mollusc	Mollusca	M
Meriones unguiculatus	Mongolian Gerbil	terrestrial mammal	Chordata	T
Mesotriton alpestris	Alpine Newt	amphibian	Chordata	TF
Micropterus salmoides	Largemouth Bass	bony fish (Actinopterygii)	Chordata	F
Mimulus guttatus	Monkeyflower	flowering plant	Anthophyta	T
Mnemiopsis leidyi	comb jelly			M

Muntiacus reevesi	Muntjac	terrestrial mammal	Chordata	T
Mus domesticus	House Mouse	terrestrial mammal	Chordata	T
Mustela furo	Feral Ferret	terrestrial mammal	Chordata	T
Mustela vison	American Mink	terrestrial mammal	Chordata	T
Myiopsitta monachus	Monk Parakeet	bird	Chordata	T
Myocastor coypus	Coypu	terrestrial mammal	Chordata	T
Myriophyllum aquaticum	Parrot's Feather	flowering plant	Anthophyta	F
Nasua nasua	Coati	terrestrial mammal	Chordata	T
Neogobius melanostomus	Round Goby	bony fish (Actinopterygii)	Chordata	F
Netta rufina	Red-crested Pochard	bird	Chordata	T
Nezara viridula	Southern green stink bug	insect - true bug (Hemiptera)	Arthropoda	T
Numida meleagris	Helmeted Guineafowl	bird	Chordata	T
Nyctereutes procyonoides	Raccoon Dog	terrestrial mammal	Chordata	T
Nycticorax nycticorax	Black-crowned Night Heron	bird	Chordata	T
Odontella sinensis		diatom	Chromista	M
Ondatra zibethicus	Musk Rat	terrestrial mammal	Chordata	T
Orconectes limosus	Spinycheek Crayfish	crustacean	Arthropoda	F
Orthodontium lineare	Cape Thread-moss	moss	Bryophyta	T
Oryctolagus cuniculus	Rabbit	terrestrial mammal	Chordata	T
Oxalis pes-caprae	Bermuda-buttercup	flowering plant	Anthophyta	T
Oxyura jamaicensis	Ruddy Duck	bird	Chordata	T
Pachygrapsus marmoratus	Marbled shore crab	crustacean	Arthropoda	M
Pacifastacus leniusculus	Signal Crayfish	crustacean	Arthropoda	F
Paralithodes camtschaticus	Red King Crab	crustacean	Arthropoda	M
Parthenocissus inserta	False Virginia-Creeper	flowering plant	Anthophyta	T
Parthenocissus quinquefolia	Virginia-creeper	flowering plant	Anthophyta	T
Paspalum distichum	Water Finger-grass	flowering plant	Anthophyta	T
Pelophylax esculentus	Edible Frog	amphibian	Chordata	TF
Pelophylax ridibundus	Marsh frog	amphibian	Chordata	TF
Periplaneta americana	American Cockroach	insect - cockroach (Dictyoptera)	Arthropoda	T
Periplaneta australasiae	Australian Cockroach	insect - cockroach (Dictyoptera)	Arthropoda	T
Persicaria campanulata	Lesser Knotweed	flowering plant	Anthophyta	T
Persicaria wallichii	Himalayan Knotweed	flowering plant	Anthophyta	T
Petasites albus	White Butterbur	flowering plant	Anthophyta	T
Petasites fragrans	Winter Heliotrope	flowering plant	Anthophyta	T
Petasites japonicus	Giant Butterbur	flowering plant	Anthophyta	T
Phagocata woodworthi		flatworm (Turbellaria)	Platyhelminthes	F
Phasianus colchicus	Common Pheasant	bird	Chordata	T
Phasianus versicolor	Green Pheasant	bird	Chordata	T

Picea sitchensis	Sitka Spruce	conifer	Pinophyta	T
Pikea californica	Captain Pike's weed	alga	Rhodophyta	M
Pimepales promelas	Fathead Minnow	bony fish (Actinopterygii)	Chordata	F
Pinus contorta	Lodgepole Pine	conifer	Pinophyta	T
Pinus nigra	Black Pine	conifer	Pinophyta	T
Pinus pinaster	Atlantic Maritime Pine	conifer	Pinophyta	T
Pistia stratiotes	Water Lettuce	flowering plant	Anthophyta	F
Planaria torva		flatworm (Turbellaria)	Platyhelminthes	F
Podarcis muralis	Wall Lizard	reptile	Chordata	T
Pontederia cordata	Pickerelweed	flowering plant	Anthophyta	F
Potamopyrgus antipodarum	Jenkins' Spire Snail	mollusc	Mollusca	F
Procambarus clarkii	Red Swamp Crayfish	crustacean	Arthropoda	F
Procambarus marmorkrebs	Marbled Crayfish	crustacean	Arthropoda	F
Procyon lotor	Raccoon	terrestrial mammal	Chordata	T
Prokelisia marginata	Spartina Planthopper	insect - true bug (Hemiptera)	Arthropoda	TM
Prunus laurocerasus	Cherry Laurel	flowering plant	Anthophyta	T
Prunus serotina	Rum Cherry	flowering plant	Anthophyta	T
Pseudorasbora parva	Topmouth Gudgeon	bony fish (Actinopterygii)	Chordata	F
Pseudotsuga menziesii	Douglas Fir	conifer	Pinophyta	T
Psittacula eupatria	Alexandrine Parakeet	bird	Chordata	T
Psittacula krameri	Ring-Necked Parakeet	bird	Chordata	T
Pudu puda	Pudu Deer	terrestrial mammal	Chordata	T
Pulvinaria regalis	Horse Chestnut Scale	insect - true bug (Hemiptera)	Arthropoda	T
Quercus cerris	Turkey Oak	flowering plant	Anthophyta	T
Quercus ilex	Evergreen Oak	flowering plant	Anthophyta	T
Rapana venosa	Mangrove oyster	mollusc	Mollusca	M
Rattus norvegicus	Brown Rat	terrestrial mammal	Chordata	T
Rattus rattus	Ship Rat	terrestrial mammal	Chordata	T
Reticulitermes lucifugus		insect - termite	Arthropoda	T
Rhithropanopeus harrisii	Dwarf crab	crustacean	Arthropoda	M
Rhodeus amarus	Bitterling	bony fish (Actinopterygii)	Chordata	F
Rhododendron luteum	Yellow Azalea	flowering plant	Anthophyta	T
Rhododendron ponticum	Rhododendron	flowering plant	Anthophyta	T
Ribes sanguineum	Flowering Currant	flowering plant	Anthophyta	T
Robinia pseudoacacia	False Acacia	flowering plant	Anthophyta	T
Rosa rugosa	Japanese Rose	flowering plant	Anthophyta	T
Rubus spectabilis	Salmonberry	flowering plant	Anthophyta	T
Sagittaria latifolia	Duck-potato	flowering plant	Anthophyta	F
Salvelinus fontinalis	American Brook Trout	bony fish (Actinopterygii)	Chordata	F
Salvinia molesta	Giant Salvinia	fern	Pteridophyta	F

Sander lucioperca	Pikeperch	bony fish (Actinopterygii)	Chordata	F
Sargassum muticum	Wireweed	alga	Chromista	M
Sciurus carolinensis	Grey Squirrel	terrestrial mammal	Chordata	T
Sedum album	White Stonecrop	flowering plant	Anthophyta	T
Selenochlamys ysbryda	Ghost Slug	mollusc	Mollusca	T
Senecio inaequidens	Narrow-Leaved Ragwort	flowering plant	Anthophyta	T
Senecio squalidus	Oxford Ragwort	flowering plant	Anthophyta	T
Silurus glanis	Catfish	bony fish (Actinopterygii)	Chordata	F
Smyrnium olusatrum	Alexanders	flowering plant	Anthophyta	T
Smyrnium perfoliatum	Perfoliate Alexanders	flowering plant	Anthophyta	T
Solidago canadensis	Canadian Goldenrod	flowering plant	Anthophyta	T
Solidobalanus fallax		crustacean	Arthropoda	M
Spartina anglica	Common Cord-grass	flowering plant	Anthophyta	TM
Spiraea salicifolia agg.	Spiraea Bridewort group	flowering plant	Anthophyta	T
Spodoptera littoralis	African Cotton Leafworm	insect - moth	Arthropoda	T
Styela clava	Leathery sea squirt	tunicate (Urochordata)	Chordata	M
Symphoricarpos albus	Snowberry	flowering plant	Anthophyta	T
Symphytum x uplandicum	Russian Comfrey	flowering plant	Anthophyta	T
Syringa vulgaris	Lilac	flowering plant	Anthophyta	T
Syrmaticus reevesii	Reeves's Pheasant	bird	Chordata	T
Tadorna ferruginea	Ruddy Shelduck	bird	Chordata	T
Tamarix gallica	Tamarisk	flowering plant	Anthophyta	T
Tamias sibiricus	Siberian Chipmunk	terrestrial mammal	Chordata	T
Tapes philippinarum	Manila clam	mollusc	Mollusca	M
Teredo navalis		mollusc	Mollusca	M
Thaumetopoea processionea	Oak Processionary Moth	insect - moth	Arthropoda	T
Threskiornis aethiopicus	Sacred Ibis	bird	Chordata	T
Trachemys scripta	Red-eared Terrapin	reptile	Chordata	T
Tricellaria inopinata		bryozoan	Bryozoa	M
Triturus carnifex	Italian Crested Newt	amphibian	Chordata	TF
Undaria pinnatifida	Japanese kelp	alga	Chromista	M
Urosalpinx cinerea	American tingle	mollusc	Mollusca	M
Varroa destructor	Varroa Mite	acarine (Acari)	Arthropoda	T
Vespa velutina	Asian Hornet	insect - hymenopteran	Arthropoda	T
Watersipora subtorquata		bryozoan	Bryozoa	M
Xenopus laevis	African Clawed Toad	amphibian	Chordata	TF
Zamenis longissimus	Aesculapian Snake	reptile	Chordata	T

Appendix 4. Micro-organisms excluded from the project (250 species)

Species	English name	Phylum	Establishment status	Status
Aglaospora profusa		Ascomycota	E	U
Anthostomella trachycarpi		Ascomycota	E	U
Apiognomonia errabunda		Ascomycota		U
Arachnopeziza aranea		Ascomycota	E	U
Arthrocladiella mougeotii		Ascomycota	E	U
Astrosphaeriella trochus		Ascomycota	E	U
Aulographina eucalypti		Ascomycota	E	U
Blumeriella jaapii		Ascomycota		U
Botryosphaeria rhodorae		Ascomycota	E	U
Botryotinia draytonii		Ascomycota	N	U
Botryotinia sphaerosperma		Ascomycota	E	U
Botryotinia squamosa		Ascomycota	N	U
Calonectria kyotensis		Ascomycota		U
Ciboria americana		Ascomycota	E	U
Cryptodiaporthe aesculi		Ascomycota	E	U
Cryptodiaporthe castanea		Ascomycota	E	U
Cryptodiaporthe robergeana		Ascomycota	N	U
Cryptosporella platanigera		Ascomycota	E	U
Cryptostroma corticale		Ascomycota		U
Cucurbitaria laburni		Ascomycota	E	U
Cucurbitaria piceae		Ascomycota	E	U
Cylindrocladium buxicola		Ascomycota		U
Diaporthe aucubae		Ascomycota	E	U
Diaporthe nobilis		Ascomycota	E	U
Diaporthe oncostoma		Ascomycota	E	U
Diaporthe skimmiae		Ascomycota	E	U
Didymascella thujina	Thuja Needle Scorch	Ascomycota	E	U
Didymella exitialis		Ascomycota	E	U
Didymella lycopersici	Tomato Stem and Fruit Rot	Ascomycota	E	U
Discohainesia oenotherae		Ascomycota	E	U
Dothidotthia celtidis		Ascomycota	E	U
Drepanopeziza populi-albae		Ascomycota	E	U
Drepanopeziza punctiformis		Ascomycota		U
Elsinoe ampelina	Grape Anthracnose	Ascomycota	E	U
Entoleuca mammata		Ascomycota		U
Epibelonium gaeumannii		Ascomycota	E	U
Erysiphe alphitoides		Ascomycota		U
Erysiphe arcuata		Ascomycota		U
Erysiphe euonymi-japonici		Ascomycota	E	U
Erysiphe flexuosa		Ascomycota		U
Erysiphe necator	Vine Powdery Mildew	Ascomycota	E	U
Erysiphe palczewskii		Ascomycota		U
Erysiphe platani		Ascomycota	E	U
Erysiphe rayssiae		Ascomycota	E	U
Erysiphe russellii		Ascomycota		U
Erysiphe syringae		Ascomycota	E	U
Erysiphe vanbruntiana var.		Ascomycota		U

sambuci-racemosae				
Eupropolella arundinariae		Ascomycota	E	NN
Eupropolella britannica		Ascomycota	E	U
Glomerella cingulata		Ascomycota		U
Gnomonia leptostyla		Ascomycota	E	U
Gnomonia tetraspora		Ascomycota		U
Golovinomyces orontii		Ascomycota	E	U
Guignardia aesculi		Ascomycota	E	U
Hapalocystis berkeleyi		Ascomycota	E	U
Hyalopeziza spinicola		Ascomycota	E	U
Hyaloscypha mirabilis		Ascomycota	E	U
Hysterostegiella lauri		Ascomycota	E	U
Kabatiella caulivora		Ascomycota		U
Kabatina thujae		Ascomycota		U
Khuskia oryzae		Ascomycota		U
Lachnellula resinaria		Ascomycota	E	U
Lachnellula willkommii		Ascomycota	E	U
Lachnum castaneicola		Ascomycota	E	U
Lanzia coracina		Ascomycota	E	U
Lanzia echinophila		Ascomycota	E	U
Lembosina aulographoides		Ascomycota	E	U
Leptosphaeria lunariae		Ascomycota		U
Leucostoma curreyi		Ascomycota	E	U
Leucostoma kunzei		Ascomycota	E	U
Lichenopeltella fimbriata		Ascomycota	E	U
Lophodermium piceae		Ascomycota	E	U
Lophodermium pini-excelsae		Ascomycota	E	U
Lophodermium vagulum		Ascomycota	E	U
Lophomerum ponticum		Ascomycota	E	U
Macrophomina phaseolina		Ascomycota		U
Melanomma rhododendri		Ascomycota	E	U
Microthyrium lauri		Ascomycota	E	U
Moellerodiscus advenulus		Ascomycota	E	U
Monilinia mespili		Ascomycota	E	U
Morenoina chamaecyparidis		Ascomycota	E	U
Mycosphaerella chrysanthemi	Chrysanthemum Ray Blight	Ascomycota	E	NN
Mycosphaerella cydoniae		Ascomycota		U
Mycosphaerella pini		Ascomycota		U
Mycosphaerella pinodes		Ascomycota	E	U
Mycosphaerella podagrariae		Ascomycota	E	U
Mycosphaerella rhododendri		Ascomycota	E	U
Nattrassia mangiferae		Ascomycota		U
Nectriella consolationis		Ascomycota	E	U
Neobulgaria undata		Ascomycota		U
Niptera subbiatorina		Ascomycota	E	U
Oidium hortensiae		Ascomycota		U
Oidium (Pseudoideum) sp.	Powdery mildew of rhododendron	Ascomycota	E	U
Ophiostoma novo-ulmi	Dutch elm disease	Ascomycota	E	U

Ophiostoma ulmi	Dutch elm disease (older less virulent strain)	Ascomycota	E	U
Orbilia retrusa		Ascomycota	E	U
Paurocotylis pila		Ascomycota	E	U
Pestalotiopsis guepinii		Ascomycota		U
Pezicula houghtonii		Ascomycota	E	U
Phaeocryptopus gaeumannii		Ascomycota	E	U
Phloeospora robiniae		Ascomycota		U
Phomopsis juniperivora		Ascomycota		U
Podosphaera mors-uvae	American Mildew	Ascomycota	E	U
Podosphaera xanthii		Ascomycota		U
Protoventuria arxii		Ascomycota	E	U
Pseudomassaria thistletonia		Ascomycota	E	U
Pseudonectria pachysandricola		Ascomycota		U
Pseudophacidium piceae		Ascomycota	E	U
Pseudovalsa modonia		Ascomycota	E	U
Psilachnum auranticolor		Ascomycota	E	U
Pyrenophora chaetomioides		Ascomycota		U
Ramularia collo-cygni		Ascomycota		U
Rhabdocline pseudotsugae		Ascomycota	E	U
Sarcotrochila alpina		Ascomycota	E	U
Seiridium cardinale		Ascomycota		U
Septoria betulae		Ascomycota		U
Stigmatea aegopodii		Ascomycota	E	D
Stomiopeltis cupressicola		Ascomycota	E	U
Stromatinia gladioli		Ascomycota		U
Taphrina deformans	Peach Leaf Curl	Ascomycota	E	U
Trochila laurocerasi		Ascomycota	E	U
Tympanis laricina		Ascomycota	E	U
Valsa laurocerasi		Ascomycota	E	U
Venturia saliciperda		Ascomycota		U
Xenomeris nicholsonii		Ascomycota	E	U
Agrocybe putaminum		Basidiomycota	E	NN
Amanita inopinata		Basidiomycota	E	U
Aseroe rubra	Starfish Fungus	Basidiomycota	E	U
Calocera pallidospathulata	Pale Stagshorn	Basidiomycota		NN
Chroogomphus helveticus		Basidiomycota		U
Chrysomyxa abietis	Spruce Needle Rust	Basidiomycota	E	U
Chrysomyxa ledi var. rhododendri	Rhododendron Rust	Basidiomycota	E	U
Clathrus archeri	Devil's Fingers	Basidiomycota	E	U
Clathrus ruber	Red Cage	Basidiomycota	E	U
Collybia biformis		Basidiomycota		NN
Cronartium ribicola	White Pine Blister Rust	Basidiomycota	E	U
Cumminsiella mirabilissima		Basidiomycota	E	NN
Endophyllum sempervivi	Houseleek Rust	Basidiomycota	E	U
Entyloma calendulae	Calendula Smut	Basidiomycota	E	U
Entyloma compositarum	Gaillardia Smut	Basidiomycota	N	U
Entyloma dahliae	Dahlia Smut	Basidiomycota	E	U

Entyloma fuscum		Basidiomycota		U
Flaviporus brownei		Basidiomycota	E	U
Gastrosporium simplex	Steppe Truffle	Basidiomycota	N	U
Geastrum campestre	Field Earthstar	Basidiomycota	N	U
Geastrum floriforme	Daisy Earthstar	Basidiomycota	E	U
Guepinia helvelloides	Salmon Salad	Basidiomycota	E	U
Gymnosporangium confusum		Basidiomycota	E	U
Gymnosporangium juniperi-virginianae		Basidiomycota	E	NN
Gymnosporangium sabinae		Basidiomycota	E	U
Hydnangium carneum		Basidiomycota	E	U
Ileodictyon cibarium	Basket Fungus	Basidiomycota	E	U
Laccaria fraterna		Basidiomycota	E	U
Leucocoprinus birnbaumii	Plantpot Dapperling	Basidiomycota	E	U
Leucocoprinus tenellus		Basidiomycota		U
Leucocoprinus zeylanicus		Basidiomycota		U
Lysurus cruciatus	Lizard's Claw	Basidiomycota	N	U
Melampsora amygdalinae		Basidiomycota	E	U
Melampsora lini var. liniperda		Basidiomycota	N	U
Melampsora ribesii-viminalis		Basidiomycota	E	U
Melampsora salicis-albae		Basidiomycota	E	U
Melampsoridium hiratsukanum		Basidiomycota		U
Melanotaenium hypogaeum		Basidiomycota		U
Melanotaenium jaapii		Basidiomycota	E	U
Microstroma juglandis		Basidiomycota	E	U
Mikronegeria fagi		Basidiomycota		U
Mutinus ravenelii	Red Stinkhorn	Basidiomycota	E	NN
Omphalotus olearius		Basidiomycota	E	U
Phragmidium fusiforme		Basidiomycota		U
Pisolithus arrhizus	Dyeball	Basidiomycota	E	U
Psilocybe cyanescens	Blueleg Brownie	Basidiomycota	E	NN
Puccinia aegopodii		Basidiomycota	E	U
Puccinia antirrhini	Antirrhinum Rust	Basidiomycota	E	U
Puccinia cyani	Centaurea Rust	Basidiomycota		U
Puccinia distincta	Rust of daisy	Basidiomycota	E	U
Puccinia gentianae		Basidiomycota		U
Puccinia gladioli		Basidiomycota		U
Puccinia horiana	Chrysanthemum White Rust	Basidiomycota	N	U
Puccinia kusanoi		Basidiomycota	E	U
Puccinia lagenophorae	Rust of groundsel	Basidiomycota	E	U
Puccinia ljulinica		Basidiomycota	E	U
Puccinia longicornis		Basidiomycota	E	U
Puccinia malvacearum		Basidiomycota	E	NN
Puccinia mariana		Basidiomycota		U
Puccinia oxalidis		Basidiomycota	E	U
Puccinia pazschkei var. pazschkei	Saxifrage Rust	Basidiomycota		U

Puccinia pelargonii-zonalis	Pelargonium Rust	Basidiomycota	E	U
Puccinia porri		Basidiomycota	E	U
Puccinia prostii		Basidiomycota	N	U
Puccinia smyrnii		Basidiomycota	E	U
Puccinia sorghi	Maize Rust	Basidiomycota	E	NN
Puccinia vincae	Periwinkle Rust	Basidiomycota	E	U
Queletia mirabilis	Quelet's Stalk Puffball	Basidiomycota	N	U
Sporisorium destruens	Millet Smut	Basidiomycota		NN
Sporisorium sorghi	Sorghum Smut	Basidiomycota		NN
Strobilurus esculentus	Sprucecone Cap	Basidiomycota	E	U
Stropharia aurantiaca	Redlead Roundhead	Basidiomycota	E	U
Stropharia percevalii		Basidiomycota	E	U
Suillus amabilis		Basidiomycota		D
Suillus grevillei	Larch Bolete	Basidiomycota	E	D
Suillus placidus		Basidiomycota		U
Suillus viscidus	Sticky Bolete	Basidiomycota	E	D
Tilletia caries	Bunt of wheat	Basidiomycota	N	U
Urocystis eranthidis		Basidiomycota	E	U
Urocystis gladiolicola	Gladiolus Smut	Basidiomycota	E	U
Urocystis occulta	Stripe Smut of Rye	Basidiomycota	E	U
Urocystis syncocca		Basidiomycota		U
Uromyces aecidiiformis		Basidiomycota	N	U
Uromyces appendiculatus		Basidiomycota	E	U
Uromyces colchici		Basidiomycota	N	U
Uromyces dianthi	Carnation Rust	Basidiomycota	E	D
Uromyces erythronii	Erythronium Rust	Basidiomycota	N	U
Ustilago cynodontis		Basidiomycota	E	U
Ustilago maydis	Maize Smut	Basidiomycota	E	U
Ustilago tritici	Loose Smut of Wheat and Barley	Basidiomycota	E	N-NN
Zaghouania phillyreae		Basidiomycota	X	U
Batrachochytrium dendrobatidis		Fungi (other)		U
Circinotrichum britannicum		Fungi (other)	E	U
Colletotrichum acutatum		Fungi (other)	E	U
Sphaeropsis sapinea		Fungi (other)		U
Synchytrium endobioticum	Wart disease of potato	Fungi (other)	E	NN
Bonamia ostreae	None known	Haplosporea	E	NN
Aerococcus viridans		Microorganisms	E	U
Barley mild mosaic virus	Barley mild mosaic	Microorganisms	E	U
Barley yellow mosaic virus	Barley yellow mosaic	Microorganisms	E	U
Beet necrotic yellow vein virus	Rhizomania	Microorganisms	E	U
Dickeya dianthicola	Slow wilt of potato	Microorganisms	E	U
Erwinia amylovora	Fireblight of pome fruit	Microorganisms	E	NN
Plum pox virus	Plum pox	Microorganisms	E	U
Pseudomonas syringe pv. pisi	Pea blight	Microorganisms	E	U
Ralstonia solanacearum race 3 biovar 2	Brown rot of potato	Microorganisms	E	NN
Rhabdovirus carpio	Spring Viremia of Carp	Microorganisms		

Soil-borne cereal mosaic virus	Soil-borne cereal mosaic	Microorganisms	E	U
Tomato spotted wilt virus	Tomato spotted wilt	Microorganisms	E	U
Cornuvia serpula		Mycetozoa	N	U
Aphanomyces astaci	Crayfish plague	Oomycete	E	NN
Phytophthora alni	Dieback of alder	Oomycete	E	U
Phytophthora cambivora		Oomycete		U
Phytophthora cinnamomi		Oomycete		U
Phytophthora citricola		Oomycete		U
Phytophthora citrophthora		Oomycete		U
Phytophthora drechsleri		Oomycete		U
Phytophthora ilicis		Oomycete		U
Phytophthora infestans	Potato Blight	Oomycete	E	NN
Phytophthora kernoviae	Trunk canker of beech	Oomycete	E	U
Phytophthora quercina		Oomycete		U
Phytophthora ramorum	Sudden oak death	Oomycete	E	U
Phytophthora syringae		Oomycete		U
Pseudoperonospora humuli	Downy mildew of hop	Oomycete	E	U
Ostracoblabe implexa		Zygomycota	U	U

Appendix 5. Species lists, within broad groups, designated as having a negative ecological or human impact. Region of origin and introduction pathway are also provided.

	Species	Ecological	Human	Region	Pathway
Higher plants					
Pirri-Pirri Bur	*Acaena novae-zelandiae*	N		Australasia	Stowaway
Bear's-Breech	*Acanthus mollis*	N		Europe	Ornamental
Sycamore	*Acer pseudoplatanus*	N		Europe	Ornamental
Ground-elder	*Aegopodium podagraria*		N	Europe	Agriculture
Tree-Of-Heaven	*Ailanthus altissima*	N		Asia-Temperate	Ornamental
Garden Lady's-mantle	*Alchemilla mollis*	N		Europe	Ornamental
Few-flowered Garlic	*Allium paradoxum*	N		Asia-Temperate	Ornamental
Rosy Garlic	*Allium roseum*	N		Europe	Ornamental
Three-Cornered Garlic	*Allium triquetrum*	N		Europe	Ornamental
Black Twitch	*Alopecurus myosuroides*		N	Europe	Contaminant
Juneberry	*Amelanchier lamarckii*	N		Northern America	Ornamental
Great Brome	*Anisantha diandra*	N		Europe	Contaminant
Barren Brome	*Anisantha sterilis*		N	Europe	Stowaway
Stinking Chamomile	*Anthemis cotula*		N	Europe	Contaminant
Loose Silky-bent	*Apera spica-venti*		N	Europe	Contaminant
Michaelmas-daisies	*Aster (alien N American taxa)*	N		Northern America	Ornamental
Late Michaelmas-Daisy	*Aster laevis x novi-belgii (A. x versicolor)*	N			Ornamental
Narrow-Leaved Michaelmas-Daisy	*Aster lanceolatus*	N		Northern America	Ornamental
Common Michaelmas-daisy	*Aster lanceolatus x novi-belgii (A. x salignus)*	N			Ornamental
Hairy Michaelmas-Daisy	*Aster novae-angliae*	N		Northern America	Ornamental
Confused Michaelmas-Daisy	*Aster novi-belgii*	N		Northern America	Ornamental
Wild Oat	*Avena fatua*		N	Europe	Contaminant
Animated Oat	*Avena sterilis*		N	Europe	Contaminant
Water Fern	*Azolla filiculoides*	N		Northern America	Ornamental
Buddleia	*Buddleja davidii*	N	N	Asia-Temperate	Ornamental
American Bellbine	*Calystegia silvatica*		N	Europe	Ornamental
Hottentot-Fig	*Carpobrotus edulis*	N	N	Africa	Ornamental
Corn Marigold	*Chrysanthemum segetum*		N	Europe	Contaminant
Bladder-senna	*Colutea arborescens*	N		Europe	Ornamental
Red-Osier Dogwood	*Cornus sericea*	N		Northern America	Ornamental
Wall Cotoneaster	*Cotoneaster horizontalis*	N		Asia-Temperate	Ornamental
Entire-leaved Cotoneaster	*Cotoneaster integrifolius*	N		Asia-Temperate	Ornamental
Himalayan Cotoneaster	*Cotoneaster simonsii*	N		Asia-Tropical	Ornamental
New Zealand Pigmyweed	*Crassula helmsii*	N	N	Australasia	Ornamental

Montbretia	*Crocosmia aurea x pottsii (C. x crocosmiiflora)*	N			Ornamental
Purple Dewplant	*Disphyma crassifolium*	N	N	Africa	Ornamental
Large-Flowered Waterweed	*Egeria densa*	N		Southern America	Aquaculture
Canadian Pondweed	*Elodea canadensis*	N		Northern America	Ornamental
Esthwaite Water-Weed	*Elodea nuttallii*	N		Northern America	Ornamental
Russian Vine	*Fallopia baldschuanica*	N		Asia-Temperate	Ornamental
Japanese Knotweed	*Fallopia japonica*	N	N	Asia-Temperate	Ornamental
Conolly's Knotweed	*Fallopia japonica x sachalinensis (F. x bohemica)*	N	N		Ornamental
Giant Knotweed	*Fallopia sachalinensis*	N		Asia-Temperate	Ornamental
Shallon	*Gaultheria shallon*	N		Northern America	Ornamental
Brazilian Giant Rhubarb	*Gunnera manicata*	N		Southern America	Ornamental
Giant Rhubarb	*Gunnera tinctoria*	N		Southern America	Ornamental
Giant Hogweed	*Heracleum mantegazzianum*	N	N	Asia-Temperate	Ornamental
Garden Bluebell	*Hyacinthoides hispanica*	N		Europe	Ornamental
Bluebell	*Hyacinthoides hispanica x non-scripta*	N			Ornamental
Floating Pennywort	*Hydrocotyle ranunculoides*	N		Northern America	Ornamental
Himalayan Balsam	*Impatiens glandulifera*	N	N	Asia-Tropical	Ornamental
Small Balsam	*Impatiens parviflora*	N		Asia-Temperate	Stowaway
Curly Waterweed	*Lagarosiphon major*	N		Africa	Ornamental
	Lamiastrum galeobdolon subsp. argentatum	N	N		Ornamental
Least Duckweed	*Lemna minuta*	N		Northern America	Ornamental
Uruguay Water-primrose	*Ludwigia grandiflora*	N		Northern America	Aquaculture
Wireplant	*Muehlenbeckia complexa*	N		Australasia	Ornamental
Parrot's Feather	*Myriophyllum aquaticum*	N		Southern America	Aquaculture
Pheasant's-eye Daffodil	*Narcissus poeticus*	N		Europe	Ornamental
Nonesuch Daffodil	*Narcissus poeticus x pseudonarcissus subsp. pseudonarcissus (N. x incomparabilis)*	N		Europe	Ornamental
Primrose-Peerless	*Narcissus poeticus x tazetta (N. x medioluteus)*	N		Europe	Ornamental
Spanish Daffodil	*Narcissus pseudonarcissus subsp. major*	N		Europe	Ornamental
Large-Flowered Pink-Sorrel	*Oxalis debilis*	N	N	Southern America	Ornamental
Garden Pink-sorrel	*Oxalis latifolia*	N	N	Southern America	Ornamental
Bermuda-buttercup	*Oxalis pes-caprae*		N	Africa	Ornamental

Virginia-creeper	*Parthenocissus quinquefolia*	N		Northern America	Ornamental
Green Alkanet	*Pentaglottis sempervirens*	N		Europe	Ornamental
Lesser Knotweed	*Persicaria campanulata*	N		Asia-Tropical	Ornamental
Himalayan Knotweed	*Persicaria wallichii*	N		Asia-Tropical	Ornamental
White Butterbur	*Petasites albus*	N		Europe	Ornamental
Winter Heliotrope	*Petasites fragrans*	N		Europe	Ornamental
Black Pine	*Pinus nigra*	N		Europe	Forestry
Corsican Pine	*Pinus nigra subsp. laricio*	N		Europe	Forestry
Austrian Pine	*Pinus nigra subsp. nigra*	N		Europe	Forestry
Atlantic Maritime Pine	*Pinus pinaster*	N		Europe	Ornamental
Cherry Laurel	*Prunus laurocerasus*	N		Europe	Ornamental
Portugal Laurel	*Prunus lusitanica*	N		Europe	Ornamental
Rum Cherry	*Prunus serotina*	N		Northern America	Ornamental
Arrow Bamboo	*Pseudosasa japonica*	N		Asia-Temperate	Ornamental
Turkey Oak	*Quercus cerris*	N		Europe	Ornamental
Evergreen Oak	*Quercus ilex*	N		Europe	Ornamental
Rhododendron	*Rhododendron ponticum*	N	N		Ornamental
False Acacia	*Robinia pseudoacacia*	N		Northern America	Ornamental
Dutch Rose	*Rosa 'Hollandica'*	N			Ornamental
Japanese Rose	*Rosa rugosa*	N		Asia-Temperate	Ornamental
Duck-potato	*Sagittaria latifolia*	N		Northern America	Ornamental
Broad-Leaved Bamboo	*Sasa palmata*	N		Asia-Temperate	Ornamental
Hairy Bamboo	*Sasaella ramosa*	N		Asia-Temperate	Ornamental
White Mustard	*Sinapis alba*		N	Europe	Agriculture
	Sinapis alba subsp. alba		N	Europe	Agriculture
Charlock	*Sinapis arvensis*		N	Europe	Contaminant
Alexanders	*Smyrnium olusatrum*	N		Europe	Agriculture
Townsend's Cord-Grass	*Spartina maritima x alterniflora = S. x townsendii*	N			Hybridisation
Corn Spurrey	*Spergula arvensis*		N	Europe	Contaminant
Spiraea	*Spiraea*	N		Europe	Ornamental
Billard's Bridewort	*Spiraea alba x douglasii (S. x billardii)*	N			Ornamental
Steeplebush	*Spiraea douglasii*	N		Northern America	Ornamental
Confused Bridewort	*Spiraea douglasii x salicifolia (S. x pseudosalicifolia)*	N			Ornamental
Bridewort	*Spiraea salicifolia*	N		Europe	Ornamental
Snowberry	*Symphoricarpos albus*	N		Northern America	Ornamental
Scentless Mayweed	*Tripleurospermum inodorum*		N	Europe	Contaminant
Slender Speedwell	*Veronica filiformis*	N	N	Asia-Temperate	Ornamental
Lesser Periwinkle	*Vinca minor*	N		Europe	Ornamental
Lower plants					
Green sea-fingers (tomentosoides)	*Codium fragile fragile*	N	N	Asia-Temperate	Aquaculture
	Polysiphonia harveyi	N		Pacific	Aquaculture

Wire weed	*Sargassum muticum*	N	N	Asia-Temperate	Aquaculture
Japanese kelp	*Undaria pinnatifida*	N		Asia-Temperate	Stowaway
Insects					
American Seed Beetle	*Acanthoscelides obtectus*		N	Southern America	Contaminant
Douglas Fir Woolly Aphid	*Adelges cooleyi*		N	Northern America	
Lesser Mealworm Beetle	*Alphitobius diaperinus*		N		Unknown
Black Fungus Beetle	*Alphitobius laevigatus*		N		Unknown
Australian Carpet Beetle	*Anthrenocerus australis*		N	Australasia	Contaminant
Furniture Carpet Beetle	*Anthrenus (Anthrenus) flavipes*		N	Asia-Temperate	Contaminant
Common Carpet Beetle	*Anthrenus (Anthrenus) scrophulariae*		N	Europe	Contaminant
	Anthrenus (Florilinus) olgae		N	Europe	Unknown
	Anthrenus oceanicus		N	Asia-Tropical	Unknown
Black legume aphid	*Aphis craccivora*		N	Asia-Temperate	
Cotton aphid / Melon aphid	*Aphis gossypii*		N	Africa	Ornamental
Locust Bean Moth	*Apomyelois ceratoniae*		N		Contaminant
Berberis Sawfly	*Arge berberidis*	N	N	Europe	Ornamental
	Attagenus brunneus		N	Africa	Unknown
	Attagenus cyphonoides		N		Contaminant
Wardrobe Beetle	*Attagenus fasciatus*		N		Contaminant
Two-spotted Carpet Beetle	*Attagenus pellio*		N		Unknown
Brown Carpet Beetle	*Attagenus smirnovi*		N	Africa	Unknown
	Attagenus trifasciatus		N	Europe	Unknown
Black Carpet Beetle	*Attagenus unicolor*		N	Africa	Contaminant
Mottled Arum aphid	*Aulacorthum(Neomyzus) circumflexus*		N	Asia-Temperate	
Common Cockroach	*Blatta orientalis*		N	Africa	Contaminant
Lentil Seed Beetle	*Bruchus ervi*		N	Asia-Temperate	Contaminant
Pea Beetle	*Bruchus pisorum*		N	Europe	Contaminant
Bean Seed Beetle	*Bruchus rufimanus*		N	Europe	Unknown
Dried fruit moth	*Cadra calidella*		N		Contaminant
Dried currant moth	*Cadra cautella*		N		Contaminant
Raisin moth	*Cadra figulilella*		N		Contaminant
Adzuki Beanseed Beetle	*Callosobruchus chinensis*		N	Asia-Temperate	Contaminant
	Cerataphis orchidearum		N	Asia-Tropical	
	Chaetosiphon fragaefolii		N	Northern America	
Soft scale	*Coccus hesperidum*	N	N		Ornamental
an orchid scale insect	*Coccus pseudohesperidum*		N	Southern America	Ornamental
Spruce Groundling	*Coleotechnites piceaella*		N	Northern America	Unknown
a palm scale insect	*Colobopyga kewensis*		N	Australasia	Ornamental
Rice Moth	*Corcyra cephalonica*		N		Contaminant
Asparagus Beetle	*Crioceris asparagi*		N	Europe	Unknown
Honeydew moth	*Cryptoblabes gnidiella*		N	Europe	Contaminant
Great Spruce Bark Beetle	*Dendroctonus micans*		N	Europe	Stowaway

Black Larder Beetle	*Dermestes (Dermestes) ater*		N	Europe	Contaminant
Peruvian Larder Beetle	*Dermestes (Dermestes) peruvianus*		N	Southern America	Contaminant
	Dermestes (Dermestinus) carnivorus		N	Northern America	Contaminant
	Dermestes (Dermestinus) frischii		N		Contaminant
Hide Beetle	*Dermestes (Dermestinus) maculatus*		N	Africa	Contaminant
rhododendron whitefly	*Dialeurodes chittendeni*		N		Ornamental
Dark Marbled Tabby	*Duponchelia fovealis*		N	Africa	Contaminant
	Dysaphis tulipae		N	Europe	
Green Spruce Aphid	*Elatobium abietinum*		N	Europe	
Cacao Moth	*Ephestia elutella*		N		Contaminant
Mediterranean Flour Moth	*Ephestia kuehniella*		N		Contaminant
Light Brown Apple Moth	*Epiphyas postvittana*		N	Australasia	Contaminant
Woolly Aphid	*Eriosoma lanigerum*		N	Northern America	
New Zealand weevil	*Euophryum confine*		N	Australasia	Stowaway
	Euophryum rufum		N	Australasia	Stowaway
Peach Knot-horn	*Euzophera bigella*		N		Contaminant
a fern whitefly	*Filicaleyrodes williamsi*		N		Ornamental
Laburnum sucker	*Floria variegata*		N	Europe	Ornamental
	Frankliniella occidentalis		N	Northern America	Ornamental
Broad-horned Flour Beetle	*Gnatocerus cornutus*		N	Southern America	Unknown
Rhododendron leafhopper	*Graphocephala fennahi*	N		Northern America	Unknown
Harlequin Ladybird	*Harmonia axyridis*	N	N	Asia-Temperate	Stowaway
	Hemiberlesia palmae		N		Ornamental
	Homotoma ficus		N	Europe	Agriculture
The Dump Fly	*Hydrotaea aenescens*	N		Northern America	
Large Larch Bark Beetle	*Ips cembrae*		N	Europe	Stowaway
Invasive garden ant	*Lasius neglectus*	N	N	Asia-Temperate	Ornamental
Long-Headed Flour Beetle	*Latheticus oryzae*		N	Asia-Tropical	Contaminant
Western Conifer Seed Bug	*Leptoglossus occidentalis*		N	Northern America	Stowaway
	Macrosiphoniella sanborni		N	Asia-Temperate	
Lupin Aphid	*Macrosiphum albifrons*		N	Northern America	
	Macrosiphum euphorbiae	N	N	Northern America	
Pharo's ant	*Monomorium pharaonis*		N	Africa	Unknown
	Monomorium salomonis		N	Africa	Unknown
Large peach aphid	*Myzus varians*		N	Asia-Temperate	
Plain shortwing beetle	*Nathrius brevipennis*	N		Europe	Stowaway
Southern Green Shield Bug	*Nezara viridula*		N	Africa	Contaminant
	Oceanaspidiotus spinosus		N		
Small-Eyed Flour Beetle	*Palorus ratzeburgii*		N	Africa	Contaminant

Stored Nut Moth	*Paralipsa gularis*		N	Asia-Tropical	Contaminant
Azalea whitefly	*Pealius azaleae*		N	Asia-Temperate	Ornamental
	Pentarthrum huttoni		N	Northern America	Stowaway
Indian Meal Moth	*Plodia interpunctella*		N		Contaminant
Spartina Planthopper	*Prokelisia marginata*	N		Northern America	Stowaway
Citrus Mealybug	*Pseudococcus calceolariae*		N	Australasia	Ornamental
Australian Spider Beetle	*Ptinus tectus*		N	Australasia	Stowaway
Hydrangea Scale	*Pulvinaria hydrangeae*		N	Asia-Temperate	Ornamental
Green shield scale	*Pulvinaria psidii*		N		Ornamental
Horse Chestnut Scale	*Pulvinaria regalis*	N	N	Asia-Temperate	Ornamental
Hottentot fig scale	*Pulvinariella mesembryanthemi*		N	Africa	Ornamental
Museum Nuisance	*Reesa vespulae*		N	Northern America	Unknown
	Rhopalosiphoninus latysiphon		N	Europe	
	Rhopalosiphum insertum		N	Northern America	
	Rhopalosiphum maidis		N	Asia-Tropical	
Olive hemipherical scale	*Saissetia oleae*		N		Ornamental
Greater Rice Weevil	*Sitophilus zeamais*		N		Stowaway
Biscuit Beetle	*Stegobium paniceum*		N		Stowaway
Rhododendron Lacebug	*Stephanitis rhododendri*		N	Northern America	Ornamental
Andromeda Lacebug	*Stephanitis takeyai*		N	Asia-Temperate	Ornamental
	Takecallis arundicolens		N	Asia-Temperate	
	Takecallis taiwanus		N	Asia-Temperate	
Dark Mealworm Beetle	*Tenebrio obscurus*		N		Contaminant
Large Pale Clothes Moth	*Tinea pallescentella*		N	Southern America	Unknown
	Tinocallis ulmiparvifoliae		N	Asia-Temperate	
	Tinocallis zelkowae		N	Asia-Temperate	
Rust-red Flour Beetle	*Tribolium castaneum*		N	Asia-Tropical	Contaminant
Confused Flour Beetle	*Tribolium confusum*		N	Africa	Contaminant
Dark Flour Beetle	*Tribolium destructor*		N	Southern America	Contaminant
Bay Sucker	*Trioza alacris*		N	Europe	Ornamental
Pittosporum Psyllid	*Trioza vitreoradiata*		N	Australasia	Ornamental
Coloured Cabinet Beetle	*Trogoderma glabrum*		N	Europe	Contaminant
Large Cabinet Beetle	*Trogoderma inclusum*		N		Unknown
Warehouse beetle	*Trogoderma variabile*		N		Contaminant
Invertebrates					
Eel swim-bladder nematode	*Anguillicola crassus*	N	N	Asia-Temperate	Aquaculture
Turkish Crayfish	*Astacus leptodactylus*		N	Asia-Temperate	Aquaculture
Asiatic Clam	*Corbicula fluminea*	N		Asia-Temperate	Unknown
Freshwater hydroid	*Cordylophora caspia*	N	N	Europe	Stowaway
Northern River Crangonyctid	*Crangonyx pseudogracilis*	N		Northern America	Stowaway
Brazilian oyster	*Crassostrea brasiliana*		N	Pacific	Unknown

Slipper limpet	*Crepidula fornicata*	N	N	Northern America	Aquaculture
Chestnut Slug	*Deroceras (Deroceras) panormitanum*		N	Europe	Unknown
Carpet Sea-squirt	*Didemnum vexillum*	N	N		Stowaway
Killer Shrimp	*Dikerogammarus villosus*	N		Europe	Unknown
Zebra Mussel	*Dreissena polymorpha*	N	N	Asia-Temperate	Stowaway
Say mud crab	*Dyspanopeus sayi*	N		Northern America	Stowaway
	Ergasilus briani	N	N	Europe	Aquaculture
	Ergasilus gibbus	N	N	Europe	Aquaculture
	Ergasilus sieboldi	N	N	Europe	Aquaculture
Chinese Mitten Crab	*Eriocheir sinensis*	N	N	Asia-Temperate	Stowaway
Australian tube worm	*Ficopomatus enigmaticus*		N		Stowaway
Sideswimmer	*Gammarus tigrinus*	N		Northern America	Stowaway
Orange-striped anemone	*Haliplanella lineata*		N	Pacific	Stowaway
Common Garden Snail	*Helix aspersa*		N	Europe	Unknown
A tube worm	*Hydroides dianthus*		N	Northern America	Stowaway
A polychaete worm	*Hydroides elegans*	N	N	Australasia	Stowaway
A tube worm	*Hydroides ezoensis*		N	Asia-Temperate	Stowaway
A parasitic copepod	*Mytilicola intestinalis*	N	N	Europe	Aquaculture
False dark mussel	*Mytilopsis leucophaeta*	N	N	Northern America	Stowaway
	Neoergasilus japonicus	N	N	Europe	Aquaculture
Signal Crayfish	*Pacifastacus leniusculus*	N	N	Northern America	Aquaculture
	Paraergasilus longidigitus	N		Asia-Temperate	Aquaculture
Jenkins' Spire Snail, New Zealand Mudsnail	*Potamopyrgus antipodarum*	N		Australasia	Stowaway
Root Lesion Nematode	*Pratylenchus bolivianus*		N	Europe	Ornamental
Dwarf crab	*Rhithropanopeus harrisii*	N	N	Northern America	Unknown
A barnacle	*Solidobalanus fallax*	N	N	Africa	Unknown
Leathery sea squirt	*Styela clava*		N	Asia-Temperate	Stowaway
Budapest Slug	*Tandonia budapestensis*		N	Europe	Unknown
Keeled Slug	*Tandonia sowerbyi*		N	Europe	Unknown
American Oyster Drill	*Urosalpinx cinerea*	N	N	Northern America	Aquaculture
	Watersipora subtorquata		N		Stowaway
Vertebrates					
French Partridge	*Alectoris rufa*	N		Europe	Animal husbandry
Egyptian Goose	*Alopochen aegyptiacus*	N	N	Africa	Ornamental
Canada Goose	*Branta canadensis*	N	N	Northern America	Ornamental
Barnacle Goose	*Branta leucopsis*	N	N	Europe	Ornamental
Feral Goat	*Capra hircus*		N		Animal husbandry
Sika Deer	*Cervus nippon*	N	N	Asia-Temperate	Ornamental

Fallow Deer	*Dama dama*	N	N	Europe	Ornamental
Feral Cat	*Felis catus*	N			Biocontrol
Edible Dormouse	*Glis glis*		N	Europe	Ornamental
Chinese Water Deer	*Hydropotes inermis*	N	N	Asia-Temperate	Ornamental
American Bullfrog	*Lithobates catesbeianus*	N	N	Northern America	Ornamental
Reeves's Muntjac	*Muntiacus reevesi*	N	N	Asia-Temperate	Ornamental
House Mouse	*Mus domesticus*	N	N	Europe	Stowaway
Feral Ferret	*Mustela furo*	N	N		Animal husbandry
American Mink	*Mustela vison*	N	N		Animal husbandry
Rainbow Trout	*Oncorhynchus mykiss*	N		Northern America	Animal husbandry
Rabbit	*Oryctolagus cuniculus*		N	Europe	Animal husbandry
Ruddy Duck	*Oxyura jamaicensis*	N		Northern America	Ornamental
Common Pheasant	*Phasianus colchicus*	N		Asia-Temperate	Animal husbandry
Ring-Necked Parakeet	*Psittacula krameri*	N		Asia-Tropical	Ornamental
Brown Rat	*Rattus norvegicus*	N	N	Asia-Temperate	Stowaway
Ship Rat	*Rattus rattus*	N	N	Asia-Tropical	Stowaway
Grey Squirrel	*Sciurus carolinensis*	N	N	Northern America	Ornamental
African Clawed Toad	*Xenopus laevis*	N	N	Africa	Ornamental
Other					
	Coscinodiscus wailesii		N	Pacific	Unknown

Appendix 6. Species designated as having an unknown impact.

	Species
	Acartia (Acartiura) margalefi
	Acartia tonsa
	Agardhiella subulata
Pile worm	*Alitta succinea*
A sea spider	*Ammothea hilgendorfi*
	Anthrenus flavidus
	Aphis oenotherae
	Asellus communis
Harpoon weed	*Asparagopsis armata*
Little Owl	*Athene noctua*
Big-eyed Sand-smelt	*Atherina boyeri*
	Atheta harwoodi
Worm Slug	*Boettgerilla pallens*
	Bonnemaisonia hamifera
tubificid worm	*Branchiura sowerbyi*
Wrinkled Snail	*Candidula intersecta*
Japanese skeleton shrimp	*Caprella mutica*
Common White Sucker	*Catostomus commersoni*
Vineyard Snail	*Cernuella virgata*
	Chromaphis juglandicola
	Corticeus linearis
A brown seaweed	*Corynophlaea umbellata*
Lesser White-toothed Shrew	*Crocidura suaveolens*
	Cryphalus asperatus
A red seaweed	*Cryptonemia hibernica*
	Crypturgus subcribrosus
None known	*Desdemona ornata*
Killer Shrimp	*Dikerogammarus villosus*
	Drepanosiphum acerinum
	Dysaphis tulipae
Say mud crab	*Dyspanopeus sayi*
	Eulepidosaphes pyriformis
Cypress Pug	*Eupithecia phoeniceata*
Wautier's Limpet	*Ferrissia wautieri*
	Frankliniella occidentalis
Sideswimmer	*Gammarus tigrinus*
	Goniadella gracilis

	Gonionemus vertens
Devil's Tongue Weed	*Grateloupia turuturu*
Siphoned Japan Weed	*Heterosiphonia japonica*
Marbled Cellar Spider	*Holocnemus pluchei*
	Idiopterus nephrelepidis
	Illinoia liriodendri
	Illinoia rhododendri
Western Green Lizard	*Lacerta bilineata*
Greenhouse Slug	*Lehmannia valentiana*
Pond-Perch	*Lepomis gibbosus*
tubificid worm	*Limnodrilus cervix*
	Lithocharis nigriceps
A solitary entoproct	*Loxosomella kefersteinii*
	Macrorhyncolus littoralis
	Melaphis rhois
Trumpet Ramshorn	*Menetus dilatatus*
Slender-tube amphipod	*Monocorophium acherusicum*
Oblong Orb Mussel	*Musculium transversum*
	Myzaphis turanica
	Myzocallis boerneri
	Myzocallis schreiberi
An amphipod	*Orchestia cavimana*
	Otiorhynchus (Otiorhynchus) aurifer
	Otiorhynchus (Otiorhynchus) salicicola
Privet weevil	*Otiorhynchus (Tournieria) crataegi*
	Otiorhynchus armadillo
Oriental prawn	*Palaemon macrodactylus*
None known	*Paralaeospira malardi*
Marsh frog	*Pelophylax ridibundus*
	Pemphigus populitransversus
	Periphyllus acericola
	Periphyllus aceris
	Periphyllus californiensis
	Periphyllus lyropictus
	Philonthus rectangulus
A parasitic copepod	*Phyllodicola petiti*
European physa	*Physella acuta*
Tadpole physa	*Physella gyrina*
A tube worm	*Pileolaria berkeleyana*
An annelid worm	*Pileolaria militaris*
	Pineus similis

	Pineus strobi
	Planaria torva
Wall Lizard	*Podarcis muralis*
A brown seaweed	*Pseudolithoderma roscoffense*
	Rhodobium porosum
	Rhopalosiphum rufulum
Veitch's Bamboo	*Sasa veitchii*
	Scolytus laevis
Pygmy Elm Bark Beetle	*Scolytus pygmaeus*
Lesser Caucasian-Stonecrop	*Sedum stoloniferum*
	Sitobion ptericolens
	Sitticus pubescens
	Takecallis arundicolens
	Takecallis taiwanus
A centric diatom	*Thalassiosira punctigera*
A centric diatom	*Thalassiosira tealata*
White Snail	*Theba pisana*
A Kelp Fly	*Thoracochaeta johnsoni*
A Kelp Fly	*Thoracochaeta seticosta*
	Tinocallis ulmiparvifoliae
	Tinocallis zelkowae
	Tupiocoris rhododendri
	Tuponia brevirostris
	Tuponia mixticolor
	Uroleucon erigeronensis
	Utamphorophora humboldti
	Watersipora subtorquata
Aesculapian Snake	*Zamenis longissimus*

Appendix 7. Non-native species which are known to have arrived since the onset of the project or have been highlighted by scheme experts as missing from the species register

Arocatus longiceps
Closterotomus trivialis
Dicyphus escalerae
Nysius huttoni
Macrotylus horvathi
Brachynotocoris punctipennis
Dicyphus pallicornis
Reuteria marqueti
Rhyparochromus vulgaris
Conostethus venustus
Eremocoris fenestratus
Cyphostethus tristriatus
Mytilus galloprovincialis
Mytilus trossulus
Anastrepha obliqua
Anastrepha species indet.
Bactrocera cucurbitae
Ceratitis cosyra
Cheilosia caerulescens
Chymomyza amoena
Dacus ciliatus
Dasineura oleae
Dasineura oxycoccana
Didactylomyia longimana
Lestodiplosis pini
Macrolabis aquilegiae
Medetera grisescens
Megaselia dimorphica
Phytomyza astrantiae
Phytomyza gymnostoma
Scaptomyza adusta
Sciophila fractinervis
Sphegina sibirica
Taomyia marshalli
Tephritis divisa
Elaphe guttata
Triturus marmoratus

Bufo (Pseudepidalea) viridis
Cynops spp. and Paramesotriton spp.
Bombina orientalis
Lampropeltis sspp.
Thamnophis spp.
Synophropsis lauri
Liguropia juniperi
Arocatus longiceps
Closterotomus trivialis
Dicyphus escalerae
Nysius huttoni
Zyginella pulchra
Idiocerus heydenii
Edwardsiana nigriloba
Eurhadina loewii
Batracomorphus allionii
Zygina nivea
Dryodurgades antoniae
Macrotylus horvathi
Brachynotocoris punctipennis
Dicyphus pallicornis
Reuteria marqueti
Rhyparochromus vulgaris
Conostethus venustus
Eremocoris fenestratus
Cyphostethus tristriatus
Synophropsis lauri
Liguropia juniperi
Zyginella pulchra
Acericerus heydenii
Edwardsiana nigriloba
Eurhadina loewii
Batracomorphus allionii
Zygina nivea
Dryodurgades antoniae
Fieberiella florii
Fieberiella septentrionalis
Viridicerus ustulatus
Acericerus ribauti
Anoterostemma ivanhofi