Invasive species theme plan

Strategic principles for the management of invasive species on Natura 2000 sites

'Improvement Programme for England's Natura 2000 Sites – Planning for the Future'

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

Preface

IPENS and theme plans

The Improvement Programme for England's Natura 2000 sites (IPENS), supported by European LIFE+ funding, is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when to target their efforts on Natura 2000 sites and the areas surrounding them. As part of the IPENS programme, Site Improvement Plans (SIPs) and themed action plans are being developed. SIPs provide an overview of the issues affecting features at the site level and the actions required to address them. Theme plans are high-level plans which aim to improve the way in which we manage a range of key issues on the Natura 2000 site series as a whole. Theme plans can provide an over-arching direction, recommendations or outline approaches to achieve target conservation status of Natura 2000 sites in England, to complement work already underway on individual sites. The plans do not have a legal status, and do not constitute a systematic evidence review, but are based on evidence and expert opinion. They are to inform action and initiatives of Natural England and its partners to help achieve the objectives of Natura 2000.

It is anticipated that Natural England and others, working with stakeholder and partners, will all play a role in implementing the theme plans. In the process of developing the theme plans Natural England has approached key partners and delivery bodies to seek input and agreement on the roles in delivering the improvements, although in some cases these discussions have not yet been concluded. Recommended actions and next steps identified in the theme plans are not necessarily committed or resourced but aimed at informing future resource decisions. Implementation of the theme plan recommendations will be via local prioritised delivery plans and coordinated through the IPENS After-Life Steering group, working with national and local delivery partner organisations.

Audience

The invasive species theme plan is aimed at both practitioners involved in planning and implementing actions to address invasive species on Natura 2000 sites and also policy makers. Natural England staff, partner agencies and their partner delivery organisations and major landowners including the Environment Agency, Forestry Commission, RSPB, National Trust, local authorities and the Wildlife Trusts will all find the plan useful. Natural England will seek engagement from these bodies and also landowners in the future to realise the key roles they have to play in taking forward the actions identified in the plan.

Executive summary

This document is the theme plan for invasive species produced by the Improvement Programme for England's Natura 2000 sites (IPENS). It describes the importance of addressing invasive species to the achievement of objectives set by the EC Habitats Directive. It provides a general background to the issue, including a discussion of roles, funding sources and ecosystem service benefits of addressing invasive species and goes on to recommend four overarching strategic principles to help improve ways of working for all types of invasive species issues affecting Natura 2000 sites and makes tentative suggestions for identifying priority species for action. Priority actions proposed in the plan focus on improving ways of working and strategically addressing constraints to progress, rather than site specific management requirements which vary greatly between sites.. It is structured to explain:

- the key issues that need to be addressed to ensure effective action to address invasive species (Section 2);
- delivery roles, mechanisms and sources of funding (Section 3);
- the strategic principles recommended to oversee action to address invasive species affecting Natura 2000 sites (Section 4); and
- priority actions and suggestions for implementation (Section 5).

Overview

Invasive species (including non-native species, pests and disease, competitive native species and deer) are a widespread issue in England, reported in 62% of the 267 IPENS Site Improvement Plans (which cover all 338 Natura 2000 designations in England)and which affect both Special Areas of Conservation and Special Protection Areas. Terrestrial, freshwater and marine environments are equally affected. Four categories of 'invasive species' were identified by the IPENS project scoping exercise and are addressed in the theme plan:

- Invasive non-native species
- Pests and diseases
- Deer
- Competitive native species

Invasive non-native species (including disease) impact biodiversity and ecosystems through resource competition, consumption and interbreeding (Wittenberg and others, 2001). Deer have no natural predators in the UK and where populations adversely affect woodland and other habitats they require management. Non-native deer species co-existing in the same location as native species can exacerbate impacts. Competitive native species have the potential to become invasive where habitat management is inappropriate. Key issues for each category are described, but later sections of the plan focus on the first three only, because of similarities in the management approaches required.

Many organisations have responsibilities for, or are involved in managing invasive species in England, and multiple funding streams are potentially available. To be effective, biosecurity and control action must therefore be collaborative and strategic, acting in the wider environment as well as within protected sites. Four overarching principles are proposed for work on invasive species affecting Natura 2000 sites:

a) Natura 2000 sites sit in a wider context;
b) Apply the Convention on Biological Diversity 'hierarchy of approaches' (prevention / rapid response / control or mitigate impacts);
c) Natura 2000 requirements inform prioritisation;

d) Shift to a strategic, proactive approach.

These aim to keep in mind the context of work on Natura 2000 sites, ensure that international protocols are adhered to, and continue the trajectory of change to a more strategic, proactive approach to work on invasive species, in particular to benefit access to funding.

Key messages

- INNS are considered the second biggest threat to global biodiversity following habitat loss (Defra, 2008).
- Introductions to the UK have intensified as a result of increases in trade, transport, travel and tourism, and climate change is likely to exacerbate the situation.
- Competitive native species have the potential to become 'invasive' within their natural range, where other factors, such as inappropriate habitat management, allow them to become problematic. Solutions are often site specific and may not require strategic planning.
- Most non-native invasive species, pests, disease and deer need management on an international, national or regional scale, through a collaborative effort between partner organisations and landowners. The requirements of individual Natura 2000 sites must therefore be seen in this wider context.
- In the current financial climate, prioritising where funding would best be allocated (which species, which actions and which sites) is crucial but further work to do this nationally is required.
- A successful strategic approach will involve prioritisation and also effective information sharing and reporting between partner organisations. If improvements in these areas can be continued, it will help to focus the approach to strategically securing future resources.
- Practically-implementable research, which can be used directly by site managers will be pivotal in minimising the negative effects of invasive species, particularly pests and disease, where rapid response action may be crucial to prevent irreversible damage to Natura 2000 features.
- Biosecurity measures have a key role to play in preventing non-native species from entering the country and limiting their spread once here. Biosecurity is crucial in the marine environment, where control measures are less easy to deploy.
- Improving the resilience of habitat features is particularly important to address for disease management. For some woodland habitats, diversifying the component species or range of genetic types may need to be considered, to increase the disease resilience of specific Natura 2000 features such as juniper or ash.

Priority actions

The emphasis advocated by the proposed strategic principles need to be implemented by Natural England and partner organisations to continue the already improving trajectory of change towards a more collaborative and strategic approach to invasive species work generally and for Natura 2000 site specifically. In addition to this a range of priority actions are suggested which will: build a better understanding of ongoing control work; contribute to understanding about increasing resilience; provide a clear list of priorities; and, explore use of novel technologies and 'citizen science'.

Contents

1. General Background

The Improvement Programme for England's Natura 2000 Sites (IPENS), supported by European LIFE+ funding, is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when to target their efforts on Natura 2000 sites and the areas surrounding them. As part of the IPENS programme, theme plans are being developed for issues that affect multiple sites and features and that require a more strategic approach. This is the draft theme plan for invasive species.

The Natura 2000 network comprises Special Areas of Conservation (SAC) and Special Protection Areas (SPA), designated under the European Birds Directive 1979 and Habitats Directive 1992 for their important wildlife and habitats. In England 338 Natura 2000 sites have been designated covering a total area of 2,076,875.42 hectares (some areas are covered by more than one Natura 2000 designation).

Invasive species have been identified as a priority theme for IPENS because of their widespread effects on many interest features and supporting habitats of both Special Areas of Conservation (SAC) and Special Protection Areas (SPA). The impacts of invasive species are equally important for terrestrial, freshwater and marine environments, although options for successful counter-measures vary depending on environment from biosecurity and prevention only to effective interventional control.

Based on local site knowledge, 165 (62%) Natura 2000 Site Improvement Plans (SIPs) developed by the IPENS project report either pressures (current adverse impacts) or threats (potential future adverse effects) from all types of invasive species, including non-native species, deer, pests and disease and competitive natives. SIPs show that Natura 2000 interest features, within all habitat groups are affected, including priority habitats. Interest features in all SAC species and SPA bird groups are also affected. Furthermore, evidence gathered by an IPENS funded research project has collated data records to provide a more comprehensive picture of invasive species in England's protected sites (Lush and others, 2015).

Invasive species are present in the wider environment outside of protected sites and so effective action needs to be supported by strategies approaches which adhere to the principles of the GB Invasive non-native species framework strategy (Defra, 2008). This theme plan summarises the issues related to non-native and native invasive species and diseases, and their impacts on Natura 2000 sites and features. It identifies drivers for action and available control mechanisms and funding sources. It proposes strategic principles for invasive species control in the Natura 2000 network and attempts to set the requirements of Natura 2000 sites into the context of action in the wider environment.

2. Theme description

2.1 Scope

A scoping exercise undertaken as part of the IPENS project identified three main issues under the broad heading of 'invasive species'. These are:

- **Invasive non-native species** – terrestrial, freshwater and marine plants and animals;
- **Pests and diseases** – usually refers to a subset of invasive non-natives which includes destructive insects, pathogens or other species which attack crops, food, livestock or native species etc;
- **Competitive native species** – native species (within their natural range) with the potential to become invasive in certain circumstances.

In addition, a fourth category, **Deer**, was identified. Deer include both native and non-native species, but tend to be recorded as a separate issue for site management in Natural England's protected sites recording system and so are kept separate here as they may require a different management approach. The following sections describe the key issues for each of the four invasive species categories and highlight areas that need to be addressed in order to optimise management for Natura 2000 and other protected sites in the future.

2.2 Description of the theme and scale of the problem

Invasive non-native species

Non-native species (NNS) are those that arrive outside their past or present natural range (whether or not they have become established), with the intentional or unintentional assistance of man. The introduction of NNS has intensified due to the increase in trade, transport, travel and tourism, which provides new vectors and increased opportunities for introduction to new areas. An invasive non-native species (INNS) is any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live. Many non-native species can be regarded as colonists rather than invasive, as they do not pose a threat to native ecosystems.

INNS are considered the second biggest threat to global biodiversity following habitat loss (Defra, 2008). They impact biodiversity and ecosystems through consumption, resource competition, introduction of diseases, interbreeding and disturbance (Wittenberg and others, 2001). This can result in major economic, agricultural and health impacts, with the cost of INNS to the English economy estimated to be at least £1.3 billion per year (Williams and others, 2010) (see section 2.5 for a discussion of the ecosystem service benefits of managing invasive species). Since 1850 there has been a dramatic increase in the number of non-native species arriving in Britain and becoming established (Roy and others, 2012).

INNS are an issue for terrestrial, freshwater and marine environments. Whilst biosecurity measures to prevent INNS reaching all environments are important, they are particularly crucial for marine areas, where control techniques are far harder to implement effectively.

In 2008 Defra published a Framework Strategy for invasive non-native species in Great Britain (Defra, 2008), with the aim of addressing key weaknesses in our capacity to respond to the threats posed by INNS. It provides for a more coordinated and structured approach to deal with INNS than had previously existed, and should be regarded

as the umbrella framework under which this theme plan (with its specific remit of Natura 2000 sites) sits. The strategy established a single coordinating body, consisting of a Programme Board and its Secretariat , in conjunction with a Risk Analysis Panel. Responsibility for driving the implementation of the framework strategy sits with the three Governments (central UK government via Defra, Welsh Assembly Government and The Scottish Government). There is a key role within the strategy for government bodies such as the statutory conservation bodies, JNCC, the Environment Agency, Forestry Commission and Animal and Plant Health Authority. Coordination with key NGOs, landowners and interest groups is also integral to the requirement of the Framework.

The first 5-yearly review of the GB strategy is currently being undertaken. The review will examine the continuing relevance of the aims, actions and mechanisms contained in the GB Strategy and whether any modifications or additions are required. It is anticipated that the review will complete early in 2015, with the publication of a revised strategy document. The review has sought input from many stakeholders, including Natural England, through direct comments and workshops. The strategy has also been independently reviewed from an international perspective by two experts on invasive non-native species (GB Invasive non-native species secretariat website http://www.nonnativespecies.org/index.cfm?sectionid=108). Whilst the original Strategy established high level roles, It is hoped that the revision will address the continued lack of clearly defined organisational responsibilities below this level, which can currently lead to blockages to progress. This theme plan aims to complement the GB framework strategy by focussing on the improved ways of working that will be needed to address the impact of invasive species on Natura 2000 sites and also priority species to address on this suite of sites.

The effectiveness of control methods currently available varies considerably between the target species and the habitat involved. Intensive effort over several years will help to keep many invasive non-native plants such as giant hogweed and Himalayan balsam in check. Other species are extremely difficult to control because of their ability to regenerate from tiny fragments, such as water fern (*Azolla filiculoides).* Activity will often be required at a catchment or similarly large scale, meaning that costs may be prohibitive and it may be very difficult to fully eradicate the species. Biological control agents are starting to be developed for these situations, such as the Japanese knotweed psyllid (*Aphalara itadori),* a natural insect predator of Japanese Knotweed. Following thorough testing of its impact on knotweed and potential for adverse effects on the environment, this psyllid species has been licenced by the UK Government for the biological control of Japanese knotweed and has been released in the UK. These offer the prospect of much greater success in the future.

INNS are a present and increasing risk to the favourable condition of England's protected sites and have been identified by Natural England as a key issue to be addressed as part of the IPENS project. 113 (42%) of the Site improvement plans produced by the IPENS project have highlighted issues with INNS, as illustrated in the map in Figure 1. The data on which this is based are located in Annex 1. There are no apparent spatial trends in the sites affected, with pressures or threats reported for marine, terrestrial and freshwater sites in all parts of England. Six invasive non-native species (both plants and animals) were reported 10 or more times in the SIPs: Himalayan balsam, Japanese knotweed, Rhododendron, New Zealand pygmyweed, signal crayfish and Pacific oyster. Overall, invasive non-native plant species are the most commonly cited in SIPs, with 75 species being recorded. Other species reported less frequently include riparian and freshwater plants such as water pennywort and water fern, other plants such as Montbretia and cotoneaster and a few animal species including eagle owl and grey squirrel.

A recently commissioned study (Lush and others, 2015) by Natural England as part of the IPENS project carried out an audit of available records to create lists of invasive non-native species specific to each protected site. The project collated nearly five million records of NNS using a list of 3,687 species and found that 98% of SACs and 99% of SPAs intersected with records of NNS. Potential INNS were found to intersect with 90% of SACs and 96% of SPAs. In contrast, only 42% of IPENS Site Improvement Plans record INNS as an issue (62% for invasive species of all

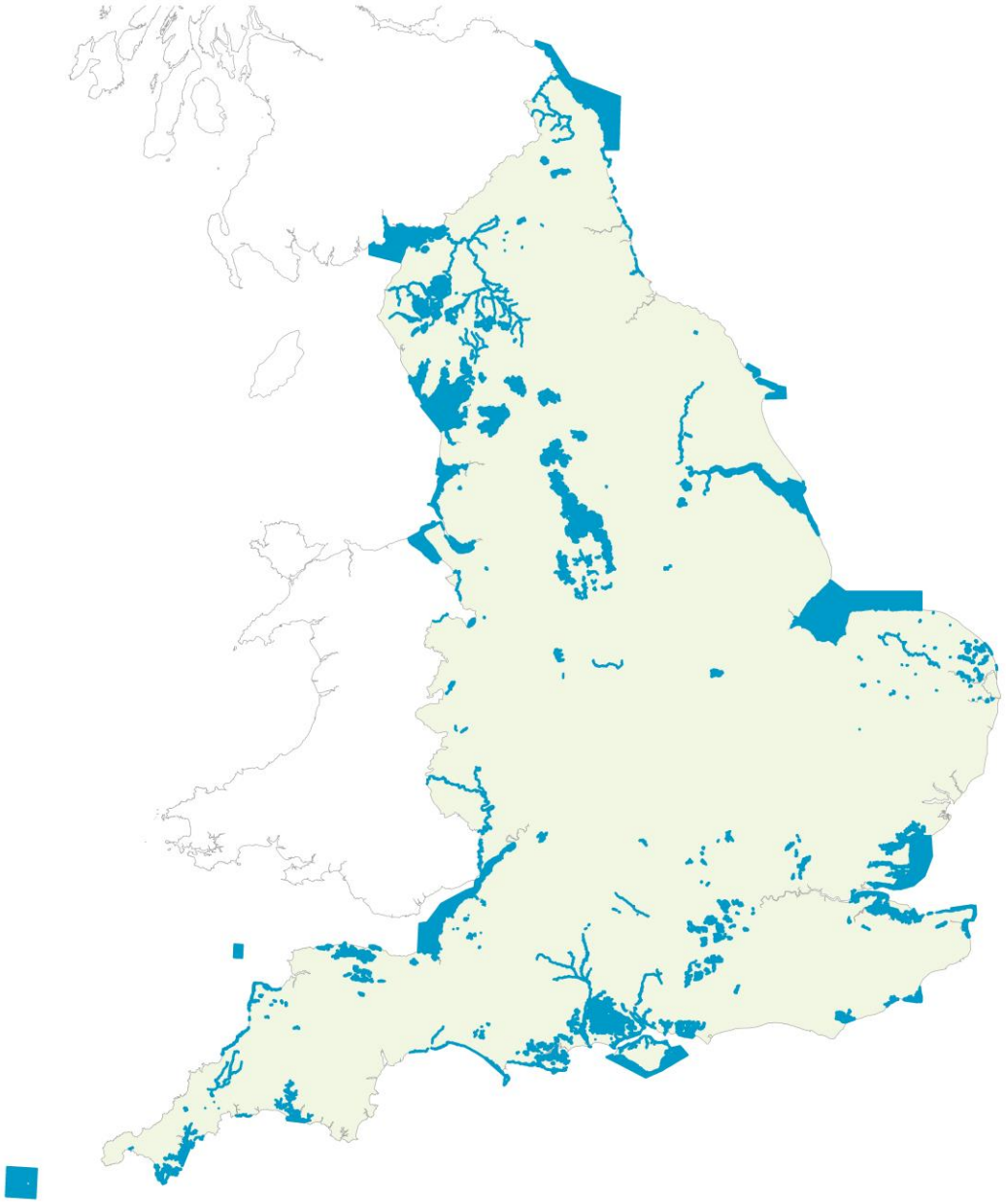


Figure 1 Site improvement plans which report issues with invasive non-native species

types), indicating that there may be a knowledge gap amongst local advisers, or issues with how current the available data are. Both of these issues were also noted by Lush and others (2015) in discussions with responsible officers for protected sites. The research will also have noted species which are recorded on a site, but which have not been reported in SIPs because they are usually not considered to be a risk to the particular interest features of a Natura 2000 site even though they may cause general, low level impacts, such as grey squirrel and parakeets, and historical records of species which may no longer be present.

Pests & Disease

Plant disease and pest outbreaks in England can cause adverse environmental, social and economic impacts and we need to develop capability to predict, monitor, control and mitigate the impact and spread of pests and pathogens on plants across the whole country. Pests and diseases should be considered alongside invasive species as, on most definitions, they either are already listed as non-native or native invasive species or they could be (eg oak processionary moth and ash dieback). Over the last two decades there has been a near exponential increase in the number of new natural environment disease outbreaks, including at least six *Phytophthora* species.

Threats to our tree and other plant populations have increased along with the globalisation of trade in goods and services, leading to importation of different trees and plants including wood for fuel and wood associated products, which may be acting as hosts or vectors for pests and diseases coming from an increasing number and range of sources. This in turn increases the risk that new plant pests and pathogens are introduced into England. In addition, trees are facing other pressures from changes to our climate such as warmer winters, and changes in seasonal rainfall and storm patterns. Therefore, we should build the resilience of our plant populations, to minimise the impact of pests and diseases, and help improve their capacity to adapt and mitigate the impact of these threats.

Pests and diseases are not limited to plants and some wild animal diseases may also be transmitted to domesticated animals and, occasionally, humans. Marine examples also exist, including gaffkaemia, a disease caused by the *Aerococcus viridans* var. *homari* bacterium which leads to fatal infections in European lobster (*Homarus gammarus*), which may have been introduced to the UK with commercial shipments of (apparently healthy) American lobsters (*Homarus americanus*). As well as its commercial value, *H. gammarus* is an important predator species within seabed communities.

UK border controls for invasive pests and disease species are relatively weak, compared for example to Australia and New Zealand, due to the prioritisation of trade and speed of entry above biosecurity. If pest and disease species remain undetected at the border, or arrive more naturally, control methods tend to focus on the prevention of spread and eradication. The speed of response, accurate identification, effective containment and eradication where possible are all crucial to a successful outcome. This reinforces the requirement for all relevant agencies and stakeholders to work in a holistic way to address the challenges of both existing and emerging pests and diseases.

Pests and disease are reported in 54 (20%) of IPENS Site Improvement Plans, covering at least 10 species or types of pest or disease. These are shown in the map in Figure 2 and the supporting data is in Annex 2. There is a notable upland trend to the reports, which is likely to reflect the incidence of *Phytophthora* spp. infection. Woodlands, rivers and vegetated sea cliff sites are also evident, reflecting ash dieback disease (*Chalara*) and crayfish plague.

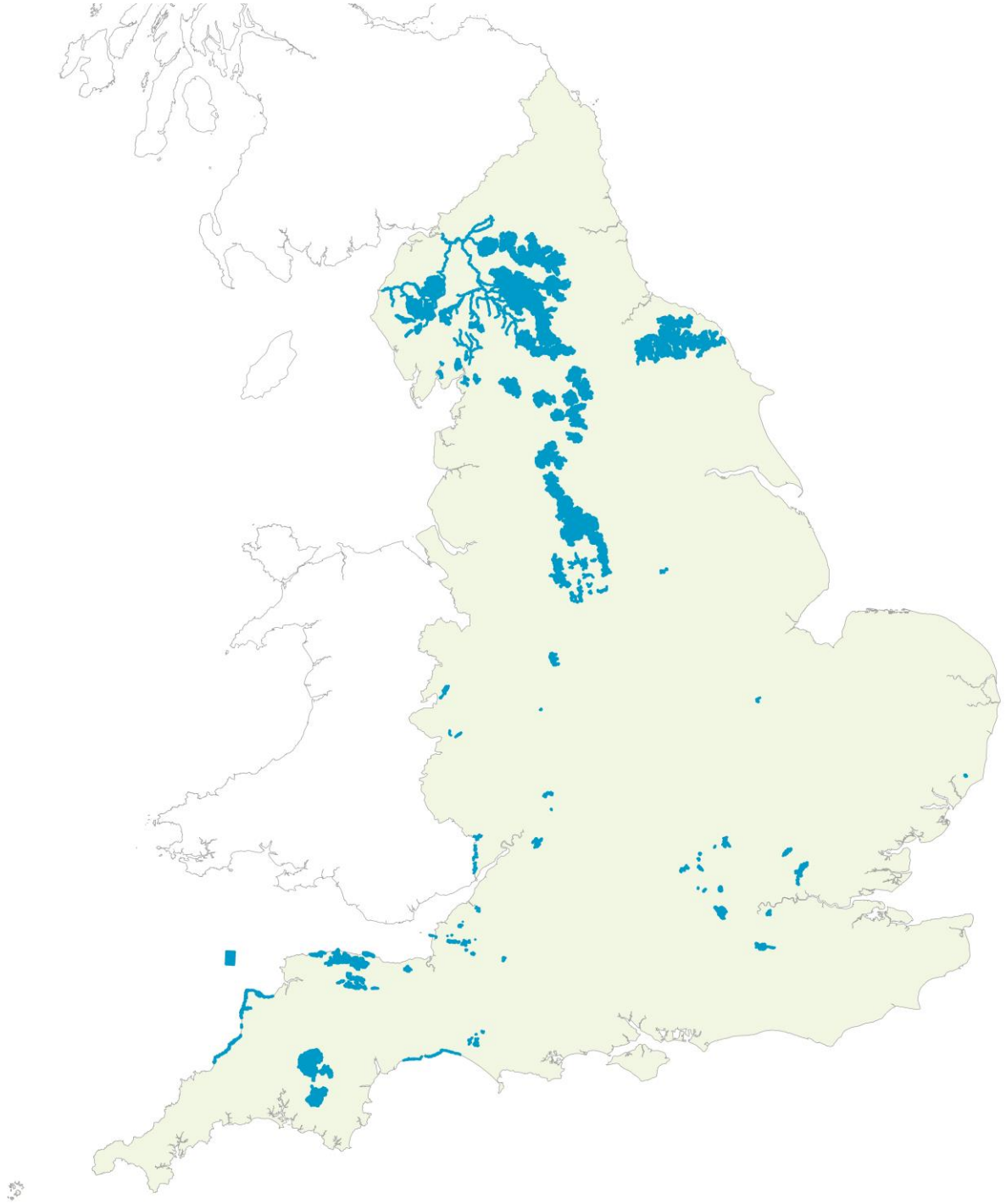


Figure 2 Site improvement plans which report issues with pests and disease

Deer

There are six species of wild deer in England, two of which are native (red deer and roe deer) and four are non-native (fallow deer, introduced around 1100AD, and Reeves's muntjac, sika deer and Chinese water deer, which were all introduced in the 1800s). As elsewhere in Europe (Gill, 1990; Apollonio and others, 2011) numbers and ranges of all six species have increased over the last 40 years (Ward 2005, 2008). Changes in agricultural practices (such as sowing winter wheat) and climate (less snow cover over the ground) may have made it easier for deer to over-winter and come through winter in better condition, with higher fecundity. Following this expansion, increasing numbers of reports are received of damage to agriculture, horticulture, forestry, sensitive vegetation in conservation areas, and deer - vehicle collisions. High numbers of deer can have a negative impact on native broadleaved woodland, altering the structure of the shrub layer by browsing it out, browsing regeneration of new

trees and preferentially browsing some species over others, and changing the ground flora through grazing/browsing. At a time where tree diseases are increasing, regeneration of trees is especially important, so resilience to disease among the saplings is needed. Deer browsing may have an impact on other species that utilise these structures (eg dormice in the shrub layer, butterflies using flowers as nectar sources). Low-level browsing may be of concern in trying to establish coppice regrowth, but may be advantageous elsewhere.

The different species of deer can be described in terms of the way they behave and browse; this influences how they are managed. Red, sika and fallow deer are the largest species and are all herding species that have large ranges. Roe deer are solitary, territorial, and generally found in small family groups. Muntjac are also solitary species, but tolerate much higher densities than roe. Chinese water deer prefer tall reed and grass habitats near water rather than woodlands and are currently limited in their range in the UK. However research shows that that at very high densities, muntjac can have an impact on established roe deer populations by changing their pattern of habitat use and by locally reducing their numbers (Chapman and others, 2009).. Sika populations are found in certain areas in the UK, and behave in a similar way to red deer; the biggest threat they pose is to the genetic integrity of red deer as they can cross-breed. Fallow deer can build up to high densities and are capable of extremely negative impacts on native woodlands. This is compounded where they occur in the same area as muntjac, as muntjac will graze out the ground flora, while fallow browse the shrub layer. Whilst a recent risk assessment acknowledged that Chinese water deer are not currently invasive, it included the caveat that management action should include monitoring to review this assessment (Peter Watson, The Deer Initiative, pers. comm.)

There is not necessarily a negative impact where deer are present, but monitoring is always important: it can help to verify how populations and impacts change over time, which can happen rapidly. It is also important to work with surrounding neighbours even where the impact is not negative on site. Monitoring can be undertaken in a variety of ways: recording deer observed (both during the day and night/thermal imaging), dung counts, vegetation monitoring, crop damage and cull records. There are a variety of management options available, depending upon what level of impact is identified and is appropriate for the site, in terms of deer culling and exclusion (from sensitive areas).

Deer are similar to other invasive animal species in that linking sites together will help them spread in range and that they have no natural predator (see the Habitat Fragmentation theme plan, linked in Annex 6, for a discussion about potentially negative effects of increasing habitat connectivity). Because they are highly mobile animals, it is difficult to manage them on individual sites, and it can be more productive to take an overview of what their range is, and collaborate with neighbouring landowners to secure effective management. Forming or joining a deer management group is a recognised way of coordinating management and working at a landscape scale.

There may also be a need to raise public awareness about why deer management is a necessary part of looking after habitat, crops and reducing the chance of road accidents. It is accepted that culling deer may pose ethical problems for managers of some sites (particularly sites privately-owned or run by local Wildlife Trusts). However, in many cases the perceived problem may be greater than the actuality; it is common experience that where these issues are raised amongst the membership of such organisations, in the majority of cases, once the issues have been properly explained, members do give their support - albeit tacit - to a programme of evidence based culling. There is some benefit to be had in introducing the public to the concept of culling and large, well-known organisations have a responsibility to play in that. If objections to culling cannot be overcome, permanent fencing, however visually intrusive, is the only realistic alternative; however no fence can be expected to remain deer proof forever, many are breached within months or a few years. If the entire site is fenced this gives rise to the issue of deer trapped within the fence, potentially leading to the need to cull anyway if impacts then become intolerable.

There is a great deal of advice available for deer management. The Deer Initiative give support and advice to owners and deer management groups, and have a produced the Best Practise Guidelines, available on their website (URL: www.thedeerinitative.co.uk). Forestry Commission work to internal operational guidance on managing deer, and there are also reviews of management options available (eg Putman 2004).

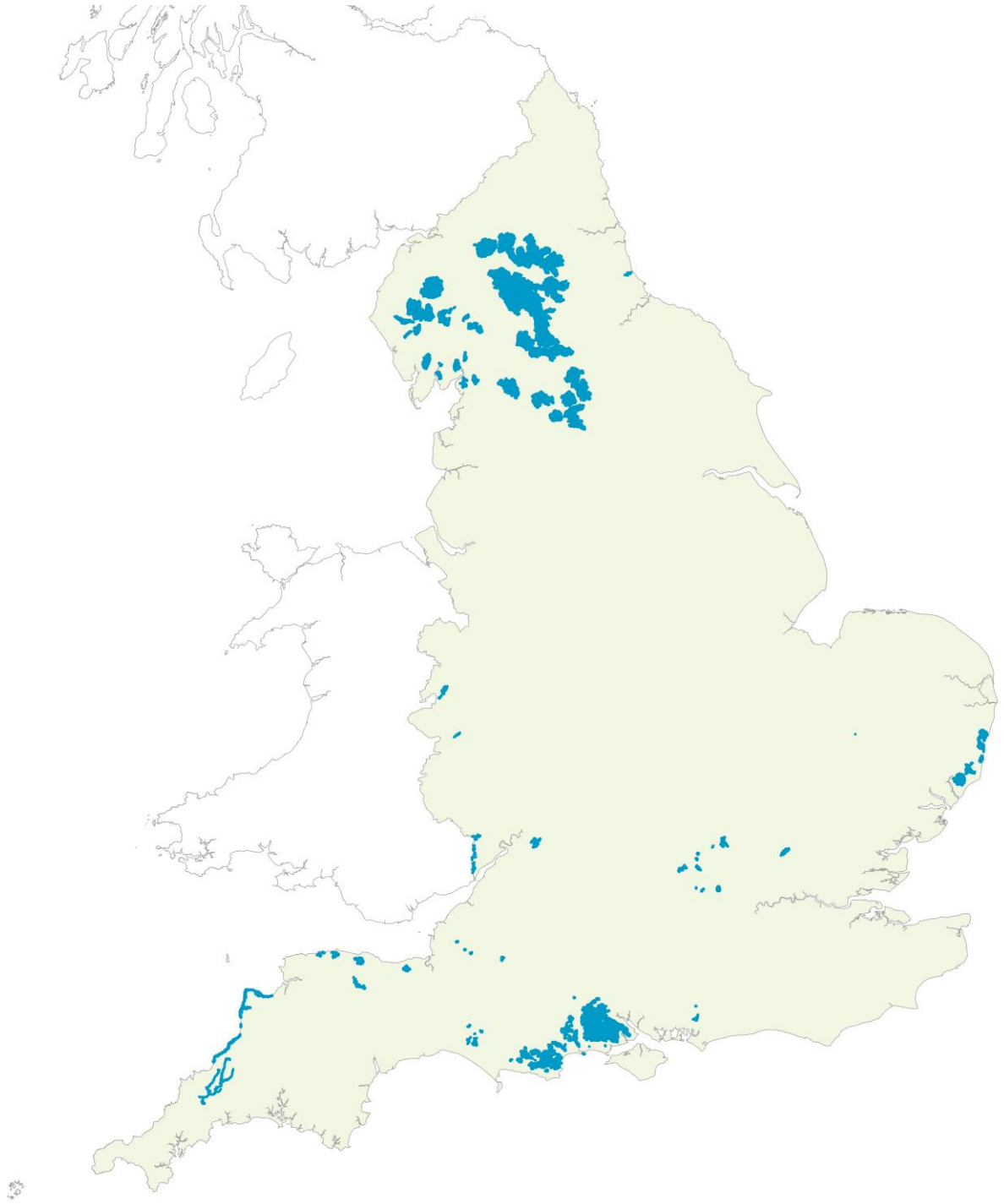


Figure 3 Site improvement plans which report issues with deer

Issues with deer are reported in 38 (14%) of the IPENS Site Improvement Plans. These are shown in the map in Figure 3 and the supporting data is in Annex 3. Five of the six species present in England are cited, the exception being Chinese water deer.

Hotspots of concern about deer activity are evident from Figure 3, including the North West, the South West through to the New Forest area, the area around Greater London, and the Suffolk coast. This pattern is significantly influenced by the distribution of woodland SACs.

Competitive native species

Competitive native species that may be regarded as 'invasive' within their natural range include any native plant or animal that in certain circumstances spreads to such an extent that it causes significant damage to other species of nature conservation value, the environment, the economy or to human health. In contrast to invasive non-native species, such competitive native species have evolved over extended periods of time within the land or aquatic environment in which they occur, and are thus a natural part of the biodiversity. This is a key distinction, as such native species are likely to support many other species and have a range of competitors, predators and parasites that have evolved with them, and that in many circumstances serve to keep their abundance in check. This is unlikely to be the case for invasive non-native species that have been artificially introduced from another part of the world.

There are many examples of such a distinction; for example, the native sallow *Salix* species can often be an invasive nuisance on wetland sites, invading and dominating shorter vegetation that is rich in species of conservation value. However, sallows themselves support a wide range of other species, are the food plants of many insects such as moths, and have a valuable place within the natural environment. This is not the case for invasive non-native species such as New Zealand Pigmyweed *Crassula helmsii* and Parrot's-feather *Myriophyllum aquaticum* that rapidly form smothering carpets over native wetland vegetation, and support few other species when away from their native locations.

Problems caused by competitive native species that become invasive are thus due not to the presence of the species themselves but are instead due to other factors, in particular the management of the sites on which they occur. In the above-mentioned example of sallows becoming invasive the key issue is that the sites affected should receive sufficient management, whether by grazing by livestock, scrub clearance, or by some other method. In most cases, when appropriate management or environmental conditions are re-established, the problem species will become less competitive.

Issues with competitive native species including scrub control and inappropriate weeds or vegetation management are reported in 81 (30%) of the IPENS Site Improvement Plans. These are shown in the map in Figure 4 and the supporting data are in Annex 4. There is no clear geographical trend in where competitive native species are considered to be an issue, with the apparent gap in central England being more reflective of the smaller number of Natura 2000 sites in this area, rather than a lack of issues. Species commonly cited include birch, gorse, sea buckthorn, bramble, thistle, ragwort, nettles, pine and willow.

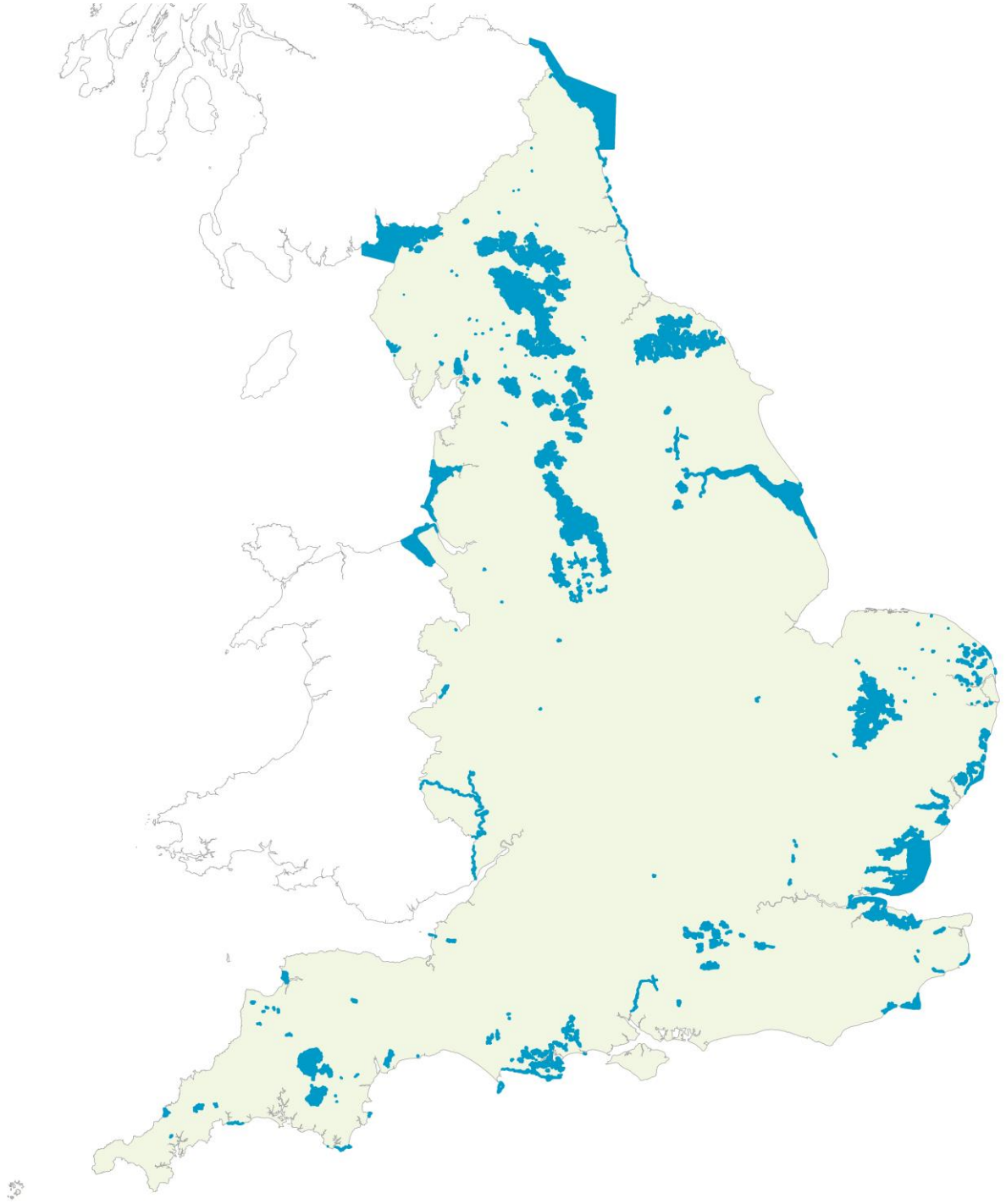


Figure 4 Site improvement plans that report issues with competitive native species

2.3 Issues to address

This section outlines the key issues that need to be addressed in order to establish a more effective strategy for the control of invasive species nationally and at the level of protected sites including the Natura 2000 network. An IPENS technical workshop was convened in August 2013 to gather information to inform the content of this theme plan. A wide range of issues were raised which are seen to be causing blockages to progress, including specific issues relating to: strategic planning and coordination of effort; funding; monitoring, surveillance and horizon scanning; demonstrating the economic impact of invasive species; knowledge; staff and equipment; and public

perception. Key issues from this workshop are summarised in Annex 5. The following sections describe specific issues for each of the four categories of invasive species covered by this plan.

Invasive non-native species

There are a number of current projects (see examples in section 3.2) where Natural England is undertaking control work on INNS related to improving site condition; however, a strategic approach to this work is lacking. We need to build on the strategic approach to the management of invasive non-native species in local areas adopted by Local Action Groups (LAGs) over the past four years to make best possible use of the limited resources, particularly as Defra funding for LAGs will end in March 2015. The issues that need to be addressed in order to develop this are:

Pathway control – Controlling the pathways by which invasive non-native species move is effectively the mechanism by which new species can be prevented from arriving in the UK and for limiting the dispersal of species that are already present, and is therefore a key issue. Pathway risk analysis is being undertaken under the GB Non-Native Species Risk Analysis mechanism, established in 2006, but further work is still needed, particularly to find effective means of implementing biosecurity along identified pathways.

Responsibilities and collaboration - Lack of clearly defined and agreed organisational responsibilities under the GB strategy (Defra 2008) for addressing INNS across different habitats/sectors. This includes responsibilities for leading a rapid response, ongoing control and driving forward prevention in the form of pathways management. Insufficient collaboration between landowners and managers at an appropriate scale can also be a blockage to effective management and incentives to improve collaboration may be required.

Prioritisation - Current uncertainty on how to prioritise action including which species should be addressed and what action should be recommended. There are currently only 6 published species action plans http://www.nonnativespecies.org/index.cfm?sectionid=92 .

Reporting current work - Lack of awareness of current INNS control work relating to Natura 2000 sites where Natural England is not involved in or commissioning the control activity or training and education work. Whilst Natural England staff should know about any control work relating to protected sites, there is low confidence that this is the case. Control work tends to only get reported on the SSSI reporting system where Natural England leads on the work, and there is no agreement on any other central location that could be used for this type of reporting. Working together across different organisations to identify actions to address these issues – identifying and agreeing responsibilities and priorities – will focus the approach to strategically securing future resources.

Pests & Disease

Approaches to protected sites - The scope of pest and disease issues is very wide and it is likely to lead to uncertainty with regard to some traditional approaches to site selection and site management. For instance, it may not be possible to maintain the original features of interest where the genetic diversity is low, including monocultures and they become the favoured food source for a significant pest or become highly susceptible to a major disease. More diversity of species, and greater genetic diversity within them, may well be required to establish greater resilience to both current and future pests and diseases. Some diseases, especially fungal ones, also have the ability to rapidly mutate and otherwise evolve so that, for example, there is unlikely to be a sole genotype of ash tree that will forever be resistant to ash dieback. Given that a number of disease species are already affecting species for which Natura 2000 sites are designated, this area needs to be addressed as soon as possible, with involvement nationally and at a European level.

Importance of research, national organisations and strategies - Practically-implementable research, which can be utilised directly by site managers, will be pivotal in minimising the negative effects of pests and diseases. National organisations will need to work very closely together, within integrated strategies, to deliver effective outcomes. Surveillance and monitoring increasingly exploits the active engagement of volunteers and forms of 'citizen science' and this is rapidly becoming more valuable and timely due the utilisation of smartphone applications (eg to record accurate locations, verify identifications, and enter results directly into national databases).

Some pests and diseases have been successfully controlled through the use of organisms that are their predators, parasites, or are pathogens. Such controls often require lengthy and expensive development. All relevant organisms need to be screened to identify efficacious, safe and reliable biological control agents.

Importance of biosecurity - Biosecurity, starting at the nation's borders, has a key role to play in preventing most non-native pests and diseases from entering the country but some can be carried by wind or by water. Biosecurity is also important in the marine environment, particularly within, or within range of protected sites.

Implementing biosecurity control measures for tree diseases and pests is complex, requiring plant health authorities to work closely with private sector bodies. The range of those that can be affected (gardeners, the horticultural trade, foresters, local authorities, nature conservation bodies, etc.) poses significant challenges to plant health authorities. Statutory powers are available to allow access to property and enforce control measures where necessary. However, unlike livestock disease outbreaks, the cost of dealing with tree disease outbreaks falls on owners, who must pay for measures, such as felling trees and destroying material that could spread the disease. Felling that may disturb wildlife protected under the Wildlife and Countryside Act, such as birds during the breeding season, is risk assessed and mitigation measures such as buffer zones are used. Other forestry operations such as deforestation, afforestation and certain quarry and road projects are subject to the Environmental Impact Assessment (Forestry) Regulations.

At present, there is relatively low public awareness of the role of humans in the dispersal of tree pests and diseases, despite initiatives to encourage reporting. Many large landowning organisations, such as the National Trust, now undertake biosecurity measures, such as regular cleaning of boots, tools and vehicles between sites. Raising awareness by landowners may ensure that disease outbreaks are reported promptly, reducing the risk of disease transfer between sites. Implementation of biosecurity measures would need to be developed and promoted in conjunction with a range of different stakeholders, including the horticultural trade, to promote trust among affected parties and ensure wider information exchange. A high percentage of UK woodlands have public access, creating difficulties in enforcing biosecurity measures.

In the marine environment, biosecurity has to focus on targeting the main vectors by which pest and disease species can move. These include bio-fouling of mobile structures such as the hulls of ships, addressing ballast water discharge and ensuring that shipment of commercial species does not introduce problematic 'hitch-hiker' species.

Increasing the resilience of habitats – A key concept in managing risk and increasing the resilience of habitats to disease and pests is diversification: from broadening the choice of genetic material and mixing species in different ways, to varying management systems and the timing of operations. Thinking on how to increase the resilience of habitats is most developed for woodlands, given the number of diseases which threaten woodlands in the UK, *Chalara* disease of ash trees being a current example.

Whilst natural regeneration of sites affected by disease is the preference, some planting to fill gaps may become inevitable to avoid losing a canopy cover, or for domination by sycamore which is the most likely tree to replace ash at many sites. Some tree specimens may be naturally resistant to a particular disease and so careful

consideration needs to be given to whether to remove diseased trees before they die naturally. Resistant stock may be used in breeding programmes which attempt to preserve species for the future.

Improving the integrity of ecosystems as a whole will help to improve disease resistance. Factors such as habitat fragmentation and climate change are thought to increase susceptibility to disease and so measures designed to increase habitat connectivity and adapt to climate change are likely to be beneficial.

Deer

Collaboration – Successful deer management relies on collaboration between landowners and managers. Whilst strategic planning and coordination is needed, effective collaboration at an appropriate scale is crucial. A lack of incentives for collaboration can be a significant barrier to effective management.

Funding - Deer management includes fencing and culling. There is a place for both in an area with high deer populations, especially if the wood is being managed by coppice or by continuous cover forestry, where regeneration is important. Fencing alone is not sufficient, as the overall deer population will continue to grow, therefore increasing the level of future issues. Deer management can be expensive, in terms of deer stalkers' time, infrastructure (eg high seats) and deer fencing. Whilst grants are available that can pay for infrastructure, the overall expense and long-term nature of control programmes means that it can be difficult to secure adequate funding. Stalking schemes operated by the British Association of Shooting and Conservation (BASC) are cost effective and may be worth considering as an alternative to existing methods of control.

Public perception - In terms of public perception, it is important to explain that deer fencing is a possible option, but does not address the problem, and is likely to exacerbate it elsewhere. Deer population management may not seem to be the ideal solution when fencing is available; therefore, it is necessary to increase public understanding of the ecological impacts and consequences of not controlling deer. Other issues, like deer-vehicle collisions, can also help explain the scale of the issue.

Markets for venison - Venison marketing may be worthwhile promoting as the end-product of deer management. It is a very lean meat but as people are less familiar with it, there is sometimes a resistance to buying it because people don't know how to cook it. A marketing strategy may therefore help to generate demand for venison, and thereby increased sales could be used to fund deer control or other environmental improvements. A marketing strategy would not be without challenges, as, for example, people tend not to distinguish between farmed and wild venison, and also venison is currently imported from New Zealand where there is also a very high deer population.

Competitive native species

Overview of requirements - Control of competitive native species that have a tendency to become invasive, for example the management of native scrub species, is a frequent and normal part of the management of sites all across the country, and is one of the most common operations included within site management plans. It is, however, of value to acquire an overview to detect if there are particular issues regarding the management of native invasive species on Natura 2000 sites, to enable funds and resources to be targeted in the most effective manner, and analysis of the IPENS Site Improvement Plans dataset and SSSI recording system will allow this to happen.

There is perhaps less of a requirement to co-ordinate such everyday management activities than there is for the control of invasive non-native species. As a result, it was agreed that competitive natives would not be specifically dealt with in later sections of this plan.

2.4 Drivers for taking action

The existing legislative and policy framework relating to invasive species is complex, with many international instruments and codes of practice containing provisions for invasive non-native species (including pests and disease) as well as domestic legislation and species specific instruments. Many of these are relevant to Natural England and include, for example:

- Conventions: The Convention on Biological Diversity (CBD) (1992), Ramsar (1971), Bern Convention (1979), Convention on Trade in Endangered Species of Wild Flora and Fauna (CITES, 1973).
- EU Directives and Regulations: Birds and Habitat Directives (1979 and 1992), Water Framework Directive (2000), Marine Strategy Framework Directive (2008), Invasive Alien Species Regulations (2015).
- Domestic legislation: Wildlife & Countryside Act (1981), Destructive Imported Animals Act (1932), Marine and Coastal Access Act (2009).
- Specific instruments: The import of Live Fish Act (1980), Crayfish orders.

The sections below give an overview of the most significant pieces of legislation of relevance to Natura 2000 sites.

International

The Convention on Biological Diversity (CBD) outlines a set of guiding principles for implementation of action to combat INNS. This includes the three stage hierarchical approach to action – 1. Prevention, 2. Early detection and rapid action, and 3. Longer term control and management. Natural England's responsibilities with regards to INNS are delivered through the INNS Framework Strategy for Great Britain (Defra, 2008) which contains a series of actions that follow the guiding principles of the CBD.

The Aichi Biodiversity Targets from the CBD Strategic Plan for Biodiversity 2011 – 2020 also address invasive non-native species:

Target 9

By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

European

Habitats Directive and Birds Directive: The Birds Directive and the Habitats Directive do not include specific duties relating to invasive species, pests, disease or deer with respect to Natura 2000 sites. However, they do include general duties regarding the protection of SPAs and SACs, and it is on these that the requirement to control invasive species in relation to Natura 2000 must rely:

- **Habitats Directive, Article 2(2):** *"Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest."*

- **Habitats Directive, Article 6(2):** *"Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive."*

- **Birds Directive, Article 4:** *"In respect of the protection areas …., Member States shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as*

these would be significant having regard to the objectives of this Article. Outside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats."

It is clear then, that any measures taken to control invasive species specifically for the purpose of protecting Natura 2000 sites must be necessary for the maintenance or restoration, at favourable conservation status, of the birds, habitats or other species for which Natura 2000 sites are designated. If this link does not exist, invasive species control activities may still be required for the protection of other priority habitats or species, but not specifically for Natura 2000 purposes. This distinction may be important for Natura 2000 related funding sources such as LIFE+.

EU Invasive Alien Species (IAS) Regulation: The regulation came into force on 1st January 2015, after which the Commission has a further 12 months to propose a statutory list of species to which the regulation will apply. Member states will then have between 1-3 years to put in place the required measures. For the species listed member states will be required to have surveillance and control feasibility procedures in place such that if/when a species arrives it can be detected and quickly assessed for feasibility of control. If control is feasible it has to be started within three months of the species having been detected. In addition, for widespread and non-controllable species we will be required to have management plans in place. Because this will be statutory work this will have considerable implications for Natural England, who will be expected to lead on control of species which impact protected sites or other terrestrial biodiversity. We will be required to feed into this work and potentially to help write some of the contingency plans for species on the EU list.

Water Framework Directive (WFD): In the Water Framework Directive (WFD), the European Union (EU) has established a framework for the protection of inland surface waters, groundwater, transitional waters and coastal waters across Europe. The WFD has a number of objectives, such as preventing and reducing pollution, promoting sustainable water usage, environmental protection, improving aquatic ecosystems and mitigating the effects of floods and droughts. Its ultimate objective is to achieve "good ecological and chemical status" for all Community waters by 2015.

A key element of achieving good ecological status is the control of invasive non-native species. A technical sub-group has been established (UK TAG Alien Species Group – ASG) which provides scientific advice to the WFD UK Technical Advisory Group. Based on evidence, invasive non-native species are categorised in relation to the potential level of adverse risk and impact they present to the water environment. This listing is then incorporated into WFD implementation guidance.

Marine Strategy Framework Directive (MSFD): There are targets to reduce the introduction and spread of INNS through pathways management, surveillance of new introductions and development of action plans. Natural England may have a role in both monitoring introductions and implementing any measures identified but these are currently out for consultation.

Domestic

Wildlife and Countryside Act 1981: The Wildlife and Countryside Act 1981 makes a number of provisions relating to invasive non-native species, the most important of which is that section 14 makes it an offence to release or allow to escape into the wild any animal or plant listed on Schedule 9 of the Act. Natural England has a duty to regulate the release of non-native species through the licensing regime.

GB Framework Strategy for invasive non-native species: In 2001 Defra commissioned a review of policy and legislation on non-native species in Great Britain. A key recommendation was the need for a single lead coordinating body and it was this that led to the publication of the GB Framework Strategy (Defra, 2008) and

creation of the GB Non-Native Species Mechanism. The GB Programme Board is at the core of this, supported by the Non-Native Species Secretariat (NNSS) and various working groups and mechanisms.

Natural England is represented on the GB Programme Board and is a key player in the development, support and delivery of the GB Non-Native Species Mechanism and Strategy and there is an expectation that this should continue. This engagement is key to Natural England's role as lead delivery body for Biodiversity 2020, with the implementation of the Strategy identified in the England Biodiversity 2020 strategy (Defra, 2011) as the key action for tackling the pressure of INNS.

Under that strategy Natural England would be the coordinating body for a rapid response against a newly arrived invasive species where the impact is solely/mainly on a designated site (SPA, SAC, SSSI) or the main impact is on terrestrial biodiversity. The situation is more complex for marine sites where currently either Defra or Natural England is the coordinating body.

Currently the GB Strategy is under review; however, we can be reasonably certain that, if anything, the requirements for agencies will be strengthened in a new strategy. For example, it is anticipated that coordinating body roles in the marine environment will be clarified. One of the criticisms of the current arrangements is that there is not a firm enough (statutory) requirement to take action making prioritising this work difficult.

Biodiversity 2020 : The Biodiversity 2020 strategy for England's wildlife and ecosystem services (Defra, 2011) provides a national framework for action to help collectively achieve the goals set out in the Convention on Biological Diversity 'Aichi' targets (2010) and the aspirations set out in the 'Making space for nature' report (Lawton and others, 2010). The Biodiversity 2020 strategy makes specific reference to the need to continue to deliver our contribution to the GB INNS Framework Strategy, meaning that work undertaken on non-native species directly contributes to Biodiversity 2020 outcomes.

Species control orders: Section 23 of the Infrastructure Act 2015 which received Royal Assent on 12 February 2015, amends the Wildlife and Countryside Act 1981 by inserting a new Schedule 9A to introduce a new statutory regime of species control agreements and orders to ensure that landowners take action on invasive non-native species or permit others to enter the land and carry out those operations.

The powers enable the Secretary of State or one of the named environmental authorities (Natural England, Environment Agency, Forestry Commission) to set up species control agreements with landowners on whose land invasive species are found, or species control orders where: owners fail to comply with a species control agreement they have entered into; owners refuse to enter an agreement that has been offered; in cases of urgent necessity; and where no landowner can be identified. If the agreements fail to bring about a successful control a species control order can then be served which enables access to the land to undertake the control. Failure to comply with a species control order, without reasonable excuse, constitutes an offence. Natural England has a role as an environmental authority able to issue control agreements and orders. It is likely that LAGs could also have a very useful role in assisting the environmental authorities, for example by providing evidence.

2.5 Ecosystem Service benefits

Ecosystem services are defined as services provided by the natural environment that benefit people. They provide outputs or outcomes that directly and indirectly affect human wellbeing. There is high certainty that biodiversity, including the number, abundance, and composition of genotypes, populations, species, functional types, communities, and landscape units, strongly influences the provision of ecosystem services and therefore human well-being (Di'az and others, 2005).

Biodiversity underpins ecosystem goods and services through the functional role it plays within ecosystems. There is increasing concern that the ongoing loss of biodiversity, including changes resulting from habitat fragmentation, may compromise the provision of ecosystem goods and services in the near future. Invasive species can affect natural ecosystems in many ways and thereby affect the services they provide. This is summarised in Figure 4.

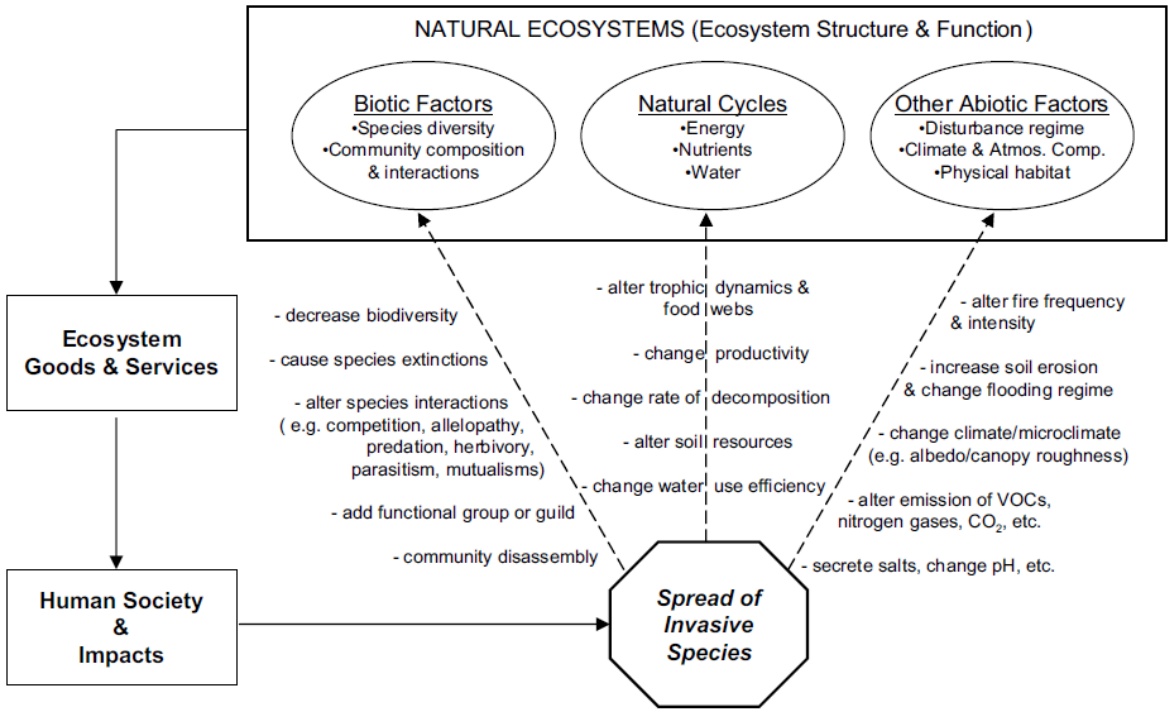


Figure 4 Mechanisms of ecosystem service alteration by invasive species (Charles and Dukes, 2007)

Ecosystems differ in terms of the ecosystem services most at risk and the invasive species which are most likely to affect them. This has been described by Charles and Dukes (2007), an extract of which is presented in Table 1 below. Whilst largely drawn from an American context, the general impacts are likely to be equally applicable to the UK.

Table 1 Ecosystem types, ecosystem services most at risk and most prevalent invasive species (extract from Charles & Dukes, 2007).

Ecosystem type	Ecosystem service most at risk	Most prevalent invasive species
Coasts and oceans	– Commercial fisheries – Shellfish beds – Water purification – Waste treatment – Disease regulation – Recreation, tourism	– Algae (unicellular), seaweeds – Molluscs – Crustaceans – Fish
Forests	– Timber – Non-wood products – Genetic resources – Ornamental resources – Aesthetic value	– Fungal pathogens – Flowering plants (non-grass) – Shrubs – Insects – Mammals

Fresh waters	– Water purification – Water regulation – Erosion control – Disease regulation – Recreation, tourism	– Aquatic plants – Fish – Molluscs – Amphibians
Grasslands and shrublands	– Livestock forage – Genetic resources – Air quality regulation – Nutrient cycling – Cultural heritage	– Grasses – Flowering plants (non-grass) – Shrubs – Trees – Mammals

The cost of invasive non-native species to the English economy has been estimated to be at least £1.3 billion per year (Williams and others, 2010) and will be significantly higher when competitive native species and deer are included. Whilst effective control of invasives may be costly and difficult, there are, therefore, significant benefits to be gained economically from implementing control measures, and also added benefits from the ecosystem service benefits that will be realised.

When a non-native species with the potential to become invasive is managed effectively, their negative impact on the ecosystem can be minimal. Non-native species may provide a food source or pollination for native species. Some invasive species may be harvested for food as part of control programmes, eg deer and signal crayfish. It could also be argued that by adding more species to an ecosystem, resilience to climate change is increased. In the context of Natura 2000, however, any positive services potential provided by invasive species must be weighed against the requirement to protect Natura 2000 interest features.

3. Delivery roles and mechanisms

3.1 The role of Natural England, Environment Agency and Forestry Commission

The various executive agencies and non-departmental public bodies sponsored by Defra play a key role in addressing invasive species in England, and as competent authorities under the Habitats Directive, all have particular responsibilities towards Natura 2000 sites. Section 3.2 goes on to discuss the roles of other organisations also involved in this work area.

Natural England

Strategic input - Natural England sits on the Great Britain Programme Board and are active players in advancing work on invasive species. Advice is provided to Defra and the NNS Secretariat in a more ad hoc manner, including time limited commissions such as the review of Schedule 9 of the Wildlife and Countryside Act, which is likely to feed into discussions around the UK species listed under the EU Invasive Alien Species (IAS) Regulation. Technical input is provided for legislation, for example the Infrastructure Bill, of which Species Control Orders will be one part, and the WFD Alien Species Group.

Delivery - Natural England has rapid response responsibilities under the Great Britain strategy and are currently undertaking a programme of work to eradicate bullfrogs from a site in Sussex. Once the IAS Regulation comes into force Natural England is likely to need to undertake contingency planning for rapid responses for those species for which they would have a lead responsibility. Natural England has responsibility for leading or supporting some actions within national eradication programmes or Great Britain level Invasive Species Action Plans (ISAPs); *e*xamples include sacred ibis and floating pennywort. Control work on protected sites undertaken by Natural England tends to be focused on improving site condition, rather than part of a wider strategic control plan. Under the EU IAS Regulation it will be necessary to have management plans in place for those species where we do not believe eradication is feasible. Under the Wildlife and Countryside Act, Natural England has a duty to regulate, through the issuing of licences, the release of non-native species, whether to support industry/agriculture or for research.

Evidence & Research - Natural England is involved in a number of research projects or initiatives, including: Biological Control research; funding projects looking at alternative control methods; conservation evidence synopsis of management techniques for Freshwater INNS and Case Studentships. Natural England is represented on the project team for the *Marine Pathways Project* which is a UK and Ireland wide project contributing to the Marine Strategy Framework Directive. The overall aim of the project is to protect marine biodiversity in the UK and Ireland by managing key pathways by which marine invasive non-native species are introduced and spread. The project is funded to April 2015 and further information can be found via this link: www.nonnativespecies.org/index.cfm?pageid=475

Environment Agency

Strategic input – The Environment Agency sits on the Great Britain Programme Board and because of the significant impacts of INNS on their role, contribute to work carried out by Defra, the Non-native species secretariat, other agencies and the Water Framework Directive (WFD) technical advisory group on alien species.

Delivery – The Environment Agency lead eradication programmes for topmouth gudgeon and water primrose. The presence of invasive non-native species has an impact on many areas of Environment Agency work, including on flood risk management, angling, recreation and navigation, biodiversity and achievement of good ecological status for the WFD. Delivery of prevention, control and management measures are coordinated through the WFD. WFD funding has supported Local Action Groups in delivering measures to address invasive non-native species. Invasive non-native species records discovered as part of the Environment Agency's extensive WFD monitoring are shared

via the National Biodiversity Network and the Environment Agency operate a small invasive non-native specific monitoring programme for killer shrimp and quagga mussel.

Evidence & Research – The Environment Agency is involved in steering research into biological control; commissioning research into ecological impacts of invasive non-native species and threats from species from the Ponto-Caspian region (https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=1175; https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=1174) ; and the application of eDNA in the monitoring and control of invasive non-native species. The Environment Agency uses its own monitoring evidence to assess the ecological impacts of invasive non-native species and their impacts on the WFD classification tools.

Forestry Commission

Strategic input – Forestry Commission sits on the Great Britain Programme Board. Advice is provided to Defra and the NNS Secretariat as requested including on the review of Schedule 9 of the Wildlife and Countryside Act, development of the non-native species strategy, development of the EU Invasive Alien Species (IAS) Regulation and implications for forestry and selection of species for the list of species of Union Concern. Forestry Commission also provides technical input for legislation, for example the Infrastructure Bill, and the recent Law Commission Review of Wildlife Law.

Delivery – Forestry Commission has rapid response responsibilities under the Great Britain strategy. Like Natural England, once the EU IAS Regulation comes into force, the Forestry Commission is likely to need to undertake contingency planning for rapid responses for those species for which they would have a lead responsibility. Under the IAS Regulation it will be necessary to have management plans in place for those species where we do not believe eradication is feasible. Forestry Commission England has recently published the Grey Squirrel policy and action plan which is intended to assist landowners and managers to more effectively control grey squirrels to protect and enhance red squirrel populations and England's woodlands. The Forestry Commission also has a key role in funding and delivering deer management.

Evidence & Research – Forestry Commission funds research into grey squirrels, including bark stripping behaviour in grey squirrels and recently supported FERA research into immuno-contraception and its applicability to grey squirrels. The Forestry Commission also produce sector guidance on control of *Rhododendron ponticium* and other invasive woodland species.

Marine Management Organisation

Strategic input – The Marine Management Organisation (MMO) is responsible for preparing marine plans in England. Marine plans will inform and guide marine users and regulators across England, managing the sustainable development of marine industries and the need to conserve and protect marine species and habitats. Policies and objectives which are produced in marine plans will be derived from key priority issues identified through evidence gathering and stakeholder engagement in the plan areas.

Delivery – The MMO has certain powers under the Marine and Coastal Access Act in regard to non-native species offences. These include enforcement of specific regulations under the Conservation of Species and Habitats Regulations 2010 and The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 which creates offences for the introduction of new species from ships and offshore marine installations. Offences relate to the deliberate introduction of any live animal or plant of a kind having a natural range which does not include any area in Great Britain. In addition, MMO can enforce Section 14 of the Wildlife and Countryside Act of releasing or allowing to escape into the wild any animal which is of a kind not ordinarily resident in and not a regular visitor to Great Britain, though this schedule does not currently include any marine species. In addition, the MMO is responsible for marine licensing of a range of activities. Decision on whether to give a marine license would be

informed by a suitable assessment of risk, and may be subject to conditions to ensure that suitable mitigation measures to address risks are in place.

Evidence & Research –The MMO does not have any current evidence commissions which relate to invasive non-native species. However, the MMO continues to liaise with other organisations on the collection of evidence and research to inform management decisions. Organisations include Cefas, Natural England, JNCC, and the ten Inshore and Fisheries Conservation Authorities (IFCA). In addition, the MMO has developed a framework agreement with range of external science providers to provide scientific services. This framework is also available to other partners within the Government departments.

3.2 Other delivery organisations

Delivery of invasive species control is very often focused around the activities of one or more groups undertaking practical action. This section describes the more frequent groups through which invasive species control work is currently delivered.

Local practical action

There are a number of different groups and organisations operating at this level, however, much of the work is piece-meal and issues based.

- **Local Action Groups (LAGs)**

The first LAGs were set up to deal with local issues, the oldest being the Cornwall Knotweed Group. They are not centrally organised, are mainly voluntary and there is no set model as to how they operate. Larger, better organised groups deal with a range of invasive issues in their area of concern. In some cases where they are directly contributing to outcomes of the GB strategy they may get some funding from Defra. The Secretariat has encouraged groups to set up and provided help via the local action toolkit. In recent years Defra has funded 29 LAGs through WFD funding. A review of the effectiveness of the funding was commissioned during the summer of 2014 and submitted to Defra in January 2015 (currently unpublished).

The Local Action groups are a partnership frequently with representation from the Environment Agency and Natural England, together with other local groups such as Wildlife Trusts. Many of the LAGs are set up around defined geographic areas such as a river catchment. They have been good at raising local awareness of invasive issues through an enthusiastic volunteer base.

- **Non-Governmental Organisations (NGOs)**

NGOs undertake some work on invasive species independent of LAGs including important contributions to awareness raising via publications and displays in their visitor centres. Wildlife Trusts often play a key role in LAGs, and undertake management and control work on the sites they manage. Plantlife has gained a lot of experience removing cotoneasters within Important Plant Areas (some of which overlap with SACs) and is starting to share knowledge with other NGOs such as the National Trust to increase the range of cotoneaster removal. They have also removed hottentot fig from the cliffs of the Lizard peninsula. The National Trust, which has large land holdings, is planning work including the eradication of Asian super ants at Hidcote in Gloucestershire.

- **Interest Groups**

Interest groups such as angling and boating organisations, shooting groups and trade groups have been very good at spreading messages relevant to their membership and undertake some invasive species control work. Good examples of this include the Royal Yachting Association and The Green Blue's work on invasive non-native species, mink trapping by shooting groups working with BASC and Natural England in the Somerset Levels and the Check Clean Dry campaign led by the GB Non-native species secretariat. There is potentially more that could be done

here and DEFRA are currently working on improvements to trap design for non-native crayfish (due to report March 2015) which they hope will lead to the production of best practice guidelines for use by volunteers to more effectively control signal crayfish. This is analogous to the work undertaken in Scotland on mink trapping that harnesses volunteers to, in the first place, undertake presence/absence work but some of whom have gone on to become directly involved in the trapping work.

- **Natural England role at a site level**

Control of non-native and competitive native species that become invasive is a frequent and normal part of the management of protected sites for which Natural England has responsibility, and is one of the most common operations included within site management plans. Natural England has a role in directly managing sites in its ownership, which are usually National Nature Reserves (NNRs), and also overseeing the management of SSSIs and Natura 2000 sites owned by others.

Control of invasive non-native plants is currently occurring across a number of Natural England managed NNRs, including Axmouth-Lyme Regis Undercliffs (Devon/Dorset), Collyweston Great Wood (Northants), Holt Heath (Dorset), Lindisfarne (Northumberland), North Solent (Hants), Pevensey Levels (East Sussex), Roudsea (Cumbria) and Winterton Dunes (Norfolk). Species being controlled include rhododendron, Himalayan balsam, Turkey oak, holm oak, laurel, pitcher plant, Japanese knotweed, pampas grass, buddleia, gaultheria, pirri-pirri bur, New Zealand pigmyweed, snowberry and various softwoods. Herbicides are the usual means of control but manual methods alone are used where possible. Colleagues at Lindisfarne are undertaking research into the control of pirri-pirri bur and a manual is planned.

Natural England also administers the Common Agricultural Policy (CAP) environmental land management scheme under the Rural Development Programme. A new scheme called 'Countryside Stewardship' begins in 2015. This scheme and its predecessors provide funding to farmers and land managers through grants, incentive schemes, and advice to enhance the natural environment. Countryside Stewardship will include specific options for the control of invasive species and Natural England will be working closely with landowners to ensure that these options are targeted where they can bring most benefit to protected sites.

Regional / National

- **Defra and environmental agencies**

The Non-Native Species Secretariat (within the Animal and Plant Health Authority) has responsibility for helping to coordinate the approach to invasive non-native species in Great Britain. They are responsible to a Programme Board which represents the relevant governments and agencies of England, Scotland and Wales.

Defra, Natural England, the Environment Agency and Forestry Commission fund site specific and strategic work to address invasive species, including Defra funding of LAGs. Defra, Natural England and the Forestry Commission largely fund the Deer Initiative to deliver the Government policy on sustainable deer management.

- **Water Framework Directive – Catchment Based Partnerships**

The Government has clearly signalled that more locally focussed decision making and action should be central to the debate about the future direction of improvements to the water environment and to support river basin management planning as part of Water Framework Directive activities. Better coordinated action is desirable at the catchment level by all those who use water or influence land management; this requires greater engagement and delivery by stakeholders at the catchment as well as local level, supported by the Environment Agency and other organisations. To this end Catchment Based Partnerships have been established, which have an important role in implementing actions to meet the objectives of the River Basin Management Plans, including those for invasive species.

- **Research organisations / academia**

The GB invasive non-native species framework strategy (Defra, 2008) has set a specific objective to encourage a more strategic and coherent research stream to underpin GB invasive non-native species policy and action. Under this, specific actions are set to:

- underpin all risk assessment, prevention, detection, surveillance, monitoring and management with high quality science;
- seek to secure funding for research priorities that have been identified;
- encourage collaborative research projects and wide access to results; and
- monitor developments in research nationally and internationally to detect technological or biological advances and ensure research in Great Britain is cutting edge.

A lot of research into issues relating to invasive species is going on in Great Britain, but further work needs to be commissioned. Currently 'blue sky' research is funded by NERC and Defra have funded some work on specific problems. A key ongoing issue is the lack of coordination of research on INNS and there is a need for an overarching strategic plan for research needs. Amongst research requirements is a need for work on interacting ecological effects, rather than just impacts of single target species.

Examples of recent or current research include:

- Defra is looking at research into long term control of invasive weeds such as Japanese knotweed (launched in 2010), Himalayan Balsam and other INNS aquatics.
- Defra is also involved in other research and review work, including a review of the success of LAG funding and specific work on improving trap design for non-native crayfish, which they hope will lead to the production of best practice guidelines.
- In the marine environment, the Marine Biological Association is responsible for all marine species information under the GB non-native species information portal (GBNNSIP – part of the National Biodiversity Network). It undertakes surveys of non-native species on rocky shores (as part of MarClim and the participatory science 'The Shore Thing' programme) and in marinas and harbours. It also has a strong awareness raising / outreach programme relating to non-native species.

3.3 Prevention, early detection and control

Assessing and reducing the risk of key dispersal pathways for the movement of potentially invasive species is a crucial part of the approach to prevention. Although work is underway in this area, ongoing research is likely to be needed, to ensure intelligence is kept up to date. This should include pathways of entry to the UK and also potential dispersal pathways once species have arrived. In the marine environment, a Marine Pathways Project has been established by CEFAS with the aim of protecting marine biodiversity in the UK and Ireland by managing key pathways by which marine invasive non-native species are introduced and spread. For freshwater Natura 2000 sites, pathway risk has also been incorporated into the risk tool developed under an IPENS evidence project (ECUS Ltd., 2015). Pathway risk assessment is also an integral part of the work done under the GB Non-Native Species Risk Analysis Mechanism. Completed risk assessments can be found on the GB non-native species secretariat website (URL: http://www.nonnativespecies.org/index.cfm?sectionid=51).

Despite best efforts it will not be possible to prevent the arrival of all potentially invasive species, and so in addition to preventative methods, provisions for early detection, surveillance and rapid response are crucial. The GB Framework Strategy for invasive non-native species sets out a strategy for both prevention and early detection and the GB non-native species secretariat is developing work in this area. Horizon scanning is an important component of early detection. It enables forward planning for rapid response and implementation of appropriate

control methods in a timely manner should a species arrive and/or become established in the future. Research undertaken by Roy and others (2014) describe a consensus building method used for horizon scanning for invasive alien species in Great Britain. It identified ninety three species which were agreed to pose at least a medium risk with respect to them arriving, establishing and posing a threat to native biodiversity.

Once a species becomes established, the exact control methods required will vary by species and with environment so it is not possible to be prescriptive about which control methods are likely to be most effective. Experience shows that combinations of methods (eg mechanical removal followed by herbicide spot treatment for invasive plants) are likely to be the most effective. Expert advice should be sought on the most appropriate strategy for a particular site. Clearly there are risks associated with such management activity and precautions need to be taken to safeguard populations of important native species. Even where the extent of control action required is a significant challenge, benefits can still be gained from partially addressing the problem, such as clearing invasive plants from part of a habitat or river system. Figure 5 illustrates the key steps in establishing a successful control programme.

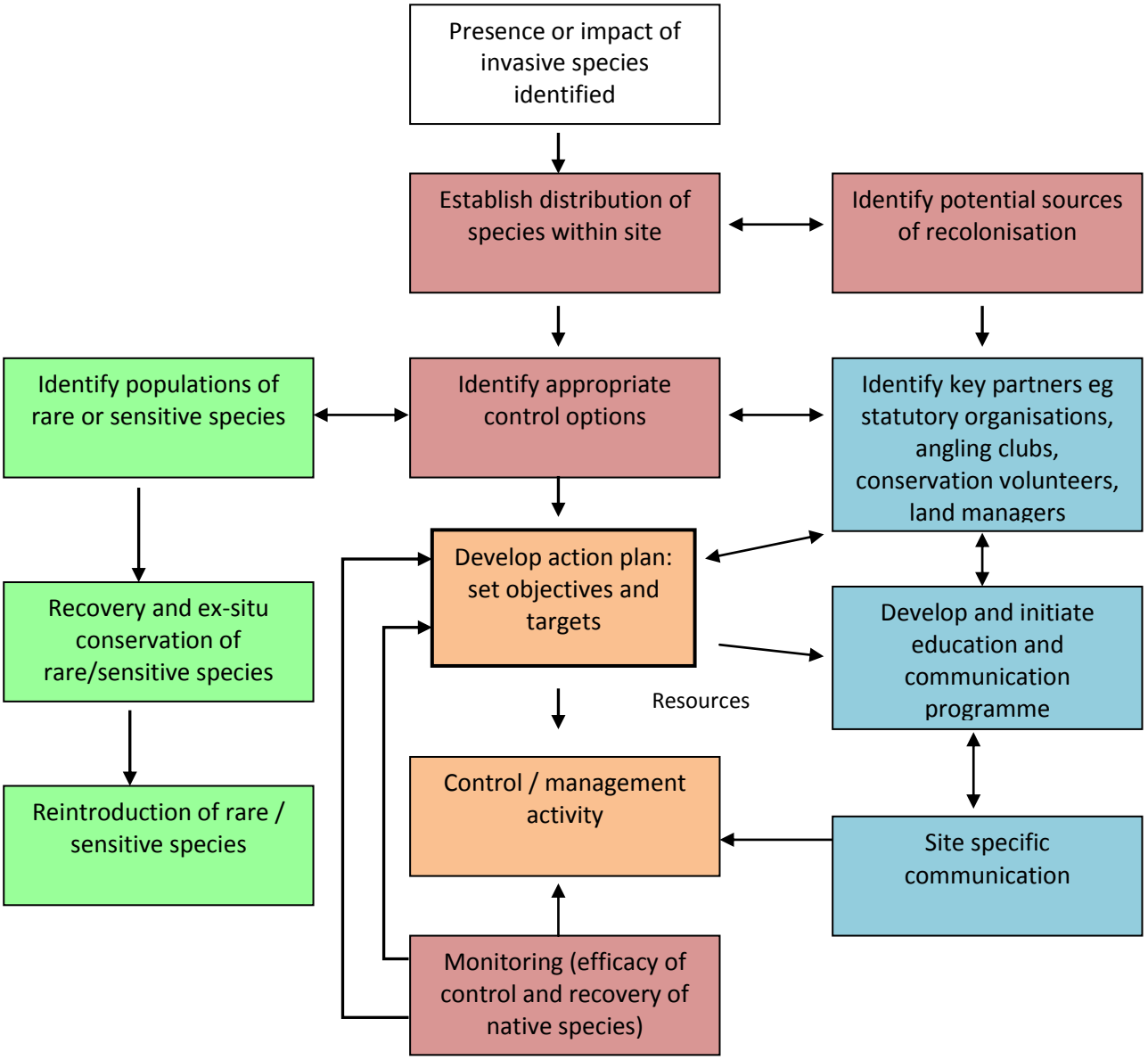


Figure 5 Key steps in establishing a successful invasive species control programme (from Lycett & Taylor, 2008)

Further information on control methods is widely available and the following links give a good starting point:

- Control methods for invasive non-native plants, GB Non-native species secretariat. URL: http://www.nonnativespecies.org/index.cfm?pageid=208

- Aquatic and riparian plant management guide, Environment Agency URL: http://evidence.environment-agency.gov.uk/FCERM/en/Default/FCRM/Project.aspx?ProjectID=B081237C-AF90-4E75-B74B-586A6C254709&PageId=a0fe6dfc-506a-452c-9bff-a7ec06b4e6b0

- Best practice guidance for deer management, The Deer Initiative URL: http://www.thedeerinitiative.co.uk/best_practice/

- Management and guidance information for a range of non-native invasive species including marine species, GB non-native species secretariat. URL: http://www.nonnativespecies.org/index.cfm?sectionid=53

3.4 Sources of funding

There is no dedicated funding stream for invasive species work so a wide range of potential funding sources exist which may be able to contribute. The list below includes many of the more frequently used funding sources for invasive species management at the site level and also a few less common ones which have the potential to be further exploited in the future. Some funding options require match funding to be sourced, which can prove difficult to obtain, particularly given current financial constraints. There is also a risk that invasive control work may not match well the requirements of existing funding streams and therefore could be difficult to secure adequate resources for. This has recently been the case for work to control for bullfrogs. It is likely that some of the funding options listed will be appropriate for the more strategic actions recommended in sections 4 and 5 of this plan.

EU LIFE+

European funding aimed at the Natura 2000 network or the conservation of habitats and species covered by the Habitats or Birds Directives or Threatened Species on the European Red list. Each country is given an indicative allocation of funding; however, this still has to be bid for on a project by project basis. The current UK allocation is circa EUR 21.m per year, and we only utilise circa EUR10m. This is an underutilised source of funding for larger biodiversity orientated projects.

EU Interreg

EU fund aimed at collaborative cross-border projects, involving several countries and partners. A number of Interreg funds are aimed at delivering conservation objectives, especially within shared biogeographic regions. Projects can range from EUR45k up to EUR4m. A new programme is available for 2014-2020.

Rural Development Programme Countryside Stewardship scheme

The new Rural Development Programme (RDP) environmental land management scheme will be known as Countryside Stewardship (CS) and agreements under it will begin in 2016. The main priority for CS is biodiversity, with water quality as another important priority.

Together with ongoing Environmental Stewardship (ES) and England Woodland Grant Scheme (EWGS) agreements, Countryside Stewardship will be the main way of helping farmers and land managers deliver against a wide range of local, national and international environmental commitments, including control of invasive species. CS options will be available for control of competitive natives such as scrub, rushes and bracken and there will also be specific options for active management aimed at eradicating invasive plant species.

Water Framework Directive grant-in-aid

In recent years, Government grant-in-aid funding has been available for activities which contribute to the achievement of objectives under the Water Framework Directive. This money has been allocated by Natural

England through a bidding process and can be used to fund control of invasive species. In addition, Defra has funded 29 Local Action Groups in recent years.

Heritage Lottery Fund

Domestic funding aimed at a range of heritage conservation portfolios, including natural heritage (which includes biodiversity). Natural heritage projects can include elements of habitat restoration and creation, public access, species recovery, education and training. Projects also need to clearly demonstrate how they are benefiting/ engaging people and communities. HLF run several grant programmes of which the most suitable would be: *Heritage Grants:* This represents a programme providing grants of £100k+ (potentially up to £5m+). This is a relatively under-explored funding stream for the environmental sector. There is an opportunity to develop 4-6 large-scale Heritage Grant applications per annum.

Landfill Communities Fund

This is a tax credit scheme to enable landfill operators and environmental bodies to work in partnership to create environmental benefits. There is a specific objective for 'the conservation of a specific species or habitat where it naturally occurs'. The LCF fund is approx. £70 million per annum spread over a number of landfill trusts that award and distribute the money to eligible projects on behalf of landfill operators, with circa £10m per annum awarded to biodiversity orientated projects. The amount of money available varies between the individual LCF Trusts (eg Sita Trust, Wren and Biffa).

Charitable Trusts

There are relatively few Charitable Trusts with clear environmental objectives and applications are generally limited to charities. Analysis has shown that environmental awards from the largest grant-giving trusts tend to be less than 3% of overall trust funding, only a fraction of which will be focused on biodiversity. There is the potential to work with the environmental sector to collaboratively identify and influence existing Trusts to increase the potential for increased numbers of biodiversity-focused grants.

Flood and coastal risk management (FCRM) funding

FCRM funding is not dedicated to invasive species control but in certain circumstances synergies can be achieved.

Corporate funding

Corporate funding may be an option in some cases, although will not be relevant everywhere. It would usually be necessary to 'tell the right story' for the work required to appeal to the potential funding company so that there is a clear link between the work required and potential enhancements to their brand reputation. It is likely to be more difficult to secure this type of funding for species control work, and particularly for preventative work, unless there is a strong narrative about the necessity of invasive species control for the purpose of habitat improvement.

Other sources

Many other funding sources have the potential to be used for invasive species control work. The following lists some options which may be considered when planning work:

- NGOs using membership money to fund projects.
- Direct contributions from governmental or other bodies eg Environment Agency and Crown Estate.
- Section 106 planning conditions.
- Flood and coastal risk management funding.
- Green infrastructure funding.
- European structural and investment funds.
- Tax allowances and reliefs for corporate and other landowning sectors.

4. A strategy for England's Natura 2000 sites

4.1 Overarching principles for Natura 2000 sites

Work to address the impacts of invasive species in England is very wide ranging, covering many species, research programmes and with very detailed requirements at a site level. For invasive non-native species (including pests and disease), this work is overseen nationally by the GB Invasive non-native species framework strategy, as discussed in 2.2a. Under this broad strategy, the requirements of Natura 2000 receive no specific focus. To ensure that work under the strategy can be tailored for the objectives of Natura 2000 sites and coordinated and undertaken appropriately on the ground, common ways of working would be beneficial. This plan therefore, recommends the use of four overarching principles to complement the GB strategy and help give focus to work relating to Natura 2000 sites. The principles are described below and are intended for use with all types of invasive species, including deer. They may also help to set the context for work on competitive native species.

The principles are:

Natura 2000 sites sit in a wider context

Natura 2000 sites must be viewed in the context of the wider environment in which they sit, because they are not isolated and invasive species will usually enter Natura 2000 sites from areas that are not designated for protection. Controlling invasive species solely on a Natura 2000 site will often be ineffective, unless other control activity is implemented on the wider population in the area. Any invasive control activity on Natura 2000 sites must therefore be planned as part of the wider (local / regional / national / international) strategy for control of a given species. The consequence of applying this principle is that control will be more effective and communications, governance and monitoring are likely to improve.

Apply the hierarchy of approaches

It is widely acknowledged that it is easier and more cost effective to prevent non-native species problems than it is to tackle species once they are established. This acknowledgement is supported by the well-established hierarchy of approaches to be employed in tackling non-native species problems (Figure 6), first adopted in the Convention on Biological Diversity in 1991. The hierarchy is appropriate for prioritising management from national/strategic scale to local site specific and should be used to inform the approach to invasive non-native species management on Natura 2000 and other protected sites.

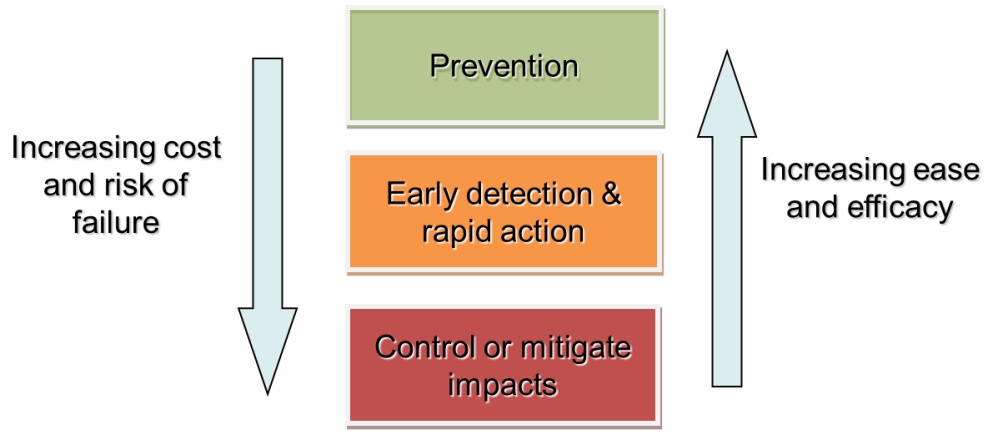


Figure 6 Hierarchy of approaches to tackling INNS

Natura 2000 requirements inform prioritisation

Addressing the impacts of invasive species on Natura 2000 sites must be seen in the context of the wider control strategies, however, the legal duties of the Birds and Habitats Directives mean that the need to protect Natura 2000 interest features should inform how invasive control activities are prioritised on and around Natura 2000 sites. For example, on a SAC designated for a standing water interest feature with undesignated woodland in the catchment, if both an aquatic invasive plant species and deer are present, the requirements of the designated standing water feature would indicate that activity to control the aquatic invasive plant is prioritised over that for deer. In this example deer control may still be required as part of a regional control strategy, but it should not be a priority for Natura 2000 improvement planning. In prioritising work, direct and indirect effects of invasive species on Natura 2000 interest features should be considered.

Shift to a strategic, proactive approach

The Invasive Non-native Species Framework Strategy (Defra, 2008), intends to provide a strategic framework within which the actions of government departments, their related bodies and key stakeholders can be better coordinated. Since the introduction of the strategy progress has been made, with LAGs using a local strategic approach and national data and best practice sharing through local records centres (LRCs) and the National Biodiversity Network (NBN). Further improvements to make the approach to invasive species more strategic and proactive are still needed, however, particularly in relation to control techniques and funding.

Horizon scanning (eg Roy and others, 2014) can provide information about which new invasive species are most likely to arrive in the UK in the near future. Ideally this information should be used to inform proactive planning work to identify which control techniques would be the best to use should that species appear. A proactive approach is likely to increase the speed by which rapid response action can be taken, and improve its effectiveness. In some cases this type of planning will reveal that there are no suitable control techniques, and therefore the importance of biosecurity and preventative measures will be highlighted.

Despite progress towards a more strategic approach, funding for invasive species work at present tends to be ad hoc and reactive with projects carried out by a number of different organisations. Control work on invasive species related to improving site condition requires the development of a strategic approach in order to make best possible use of the limited resources available. Identifying and agreeing responsibilities and priorities will focus the approach to strategically securing future resources. The GB strategy attempts to improve how organisations are working together and there is a need to ensure work is coordinated between organisations to maximise efficient use of available funds. A well co-ordinated strategy will also provide opportunities to more effectively influence funding sources, so that sufficient resources are targeted where they are most needed. Priority Action 6 in Table A priority action is included in Table 2 aims to address this need.

If a shift can be made to a more strategic and proactive approach for Natura 2000 sites, it should help to encourage similar changes for work on other protected sites and in the wider environment, thereby improving the efficiency of invasives work overall.

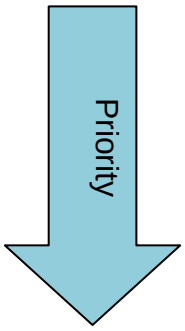
4.2 Identifying priority species for control in the Natura 2000 network

The ever increasing number and influence of invasive species, particularly non-native species, in Great Britain (http://www.nonnativespecies.org/factsheet/), the complex nature of designated sites and the actual and potential impact from invasive species make it impractical to maintain a single prioritised list of species that should be tackled on all sites. At the same time, improved collaborative working between partner organisations as advocated by the GB framework strategy and this plan, particularly where funding is limited, necessitates reaching agreement on which species to address. Where agreement is reached, it will help partners to take a more strategic and proactive approach to securing funding (fourth strategic principle above).

It should be recognised, however, that priorities may differ depending on the target area. National priorities may be more informed by factors such as economic impact of a species and so may differ from priorities specifically for management of Natura 2000 sites. It is important that management work takes into account these differences and attempts to reach a balance between different priorities. Having regard to the first and third strategic principles outlined above will help with this.

Decisions upon which species to prioritise for action should be informed by the hierarchy of approaches outlined previously and by appropriate drivers eg EU Invasive Alien Species (EU IAS), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD), and associated existing lists (eg Great Britain Alert species http://www.nonnativespecies.org/alerts/index.cfm and WFD priority list, http://www.wfduk.org/sites/default/files/Media/Assessing%20the%20status%20of%20the%20water%20environment/UKTAG%20classification%20of%20alien%20species%20working%20paper%20v7.PDF) relevant to the site(s) in question.

The following provide an aid to decision making as to the priority in which species should be managed:



- Species on statutory lists eg EU IAS Directive species of union concern list, WFD high priority list, EU IAS member regional or member state lists
- GB alert species, GB horizon scanning species
- Species which are having or have the potential to have a negative impact on the designated site feature[1]
- Species which are having or have the potential to have a negative impact on the supporting habitat of the site
- GB Invasive Species Action Plan species
- Invasive non-native species present on site

[1] Information on potential impacts to help this assessment can be found through Great Britain NNS Secretariat risk assessments, or on the non-native species information portal: http://www.nonnativespecies.org/index.cfm?sectionid=51 http://www.nonnativespecies.org/factsheet/index.cfm

The nature of the action required for prioritised species will vary depending on how well established they are, the level of evidence / knowledge available, availability of control options and scale of impact. For well-known invasive non-native species such as Himalayan balsam or Japanese knotweed, action is likely to focus around eradication using various methods including newer biological controls. For many pest and disease species, however, actions are more likely to involve horizon-scanning, biosecurity and rapid response measures. For deer, current policy is not to seek eradication for any species, however, control measures may be necessary where significant damage occurs. The highest priority areas for control are likely to be where deer populations are highest, regardless of which species are present (BASC, pers. comm.).

Data gathered in IPENS Site Improvement Plans (SIPs) have been analysed by looking at frequency of reporting of each invasive species across the SIPs. In total 75 invasive non-native species, 10 pests and diseases and 21 competitive native species were reported. The top three most frequently reported species were:

- Invasive non-native species: Himalayan balsam (34 SIPs), Japanese knotweed (26), rhododendron (21)
- Pests and disease: Ash dieback *Chalara* (22), all *Phytophthora* diseases (15), all oak diseases (8).
- Competitive native species: unspecified trees / scrub (41), bracken (10), cord grass *Spartina* sp. (7).

The full ranked species lists are in Annex 7, together with information on typical actions identified in the SIPs for the higher ranked species.

It is suggested that this information could be used as an initial, tentative prioritisation, to inform discussions with partner organisations, with the aim of developing a more strategic approach to where resources should be targeted. IPENS SIP data will be analysed further in the future and will be able to help inform discussions about regional priorities and actions that should be undertaken.

4.3 Underpinning information

This section provides further information to underpin the overarching strategy described in section 4.1. For each of the three categories of invasive species, three topics are discussed; scale of action, resilience and funding and coordination of action. Note that as discussed in section 2.3 competitive native species are not included here, as their control is usually dealt with through normal site management activity.

Invasive non-native species

Scale of action - Prevention and containment (early detection and rapid action) actions are important at the site level, although in many cases these may be managed through strategic approaches as well as at the site level, for example, prevention through adopting adequate biosecurity and pathway management at both a national and local scale. In the marine environment, prevention in the first instance is really the key focus as any control or removal of a marine species is particularly difficult. Early detection and rapid action requires surveillance and management, which could be undertaken through national (if an alert species) or local programmes. Pathway action plans are a key tool for prevention and the NNS Secretariat will be focussing on producing these.

The nature of many non-native invasive species problems is such that ongoing, interventionist management will be required to restore Natura 2000 sites to favourable condition, particularly where a species has become well established. Experience in controlling non-native species such as New Zealand pigmyweed (*Crassula helmsii*) has shown that complete eradication is very rarely possible (though may be achievable in small water bodies if the early stages of colonisation are tackled). With some invasive species it may be possible to instigate a programme of management to reduce the level of infestation or biomass to a point at which the impacts upon the native plant and animal community are deemed to be reduced to a level consistent with favourable condition. This may require ongoing and repeated control effort but might be seen as analogous to routine conservation management activity such as scrub control, provided that the ongoing management does not in itself cause detrimental effects on the native species present.

In a few cases issues relating to achievement of favourable conservation status of a Natura 2000 feature across Europe will need to be considered in light of impacts from invasive species. A good example is white-clawed crayfish *Austropotamobius pallipes*, which occurs throughout Europe. Populations in mainland Europe and Great Britain have been decimated by crayfish plague disease (*Aphanomyces astaci*) which is carried by invasive signal crayfish *Pacifastacus leniusculus.* Signal crayfish and crayfish plague, however, have not yet arrived in Ireland, thus providing the opportunity to tailor control efforts such that Great Britain acts as a buffer zone to protect the stronghold for native crayfish in Ireland.

Resilience - Invasive non-native species tend to get a foothold in locations where they have no natural predators and this will remain the case unless environmental conditions change significantly so that they are no longer as competitive. Improving the resilience of habitats to non-native invasive species is therefore less of a priority than it is for disease. In ecological terms, where habitats are in a good condition and have a good mix of native species, they may be less susceptible to new invasive non-native species. In practice, however, this will not always be the case and other factors such as land use change, habitat fragmentation and climate change act to reduce the resilience of habitats through increased 'edge' effects or altered environmental conditions.

Funding and coordination of action – Achieving a shift to a more strategic approach to funding as per the overarching strategy described above is largely dependent on having a clear picture of funding priorities. Invasive non-native species are a massive problem in England and faced with that, it can be difficult to know where to start with addressing the issues they present. There is currently no clear list of priorities, and so work tends to be ad hoc and uncoordinated. In addition to this, the various bodies working on invasive species tend to have their own areas of focus, for example Natural England is primarily involved with protected sites and species, whilst Wildlife Trusts have specific sites that they manage and also play a key role in LAGs. The new EU IAS Regulation and the GB strategy review will help move in the right direction, although further work on priorities may well be required. Once identified, methods of communicating priorities of which species to address in which locations should be explored in order to ensure that local action can be coordinated towards the highest priority issues.

Pests and disease

Scale of action – At a national or international scale, human-caused introductions of pests or pathogens, or otherwise 'pathogen pollution' (defined as the anthropogenic movement of pathogens outside their natural geographical or host-species range), is a major driver; this also includes (a) introduction of vectors, and (b) level of compliance of travellers, importers and workers. Addressing this depends on effective UK Border controls, identification, traceability and verifiable provenance.

At the site scale, actions may require reviews of features of interest, their inter-species and intra-species genetic diversity, and assessment of their connectivity within landscapes and ecosystems. Greater diversity of species and genotypes is likely to be necessary for multi-factorial resilience.

Resilience - The maximisation of genetic diversity across all species, and particularly within species, is a fundamental attribute of potential "resilience". Economic, technological and market changes and developments (eg mechanisation, cloning, GM, automated/robotic systems, standardisation of commodity products, uniformity, etc.), however, all tend to favour more species and genotypic monocultures which are likely to be the antithesis of pest and disease resilience. Single species and intra-species genotypic monocultures should be avoided or reduced, especially at large and increasing spatial scales, with cultivated and other farmed species (including tree species, eg effect of *Phytophthora ramorum* outbreaks on Larch plantations).

Our approach to increasing the resilience of specific Natura 2000 interest features to disease needs to be addressed urgently, particularly given the current spread of tree diseases such as ash dieback (*Chalara* disease) affecting ash and *Phytophthora* disease affecting juniper. Diversification of species or sub-species within designated habitats will need to be considered to maximise genetic diversity and increase resilience. This will require greater knowledge about the range of species present and especially the within-species genetic diversity / genotypic diversities, for example through establishing comprehensive inventories of the same. For example, in the face of the spread of ash dieback disease, we urgently need to know the genetic diversity present in our existing populations of ash trees so that any that show disease resistance or tolerance can be genotypically-identified as soon as possible. This, however, may be controversial in the context of Natura 2000, the purpose of which is to protect defined habitat types. For example, if ash trees are lost from a stand of *Tilio-acerion* forest (H9180), would it be acceptable to significantly increase numbers of sycamore (non-native in UK), and if this happens, would the habitat still qualify as a Natura 2000 interest feature?

Funding & coordination of action – Without adequate co-ordination, sufficient funding and speed of actions, opportunities will be missed to prevent the introduction and spread of pests and diseases. Failure to prevent introduction may be overcome but only if early detection and rapid action is effective. All possible means of surveillance need to be utilised, including but not limited to, remote sensing, e-DNA testing, 'citizen science' approaches, Meteorological Office weather forecasts and atmospheric dispersion modelling (used very successfully to predict the arrival of bluetongue disease and Schmallenberg viruses carried by midges) and accurate in-field identification techniques.

The availability and changes in incentive schemes (eg for tree planting, woodland creation, forest management, farming subsidies, etc.) may have substantial effects on the risks of pests and diseases in the wider environment. We need spatial (GIS) and data records of all uptakes of incentive schemes; including, for example, species / variety / clone / GM patent etc., densities, previous cropping/land use and spatial distributions, in order to assess the risks of pest and disease outbreaks, transmission and spread. The commencement of new funding schemes (plus their duration, eligibility and compliance conditions) should be undertaken with comprehensive knowledge of the current and likely future pest and disease risks.

Deer

Scale of action - The impacts of deer are widespread, and are recorded as a priority for action in 38 Site Improvement Plans (see the map in Figure 3). Deer impacting protected sites are usually part of a population in the wider area around the site, or even a regional population. It is therefore usually necessary for action to reduce deer populations to be implemented at a regional scale. Although site specific measures to deter deer from using protected sites eg fencing, are available options, they will often not be the preferred option for site managers.

Resilience – Increasing resilience is not relevant in terms of deer themselves but is highly relevant in terms of building resilience in woods, and deer are potentially a factor that is preventing that from happening. An example is with ash dieback disease, where trees resistant to ash dieback are being sought. However, ash is a species that deer browse preferentially, and so the impact of deer browsing is likely to be a significant factor preventing or slowing attempts to make ash woodlands more resilient to disease.

Funding and coordination of action - As a mechanism to encourage deer management, Natural England has supported the work of the Deer Initiative Ltd since 1995 and has been a member of the Deer Initiative partnership for over 10 years. It is useful to work with other interested parties to get the best solutions. Natural England and the Forestry Commission have funded the Deer Initiative Ltd and at the end of 2016 will come to the end of a three year funding period, after which arrangements will be reviewed. It will be necessary for Natural England and partners to carefully consider how to continue with deer management on Natura 2000 sites during this future period of uncertainty.

5. Implementation and further recommendations

5.1 Implementing the strategy

To address the impacts of invasive species in a more coordinated and proactive way in order to secure favourable conservation status of Natura 2000 sites in England, it is strongly recommended that the strategic principles outlined in section 4 are implemented as soon as possible. This will mean that the emphasis and approach they advocate will need to be applied to all invasive species work undertaken in relation to Natura 2000 sites by Natural England and partner organisations. It is hoped that use of the strategic principles in the Natura 2000 network will help to continue the already improving trajectory of change in invasive species work, towards far more proactive activity, where work is well planned and coordinated and funding sources are influenced. If this is to be successful, close working between all partner organisations will be necessary.

Update Site Improvement Plans (Natural England staff only)

The Site Improvement Plans (SIPs) produced by the IPENS project for each Natura 2000 site are live documents and where necessary will be updated annually by Natural England to reflect new understanding about issues affecting the sites. It is recommended that Natural England staff should ensure that the strategic principles recommended in this plan are used to review and if necessary change SIP actions relating to invasive species. Where necessary, any changes can be included in future updates to the SIPs.

In addition, results from other research may be reviewed and where appropriate used to update actions in the SIPs. This includes the two IPENS funded evidence project (ECUS Ltd., 2015 and Lush and others, 2015), horizon scanning work such as Roy and others (2014), GB NNSS risk assessments (URL: http://www.nonnativespecies.org/index.cfm?sectionid=51), and other data such as marine 'hotspot' areas for introduction and establishment of marine non-native invasive species identified in Pearce and others (2012).

5.2 Priority actions

The strategic principles for Natura 2000 sites presented in section 4 together with the initial prioritisation fit into the wider programme of work under which activity is already going on nationally, for example actions being addressed through the GB strategy review and a developing Natural England strategy.

Implementation of the strategic principles needs to be enhanced by a range of more specific priority actions which will help support the strategy for Natura 2000 sites by improving the evidence base, planning and coordination, monitoring and sharing best practice. These are presented in Table 2 and complement actions within the Non-native Species Strategy for Great Britain. They are more specifically targeted to Natural England and Natura 2000 sites and help to address many of the issues raised at the IPENS technical workshop held in 2013 (see Annex 5). The GB Strategy is focussed on improving co-ordination between groups, increasing awareness of issues, having contingency plans in place (for prevention and control), best use of resources for improved detection and monitoring, and identifying gaps. The GB Strategy only covers non-native species which are known to be or are potentially invasive; it does not include pests and diseases or competitive natives, and is unclear regarding deer (only non-native and not native). Actions in Table 2 more specific to Natura 2000 sites include communication, advice and training within Natural England, prevention and control work on Natura 2000 sites, issues in relation to interest features (monitoring, increasing resilience) . Also actions related to deer (action 11) and pests and diseases (action 6).

Table 2 Priority actions

Action no.	Action description	Link to GB Framework Strategy	Timescales	Lead body(ies)
1	Encourage the use of the recommended invasive species overarching strategy on Natura 2000 sites (see section 4) through sharing best practice and improved internal advice/training for staff.	Strategic planning and coordination	2015 onwards	Natural England
2	Ground-truth SIP data, including comparison with baseline data (Lush and others, 2015).	Evidence	2015 onwards	Natural England
3	Undertake detailed analysis of IPENS SIP data to further refine the initial list of priority species.	Evidence	2015 onwards	Natural England
4	Building on the work of the NNS Secretariat, IPENS vulnerability to INNS project (ECUS Ltd, 2015) and IPENS SIP analysis of priorities, collaborate with partner organisations to produce a clear list of priorities (species and sites) for invasive species control for Natura 2000 sites. This will help to deliver action 5.	Strategic planning and coordination	Late 2015 / 2016 onwards	Defra agencies and partners
5	Explore options for providing advice eg online maps, about which species to prioritise for control in which locations, to inform local work programmes and assist coordination of partnership work and funding.	Guidance	2015 onwards	NNS Secretariat, Natural England
6	Identify and bid for external funding for the priority species and locations identified through actions 3 and 4, by working strategically and proactively via Defra and Natural England project pipeline structures, and in partnership with other delivery bodies.	Funding	2015 onwards	Natural England, Defra, partner organisations
7	Establish a relationship between the central Natural England INNS network and Area Teams to help provide advice on prioritisation and sharing best practice, helping to strategically coordinate funding. This will help deliver action 1 and contributes to action 6.	Strategic planning and coordination	2015	Natural England
8	Use horizon scanning as the basis for increasing proactive planning for new invasive species likely to arrive in the UK.	Strategic planning and coordination	To be determined	NNS Secretariat and all partner organisations
9	Contribute to the development of a clear approach to biosecurity across England.	Strategic planning and coordination	2015	Natural England, Defra agencies, partner organisations (under leadership of the GB NNS Secretariat
10	Reduce the risk of the spread of INNS to Natura 2000 sites and in the wider environment by developing pathway management plans, focusing effort in key areas of spread (ie hotspots) and areas most likely to be affected (eg sensitive habitats).	Strategic planning and coordination	To be determined	GBNNS Secretariat, Defra agencies and partners

11	Explore the possibility of implementing a venison marketing strategy linked to control of problem deer populations relevant to Natura 2000 sites.	Strategic planning and coordination	To be determined	Forestry Commission, Natural England, National Trust, BASC, The Deer
12	Undertake work to determine how best to increase the resilience of Natura 2000 interest features to disease and pest outbreaks, particularly focusing on diseases affecting trees eg ash, alder and juniper. As part of this, consider ways to establish an inventory of genotypic diversity present in UK.	Evidence	2015	Natural England
13	Promote further research into the impacts of INNS – both socioeconomic and environmental, to further evidence and support the need for prevention and uptake of biosecurity best practice.	Evidence	To be determined	Natural England, NNS Secretariat, partner organisations
14	Investigate opportunities and implement the wider use of novel technologies and 'citizen science', particularly for alerting agencies to the location of invasive species on Natura 2000 sites and in the wider environment. Current examples include the Environment Agency, CEH and University of Bristol 'PlantTracker' app and BASC's Green Shoots Mapping website.	Monitoring and surveillance	To be determined	To be determined
15	Build a better understanding of the control work on established invasive non-natives that Natural England and others are doing or contributing to on Natura 2000 sites and in the wider environment, in order to share best practice and better align available resources.	Knowledge of current activities	2015	Natural England / NNS Secretariat
16	Ensure that all relevant Defra agencies are in a position to make use of species control orders, and that local councils use Community Protection Notices to control invasive species.	Regulation	2015	Natural England, Environment Agency, Forestry Commission, local authorities
17	Continue to implement communications and training opportunities for Natural England staff, to disseminate the results of the two IPENS evidence projects (ECUS Ltd, 2015 & Lush and others, 2015) evidence projects and raise awareness of invasive species issues in order to benefit work coordination.	Sharing best practice	2015 onwards	Natural England
18	Improve awareness of, and compliance with, good biosecurity practices amongst the wider public, industry, contractors and staff eg cleaning of boots / tools / vehicles at public entry points (eg car parks) to Natura 2000 and other protected sites.	Sharing best practice	To be determined	Defra agencies, partner organisations
19	Sharing of best practice was identified as an issue at the workshop. Use information from Local Action Groups and national projects/bodies such as The Green Blue, to identify and disseminate best practice techniques for invasive prevention and control. *(This action may already be covered by a recent review of LAG groups commissioned by Defra, publication of report pending)*	Sharing best practice	To be determined	NNS Secretariat / Defra / Natural England

Annex 1. SIP data – Invasive non-native species

The following table lists SIPs where invasive non-native species have been recorded as a pressure or threat. Competitive natives included in the SIPs within the same issue as non-natives are listed in Annex 4.

SIP Name	Pressure or threat	Invasive non-native species reported in the SIP
Arnecliff and Park Hole Woods	Threat	Western hemlock *Tsuga heterophylla*
Asby Complex	Threat	Threat of aquatic invasive species eg New Zealand pigmyweed *Crassula helmsii*
Avon Gorge Woodlands	Threat	*Cotoneaster* spp., holm oak *Quercus ilex*, laurustinus *Viburnum tinus*, butterfly-bush *Buddleja davidii*, everlasting pea *Lathyrus latifolius*, alexanders *Smyrnium olusatrum*, Japanese knotweed *Fallopia japonica*, Himalayan balsam *Impatiens glandulifera*, garlics/onions *Allium* spp., Turkey oak *Quercus cerris*
Avon River and Valley	Pressure/Threat	Orange balsam *Impatiens capensis*, Japanese knotweed *Fallopia japonica*, giant hogweed *Heracleum mantegazzianum*, creeping water primrose *Ludwigia peploides*, skunk cabbage *Lysichiton* sp., water fern *Azolla filiculoides*, Himalayan balsam *Impatiens glandulifera*, signal crayfish *Pacifastacus leniusculus*
Birklands & Bilhaugh	Pressure/Threat	Japanese knotweed *Fallopia japonica*, Himalayan balsam *Impatiens glandulifera*, Rhododendron *Rhododendron* spp.
Bowland Fells	Threat	Eagle owl *Bubo bubo*
Broadland	Pressure	A number of unspecified species
Brown Moss	Pressure/Threat	Water fern *Azolla filiculoides*, New Zealand pigmyweed *Crassula helmsii*
Cannock Chase	Pressure	A number of unspecified species
Cannock Extension Canal	Pressure/Threat	Water fern *Azolla filiculoides* and floating pennywort *Hydrocotyle ranunculoides*
Castle Eden Dene	Pressure/Threat	Rhododendron *Rhododendron* spp., Himalayan balsam *Impatiens glandulifera*, Snowberry *Symphoricarpos albus*
Chesil Beach & The Fleet	Pressure/Threat	Pacific oyster *Crassostrea gigas*, Japanese wireweed *Sargassum muticum*
Chilterns Beechwoods	Pressure/Threat	Grey squirrel *Sciurus carolinensis*, edible dormouse *Glis glis*
Cotswold Beechwoods	Threat	Sycamore *Acer pseudoplatanus*

Craven Limestone Complex	Threat	Introduction of aquatic non-native species may impact on a wide variety of the features of this site
Culm Grasslands	Pressure	Himalayan balsam *Impatiens glandulifera*
Dee Estuary/Aber Dyfrdwy & Mersey Narrows	Pressure/Threat	New Zealand pigmyweed *Crassula helmsii*, Giant Hogweed *Heracleum mantegazzianum*, Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, Canada goose *Branta canadensis*, clematis *Clematis* sp., Chinese mitten crab *Eriocheir sinensis* and Asian shore crab *Hemigrapsus sanguineus*
Denby Grange Colliery Ponds	Threat	Himalayan balsam *Impatiens glandulifera*
Dorset Heaths	Pressure	*Rhododendron* spp., *Gaultheria* sp., carp *Cyprinus* sp., New Zealand pigmyweed *Crassula helmsii*, Canadian pondweed *Elodea canadensis*
Downton Gorge	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica* and *Rhododendron* spp.
Duddon Mosses	Pressure	Rhododendron *Rhododendron* spp.
Dungeness	Pressure/Threat	Freshwater non-native species eg New Zealand pigmyweed *Crassula helmsii*
Durham Coast	Threat	Sycamore *Acer pseudoplatanus*, Himalayan balsam *Impatiens glandulifera*, cultivated species
East Hampshire Hangers	Pressure	Non-native hybrid ivy *Hedera* sp.
Epping Forest	Pressure/Threat	Grey squirrel *Sciurus carolinensis*
Essex Estuaries	Pressure/Threat	Pacific oyster *Crassostrea gigas*, American whelk tingle *Urosalpinx cinerea*, slipper limpet *Crepidula fornicate*
Exmoor & Quantock Oakwoods	Pressure/Threat	Rhododendron *Rhododendron* spp., invasive knotweeds *Fallopia* spp., Montbretia *C. x crocosmiiflora*, Himalayan balsam *Impatiens glandulifera*, fringecups *Tellima grandiflora*
Exmoor Heaths	Threat	Rhododendron *Rhododendron* spp., invasive knotweeds *Fallopia* spp. and Montbretia *C. x crocosmiiflora*
Fal & Helford	Threat	Pacific oyster *Crassostrea gigas*, sea squirt *Didemnum vexillum*, Japanese wireweed *Sargassum muticum*, slipper limpets *Crepidula fornicata*
Fenn's, Whixall, Bettisfield, Wem & Cadney Mosses	Pressure/Threat	New Zealand pigmyweed *Crassula helmsii,* Japanese knotweed *Fallopia japonica*
Flamborough and Filey Coast	Threat	Cultivated species eg Montbretia *C. x crocosmiiflora*

Great Yarmouth Winterton Horsey	Pressure/Threat	Russian vine *Fallopia baldshuanica*
Greater Thames Complex	Threat	Sea squirt (species not recorded), pacific oyster *Crassostrea gigas*, floating pennywort *Hydrocotyle ranunculoides*, New Zealand pigmyweed *Crassula helmsii*, parrot's feather *Myriophyllum aquaticum*
Harbottle Moors	Threat	Japanese knotweed *Fallopia japonica*, sitka spruce *Picea sitchensis*, Himalayan balsam *Impatiens glandulifera*
Humber Estuary	Threat	Water fern *Azolla filiculoides*, Himalayan balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, Japanese knotweed *Fallopia japonica*, slipper limpet *Crepidula fornicata*, Chinese mitten crab *Eriocheir sinensis*
Ingleborough Complex	(blank)	Rabbit *Oryctolagus cuniculus,* Beech *Fagus sylvatica*
Isles of Scilly Complex	Pressure/Threat	Brown rat *Rattus norvegicus*
Lake District High Fells	Threat	Larch *Larix* sp. and spruce *Picea* sp. seedlings, rhododendron *Rhododendron* sp.
Lee Valley	Threat	Water fern *Azolla filiculoides*, invasive aquatic blanket weeds
Lower Derwent Valley	Threat	Mink *Mustela vison*, Himalayan balsam *Impatiens glandulifera*
Lundy	Pressure/Threat	Japanese wireweed *Sargassum muticum*, Harpoon weed *Asparagopsis armata*
Marazion Marsh	Threat	Water fern *Azolla filiculoides*, Japanese knotweed *Fallopia japonica*
Martin Mere	Threat	New Zealand pigmyweed *Crassula helmsii*, Himalayan balsam *Impatiens glandulifera*
Mersey Estuary	Pressure/Threat	Canada goose *Branta canadensis*, Chinese mitten crab *Eriocheir sinensis*
Morecambe Bay	Pressure / Threat	Japanese rose *Rosa Rugosa*, pacific oyster *Crassostrea gigas*, Chinese mitten crab *Eriocheir sinensis*
Morecambe Bay Pavements	Pressure/Threat	*Cotoneaster* sp., larch *Larix* sp.
New Forest	Pressure	New Zealand pigmyweed *Crassula helmsii*, parrot's feather *Myriophyllum aquaticum*, pitcher plant *Sarracenia purpurea*, rhododendron *Rhododendron* sp., turkey oak *Quercus cerris* and Himalayan balsam *Impatiens glandulifera*
Newlyn Downs	Pressure	Butterfly-bush *Buddleja davidii*, Japanese knotweed *Fallopia japonica*
Norfolk Valley Fens	Threat	Himalayan balsam *Impatiens glandulifera*, orange balsam *Impatiens capensis*, New Zealand pigmyweed *Crassula helmsii*
North Downs Woodlands	Pressure	Sycamore *Acer pseudoplatanus*

North East Kent (Thanet)	Pressure	Pacific oysters *Crassostrea gigas*, Japanese wireweed *Sargassum muticum*; Chinese mitten crab *Eriocheir sinensis*; carpet sea squirt *Didemnum vexillum*; Wakame *Undaria pinnatifida*; *Caulacanthus ustulatus* (a red algae)
North Somerset & Mendip Bats	Pressure	Sycamore *Acer pseudoplatanus*
Northumberland Coastal	Threat	Pacific oyster *Crassostrea gigas*, pirri-pirri-bur *Acaena novae-zelandiae*, Japanese skeleton shrimp *Caprella mutica*
Oak Mere	Pressure/Threat	New Zealand pigmyweed *Crassula helmsii*
Oxford Meadows	Threat	New Zealand pigmyweed *Crassula helmsii*
Peak District Dales	Pressure	Signal crayfish *Pacifastacus leniusculus*
Pevensey Levels	Threat	Floating pennywort *Hydrocotyle ranunculoides*, New Zealand pigmyweed *Crassula helmsii*
Plymouth Sound and Tamar Estuary	Threat	Pacific oyster *Crassostrea gigas*, wakame, Japanese wireweed *Sargassum muticum*
Polruan to Polperro	Threat	Cultivated shrub species
Portland-Studland & St Albans-Durlston	Pressure/Threat	Wall cotoneaster *Cotoneaster horizontalis*, holm oak *Quercus ilex*, Butterfly-bush *Buddleja davidii*, Japanese knotweed *Fallopia japonica*
Rex Graham Reserve	Threat	Rabbit *Oryctolagus cuniculus*
River Axe	Pressure	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, giant hogweed *Heracleum mantegazzianum*
River Camel	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, laurel (species not recorded), rhododendron *Rhododendron* sp., pines *Pinus* sp., sycamore *Acer pseudoplatanus*
River Clun	Pressure	Himalayan balsam *Impatiens glandulifera*
River Dee and Bala Lake	Pressure / Threat	New Zealand pygmyweed *Crassula helmsii*, Giant Hogweed *Heracleum mantegazzianum*, Mitten Crab *Eriocheir sinensis*, Asian Shore Crab *Hemigrapsus sanguineus*, Himlayan Balsam *Impatiens glandulifera*, Japanese Knotweed *Fallopia japonica*, Canada Geese *Branta canadensis*, Clematis spp.
River Derwent	Threat	Himalayan balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, Japanese knotweed *Fallopia japonica*.
River Derwent & Bassenthwaite Lake	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, New Zealand pigmyweed *Crassula helmsii*, signal crayfish *Pacifastacus leniusculus*, ruffe *Gymnocephalus cernuus (not native to River Derwent catchment)*

River Eden	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, signal crayfish *Pacifastacus leniusculus*
River Ehen	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*
River Itchen	Pressure	Signal crayfish *Pacifastacus leniusculus*, Himalayan balsam *Impatiens glandulifera*, orange balsam *Impatiens capensis*
River Kent	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*
River Lambourn and Kennet-Lambourn Floodplain	Pressure	Signal crayfish *Pacifastacus leniusculus*, water fern *Azolla filiculoides*
River Mease	Pressure	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, signal crayfish *Pacifastacus leniusculus*
River Tweed	Pressure/Threat	Giant hogweed *Heracleum mantegazzianum*, Japanese knotweed *Fallopia japonica*, Himalayan balsam *Impatiens glandulifera*, signal crayfish *Pacifastacus leniusculus*
River Wensum	Pressure	Signal crayfish *Pacifastacus leniusculus*, invasive plant species
River Wye	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*, giant hogweed *Heracleum mantegazzianum*, signal crayfish *Pacifastacus leniusculus*
Roman Wall Loughs	Threat	Canadian pondweed *Elodea canadensis*
Roudsea Wood and Mosses	Pressure	Rhododendron *Rhododendron* sp., sheep-laurel *Kalmia angustifolia*
Rutland Water	Threat	Zebra mussel *Dreissena polymorpha*, bloody-red mysid *Hemimysis anomala*, Canadian pondweed *Elodea canadensis*, Nuttall's pondweed *Elodea nuttallii*, signal crayfish *Pacifastacus leniusculus*
Sefton Ribble	Pressure/Threat	White poplar *Populus alba*, Japanese rose *Rosa rugosa* Japanese skeleton shrimp *Caprella mutica*, seaweed species *Undaris pinnafitida*, Chinese mitten crab *Erocheir sinensis*
Severn Estuary	Threat	Zebra mussel *Dreissena polymorpha*, Chinese mitten crab *Eriocheir sinensis*, killer shrimp *Dikerogammarus villosus*
Sidmouth to West Bay	Pressure	Butterfly-bush *Buddleja davidii*, Pampas-grass *Cortaderia* sp., Japanese knotweed *Fallopia japonica*, laurel (species not recorded)
Simonside Hills	Pressure/Threat	Rhododendron *Rhododendron* sp., sitka spruce *Picea sitchensis*
Solent	Threat	Marine INNS, including Pacific oyster *Crassostrea gigas*

Solent and Isle of Wight Lagoons	Threat	Marine INNS
Solway Firth	Threat	Leathery sea squirt *Styela clava*, carpet sea squirt *Didemnum vexillum*, Japanese skeleton shrimp *Caprella mutica*, wakame *Undaria pinnatifida*, and Japanese wireweed *Sargassum muticum*
South Pennine Moors	Pressure/Threat	Rhododendron *Rhododendron* sp.
South Solway Mosses	Threat	Pitcher plant *Sarracenia purpurea*, Rhododendron *Rhododendron* spp., Japanese knotweed *Fallopia japonica*, Himalayan balsam *Impatiens glandulifera*
South West London Waterbodies	Pressure/Threat	New Zealand pigmyweed *Crassula helmsii*, Egyptian goose *Alopochen aegyptiaca*
South Wight Maritime	Pressure/Threat	Carpet sea squirt *Didemnum vexillum*
St Austell Clay Pits	Pressure/Threat	Rhododendron *Rhododendron* spp., laurel (species not recorded)
Stodmarsh	Pressure/Threat	New Zealand pigmyweed *Crassula helmsii*
Tarn Moss	Threat	Sitka spruce *Picea sitchensis*
Thames Basin	Pressure/Threat	Rhododendron *Rhododendron* sp., *Gaultheria* sp., pirri-pirri-bur *Acaena novae-zelandiae*
The Lizard	Threat	Hottentot fig *Carpobrotus edulis* and related succulent species
The Mens	Threat	Rhododendron *Rhododendron* spp.
The Stiperstones and The Hollies	Pressure	Japanese knotweed *Fallopia japonica*
The Wash and North Norfolk Coast	Threat	American razor clam *Ensis directus*, slipper limpet *Crepidula fornicate*, pacific oyster *Crassostrea giga*, oyster parasite *Bonamia* sp.
Thorne and Hatfield Moors	Threat	New Zealand pigmyweed *Crassula helmsii*
Tintagel Marsland Clovelly Coast	Threat	Rhododendron *Rhododendron ponticum*, Montbretia, Himalayan balsam *Impatiens glandulifera*
Tyne and Allen River Gravels	Pressure	Himalayan balsam *Impatiens glandulifera*, Japanese knotweed *Fallopia japonica*
Wast Water	Threat	Freshwater / riparian invasive non-natives
Wealden Heaths Woolmer Forest	Pressure	New Zealand pigmyweed *Crassula helmsii*

West Dorset Alder Woods	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*
Windsor Forest and Great Park	Threat	Turkey oak *Quercus cerris*, rhododendron *Rhododendron* sp.
Witherslack Mosses	Pressure	Rhododendron *Rhododendron* sp.
Wormley-Hoddesdonpark Woods	Threat	Sycamore *Acer pseudoplatanus*, turkey oak *Quercus cerris*, rhododendron *Rhododendron* sp. and snowberry *Symphoricarpos albus*
Wye Valley Woodlands/ Coetiroedd Dyffryn Gwy	Pressure/Threat	Himalayan balsam *Impatiens glandulifera*, periwinkle *Vinca* sp., Japanese knotweed *Fallopia japonica*, cherry laurel *Prunus laurocerasus*, conifer regeneration, sycamore *Acer pseudoplatanus*
Yewbarrow Woods	Threat	Beech *Fagus sylvatica*

Annex 2. SIP data – Pests and disease

The following table lists SIPs where pests and diseases have been recorded as a pressure or threat.

*Marked records are included here rather than in Annex 1: a) for consistency with other records of oak processionary moth, or b) although heather beetle is a native species, it can have an effect comparable to that of a pest species.

SIP Name	Pressure or threat	Issue reporting category	Issue reported in the SIP
Aston Rowant	Pressure/Threat	Disease	*Phytophthora austrocedrae* (on juniper *Juniperus communis*)
Avon Gorge Woodlands	Threat	Disease	Ash dieback *Chalara fraxinea*
Birklands & Bilhaugh	Threat	Disease	Introduced disease affecting oak (*Quercus* spp.)
Borrowdale Woodland Complex	Threat	Disease	Sudden oak death *Phytophthora ramorum*, other *Phytophthora* diseases and ash die-back *Chalara fraxinea*
Bredon Hill	Threat	Disease	Ash die-back *Chalara fraxinea*
Burnham Beeches	Threat	*Invasive species	*Oak processionary moth *Thaumetopoea processionea*
Cannock Chase	Pressure	Disease	*Phytophthora pseudosyringae* affecting bilberry *Vaccinium* spp.
Chilterns Beechwoods	Threat	Disease	Box blight *Cylindrocladium buxicola* (syn. *Calonectria pseudonaviculata*) and *Pseudonectria buxi*. Threat of other diseases
Cotswold Beechwoods	Threat	Disease	Ash dieback *Chalara fraxinea*
Craven Limestone Complex	Threat	Disease	Ash dieback *Chalara fraxinea*, *Phytophthora* spp. and crayfish plague *Aphanomyces astaci*
Dartmoor	Threat	Disease *Invasive species	Acute oak decline (causal agent thought to be pathogenic bacteria) or oak processionary moth *Thaumetopoea processionea* *Heather beetle *Lochmaea suturalis*
Dixton Wood	Threat	Disease	Ash dieback disease *Chalara fraxinea*

Downton Gorge	Pressure/Threat	Disease	*Phytophthora* disease (on alder *Alnus glutinosa*); threat of ash-dieback disease *Chalara fraxinea*
Epping Forest	Threat	Disease *Invasive species	*Phytopthora* (on beech *Fagus sylvatica*) *Heather beetle *Lochmaea suturalis*
Exmoor & Quantock Oakwoods	Threat	Disease	Ash dieback *Chalara fraxinea*; threat of oak processionary moth *Thaumetopoea processionea* and acute oak decline (causal agent thought to be pathogenic bacteria)
Exmoor Heaths	Pressure/Threat	*Inappropriate pest control	*Heather beetle *Lochmaea suturalis*
Fens Pools	Threat	Disease	Chytrid fungus *Batrachochytrium dendrobatidis* (affecting great crested newt *Triturus cristatus*)
Helbeck & Swindale Woods	Threat	Disease	Ash dieback disease *Chalara fraxinea*
Ingleborough Complex	Pressure / Threat	Disease *Invasive species	*Phytophthora austrocedrae* (on juniper *Juniperus communis*); threat of other *Phytophthora* species (on bilberry *Vaccinium* spp. and other shrub species); threat of ash dieback disease *Chalara fraxinea* *Heather beetle *Lochmaea suturalis*
Lake District High Fells	Threat	Disease	*Phytophthora austrocedrae* (on juniper *Juniperus communis*); threat of ash dieback disease *Chalara fraxinea*
Lundy	Pressure/Threat	Disease	Necrotic disease (affecting Pink sea fan *Eunicella verrucosa*); threat of other pathogens
Mendip Limestone Grasslands	Threat	Disease	Ash dieback disease *Chalara fraxinea*
Mendip Woodlands	Threat	Disease	Ash dieback disease *Chalara fraxinea*
Mole Gap to Reigate Escarpment	Pressure/Threat	Disease	Box blight *Cylindrocladium buxicola* (syn. *Calonectria pseudonaviculata*) and *Pseudonectria buxi*
Morecambe Bay Pavements	Pressure	Disease	*Phytophthora austrocedrae* (on juniper *Juniperus communis*)
North Pennines Group	Threat	Disease	*Phytophthora austrocedrae* (on juniper *Juniperus communis*)
North Somerset & Mendip Bats	Threat	Disease	Ash dieback disease *Chalara fraxinea*
North York Moors	Pressure/Threat	Disease	*Phytophthora* species (on dwarf shrubs)

Orton Pit	Threat	Disease	Chytrid fungus *Batrachochytrium dendrobatidis* (affecting great crested newt *Triturus cristatus*)
Ox Close	Threat	Disease	Ash dieback disease *Chalara fraxinea*
Peak District Dales	Pressure / Threat	Disease	Crayfish plague *Aphanomyces astaci;* threat of ash dieback disease *Chalara fraxinea*
River Clun	Pressure	Disease	*Phytophthora* disease (on alder *Alnus glutinosa*)
River Derwent & Bassenthwaite Lake	Threat	Fisheries: Fish stocking	Potential for disease to enter via unlicensed fish stocking
River Eden	Threat	Disease	Crayfish plague *Aphanomyces astaci*
River Kent	Threat	Disease	Crayfish plague *Aphanomyces astaci*
Roudsea Wood and Mosses	Threat	Disease	Ash dieback disease *Chalara fraxinea*
Sidmouth to West Bay	Threat	Disease	Ash dieback disease *Chalara fraxinea*
South Pennine Moors	Threat	Disease	*Phytophthora* spp., including *P. pseudosyringae*, *P. cactorum*, *P. syringae* and *P. ramorum*
Staverton Park and The Thicks, Wantisden	Pressure/Threat	Disease	Acute oak decline (causal agent thought to be pathogenic bacteria) and threat of other tree diseases
The Stiperstones and The Hollies	Threat	Disease	*Phytophthora* spp. (on bilberry *Vaccinium myrtillus*)
Tintagel Marsland Clovelly Coast	Threat	Disease	Ash dieback disease *Chalara fraxinea*
West Dorset Alder Woods	Threat	Disease	Ash dieback disease *Chalara fraxinea*; bovine tuberculosis affecting grazing levels
Wimbledon Common	Threat	*Invasive species	*Oak processionary moth *Thaumetopoea processionea*
Windsor Forest and Great Park	Threat	Disease *Invasive species	Diseases affecting oak *Quercus* spp. *Oak processionary moth *Thaumetopoea processionea*

Wormley-Hoddesdonpark Woods	Threat	Disease	Acute oak decline (causal agent thought to be pathogenic bacteria)
Wye Valley Woodlands/ Coetiroedd Dyffryn Gwy	Threat	Disease	Ash dieback disease *Chalara fraxinea*, sudden oak death *Phytophthora ramorum* and others
Yewbarrow Woods	Threat	Disease	*Phytophthora austrocedrae* (on juniper *Juniperus communis*); threat of ash dieback disease *Chalara fraxinea* and *Phytophthora alni* affecting alder *Alnus glutinosa*

Annex 3. SIP data - Deer

The following table lists SIPs where deer have been recorded as a pressure or threat.

SIP Name	Pressure or threat	Issue reported in the SIP
Aston Rowant	Pressure/Threat	Negative impacts on beech woodland, long-term impacts on woodland composition and tree reproduction.
Borrowdale Woodland Complex	Pressure/Threat	Red deer *Cervus elaphus* and other species. Need sustainable population for natural tree regeneration.
Bracket's Coppice	Pressure	Browsing causing damage to the understorey.
Burnham Beeches	Pressure/Threat	Adverse impacts on tree regeneration and ground flora composition.
Castle Eden Dene	Pressure/Threat	Impacts of browsing on yew *Taxus baccata* seedlings.
Chilterns Beechwoods	Pressure/Threat	Fallow deer *Dama dama*, roe deer *Capreolus capreolus* and muntjac deer *Muntiacus reevesi*. Impacts of browsing on natural regeneration of trees and ground flora.
Cotswold Beechwoods	Threat	Impacts of browsing on tree regeneration and possibly ground flora.
Craven Limestone Complex	Pressure/Threat	Impacts of grazing on natural regeneration of woodland trees.
Dorset Heaths	Pressure	Impacts on heathland and mire.
Downton Gorge	Pressure	Adverse impacts on woodland vegetation and effects on vertical woodland structure.
Exmoor & Quantock Oakwoods	Threat	Severe limitation of woody regeneration and the ground flora.
Great Yews	Pressure/Threat	Effects of browsing limiting the natural regeneration of yew.
Ingleborough Complex	Pressure/Threat	Effects of browsing on regeneration in woods and establishment of trees/scrub and emergent vegetation on limestone pavement.
Kingley Vale	Threat	Large herds of fallow deer *Dama dama* preventing natural regeneration of the yew *Taxus baccata* trees.

Lake District High Fells	Pressure	Red deer *Cervus elaphus* and other species having grazing/browsing impacts
Leighton Moss	Pressure/Threat	Damage to reedbed habitat from red deer movement, grazing and nutrient enrichment.
Mendip Woodlands	Pressure/Threat	Unsustainable grazing pressure. Effects on woodland management.
Minsmere to Walberswick Heaths and Marshes	Threat	Damage to reedbed and woodland habitat by red deer *Cervus elaphus*.
Morecambe Bay Pavements	Pressure	Browsing effects on scrub and tree regeneration. Effects on ground flora and emergent vegetation with limestone pavement.
Naddle Forest	Threat	Red deer *Cervus elaphus* browsing impacting on designated habitats, especially woodland.
New Forest	Pressure	Browsing preventing regeneration, causing a decline in the shrub and field layer of woodlands.
North Pennines Group	Threat	Grazing of trees by deer reduces regeneration, thereby impacting juniper *Juniperus communis* and sessile oak *Quercus petraea* woodland.
Ox Close	Pressure/Threat	Potential effects of browsing on woodland understorey.
Poole Harbour	Pressure	Impacts of trampling and wallows on reedbeds and saltmarsh
Rex Graham Reserve	Threat	Browsing effects on orchid populations
River Camel	Pressure	Browsing negatively affecting tree regeneration and woodland ground flora
Rook Clift	Pressure/Threat	Threats to woodland regeneration.
Roudsea Wood and Mosses	Pressure/Threat	High browsing pressure impacting on woodland. Threat of muntjac deer *Muntiacus reevesi* colonisation via increased browsing of trees, shrubs and ground flora.
Sandlings	Threat	Effects of grazing pressure and trampling on nesting habitat.
Staverton Park and The Thicks, Wantisden	Pressure	Deer browsing prevents regeneration in parts of the wood.
Subberthwaite, Blawith & Torver Low Commons	Threat	Browsing and wallowing damaging the surface of the SAC features.

The Stiperstones and The Hollies	Threat	Threat of increasing deer populations on woodland
Tintagel Marsland Clovelly Coast	Threat	Suppression of natural regeneration of trees and loss of woodland structure by browsing.
Ullswater Oakwoods	Threat	Deer browsing impacts on woodland and other designated habitats.
West Dorset Alder Woods	Pressure/Threat	Threat of deer grazing and trampling affecting tree and understorey development.
Wormley-Hoddesdonpark Woods	Threat	Browsing and grazing reducing tree regeneration and damage the woodland understorey and ground flora.
Wye Valley Woodlands/ Coetiroedd Dyffryn Gwy	Pressure/Threat	Effects of excessive browsing levels on woodland plants and natural regeneration.
Yewbarrow Woods	Threat	Browsing by deer is adversely affecting the natural regeneration of the woodland and shrub layers.

Annex 4. SIP data – Competitive native species

The following table lists SIPs where competitive native species have been recorded as a pressure or threat, including issues reported under categories such as 'inappropriate scrub control' and 'inappropriate weed control' and all native species reported under the 'Invasive species' reporting category. Although not a true native, records of common cord-grass *Spartina anglica* are included on this list as it first arose in the UK through hybridisation. All records of sea buckthorn *Hippophae rhamnoides* are also included in this list. Although it is a native species and a Natura 2000 interest feature on some SACs, it is recognised that it has been introduced outside of its natural range to other parts of England where it can become invasive.

SIP Name	Pressure or threat	Issue reporting category	Issue reported in the SIP
Alde-Ore Estuaries	Pressure/Threat	Invasive species	Cord-grass *Spartina* spp.
Beer Quarry & Caves	Threat	Inappropriate scrub control	Tree/shrub species
Bolton Fell Moss	Pressure	Inappropriate scrub control	Tree/shrub species
Braunton Burrows	Threat	Inappropriate scrub control Agricultural management practices	Sea buckthorn *Hippophae rhamnoides* Scrub encroachment by willow, birch and privet
Breckland	Pressure / Threat	Inappropriate scrub control Inappropriate weed control	Tree/shrub species Invasion of dry heath, dune and calcareous grassland by *Calamagrostis epigejos*.
Breney Common and Goss & Tregoss Moors	Pressure	Inappropriate scrub control	Tree/shrub species
Broadland	Pressure	Inappropriate scrub control	Tree/shrub species
Butser Hill	Threat	Inappropriate scrub control	Bramble *Rubus fruticosus* agg., gorse *Ulex* spp. and other scrub species
Carrine Common	Pressure	Inappropriate scrub control	Bracken *Pteridium aquilinum* and gorse *Ulex* spp. scrub
Cerne & Sydling Downs	Pressure	Inappropriate weed control	Tree/shrub species
Craven Limestone Complex	Pressure	Inappropriate weed control	Weed species, especially thistles. Bracken *Pteridium aquilinum*
Culm Grasslands	Pressure/Threat	Inappropriate scrub control	Tree/shrub species

Cumbrian Marsh Fritillary Site	Pressure	Inappropriate scrub control	Woodland/scrub species
Dartmoor	Threat	Invasive species	Bracken *Pteridium aquilinum*
Dee Estuary/Aber Dyfrdwy & Mersey Narrows	Pressure	Inappropriate scrub control	Tree/shrub species
Devils Dyke	Pressure/Threat	Inappropriate scrub control	Tree/shrub species
Dorset Heaths	Pressure	Inappropriate scrub control Invasive species	Tree / shrub species Bracken *Pteridium aquilinum*
Dover to Kingsdown Cliffs	Pressure	Inappropriate scrub control	Tree/shrub species
Drigg Coast	Pressure	Inappropriate scrub control	Sea buckthorn *Hippophae rhamnoides*
Dungeness	Pressure/Threat	Inappropriate scrub control Invasive species	Tree/shrub species Sea buckthorn *Hippophae rhamnoides*
Durham Coast	Threat	Invasive species	Scrub, bracken *Pteridium aquilinum*
East Devon Heaths	Pressure	Inappropriate scrub control	Birch *Betula* spp.
Essex Estuaries	Pressure	Invasive species	Common cord-grass *Spartina anglica*
Fen Bog	Threat	Inappropriate scrub control Invasive species	Tree/shrub species Common reed *Phragmites australis* and Bog myrtle *Myrica gale*
Fens Pools	Pressure	Inappropriate scrub control	Tree/shrub species
Folkestone to Etchinghill Escarpment	Threat	Inappropriate scrub control	Tree/shrub species
Great Yarmouth Winterton Horsey	Threat	Inappropriate scrub control	Tree/shrub species
Greater Thames Complex	Threat	Invasive species	Common cord-grass *Spartina anglica*
Hamford Water	Pressure/Threat	Inappropriate scrub control	Tree/shrub species

Humber Estuary	Pressure	Inappropriate scrub control	Tree/shrub species
Ingleborough Complex	Pressure	Forestry and woodland management	Scots pine and hornbeam
Lee Valley	Threat	Inappropriate scrub control	Tree/shrub species
Little Wittenham	Pressure/Threat	Invasive species	Predatory fish species (unlicensed releases)
Lower Derwent Valley	Threat	Inappropriate scrub control Invasive species	Willow *Salix* spp. Marsh ragwort *Senecio aquaticus*
Mendip Limestone Grasslands	Threat	Inappropriate scrub control	Tree/shrub species
Minsmere to Walberswick Heaths and Marshes	Pressure	Invasive species	Common cord-grass *Spartina anglica*
Mole Gap to Reigate Escarpment	Pressure	Inappropriate scrub control	Tree/shrub species
Morecambe Bay Pavements	Threat	Inappropriate scrub control	Tree/shrub species
Norfolk Valley Fens	Pressure	Inappropriate scrub control	Tree/shrub species
North Pennine Dales Meadows	Threat	Invasive species	Cow parsley *Anthriscus sylvestris* and blackthorn *Prunus spinosa*
North Pennines Group	Threat	Invasive species	Soft rush *Juncus effusus*
North York Moors	Pressure/Threat	Invasive species	Bracken *Pteridium aquilinum*
Northumberland Coastal	Threat	Invasive species	Cord grass *Spartina sp*
Orton Pit	Threat	Inappropriate scrub control Predation	Tree/shrub species Predatory fish species (unlicensed releases)
Peak District Dales	Pressure	Inappropriate scrub control	Tree/shrub species
Penhale Dunes	Pressure	Invasive species	Tree/shrub species (especially blackthorn *Prunus spinosa*) and sea buckthorn *Hippophae rhamnoides*
Polruan to Polperro	Pressure	Inappropriate scrub control	Tree/shrub species

Portland-Studland & St Albans-Durlston	Pressure	Inappropriate scrub control	Tree/shrub species, notably gorse *Ulex* spp.
Rex Graham Reserve	Threat	Invasive species	Hare *Lepus europaeus* (and rabbit *Oryctolagus cuniculus*)
River Itchen	Pressure	Inappropriate scrub control	Tree/shrub species
River Wye	Pressure/Threat	Inappropriate scrub control	Tree/shrub species
Rooksmoor	Pressure	Inappropriate scrub control	Tree/shrub species
Sandlings	Pressure	Inappropriate scrub control	Tree/shrub species
Sefton Ribble	Pressure/Threat	Inappropriate scrub control Invasive species	Tree/shrub species Sea buckthorn *Hippophae rhamnoides*
Skipwith Common	Threat	Inappropriate scrub control	Tree/shrub species particularly birch *Betula* spp.
Solway Firth	Threat	Invasive species	Common Cord-grass *Spartina anglica*
South Devon Shore Dock	Threat	Inappropriate scrub control	Tree/shrub species
South Hams	Threat	Inappropriate scrub control	Tree/shrub species (blackthorn *Prunus spinosa*, gorse *Ulex* spp.)
South Pennine Moors	(blank)	Invasive species	Bracken *Pteridium aquilinum*
South Solway Mosses	Pressure	Invasive species	Tree/shrub species
Staverton Park and The Thicks, Wantisden	Pressure	Forestry and woodland management	Bracken *Pteridium aquilinum*
Stodmarsh	Threat	Inappropriate scrub control	Tree/shrub species
Stour and Orwell Estuaries	Pressure/Threat	Invasive species	Common cord-grass *Spartina anglica*
Strensall Common	Threat	Inappropriate scrub control	Tree/shrub species, particularly by birch *Betula* spp. and pine *Pinus* spp.
Thames Basin	Pressure	Inappropriate scrub control	Tree/shrub species
The Stiperstones and The Hollies	Pressure	Invasive species	Bracken *Pteridium aquilinum*

Thorne and Hatfield Moors	Pressure	Inappropriate scrub control	Tree/shrub species
Tyne and Allen River Gravels	Pressure	Inappropriate scrub control	Tree/shrub species
West Midlands Mosses	Pressure	Inappropriate scrub control	Tree/shrub species, typically birch *Betula* spp. and pine *Pinus* spp.
Witherslack Mosses	Pressure	Inappropriate scrub control	Tree species
Wye and Crundale Downs	Pressure	Inappropriate scrub control	Tree/shrub species
Yewbarrow Woods	Threat	Inappropriate vegetation management	Bracken *Pteridium aquilinum*

Annex 5. Technical workshop – Key gaps and blockages

The table below lists key gaps and blockages raised at the IPENS invasive species and deer technical workshop, August 2013. NB: the workshop pre-dates the EU Invasive Alien Species Regulations (2015), which now help to address the points marked with an asterisk.

Issue	Detail
Strategic planning and coordination of effort	• Clear roles and accountability for taking action needed. • Coordination needed at the right scale and avoiding duplication. • The marine environment doesn't have an equivalent of 'managers' but instead has a range of authorities with different responsibilities.
Funding	• Difficulties in securing the long term funding that is required to control invasive species. • Difficulties in obtaining funding in areas outside of Natura 2000 sites. • Securing funding often takes a long time, when required action may be urgent and difficult to predict. • Funding for Local Action Groups is coming to an end – they need to be supported for the important role they play.
Demonstrating economic impacts of invasive species	• If we can demonstrate economic impacts it can be persuasive for Government; • A cost-benefit assessment of not taking action on invasive species may be useful.
Introductions of new invasive species	• *If the 'polluter pays' principle could be applied to introductions of invasive species, it may act as an important deterrent and encourage best practice for avoiding accidental introductions.
Monitoring, surveillance and horizon scanning	• Improved access onto private land for monitoring purposes would be helpful in some circumstances; • Positive feedback about successful work is not done often enough but can help to motivate volunteers.
Knowledge	• Best practice techniques for control of invasive species need to be shared, particularly experience gained by Local Action Groups and national projects (eg The Green Blue, a joint environment programme between the British Marine Federation and the Royal Yachting Association); • Awareness raising of early symptoms is required to facilitate rapid response action; • *Knowing what control techniques are available before a species

Staff and equipment	• It can be difficult to retain staff or recruit new volunteers for undertaking invasive control work; • Herbicides of choice are becoming less readily available due to EU chemicals legislation eg asulam. • The technical feasibility and cost of control can be prohibitive.
Incentivised control	• More innovation is needed to incentivise control of invasive species, for example through recognition awards for volunteers or competitions.
Data systems	• A means of centrally recording invasive control activity is needed; • Where eradication has happened, negative records need removing from existing systems.
Regulation	• *The IMO Ballast Water Convention has not yet been agreed.
International collaboration	• International collaboration is required to control the pathways by which invasive species spread; • An international perspective on Favourable Conservation Status may be appropriate for some species affected by invasives, eg white-clawed crayfish.
Public perception	• There are sensitivities around control of some species which can affect public and media perceptions eg grey squirrel and deer. • More communications needed to better educate the public.

Annex 6. IPENS theme plans

The table below provides hyperlinks to the suite of IPENS theme plans, which are available on the Natural England publication catalogue.

Theme plan	Hyperlink
Atmospheric nitrogen deposition	http://publications.naturalengland.org.uk/publication/6140185886588928?category=5605910663659520
Climate change	http://publications.naturalengland.org.uk/publication/4954594591375360?category=5605910663659520
Diffuse water pollution	http://publications.naturalengland.org.uk/publication/5848526737113088?category=5605910663659520
Grazing	http://publications.naturalengland.org.uk/publication/4839898496368640?category=5605910663659520
Habitat Fragmentation	http://publications.naturalengland.org.uk/publication/5004101806981120?category=5605910663659520
Hydrological functioning	http://publications.naturalengland.org.uk/publication/6400975361277952?category=5605910663659520
Inappropriate coastal management	http://publications.naturalengland.org.uk/publication/6371629661683712?category=5605910663659520
Invasive species	http://publications.naturalengland.org.uk/publication/6130001713823744?category=5605910663659520
Lake restoration	http://publications.naturalengland.org.uk/publication/5583022327857152?category=5605910663659520
Public access and disturbance	http://publications.naturalengland.org.uk/publication/6621454219083776?category=5605910663659520
River Restoration	http://publications.naturalengland.org.uk/publication/5478339747774464?category=5605910663659520

Annex 7. Data to inform prioritisation

The tables below show the number of times invasive species are reported across all 267 SIPs. Invasive non-native species, pests and disease, and competitive native species are tabulated separately. Deer were reported as an issue on 38 SIPs but are not shown here as the data tended not to be species specific.

Table A7.1 Invasive non-native species

Species	Number of SIPs	Typical actions (for species reported 10 or more times)
Himalayan balsam *Impatiens glandulifera*	34	Monitoring; control; investigate impact; eradication; develop and implement strategic plans and partnership working
Japanese knotweed *Fallopia japonica*	26	Coordinated approaches to monitor, investigate and eradicate
Rhododendron *Rhododendron spp.*	21	Develop and implement strategic management and control plans; monitoring; clear and eradicate from sites; survey effects
New Zealand pygmyweed *Crassula helmsii*	19	Undertake programme to monitor, control and if possible eradicate Crassula; use best practice management options
Signal crayfish *Pacifastacus leniusculus*	11	investigation; research; monitoring
Pacific oyster *Crassostrea gigas*	10	Monitor; control; investigate extent and impacts; identify potential management options; establish baselines; improve biosecurity; develop management plans; investigate dispersal pathways
Chinese mitten crab *Eriocheir sinensis*	8	
Giant hogweed *Hercleum mantegazzianum*	8	
Sycamore *Acer pseudoplantanus*	7	
Water fern *Azolla filiculoides*	7	
Japanese wireweed *Sargassum muticum*	6	
Butterfly bush *Buddleja davidii*	4	
Carpet sea squirt *Didemnum vexillum*	4	
Montbretia *C. x crocosmiiflora*	4	
Slipper limpet *Crepidula fornicate*	4	
Spruce including sitka spruce *Picea sitchensis*	4	
Turkey oak *Quercus cerris*	4	

Canada goose *Branta Canadensis*	3	
Canadian pondweed *Elodea Canadensis*	3	
Cotoneaster spp	3	
Floating pennywort *Hydrocotyle ranunculoides*	3	
Japanese skeleton shrimp *Caprella mutica*	3	
Laurel (species not specified)	3	
Orange balsam *Impatiens capensis*	3	
Wakame *Undaria pinnatifida*	3	
Asian shore crab *Hemigrapsus sanguineus*	2	
Beech *Fagus sylvatica*	2	
Clematis sp.	2	
Gaultheria sp.	2	
Grey squirrel *Sciurus carolinensis*	2	
Holm oak *Quercus ilex*	2	
Japanese rose *Rosa rugose*	2	
Larch *Larix sp.*	2	
Parrot's feather *Myriophyllum aquaticum*	2	
Pirri-pirri bur *Acaena novae-zelandiae*	2	
Pitcher plant *Sarracenia purpurea*	2	
Rabbit *Oryctolagus cuniculus*	2	
Snowberry *Symphoricarpos albus*	2	
Zebra mussel *Dreissena polymorpha*	2	
Alexanders *Smyrnium olusatrum*	1	
American razor clam *Ensis directus*	1	

American whelk tingle *Urosalpinx cinerea*	1	
Aquatic blanket weeds (species not specified)	1	
Bloody-red mysid *Hemimysis anomala*	1	
Brown rat *Rattus norvegicus*	1	
Carp *Cyprinus sp.*	1	
Caulacanthus ustulatus (red algae)	1	
Cherry laurel *Prunus laurocerasus*	1	
Creeping water primrose *Ludwigia peploides*	1	
Eagle owl *Bubo bubo*	1	
Edible dormouse *Glis glis*	1	
Egyptian goose *Alopochen aegyptiaca*	1	
Everlasting pea *Lathyrus latifolius*	1	
Fringecups *Tellima grandiflora*	1	
Garlic / onions *Allium spp*	1	
Harpoon weed *Asparagopsis armata*	1	
Hottentot fig *Carpobrotus edulis*	1	
Killer shrimp *Dikerogammarus villosus*	1	
Laurustinus *Viburnum tinus*	1	
Leathery sea squirt *Styela clava*	1	
Mink *Mustela vison*	1	
Non-native ivy *Hedera sp*	1	
Nutall's pondweed *Elodea nutallii*	1	
Oyster parasite *Bonamia sp*	1	
Pampas grass *Cortaderia sp.*	1	

Periwinkle *Vinca sp*	1	
Pine species *Pinus sp.*	1	
Ruffe *Gymnocephalus cernuus*	1	
Russian vine *Fallopia baldshuanica*	1	
Seaweed species *Undaris pinnafitida*	1	
Sheep laurel *Kalmia angustifolia*	1	
Skunk cabbage *Lysichiton sp.*	1	
Western hemlock (*Tsuga heterophylla*)	1	
White poplar *Populus alba*	1	

Table A7.2 Pests and disease

Note that although *Phytophthora ramorum* is the pathogen which causes sudden oak death, there is no overlap in the data between the 'All Phytophthora' and 'Oak diseases' categories shown below.

Species	Number of SIPs	Typical actions
Ash dieback (*Chalara* disease*)*	22	Regular monitoring for presence of Chalara; monitor national research; develop & implement biosecurity plans; identify appropriate adaptive actions eg increasing resilience; develop & implement management plans (national & site); investigate effect of tree death on persistence of wood mould (for violet click beetle)
All Phytophthora disease, including *P.austrocedrae, ramorum, pseudosyringae, syringae, cactorum, alni* and unspecified species	15	Biosecurity to prevent new infections; control activity eg removing rhododendron; monitoring; investigate hotspots & use them to devise means of reducing impacts; collect seed in seedbanks; create ark populations offsite eg juniper; research on mechanisms of spread, gentic variation of host spp and pathogens, control mechanisms etc; develop & implement *Phytophthora* resilience plans.
Oak diseases including Acute oak decline (bacterial), Sudden oak death *Phytophthora ramorum*, and unspecified disease	8	Survey SAC habitat and surrounding area for disease outbreaks; prevent spread by coordinated biosecurity; increase resilience by investigating & diversifying genetic variation of woodlands; replant / allow natural regeneration
Oak processionary moth	5	Develop survey and monitoring strategy; develop and implement invasive species response plan, including control measures where necessary

Crayfish plague	4	Develop and implement biosecurity plans; develop a national strategic approach to address loss of native crayfish on SAC sites; develop site specific risk register for sites with known / historic native crayfish populations, review likely causes of population loss and assess potential for recovery and assess potential for long term recovery / contribution to Favourable Conservation Status.
Heather beetle	4	Monitor for infestations; research impact; agree and implement management plans / measures to reduce impacts;
Box blight *Cylindrocladium buxicola* & *Pseudonectria buxi*	2	Put in place biosecurity measures
Chytrid fungus	2	Monitor for signs of disease in great crested newt populations; develop and implement a management strategy
Bovine TB	1	No actions stated specific to this disease (the threat is to interest features via impacts on grazing)
Necrotic disease	1	Investigate the population dynamics and the health of Pink sea fan, *Eunicella verrucosa*.

Table A7.3 Competitive native species

Species	Number of SIPs	Typical actions (for species reported more than once)
Unspecified tree / shrub species	41	Implement management plans (3-5 years, rotational management etc); large scale removal of trees / scrub and follow up management; achieve / maintain appropriate grazing levels; investigate innovative control methods; acquire machinery to enable scrub control
Bracken	10	Research spread of bracken; develop and implement robust management plans; collaborate to find alternative control options (ie alternative to asulam); implement control eg by mechanical control and cattle grazing
Cord grass *Spartina spp*	7	Monitor, manage encroachment, investigate effects, develop and implement management plans
Birch *Betula spp*	5	Scrub clearance including by grazing management
Sea buckthorn *Hippophae rhamnoides*	5	Develop and implement management plans; sustained clearance programmes
Gorse *Ulex spp*	4	Develop and implement management plans; control and reduce extent of scrub
Blackthorn	3	Control scub
Pine *Pinus spp*	3	Scrub clearance and selective felling
Predatory fish	2	Communicate with anglers and control stocking
Willow *Salix spp*	2	Control scub
Bog myrtle	1	

Bramble	1	
Wood small-reed *Calamagrostis epigejos*	1	
Common reed *Phragmites spp*	1	
Cow parsley	1	
Hare	1	
Hornbeam	1	
Marsh ragwort	1	
Privet	1	
Soft rush	1	
Thistles	1	

Annex 8. Key evidence sources

APOLLONIO, M., PUTMAN, R., GRIGNOLIO, S. & BARTOS, L. (2011) 'Hunting season in relation to biological breeding seasons and implication for the control or regulation of ungulate populations' *In* PUTMAN, R., APOLLONIO, M. and ANDERSEN, R. eds. *Ungulate Management in Europe: Problems and Practices*. Cambridge: Cambridge University Press, pp. 80-105

CHAPMAN, N.G., CLAYDON, K., CLAYDON, M., FORDE, P.G. & HARRIS, S. (2009) Sympatric populations of muntjac (*Muntiacus reevesi*) and roe deer (*Capreolus capreolus*): a comparative analysis of their ranging behaviour, social organization and activity. *Journal of Zoology* 229(4), 623 – 640. DOI: 10.1111/j.1469-7998.1993.tb02660.x

CHARLES, H. and DUKES, J.S. (2007) Impacts of invasive species on ecosystem services. Chapter 13 *In:* NENTWIG, W. ed. *Biological Invasions*. Ecological Studies Vol 193. Springer.
URL: http://www.planta.cn/forum/files_planta/biological_invasions_110.pdf [Accessed 26 February 2014]

DEFRA (2008) *The invasive non-native species framework strategy for Great Britain: Protecting our natural heritage from invasive species*. Department for Environment Food and Rural Affairs.
URL: https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=99 [Accessed 24 February 2015]

DEFRA (2011) *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*
URL: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf [Accessed 18 February 2015]

DI´AZ, S., TILMAN, D., FARGIONE, J. (coordinating lead authors); CHAPIN, F.S., DIRZO, R., KITZBERGER, T., GEMMILL, B., ZOBEL, M., VILA, M., MITCHELL, C., WILBY, A., DAILY, G.C., GALETTI, M., LAURANCE, W.F., PRETTY, J., NAYLOR, R., POWER, A., HARVELL, D. (lead authors); POTTS, S., KREMEN, C., GRISWOLD, T., EARDLEY, C., (contributing authors); CEBALLOS, G., LAVOREL, S., ORIANS, G., PACALA, S., SUPRIATNA, J. (review editors) Biodiversity regulation of ecosystem services. Chapter 11 *In:* HASSAN, R., SCHOLES, R. & ASH, N. eds (2005) *Ecosystems and human well-being : current state and trends : findings of the Condition and Trends Working Group.* The Millenium Ecosystem Assessment Series, Vol 1. Island Press

ECUS LTD. (2015) Vulnerability of freshwater Natura 2000 sites to invasion from invasive non-native species. IPENS 045. Natural England. URL:
http://publications.naturalengland.org.uk/publication/4813768615788544?category=6337991412809728

GILL, R.M.A. (1990) Monitoring the status of European and North American Cervids. GEMS Information Series 8. Global Environment Monitoring System, United Nations Environment Programme, Nairobi, Kenya.

LAWTON, J.H., BROTHERTON, P.N.M., BROWN, V.K., ELPHICK, C., FITTER, A.H., FORSHAW, J., HADDOW, R.W., HILBORNE, S., LEAFE, R.N., MACE, G.M., SOUTHGATE, M.P., SUTHERLAND, W.A., TEW, T.E., VARLEY, J., & WYNNE, G.R. (2010) *Making Space for Nature: a review of England's wildlife sites and ecological network*. Report to Defra.
URL: http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf
[Accessed 26 February 2015]

LUSH, M.J., LUSH, C.E. & PAYNE, R.D. (2015) *Understanding the impacts of invasive non-native species on protected sites*. IPENS 046 Final report. Natural England. URL:
http://publications.naturalengland.org.uk/publication/4915276141297664?category=6337991412809728

LYCETT, E. & TAYLOR, E. 2008. *Freshwater non-native species management initiatives*. Natural England Research Reports, Number 023. URL: http://publications.naturalengland.org.uk/publication/32029?category=47020
[Accessed 5 March 2015]

PEARCE, F., PEELER, E. & STEBBING, P. (2012) *Modelling the risk of the introduction and spread of non-indigenous species in the UK and Ireland*. Project report for E5405W. CEFAS.
URL: https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=791 [Accessed 26 February 2014]

PUTMAN, R.J. (2004) *The deer manager's companion: A guide to deer management in the wild and in parks*. Swan Hill Press.

ROY, H.E., BACON, J., BECKMANN, B., HARROWER, C.A., HILL, M.O., ISAAC, N.J., PRESTON, C.D., RATHOD, B., RORKE, S.L., MARCHANT, J.H., MUSGROVE, A., NOBLE, D., SEWELL, J., SEELEY, B., SWEET, N., ADAMS, L., BISHOP, J., JUKES, A.R., WALKER, K.J. and PEARMAN, D. 2012. *Non-Native Species in Great Britain: establishment, detection and reporting to inform effective decision making*. Defra.
URL: https://secure.fera.defra.gov.uk/nonnativespecies/downloadDocument.cfm?id=753 [Accessed 26 February 2015]

ROY, H.E., PAYTON, J., ALDRIDGE, D.C., BANTOCK, T., BLACKBURN, T.M., BRITTON, R., CLARK, P., COOK, E., DEHNEN-SCHMUTZ, K., DINES, T., DOBSON, M., EDWARDS, F., HARROWER, C., HARVEY, M.C., MINCHIN, D., NOBLE, D.G., PARROTT, D., POCOCK, M.J.O., PRESTON, C.D., ROY, S., SALISBURY, A., SCHONROGGE, K., SEWELL, J., SHAW, R.H., STEBBING, P., STEWART, A.J.A., WALKER, K.J (2014) Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. *Global Change Biology* 20, 3859–3871, doi: 10.1111/gcb.12603.
URL: http://onlinelibrary.wiley.com/doi/10.1111/gcb.12603/pdf [Accessed 25 February 2015]

WARD, A.I. (2005) Expanding ranges of wild and feral deer in Great Britain. *Mammal Review*, **35**, 165-173.

WARD, A.I., ETHERINGTON, T. & EWALD, J. (2008) Five years of change. *Deer*, **14**, 17-20.

WILLIAMS, F., ESCHEN, R., HARRIS, A., DJEDDOUR, D., PRATT, C., SHAW, R.S., VARIA, S., LAMONTAGNE-GODWIN, J., THOMAS, S.E., MURPHY, S.T. and others (2010). *The economic cost of invasive non-native species on Great Britain*. CABI report, 198pp. Available at:
http://195.144.0.240/projectsuploads/projectsdb/documents/6534/Economic%20Costs%20of%20INNS%20to%20the%20British%20Economy%20-%20Final%20Report%20v3.pdf [Accessed 26 February 2015]

WITTENBERG, R. & COCK, M.J.W. (eds.) (2001) *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices.* CAB International, Wallingford, Oxon, UK, xvii - 228. URL:
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.115.4342&rep=rep1&type=pdf [Accessed 26 February 2015]

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