

Invasive Alien Plant Species



Some alien plant species can become invasive and have detrimental ecological, social and economic effects. This POSTnote summarises debate over the risks posed by such plant species and the policy frameworks and measures for addressing these risks.

Background

Invasive alien plant species (IAPs) exhibit greater abundance, density, or competitive dominance than species native to habitats (Box 1). Habitats that have been isolated for long periods, such as on islands, may have high numbers of endemic species (species which only occur in that specific geographic location). These habitats and species are particularly vulnerable to invasive species, and invasive species have been ranked the second most important driver of biodiversity loss at the global level.¹ For example, the UK Overseas Territories that have high levels of endemic species are significantly affected by invasive alien plant and animal species (POSTnote 427).

Alien Plants in Great Britain

The introduction of alien plant species that provide significant benefits, such as for horticulture, is a traditional component of land management in Great Britain. However, the rate of introduction of species accelerated with the expansion of international trade and travel in the latter half of the twentieth century,² with most introduced after 1850. IAPs predominantly originate from Europe, but are increasingly from Asia and the US. There are 1350 terrestrial alien plant species now established in Great Britain and 23 freshwater alien plant species,³ with between 80 to 90% of these occupying less than 10% of the available suitable habitat.⁴ This supports the idea that most introductions of alien plant species do not result in invasions,⁴ with only 108 considered to have negative

Overview

- An alien or non-native plant species is one which has been introduced by human action, deliberately or accidentally, into an area in which it would not occur naturally.
- A minority of these alien plant species become invasive affecting native species and the ecology of habitats.
- Current regulatory approaches seek to prevent invasive alien plant species (IAPs) likely to pose a threat to native species from becoming established in the wild.
- Once established, early detection and eradication are more cost effective than long term control. Biological control is the most cost effective long term control, but is not currently used widely for IAPs in Europe.

economic, social and ecological impacts.³ The somewhat arbitrary definitions of alien and invasive (Box 1) have led to

Box 1. Defining Alien and Invasive Plant Species

Plant species are defined as native or alien according to their time of arrival in Great Britain:

- **Native** or indigenous species are species that re-colonised via land bridges after the last glaciation 8,000 years ago and endemic species. Great Britain has a low number of endemic plant species. Most of these are ice age relict alpine species restricted to a few locations, belonging to plant families more common in the Arctic and Alpine areas, such as the Scottish Primrose.
- **Archaeophytes** are plant species introduced by humans before Columbus discovered the New World (1492). This POSTnote does not include discussion of archaeophytes, such as corn marigold, many of which are now protected species.
- **Alien**, non-native, exotic, neophyte or non-indigenous plant species are those introduced after 1492 such as Buddleia.

Invasive Species

Invasion ecology is the study of how organisms spread into habitats to which they are not native. It attempts to quantify the potential of organisms to be invasive and the vulnerability of habitats to invasion, with invasive organisms viewed as a form of biological pollutant. The term 'invasive' has been used variously to describe:

- all introduced alien species
- alien species that spread rapidly in a new region
- alien species that have harmful environmental effects, particularly on native species.⁵

The second definition in various forms is more commonly used by invasion ecologists, while the third definition is the primary focus for policy and legislation and of this POSTnote.

suggestions that management should be based solely on the likelihood of impacts.⁶ There is no agreed biodiversity indicator (POSTnote 312) for the overall effect of invasive alien species, but the cumulative number of established alien species has been proposed as a pan-European indicator.⁷ A report for Defra and the devolved administrations has estimated that the total annual cost of all invasive alien species to the economy of Great Britain is approximately £1.7 billion.⁸

Effects of Invasive Alien Plant Species

IAPs need to be seen in a context of wider environmental change,⁹ as many are weed species that are well adapted to disturbed conditions.¹⁰ Some act as opportunistic invaders or 'passengers' that invade vulnerable habitats because of changes in land management.¹¹ This is reflected in the high levels of non-native plant species in urban areas, which are able to exploit 'brownfield' habitats.¹² Other IAPs act as 'back seat drivers', invading disturbed habitats, but then cause a further decline in native species,¹³ such as Japanese knotweed.¹⁴ Invasion depends not only on the characteristics of the invader species, but also those of the invaded habitat.¹⁵ 'Dynamic' habitats, such as sand dunes, cliffs and freshwater habitats, in which instability is integral to their ecology, are particularly vulnerable to invasion (Box 2). Some freshwater habitats are also interconnected, with water bodies carrying the IAPs to new areas.

Some IAPs affect native plant species and the species they support (such as pollinators) simply by occupying a large amount of space in habitats.¹⁶ An ecological impact consists of a significant effect on an ecological process,¹⁷ but only a minority of IAPs are known to have such effects (Box 3).¹⁷ A robust framework has not yet been established that can quantify effects on habitats and ecosystem services (POSTnote 378).¹⁸ This would require data before and after a habitat is invaded, which are rarely available. The lack of

such a framework limits the ability to predict when and where effects will be significant,²³ how to mitigate them and if they may be offset by some benefits.²⁴ For example, although Himalayan balsam (Box 3) is a food source for generalist pollinators,²⁵ it reduces the diversity of above ground plants and invertebrates (such as beetles) and below ground fungi.²⁶ These impacts outweigh the benefit.

Novel Interactions

To become abundant, an alien plant species needs to be dispersed, have the ability to grow and reproduce in the new climate and soils, and interact with the ecology of other organisms present in that habitat (for example, competing with other plant species). Compared to native plant species, IAPs will be less affected by specialist herbivores, pests and diseases (which ecologists refer to as the 'enemy release' hypothesis). Some IAPs also release chemicals to inhibit other plant species (allelopathy). For example, chemicals in the leaf litter of *Rhododendron* inhibit germination of the seeds and growth of other species (Box 3). Allelopathy is not confined to IAPs, but native plant species may be less well adapted to IAP allelopathic chemicals (the 'novel weapons' hypothesis). It has also been suggested novel interactions between native microbes and alien plant species may be a critical factor in invasions.²⁷

Hybridisation

The outcomes of alien plant species breeding with related native or other alien species (hybridisation) are highly uncertain and the role of hybridisation in plant invasions has not been extensively studied.²⁸ Some alien plant species may hybridise with native species, with the hybrids displacing the native parent species in habitats. For example, Spanish bluebell hybridises with the native bluebell species, and the hybrid bluebell is now widespread in UK urban areas,²⁹ resulting in a loss of native genetic diversity. Other hybrids are invasive, such as Bohemian

Box 2. Examples of Invaders of Vulnerable Habitats

Species affecting vulnerable habitats in the UK include:

- **Hottentot fig** (*Carpobrotus edulis*) and **Sally-my-Handsome** (*C. acinaciformis*) compete aggressively with other plant species for nutrients, water, light and space, forming impenetrable mats in coastal cliff and dune habitats.¹⁹ These are two of the sixty-five habitats of principal importance listed under Section 41 of the NERC Act 2006 in England (Section 42 in Wales). One of habitats affected is cliffs in Cornwall where it is smothering the grassland swards that host the invertebrate species that the recently re-established red-billed croug population feeds on.
- **Floating pennywort** (*Hydrocotyle ranunculoides*) is widespread and well established in the south and east of England and appears to be spreading rapidly north and westwards. In areas of heavy infestation it eliminates virtually all other freshwater plant species.²⁰ In 1996, in the Netherlands, it was initially dismissed as unlikely to spread, but regarded as uncontrollable by 2000.²¹ Rapid invasion by floating aquatic alien plant species is not unusual.
- **New Zealand Pygmyweed** (*Crassula helmsii*) is an aquatic species that can tolerate a wide range of water conditions, from lakes to ditches and can grow on damp ground. Stands may become extremely dense limiting light and oxygen, having an adverse effect on aquatic habitats. It can become established from a small fragment of the plant, increasing the chance of accidental spread and making it difficult to eradicate.²²

Box 3. Examples of IAPs that have Ecological Effects

Species impacting the ecology of habitats in the UK include:

- **Rhododendron** species were repeatedly hybridised and backcrossed to breed climate tolerant hybrids (*Rhododendron x superponticum*) in the 19th Century.³⁰ *Rhododendron* became naturalised and widespread and is most invasive in western and upland GB areas. It can affect native plant species through the release of phenolic compounds from its leaf litter, which can also affect water quality in adjacent watercourses. They have significant detrimental effects on acid woodland and heathland, including the Atlantic woodlands of Scotland and Wales of international conservation importance, and are a host for *Phytophthora* tree diseases (POSTnote 394).³¹
- **Common cordgrass** (*Spartina anglica*) was derived from a hybrid between European small cordgrass and smooth cordgrass from America. It was widely planted for coastal erosion control, but its rapid vegetative spread has altered saltmarsh habitats, led to loss of fish habitat, excluded native plant species and stopped feeding by wading birds.³²
- **Himalayan balsam** (*Impatiens glandulifera*) colonises riverbanks and areas of damp ground, forming dense stands that exclude native plant species.³³ It inhibits mycorrhizal fungi, which help some native plants to colonise areas, creating an impediment to restoration.³⁴ It reduces invertebrate species richness and displaces some functional feeding groups.²⁶

knotweed, a hybrid of Japanese knotweed and giant knotweed.³⁵

Effects on Biodiversity

The recent UK National Ecosystem Assessment noted that while there is evidence that IAPs can have an effect on biodiversity, they have had more limited effect than other drivers, such as land use change.³⁶ Although invasive native plant species (such as brambles, bracken and nettles) are food plants for butterflies and other species, the Botanical Society of the British Isles suggests that they have a greater effect on biodiversity than IAPs.³⁷ Invasions by native plant species occur because of a change in land management. Other organisations, such as Plantlife, contend that key areas for conservation of rare plant species are being affected by IAPs.³⁸ Controlling IAPs can impose significant costs on conservation bodies in addition to standard land management. For example, to remove *Rhododendron* (Box 2) requires cutting and herbicide treatment over several years at a cost of £4,000 to £12,000 per hectare depending on the slope of the site.

Other Effects

IAPs can reduce productivity in sectors such as agriculture and forestry, block waterways, may increase flood risk, reduce the recreational value of areas and damage infrastructure. The control of IAPs can impose significant economic costs on some sectors, such as landowners (see below). Some IAPs have human health effects,⁸ for example:

- are poisonous if ingested, such as False Acacia
- the sap of the Tree of Heaven can cause severe skin inflammations,³⁹ as can Giant Hogweed⁴⁰
- the pollen of common ragweed (or hay fever weed) is highly allergenic and a significant cause of asthma.⁴¹

Prevention and Control

Preventing the introduction of IAPs is the most effective means of avoiding their effects. Failing that early detection and eradication is preferable to protracted management and control.⁴²

Prevention

The main pathway of introduction is the horticultural trade,⁴³ which is worth approximately £9 billion to UK GDP; the sale of plants constitutes £1.5 to £2 billion of this. Approximately 35,000 plant species are available from 600 nurseries countrywide.⁴⁴ Prevention can occur at different stages, such as restricting the pathway of entry and assessing the risk of intentional imports to identify which plant species likely to have significant effects.⁴⁵ The European Commission is preparing legislation on invasive alien species, in line with existing international obligations (Box 4). England, Wales and Scotland have existing legislation on invasive species (Box 5). In England, IAPs that are established or need to be prevented from becoming established in the wild are placed on schedule 9 of the Wildlife and Countryside Act 1981. Their trade can also be prohibited or 'black listed' (Box 5). Black listing has been criticised for not being sufficiently comprehensive.⁴⁶

Alternative approaches include:

- A 'white list' approach, where alien plant species may not be introduced until they are approved by risk assessors.

However, this would have cost implications as well as contravening EU and WTO trade agreements.

- A 'green list' approach of encouraging the use of alien plant species assessed as posing a low risk of invasion.⁴⁴ However, reducing the number of species traded would affect the horticultural industry.

Risk Assessment

Risk assessment approaches vary in detail, but attempt to identify the level of threat posed by a species and the likelihood of it becoming established.⁴⁶ Various risk analysis inventories of invasive alien species have been launched, such as the EU Delivering Alien Invasive Species Inventories for Europe (DAISIE).⁴⁷ The Non-native Species Secretariat (NNSS, Box 6) manages the Risk Assessment Scheme in Great Britain. Risk assessment will be extended from individual invasive alien species to whole trade pathways in the future.⁴⁸ The risk assessments are drafted and peer reviewed by independent experts, approved by the Non-native Species Risk Analysis Panel, with stakeholders given the opportunity to comment. However, conservation NGOs such as Plantlife, argue that the process is too academic, and excludes their relevant experience.

In the absence of peer reviewed evidence, risk assessments use expert judgement to identify the level of threat. There are uncertainties in predicting whether a species will be transported and introduced, become established, then if it will increase in abundance, spread and have detrimental effects.⁴⁹ Full risk assessments are time and resource intensive,⁴⁶ although rapid screening methodologies can be used to identify priorities.⁵⁰ There is an extensive academic literature critiquing invasive alien species risk assessment methodologies.⁵¹ However, risk assessments are only intended to quantify the magnitude of risks posed by invasive alien species not whether risk management is pragmatic, for which other tools are being developed for Great Britain.

Awareness Campaigns

There are campaigns to target specific user groups with plant biosecurity messages. For example, the 'be plantwise'

Box 4. Multilateral Environmental Agreements and IAPs

A number of International and Regional Environmental Agreements set out requirements to address the effects of IAPs including:

- Article 8(h) of the Convention on Biological Diversity states that "Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species".
- Aichi Biodiversity target 9: By 2020, invasive alien species and pathways will be identified and prioritised, priority species will be controlled or eradicated, and measures will be in place to manage pathways to prevent their introduction and establishment
- In accordance with the International Plant Protection Protocol, the European and Mediterranean Plant Protection Organisation (EPPO) provides information on quarantine pest organisms, including invasive alien plant species, and pest risk assessments, on which the Non-native Species Secretariat has based its risk assessment protocol (Box 6).⁵²
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), commits contracting parties to a strict control of alien species (article 11).
- EPPO and the Bern Convention jointly published the European Code of Conduct on Horticulture and Invasive Alien Plants.

Box 5. Relevant GB Legislation**England and Wales**

There are two main pieces of legislation to control invasive species:

- Under Section 14 (2) of the 1981 Wildlife and Countryside Act it is an offence to “plant or otherwise cause to grow in the wild” plant species listed in schedule 9.⁵³
- Section 50 of the 2006 NERC Act introduced section 14Za to the 1981 Act enabling the Department of Environment, Food and Rural Affairs (Defra) Secretary of State to ban the sale of invasive non-native species in England and Wales. Sale of five aquatic plant species will be prohibited from April 2014 (water fern, parrot’s feather, floating pennywort, water primrose and New Zealand pigmyweed).

NGOs and industry have raised concerns that include:

- the clarity of listing processes for schedule 9 and orders under section 14Za and the extent to which evidence of impacts is required
- if plants on schedule 9 spread to wild habitats via seed from adjacent property, legal culpability is not clear
- schedule 9 species being planted as part of publicly funded landscape schemes, despite guidance being published
- divergence with the Scottish regulatory approach (see below). Defra is considering updating the legislation.

Scotland

In Scotland, the Wildlife and Natural Environment (Scotland) Act 2011 (Commencement No.4, Savings and Transitional Provisions) Order 2012 deals with non-natives. Two further orders deal with the keeping and releasing of certain species, reporting on the presence of, and the planting of, invasive species. It also amends the 1981 Wildlife and Countryside Act, with any species listed by order of Scottish Ministers prohibited from sale. A Code of Practice on Non-native species was approved by the Scottish Parliament. The Scottish courts can use the Code when considering whether or not a person is liable in criminal proceedings.

campaign aims to change the behaviour of gardeners, such as inappropriate disposal of garden plants. The public is also being engaged in monitoring programmes. The plant tracker phone app for example, allows interested members of the public to submit geolocated photographic records of 14 different IAPs.⁵⁴ For the horticultural industry, there is a Code of Practice to help compliance with Section 14 of the 1981 Wildlife and Countryside Act (Box 5).

Early Detection and Eradication

Early detection and eradication is more cost effective and less risky than later interventions, which may have unintended consequences, such as increases in another, previously suppressed invasive alien species.⁵⁵ It is estimated that early eradication of the aquatic creeping water primrose will cost the Environment Agency £73,000 compared to £242 million if it became fully established.⁵⁶ Efforts to eradicate the more established floating pennywort (Box 2) have already cost at least £50,000 and will increase substantially. Systematic surveillance of pathways of entry, such as mapping plant species distribution around airports or container ports is used to inform rapid eradication strategies in some countries, such as New Zealand. In England, bodies such as the Environment Agency may record IAPs incidentally in routine monitoring programmes for other purposes. Records of IAP occurrence are incorporated into the GB Non-native Species Information Portal, which has an alert mechanism for new established

Box 6. Non-native Species Secretariat

The GB Non-native Species Mechanism is made up of the Programme Board, which represents the relevant governments and agencies of England, Scotland and Wales, and the Non-native Species Secretariat. The Secretariat is responsible for implementing the GB Invasive Non-native Species Framework Strategy (POSTnote 303). The strategy will be revised once the Law Commission review of wildlife law is published and the EU regulation on invasive alien species is passed by the EU Council and Parliament.

invasive alien species. But there is no formal surveillance system.

Long-term Control

Costs of long term control of established IAPs if undertaken would fall to landowners or other concerned parties, such as housing developers. In England, no organisation has powers and duties to control generally IAPs in semi-natural habitats, but Defra provides grants to local conservation groups for IAP control projects. Herbicides and mechanical removal are the primary means of non-native plant control. Costs increase as remaining individual plants become more difficult to locate in the least accessible locations, in such cases biological controls can be more cost effective (Box 7), but their release is more stringently controlled than most IAPs because of perceived risks.⁵⁷

The ecology of IAPs needs to be better understood for control measures to be effective in the long-term,⁵⁸ and to ensure control efforts are directed towards habitats where recovery is probable. Active restoration of the original community of native species may be required to address effects on some habitats.⁵⁹ Established alien plant species may take more than a century before becoming invasive,⁶⁰ and altered growing conditions with climate change could lead to more alien plant species becoming invasive.⁴³ Although trends in alien invasions will be primarily driven by future land use change,⁶¹ these factors suggest that the long term IAP control burden will increase in coming decades.

Box 7. Biological control of IAPs

Biological control uses natural enemies, such as insects and pathogens that have co-evolved with the IAPs in their region of origin. Whereas more than 400 biological control agents have been used worldwide, only one has been deliberately released for IAPs in Europe, the jumping plant louse *Aphalara itadori*. This is to control Japanese knotweed in England and Wales, management costs for which exceed £150 million pa in the UK. Biological control can offer a greater benefit to cost ratio than chemical and mechanical alternatives and may be more environmentally sustainable. However, historically there has been a lack of quantitative assessments following release.⁶² In England, the agents are extensively tested to ensure that they do not have unintended effects on non-target plant species prior to the completion of a pest risk analysis. Non-microbial agents are then considered by the Advisory Committee on Releases to the Environment. Not all invasive plant species will be viable targets, either through lack of specific natural enemies or because of conflicts of interest. For example, some IAPs are still in widespread horticultural use, such as Rhododendrons and Cotoneasters.

Endnotes

For References, please see:

http://www.parliament.uk/documents/POST/postpn439_invasive-plant-speciesreferences.pdf