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Invasive species management for infrastructure managers and the construction industry

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Summary

Business and industry need to respond to the challenge of invasive plants and animals, the cost of which, both economical and environmental, has increased dramatically in recent years. Part A of the guide describes the effect invasive species have, and the legislation and policy that regulate their management. The management of any landholding begins with surveying and assessing the invasive species present or likely to invade into it. This information coupled with the definition of the aims of management, feeds into a risk assessment leading to management options for dealing with invasive species: suppression, eradication and prevention. The final stage in the process is post-management surveillance, monitoring and maintenance to ensure any invasion or reinvasion is dealt with appropriately. Examples of 15 invasive plant and animal species (see Part B) and 21 species that could become tomorrow's invaders (see Part C).

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Olaf is a senior ecological consultant with RPS and has over six years experience as an invasive species specialist. His primary role has been to develop and implement invasive species management strategies for a range of clients, including developers, local authorities and other organisations with considerable landholdings. His experience includes providing sustainable solutions to the problems caused by invasive species and linking strategic management with regional and national policy. Recent examples include providing invasive species management strategies for the Highways Agency, Wembley Stadium and an extensive SSSI as well as assisting the development of a national invasive species risk assessment scheme, giving cross-sector invasive species training and workshops, developing invasive non-native species identification information for Defra and co-authoring the best practice manual *Giant hogweed management in the UK*.

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Vicky is an invasive species specialist at RPS with experience in co-ordinating invasive species consultations and research, as well as specialising in the management of Japanese knotweed and developing bespoke management plans for landholdings. Vicky's experience includes recent consultations for Defra and the Scottish Government co-ordinating risk assessments of 26 invasive or potentially invasive species.

Photographs

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Glossary

Abundant	Present in great quantity.
Acetylcholine	A vital substance that is released at nerve endings, the function of which is to pass on a nerve impulse to the next nerve.
Active ingredient	The component of the pesticide that kills or controls the target pest.
Adjuvant	An ingredient added to a herbicide to aid or modify the action of the herbicide.
Alien	See *Non-native*.
Alkaloid	A nitrogen containing naturally occurring organic compound. Derived from plants and having diverse pharmacological properties: some are poisonous.
Allelopathic	The process whereby one plant through the use of chemicals suppresses the growth and development of another plant.
Alternate leaves	Leaves alternating up a stem, occurring first on one side, then the other.
Annual	A plant that completes its life cycle from germination as a seed to production of seed followed by death within a single year.
Arabian Peninsula	A peninsula in the southern part of the Middle East.
Asexual reproduction	Reproduction that does not involve the joining of male and female genetic information.
Asset	Property of a person or company.
Atropine	A poisonous, bitter, *alkaloid* obtained from members of the Nightshade family that disrupts the activity of muscles regulated by the nervous system.
Ballast water	Water contained within a tank usually within a boat and used to increase stability when travelling with a light load.
Barbels	Fleshy, whisker like projections on a fish that help it locate food.
Biennial	Plant whose life cycle lasts two years from germination to death.
Biocontrol	See *Biological control*.
Biological control	Artificial control of pests and diseases by using other organisms, eg introducing a fungal disease of giant hogweed in the Caucasus into Western Europe to control the plant there.
Biomass	The total quantity or weight of an organism or organisms.
Biomass fuel	Liquid, solid, or gaseous fuel produced by conversion of organic material, see *Biomass*.
Bryophyte	Part of the plant kingdom containing mosses and liverworts.
Bulb	Nearly spherical underground organ of onion etc that sends shoots upwards and roots downwards.
Bulbils	An aerial *bulb* that can form a new plant.
Casual	A plant that grows from a seed but fails to establish a self-sustaining population.
Catchment	An area of land that collects water from which a river, lake or reservoir is fed.
Clonal	An organism that reproduces *asexually* producing genetically identical offspring.

Close season	The time of the year when it is illegal to hunt and kill some animals, birds, or fish.
Colonisation	The process by which a species arrives, populates and began to grow in a new area.
Compound leaf	A leaf in which the blade is divided into two or more distinct *leaflets*, see *Leaflet*.
Conjunctivitis	Infection of a membrane in the eye.
Consultant	An individual who provides expert or professional advice or services.
Contractor	An individual who provides the delivery of tasks, eg constructing a building or undertaking an application of pesticides.
Controlled waste	Waste controlled under the Water Framework Directive, household, industrial, commercial and special waste.
Corridor	A strip of land that is used by wildlife to move from one area to another, eg a hedgerow.
Cortex	Outer part of an organ
Cryptosporidiosis	A parasitic disease that effects the intestines of mammals.
Cultivation	The planting, tending and harvesting of crops and plants.
Database	A body of information stored, usually in a computer, from which particular pieces of information can be retrieved when required.
Desiccation	The process that leads to the drying out of an organism.
Distemper	An infectious viral disease of animals, eg dogs and foxes, characterised by fever, vomiting, diarrhoea, dehydration and possibly death.
Dormancy	A resting condition in which the growth of an organism is halted and life processes are slowed down.
Dorsal	On or near the back.
Dorsal fin	Fin on the back of a fish, see *Dorsal*
Ecosystem	A unit consisting of a community of organisms and the environment where they live and interact, eg woodland.
Establishment	The process by which a *species* becomes established within a new habitat or area.
Exotic	See *non-native*.
Exponential growth	Growth of a population of a species in which the rate of increase is dependent only upon the number of individuals and their reproduction rate, ie no competition occurs between individuals.
Family	A group of similar *genera* of taxonomic rank below order and above genus. With plants, the names usually end in –aceae, for example Apiaceae.
Flank	The side of an animal from the ribs to the thigh.
Forb	A broad-leaved *herb* (as opposed to a grass), especially one growing in a field or meadow.
Germination	The beginning of the growth of a seed, usually following a period of *dormancy*.
Genus	A taxonomic group lower than a family consisting of closely related species, eg *Heracleum*, (plural = genera).
Genera	See *Genus*.

Geographical information system (GIS)	A powerful set of tools for collecting, storing, retrieving at will, transforming, analysing and displaying data from the real world.
Habitat	An area where an organism or ecological community usually occurs.
Hantaan fever	Illness caused by the Hantaan virus of which brown rat is a vector, see *Vector*.
Herb	Plant whose stem is not woody or persistent, see *Herbaceous*
Herbaceous	Usually refers to tall herbs that die down during the winter and survive as underground or perennating parts till conditions improve, see *Herb*.
Herbicide	A chemical used to kill or control weeds.
Herbivory	A process in which an animal feeds on a plant.
Hibernacula	The shelter of an hibernating animal.
Hybrid	A plant originating after the fertilisation of one species by another species.
Indian Ocean rim	Ring of land around the Indian Ocean including south-east Africa, India, Indonesia and western Australia.
Introduced	In the context of this guide, a plant or animal knowingly or unknowingly brought into an area outside its native range.
Invade	To encroach onto or colonise an area previously uncolonised
Invertebrate	A collective name for those animals that do not possess a backbone or vertebra such as insects and spiders.
Journal	A publication, usually published quarterly, of papers or articles of a learned nature.
Laterally compressed	Flattened from the sides.
Leaflet	A subunit of a larger, compound leaf, see *Compound leaf.*
Lyme disease	An inflammatory disease caused by a bacterium transmitted by the bite of a tick.
Lyoscyamine	A poisonous *alkaloid* with similar effect as *atropine*.
Molluscicide	Pesticide designed to kill mollusc species.
Monitoring	Repeat surveillance at a site to detect change in the number and/or abundance of species present, see *Surveillance*.
Monoculture	A stand of plants of a single species including the cultivation of a single crop.
Native	Belonging naturally to a region, for example giant hogweed is native to the Caucasus.
Naturalisation	Process of *species* adapting to places where they are not indigenous.
Naturalised	A species that has established outside of its normal *range*.
Niche	The position or function of an organism within an ecological community.
Nitrogen fixing	The conversion of atmospheric nitrogen into nitrogen compounds by plants and bacteria.
Node	A joint or knob on a plant stem from where leaf grows.
Non-native	Not belonging naturally to a region, also referred to as alien, exotic.
Nutrient	A nourishing substance, in this context with respect to plant growth.
Ornamental	A plant grown for ornament or beauty.
Ornithosis	Disease caused by bacteria carried by birds, also known as psittacosis

Overwinter	To survive over the winter period.
Parvovirus	Any of a group of small DNA viruses that cause disease in many vertebrates.
Perennation	Survival from year to year by vegetative means. The vegetative parts of the plant, which survive the inclement period, are known as the perennating parts, for example the rhizome of Japanese knotweed.
Perennial	A plant that continues its growth from year to year.
Photodermatitis	A reaction of the skin to the UV rays of the sun.
Photosynthesis	The use of energy from light to drive chemical reactions in plants.
Physostigmine	An *alkaloid* that interferes with the metabolism of *acetylcholine*.
Phytophagous	Plant-eating.
Plankton	Small marine or freshwater animals (zooplankton) or plants (phytoplankton).
Planktonic	Of or relating to plankton.
Pollinator	An organism that effects the transference of pollen from anther to stigma, usually an insect.
Post-emergence	After an organism has risen out of groundwater or fluid.
Predation	Relationship between two species of animal in a community in which one hunts, kills and eats the other.
Protozoan	Any of a large group of single celled organisms that live in water or as parasites.
Q-fever	An infectious disease, resembling influenza, caused by a bacterium carried by some animals.
Range	The geographical region in which a *species* usually lives or grows.
Rhizome	A horizontal underground stem that differs from roots by having buds, nodes and scale-like leaves.
Riparian	Of or inhabiting a river-bank.
Risk assessment	In the context of this guide, the process whereby the chances of a particular non-native species causing problems after introduction to a given area are assessed. Based upon previous knowledge of the behaviour of the species and its relatives in its native range and in any other areas into which it has been introduced.
Root sucker	A shoot that arises from a plant's root.
Rosette	A cluster of leaves arising in a close circle from a central point, eg as in dandelion.
Rosette agent	An infectious parasite known to be deadly to salmon and trout.
Runner	A slender *stolon* that runs along the surface of the ground and sends out shoots and roots at the *nodes*.
Rut	An annually occurring state of sexual excitement in mammals, especially deer.
Salmonella	A bacterium that causes food poisoning in humans that can be found in the intestinal tracts of animals, birds, reptiles, seafood and humans
Scarification	To damage the outer coat of a seed.
Scientific name	Two part Latin or Latinised name describing the organism at both the *genus* and *species* levels.

Scopolamine	A poisonous *alkaloid* that depresses the nervous system and is used as a sedative.
Seed bank	The accumulated deposit of seeds in the soil that may persist for many years.
Self-fertilisation	Fertilisation by the union of the male and female reproductive cells from the same individual.
Self sown	Growing from seed dispersed naturally, eg by wind.
Semi-natural	Partly modified by human influence.
Sepsis	An infection of the blood.
Serovar	An individual type of a bacterium often called a strain.
Silverfish	Silver-grey wingless insect found in houses feeding on book bindings and starched clothing.
Site of Special Scientific Interest	A conservation designation denoting a protected area in the UK.
Species	A taxonomic group of individuals having common characteristics and placed under a *genus*.
Stakeholder	A person or group that has an investment, or shares an interest in operations, activities etc.
Stand	In the context of this guide, the growth or a crop of plants.
Statutory authority	An organisation established under an Act of Parliament for a public purpose.
Stolon	A horizontal stem that grows above ground and produces roots and shoots from the nodes, a *runner*.
Sub-tropical	A region of warm climate bordering on the tropics.
Succulent	A plant with thick, fleshy, water-storing leaves or stem.
Surveillance	The recording of information at a given moment in time, eg the number of a particular species.
Sward	Surface layer of ground containing a mat of grass and grass roots.
Tail-swipe	The mark the tail leaves on the ground as an animal moves. Can be used to identify the presence of a species.
Tap root	Primary root of the plant that grows vertically downwards.
Taxa	See *Taxon*.
Taxon	A biological category, a taxonomic group or unit, for example *family*, *genus*, *species* and *variety*.
Taxonomy	The classification of plants and animals.
Terminal mouth	Mouth where the upper and lower jaws form the end of the body.
Translocate	The process by which materials are transported within a plant, for example nutrients.
Tropical	From or suggestive of the tropics.
Tuberculosis	An infectious bacterial disease transmitted through the air that mainly affects the lungs. Tuberculosis is contagious and is spread through inhalation.
Umbel	A flat-topped flower cluster where all flower stalks radiate from the same point.

Understorey	Collectively the trees in a forest below the upper canopy cover.
United Kingdom	Since 1922, the official title for the kingdom consisting of England and Wales, Scotland and Northern Ireland (UK).
Variety	A group of similar plants that by structural features and performance can be identified from other varieties within the same *species*.
Vector	An organism that transmits a disease-causing pathogen
Ventral	On the belly.
Viability	The capability to live and survive.
Viral haemorrhagic disease	Viral disease of rabbit that is usually fatal.
Waterbody	A body of surface water, eg a pond, reservoir or lake.
Widespread	Occurring extensively throughout an area.
Woody	A plant stem that has hardened and will not die off in winter conditions.
Zooplankton	See *Plankton*.

How is this guide structured?

This guide is divided into three main parts:

Part A This section provides the key elements of a management plan for any individual or group of invasive species, including survey and assessment, risk management, management, prevention and monitoring. Each chapter starts with a summary of key points and a flow diagram showing the stages to complete that section. The chapters are stand-alone to allow users to dip into the guide where necessary to efficiently find solutions to issues that may arise during any project. The chapters are illustrated in part by examples of species from Parts B and C.	PART A	Guidance for the best practice approach to assessment and management of any invasive species.
Part B Information on the ecology, identification, legal aspects, assessment, management and prevention of example invasive species. Each species is described using the same headings, sub heading, figures and tables so that the reader can quickly find comparative information.	PART B	Technical detail on a range of species illustrating the different approaches and management techniques available.
Part C A range of plant and animal species that are not yet widespread in the UK but have the potential to become invasive. An image and brief description are provided for each species as well as guidance for further information.	PART C	Examples of plants and animals that have the potential to become tomorrow's invasive species.

What does each section provide?

Part A

Part A provides a structured approach to dealing with invasive species of plants and animals. It addresses the three big questions:

1 Have I got a problem?

2 If I have a problem, how do I deal with it?

3 If I don't have a problem, how can I keep it that way?

The principles and techniques described in each chapter can be applied to a wide range of species including:

- terrestrial and aquatic plants
- insects (and other invertebrates)
- fish
- amphibians
- reptiles
- birds
- mammals.

Part A has not been produced with such groups as algae, bacteria, fungi or other micro-organisms in mind, neither does it include marine species.

The areas for which it is envisaged this guidance would be used include:

- infrastructure land, eg the Highways Agency estate, railway networks, waterways
- large landholdings, eg the landholdings of English Partnerships or an energy company
- individual sites, eg a development or construction site, or a property for sale.

The core elements within a management plan that are covered in Part A include:

- survey of landholdings to initially identify and determine the presence or absence of invasive species, followed by detailed assessment to support a risk assessment and management strategy (Chapter 2)
- risk assessment to determine whether or not management is necessary, and if so what form it should take, eg prevention measures or species control, including risks associated with habitats and pathways (Chapter 3)
- management options to deal with the species on the landholding, namely prevention, suppression and eradication (Chapters 4)
- prevention options to deal with the species that have the potential to invade onto the landholding (Chapters 5)
- maintenance and monitoring of a landholding to check on the success or otherwise of management to ensure that it is not reinvaded or that invasion is prevented (Chapter 6).

To illustrate these chapters, examples are used from the species accounts in Parts B and C.

Part B

Part B has two main functions:

1 To provide detailed information on 15 invasive species that are some of the most problematic in the UK and have a significant affect on infrastructure and the construction and development industries.

2 To provide examples of a range of approaches and techniques that managers may be able to apply to other invasive species not included in Part B.

A synthesis of information is provided for each species to help guide the user through identification and survey, risk assessment, management, prevention and post-management maintenance and monitoring. Tables, figures and images are given to help aid understanding and to act as quick references.

Part C

Part C presents short profiles of several potentially invasive species. All of these species have established themselves in the UK or have the potential to do so. Many of them have already

caused problems, at least at a local level. They demonstrate the range of potentially invasive species and are examples of species land managers should be planning for and including in scoping studies.

Example questions this manual can help to cover

Example questions a developer, landowner or land manager might need to answer include:

> "Do I know what landholdings or assets we have that are affected by invasive species, where they are, how they are managed and how well?"
> Part A Chapter 1

> "Has the landholding or asset been checked for invasive species as part of scoping or pre-works surveys or asset management inspections?"
> Part A: Chapter 2, Parts B and C

> "Have I access to competent and expert assessors who can inspect and report reliably? Do I need to use consultants and, if so, who?"
> Part A: Chapter 2

> "What is the overall risk to my business and how can I effectively remove or minimise it?"
> Part A: Chapter 3, Parts B and C

> "How do I go forward with management and what types of solutions are available to me?"
> Part A: Chapter 4, Part B

> "How can I incorporate preventative measures into the ongoing management of my landholding?"
> Part A: Chapter 5

> "What can I do to achieve peace of mind that all is well with my landholding?"
> Part A: Chapter 6

Example questions relevant to a consultant or contractor:

> "I am responsible for assessing landholdings and advising my client on issues before purchase, what should I advise when it comes to invasive species?"
> Part A: Chapters 2 and 3, Parts B and C

> "My client has asked me to undertake an invasive species survey of their land. I am confident that I can identify most species, but require guidance on what issues to address when conducting my survey."
> Part A: Chapters 2–6, Parts B and C

> "I have been asked to develop a management strategy for invasive species on our landholdings."
> Part A: Chapters 2–6, Parts B and C

Readers will find different sections of this guide more or less relevant to them and their profession. Table 1 attempts to indicate which chapters are most likely to be of use.

1 Introduction, legislation and policy

Summary

Non-native plants and animals are those originating from outside the UK. Invasive plants and animals are those that spread rapidly, often becoming dominant, and have a negative effect on the environment (both built and natural). Invasive species are often non-native, however some native species can become invasive, especially when outside their normal range within the UK.

Examples of the negative effects caused by invasive species include structural damage, environmental degradation, aesthetic degradation, biodiversity loss, loss of land function, access restrictions and increased risk to human and animal health and safety.

Costs incurred because of invasive species can include repairs to damaged structures and environment, delays to works, loss in value of a landholding or other asset, potential for prosecution because of damage caused by invasive species or infringement of legislation and loss of reputation through mismanagement of invasive species.

Management of invasive species can be very expensive, often ranging into millions of pounds nationwide. UK business and industry bear much of this cost where invasive species affect their landholdings, particularly infrastructure, construction and development activities. A well informed and structured approach can help to reduce the costs and increase the effectiveness of management. This guide is designed to assist in this approach.

This section describes the effects of invasive species and the basis for sound management. A review is provided of the areas of legislation and policy that affect invasive species management. A model approach to invasive species management is summarised and the advantages of using geographical information system (GIS) are outlined.

1.1 Impacts and costs

Many species that do not occur naturally in the UK are deliberately introduced here every year for reasons as varied as sale through the horticultural trade, as pets, for food production, for energy production and for ground stabilisation. Several non-native species are also accidentally introduced from elsewhere in the world as hitchhikers, for example stowaways in ship ballast, food packaging, soils and imported plant and animal material.

The vast majority of these non-native plants and animals are unlikely to become a problem in the UK and can provide beneficial functions (eg pheasant, introduced from Asia probably by the Romans, is still a prized game bird). However, in some cases non-native plants and animals can become a serious problem. This is often because they become invasive, a process where, inhibited by the usual population controls (eg predation, disease and competition for resources), the plant or animal multiplies and spreads at a rapid rate, growing to dominate in the new environment.

Alone this would not be considered a problem, however when plants or animals undergo this rapid expansion it is often to the detriment of native species and habitats, the wider environment and can also affect human and animal health as well as the built structures we rely on (eg buildings and infrastructure).

The harmful effects of these plants and animals include:

- physical/structural damage to buildings and developed land (Box 1.1)
- human and animal health hazards (Box 1.2)
- delay to development (Box 1.3)
- environmental damage such as increased flood risk and river-bank erosion (Box 1.4)
- loss of biodiversity/desirable species (Box 1.5)
- legal restrictions and potential to cause an offence (Box 1.6)
- loss of land-use or production (Box 1.7)
- aesthetic degradation (Box 1.8).

Box 1.1 ***Structural damage caused by zebra mussels***

Zebra mussel, a freshwater mollusc, quickly and easily attaches to hard surfaces causing a variety of problems, such as clogging water pipes and interfering with machinery. It has been known to temporarily shut down treatment works in the UK, 22 of which documented problems between 2006 and 2007. The estimated cost of zebra mussels to the water industry because of structural damage and control is over £2m per annum (see also *Zebra mussels* in Part B).

Box 1.2 ***Brown rats pose human health hazard***

Brown rats are known carriers of Weil's disease and are common on urban development sites, particularly on sites where rubbish and food are abundant. The bacteria causing Weil's disease are spread through the rat's urine. The disease does not survive long on dry land but can persist for several months in water. Workers on development sites, which contain open bodies of water, are at an increased risk of contracting the disease (see also *Brown rat* in Part B).

Box 1.3 ***Japanese knotweed holds up highway development***

Japanese knotweed delayed a road development worth over £1m in Hampshire for three years while the plant was controlled using herbicidal methods. The alternative was to spend in excess of £200 000 excavating and disposing of the contamination (*Alien species invade space for development*, Rotherham, 2006) (see also *Japanese knotweed* in Part B).

Box 1.4 ***River-bank erosion due to giant hogweed infestation***

In the Tweed Valley, giant hogweed has been shown to cause severe river-bank erosion. When the plants die, which is a natural process occurring after they flower, their roots rot away leaving large, deep holes in the river-bank. These destabilise the banks and cause large areas, as long as 100 m, to slump wash away in the passing waters (see also *Giant hogweed* in Part B).

Box 1.5 ***Signal crayfish pose a threat to the native white-clawed crayfish***

White-clawed crayfish is native to the UK and until recently was widespread. Populations have seriously diminished after the introduction of the non-native signal crayfish and the Turkish crayfish from crayfish farms. As well as directly out-competing the native crayfish, the signal crayfish acts as a vector for crayfish plague that causes very high mortality rates in white-clawed crayfish but has no negative effects on the signal crayfish (see also *Racoon* and *Marsh frog* in Part C).

Box 1.6 ***Legislation and common ragwort***

Ragwort is listed under the Weeds Act 1959 later amended by the Ragwort Control Act 2003. Although these acts do not place an automatic obligation on landowners to remove this plant from their land, where ragwort is seen to be causing a problem by spreading onto adjacent land, an order may be served by Defra to the landowner to take necessary steps to prevent the weed from spreading (see also *Common ragwort* in Part B).

Box 1.7 ***Damage to woodland and forestry by grey squirrel***

Grey squirrels cause significant damage in UK woodlands by stripping bark, which can lead to disease. In 2000, the British timber industry estimated the worst-case scenario cost of damage to beech, sycamore and oak by squirrels was £10m (see also *Deer* in Part B, and *Edible dormouse* in Part C).

Box 1.8 ***Aesthetic degradation by rhododendron***

Rhododendron has invaded upland habitats, eg Snowdonia National Park, causing significant changes to the landscape (see also *Rhododendron* in Part B).

The result of these effects can include significant costs in relation to damage caused and value lost, as well as the cost of controlling the species and repairing the damage caused by them. Worldwide, invasive species have been recognised as one of the greatest threats to biodiversity, second only to habitat destruction. In 2007 the Minister for Biodiversity stated that invasive non-native species cost the British economy about £2 billion per year. Figures estimating the cost of a few example species in the UK illustrate the scale of the problem (see Box 1.9).

Box 1.9 ***Examples of costs associated with invasive species in the UK***

- £1.56 billion to eradicate Japanese knotweed nationwide (Defra, 2003)
- £2m spent to eradicate Japanese knotweed on one 2ha development site
- £11m to eradicate rhododendron from one national park in Wales (Postnote, 2008)
- £13.9m of damage per year caused by deer collisions in Great Britain (Langbein and Putman, 2006)
- £100 000 spent on modifications to cope with zebra mussels at water works in Killyhevlin, Northern Ireland (Maguire and Sykes, 2004)
- £160m spent each year in the UK to control invasive weeds.

On specific developments the cost of dealing with individual species includes:

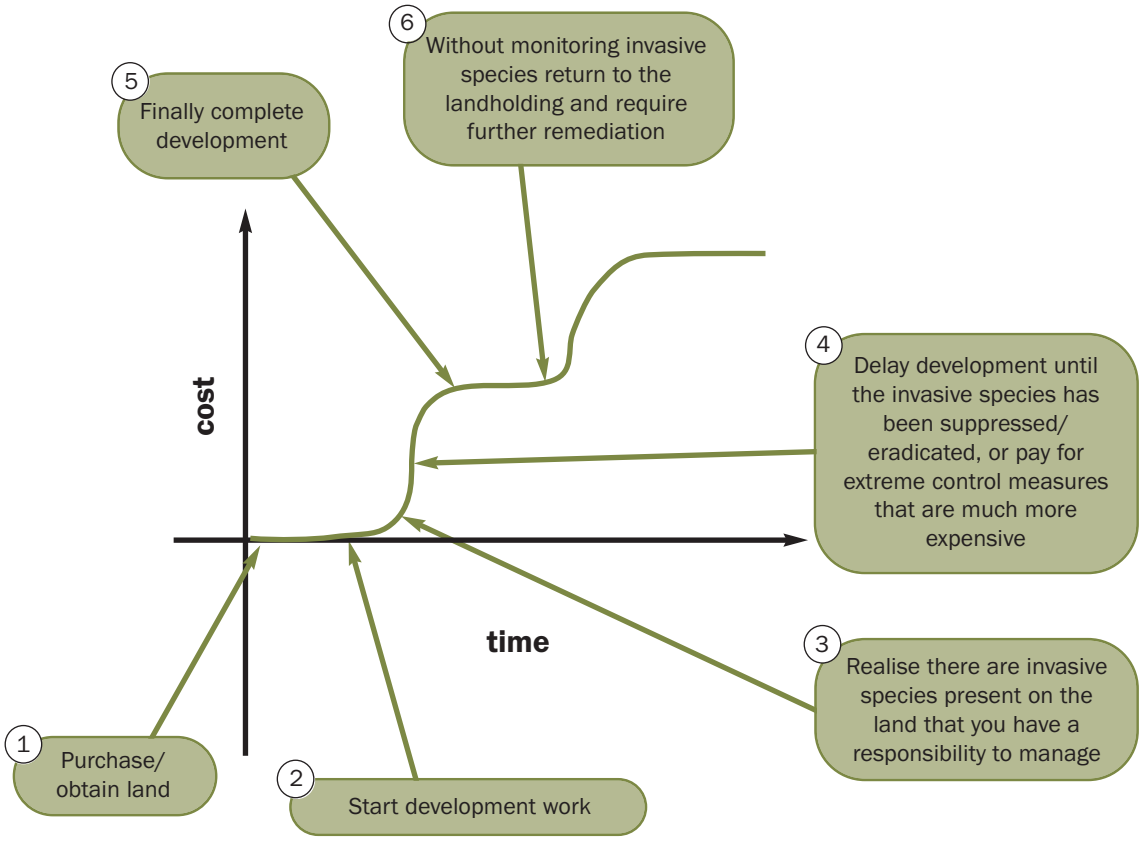
- repairing or mitigating the initial damage caused by the plant or animal (ie physical/structural damage)
- the delay to development while control or management is undertaken
- the cost of control or management.

If problem species are not managed appropriately then the landowner or developer may not only incur extra costs through damage caused and extra control measures required, but may run the risk of breaking the law, receiving negative public attention and, if found guilty, a fine or imprisonment. A better understanding of invasive species and appropriate action will help the construction industry to reduce the increasing costs associated with these species and mitigate their effects.

Delayed and ineffective management techniques can be expensive. However, by using a strategic approach and prudent resource management it is often possible to produce favourable and cost effective results. Figure 1.1 illustrates the differences between inefficient and efficient approaches and the potential costs incurred by the former.

This publication has been developed to guide good practice based on the principles of strategic management for invasive species. It also uses summary accounts for several of the most common problem invasive species (Part B) to give examples of the range of strategies and techniques that are available. Lastly, this publication offers guidance for the early identification of new species that may be a threat and methods for their prevention. It also provides examples of a range of species that have the potential to become tomorrow's problem plants and animals (Part C).

a) *a common but inefficient approach*



b) *a more efficient approach*

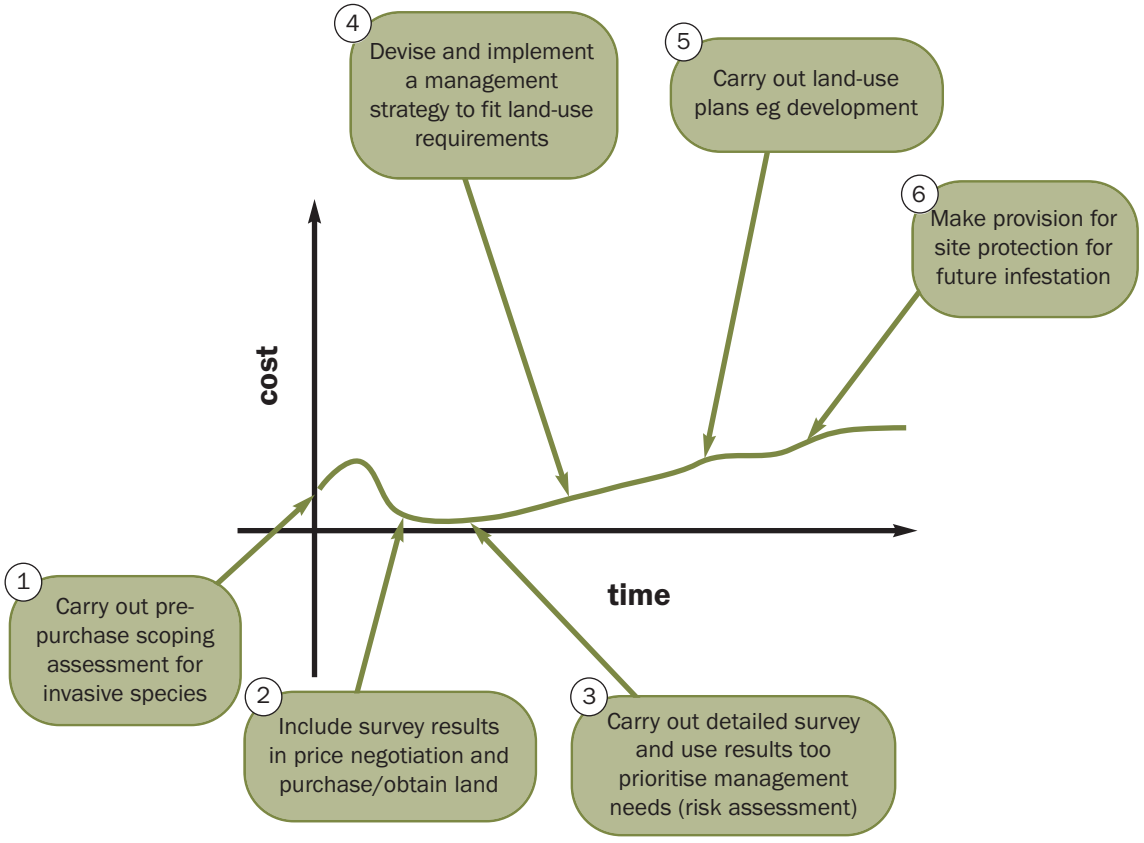


Figure 1.1 ***Inefficiencies in common approaches to invasive species management***

1.2 Legislation, policy, codes and guidelines

Legislation and policy are key factors in the management of invasive species. However, the volume of legislation relating to these plants and animals and their management is considerable and is frequently updated in response to new needs and developments. The legislation can also be different depending on which part of the UK you are working in so it is impractical in this guide to try to detail all the legislation that should be considered when dealing with invasive species. However, it is important to have an insight into this legislation and be aware of the aspects of invasive species management that are subject to legislation and policy.

The legislation and policies that land managers need to consider derives from particular aspects of managing plants and animals. These include:

- restrictions on the release, planting or movement of species to prevent their spread and/or the spread of diseases and parasites
- safeguards for animal welfare to prevent them (and sometimes their habitat) from being harmed, and restrictions governing the ways that animals can and cannot be caught and/or killed
- regulations controlling the use of herbicides, piscicides, rodenticides and other types of pesticide
- regulations governing the movement and disposal of waste
- health and safety legislation to protect workers, eg surveying for invasive species and when using pesticides.

1.2.1 Restrictions on the release, planting or movement of animals and plants

To prevent the spread of undesirable species and of diseases and parasites into the wild, restrictions have been imposed on releasing animals and plants.

Legislation that seeks to prevent the entry of undesirable species into the UK includes CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), which is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

The prevention of the release of non-native animals in the UK is chiefly provided by the Wildlife and Countryside Act 1981. This makes it illegal to release or allow to escape any species that is not normally resident in and is not a regular visitor to Great Britain in the wild state or is included in Part 1 of Schedule 9 of the Act, including species such as marsh frog, edible dormouse and zander (see Parts B and C).

No such broad approach applies to plants in the UK, however the Wildlife and Countryside Act does make it an offence to plant or otherwise cause giant hogweed and Japanese knotweed to grow in the wild (see Part B), as well as some species of seaweed, all of which are listed on Part 2, Schedule 9 of the Act. In Scotland, a further 13 plant species are included on Schedule 9, such as New Zealand pygmyweed and floating pennywort. Also, the Nature Conservation (Scotland) Act 2004 amended the Wildlife and Countryside Act in Scotland to, among other things, allow Ministers to prohibit the sale of high-risk invasive species and issue or approve guidance on invasive species.

With respect to both plants and animals, the Wildlife and Countryside Act 1981 identifies that "it shall be a defence to the charge of committing an offence … to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence".

There are several other pieces of legislation that relate to preventing the spread of invasive species in the UK, which can include both native and non-native species. For example the native species ragwort (see Part B) is one of the species controlled by the Weeds Act 1959. This was primarily designed for the management of agricultural land and gives the Secretary of State for Environment, Food and Rural Affairs the power to serve a notice requiring the occupier to take action to prevent the spread of the plants listed in the Act, but does not make it illegal to allow it to grow on the land.

Some legislation is specific to a given animal or group of animals. For example the key measure in controlling the spread of non-native fisheries has been the Import of Live Fish Act 1980 (ILFA). Under the ILFA Orders it is illegal to keep or

release any of the listed species in any water (including tanks and ponds) without a licence. Any person wishing to hold, keep or release any of the listed species is required to have a licence before obtaining the fish. All those wishing to keep a listed species, including fish farmers, fish dealers, wholesalers, retailers, hobbyists, researchers and owners of fisheries, require an individual licence to do so.

The controls on the keeping of non-native crayfish were introduced through the Prohibition of Keeping Fish (Crayfish) Order 1996 made under the ILFA. So it is only legal to keep them under licence. The exception is the signal crayfish as there are parts of England where extensive populations existed before the Order was introduced and such stringent controls were deemed inappropriate. The Order lists the areas where licences are not required to keep signal crayfish. In Scotland, the equivalent legislation for crayfish includes the Import of Live Fish (Scotland) Act 1978, the Prohibition of Keeping Fish (Crayfish) (Scotland) Order 1996, and the Aquaculture and Fisheries (Scotland) Act 2007.

1.2.2 Controls over the catching, killing and harming of animals

The catching and trapping of animals is covered by legislation such as Section 11 of the Wildlife and Countryside Act 1981, which prohibits certain methods of killing or taking wild animals, for example the use of bows, crossbows or explosives. The 1981 Act also prohibits the killing or taking of all wild birds, except under licence. Once caught, animals may also be covered by animal welfare legislation, such as the Animal Welfare Act 2006.

In the case of edible dormouse, certain methods of killing or taking are prohibited under Section 11(2) of the Wildlife and Countryside Act unless a licence has been issued, however occupiers of land may kill or take edible dormice by any non-prohibited method without needing a licence (see *Edible dormouse*, Part C).

Although many species may be considered undesirable, there is a range of restrictions as to if and how animals can be killed. Neighbouring species should also be taken into consideration. For example when controlling rabbits, you cannot use gaseous poisons near to badgers or foxes. This is due to the protection afforded to badgers under the Protection of Badgers Act 1992 and the Wildlife and Countryside Act 1981, and a lack of substances approved for gassing foxes under the Control of Pesticides Regulations 1986.

Any pest control method should be humane and not undertaken inappropriately or to cause unnecessary suffering. Section 1 of the Wild Mammals (Protection) Act 1996 states that if "any person mutilates, kicks, beats, nails or otherwise impales, stabs, burns, stones, crushes, drowns, drags or asphyxiates any wild mammal with intent to inflict unnecessary suffering he shall be guilty of an offence". Any person doing so is liable to prosecution.

The control over the process of killing an animal can be relatively complicated, eg shooting a wild boar requires that an individual's firearms licence specifically lists wild boar as they do not come under the category of other vermin. There is also legislation and guidance related to the type of rifle and ammunition used.

In some cases, there is a requirement to kill an animal and, in fact, to do otherwise would constitute an offence. For example it is an offence under the Wildlife and Countryside Act 1981 to release or allow the release of any non-native crayfish species into the wild. This means that should a signal crayfish be caught inadvertently, it would have to be kept (under licence if necessary) or destroyed. Similar requirements are placed on the capture of zander, a non-native fish species (see Part B).

1.2.3 Controlling the use of pesticides

Pesticide is a broad term covering a range of substances including fungicides, herbicides, insecticides and rodenticides that are used to control pests and diseases. There are several different Acts and Regulations that apply to the approval and use of pesticides products but all products must have an approval under the appropriate regulation before they can be advertised, marketed or used. For example for brown rat control, the Control of Pesticides Regulations 1986 and 1987 govern the sale, supply, storage and use of pesticides, including rodenticides. No rodenticide product can be sold or used without being approved. The regulatory authority in England, Scotland and Wales is the Health and Safety Executive and the Health and Safety Executive Northern Ireland is the

regulatory authority in Northern Ireland (note that the Biocidal Products (Amendment) Regulations 2003 should supersede these regulations in the future).

When approved, the use of the product is carefully controlled, particularly:

- what substance can be used
- what it can be used for
- in what concentration and the number of applications
- how the product should be used to protect people and the environment
- who can and cannot use particular products.

The use of pesticides (and other types of chemicals) in the suppression of invasive species is one of the methods available (species in Part B this applies to includes all of the plant species as well as brown rat, brown-tail moth, feral pigeon, zander and zebra mussel). Before use, it is essential to make sure that any pesticide is approved for use for a particular species, in a given location. The product must be used in accordance with instructions on the label and particular attention should be paid to any specific restrictions stated on the label, for example whether the product can be applied in or near water (see *Floating pennywort* and *New Zealand pygmyweed* in Part B and *Water hyacinth* in Part C).

Two statutory Codes of Practice provide guidance on the use of pesticides. The *Code of Practice for using plant protection products* (2006) and the revised *Approved Code of Practice for the safe use of pesticides for non-agricultural purposes* (Control of Substances Hazardous to Health Regulations, 1994).

1.2.4 Regulations governing the movement and disposal of waste

The management of invasive species often involves the generation of waste, typically in the form of plant material with or without associated soil, water and sediment, or dead animals. A careful check needs to be made to ensure that this waste is dealt with appropriately and complies with the relevant legislation. For example when Japanese knotweed is dug up to eradicate it from a site, the soil will contain rhizome (underground root-like stems) from which the plant could regenerate. This material is likely to be classified as controlled waste under the Environmental Protection Act 1990 and can only be transferred by an authorised person, ie someone who is either registered as a waste carrier or exempted from registration by the Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991. If it is sent for landfill either before or after any treatment, it must also be taken to an appropriately authorised landfill site (see Part B). In the case of common ragwort, if the plant is included in cut vegetation, it remains toxic and if used as hay could cause the death of livestock eating it (see Part B).

Legislation is not always species specific, eg water weeds such as floating pennywort and New Zealand pygmyweed (see Part B) can be classed as waste if removed from a waterbody, eg by dredging or using a weed cutting basket. If control involves leaving this material on the side of the waterbody, this activity may be covered by an exemption from the need for an environmental permit, which should be registered with the Environment Agency in England and Wales, Scottish Environment Protection Agency in Scotland and the Northern Ireland Environment Agency in Northern Ireland. However any other movement of the plant material is covered by the waste regulations and requires consultation with the relevant competent regional authority. Likewise, dead rats and pigeons are classified as controlled waste and should be disposed of at a suitably authorised incinerator or landfill (see Part B). This must be documented by an appropriate waste consignment note.

1.2.5 Health and safety legislation to protect workers

Invasive species management involves working in potentially hazardous environments, eg along river-banks, in abandoned industrial sites and along transport corridors requiring appropriate risk assessment. It also requires compliance with legislation and regulations, eg to work along a railway line you need to be a holder of a personal track safety card. Control of Substances Hazardous to Health (COSHH) regulations require employers to control the exposure of their staff to hazardous chemicals, including pesticides, herbicides and other chemicals used to control invasive species for which they may be required to hold relevant certificates. This also applies to licences for the driving and use of vehicles and associated machinery, eg hydraulic excavators.

1.2.6 Species specific legislation

Legislation requiring the control of species is limited to a few species. For most invasive species there is no requirement to undertake control, merely a requirement to prevent spread or release into the wild. An exception to this is rabbit. The legislation categorised so far, relates to specific aspects of non-native species management. It should be remembered that there is other more general legislation that could be relevant, some of which places an onus on landowners to behave responsibly. Such legislation includes common law and good examples would be species such as brown-tail moth and giant hogweed, which can be hazardous to health. If a landowner, eg a local authority does not take action to suppress the species, they could be prosecuted for not behaving responsibly.

Land managers need to be aware that policies are made from time to time and codes of conduct and guidelines issued. It is important to check whether or not any may apply. The following examples illustrate the nature and sources of such policies, codes and guidance.

To date, national policy and planning guidance has not dealt specifically with non-native species. However, such documents as Planning Policy Statement 9 *Biodiversity and geological conservation* provide encouragement for the suppression of non-native species as this could help enhance biodiversity. The UK Biodiversity Action Plan (UK BAP) and some local BAPS (usually based on a county or counties) also encourage such action, eg where an endangered species is threatened by a non-native species such as water vole by mink, some include specific reference to invasive species (for example in Greater Manchester).

Local authorities have sometimes included policies in their local plans and environment frameworks. An example of this is the City and County of Swansea where a planning policy was introduced to planning procedures. This requires that "full details of a scheme for the eradication and/or control of Japanese Knotweed shall be submitted to and approved by the Local Planning Authority prior to the commencement of work on site and the approved scheme shall be implemented prior to the use of the building commencing". Organisations can include policies in estate plans and asset management programmes, eg the National Trust and the Highways Agency, or rules or policies that apply to specific groups of people, eg members of an angling club with rules specifying the cleaning of equipment etc. These typically relate to particular invasive species and are often aimed at prevention.

Agri-environment schemes offer the potential to encourage invasive species management. Two examples are provided in Boxes 1.10 and 1.11. The Good Agricultural and Environmental Conditions (GAEC) scheme (Box 1.11) operates under the Single Farm Payment by which farmers/land managers receive a payment in return for environmental services. However, farmers could have their Single Farm Payment docked if they fail to comply with GAEC. In comparison, the *Rural Development Contracts – Rural Priorities* (Box 1.10) represents an incentive to manage for invasive species.

Box 1.10 *Rural Development Contracts – Rural Priorities*

The *Rural Development Contracts – Rural Priorities*, an integrated funding mechanism of the Scottish Government to deliver targeted environmental, social and economic benefits, includes targeted eradication and control of the five invasive non-native species in certain areas of the country. The control of non-native species option is nested within the coastal habitats package. The aim is to help protect designated sites, Biodiversity Action Plan priority species and habitats, and assist rural land managers that need to control one of the named invasive non-native species as part of another Scotland Rural Development Programme management option. For Japanese knotweed, giant hogweed and Himalayan balsam the payment rate is £160 per ha per annum, which can be divided into contractor costs of £128.75 per ha per annum and costs for glyphosate herbicide at £31.25 per ha per annum.

<http://www.scotland.gov.uk/Topics/Rural/SRDP/RuralPriorities/Packages/Coastalanddunes/Controlofinvasivenon#top>

Box 1.11 ***Good Agricultural and Environmental Condition 18: encroachment of unwanted vegetation***

Extracts from GAEC 18: encroachment of unwanted vegetation

Measure

182 You must avoid the encroachment of unwanted vegetation which degrades the agricultural and environmental value of the land to the extent that the land is not capable of returning to agricultural production by any time during the growing season in the following calendar year.

183 Taking the above into account, the encroachment of native species is allowed in the following instances:

- recolonisation of trees across the boundary line from native woodland
- recolonisation of scrub species such as gorse, birch and juniper as part of a mosaic of habitats
- reversion of land to wet grassland or wetland.

Guidance

185 Through appropriate grazing, topping or other permissible methods of control land managers can prevent the severe encroachment of unwanted vegetation which is both agriculturally and environmentally degrading including rhododendron, bracken, weeds covered by the Weeds Act 1959, Japanese knotweed, giant hogweed and Himalayan balsam.

186 Patterns of ecological succession will be regarded as consistent with Good Agricultural and Environmental Conditions provided that:

- they are consistent with maintaining the ecological status of protected areas (eg SSSIs, SPAs and SACs)
- the growth of scrub is easily reversed by regular cutting, use of approved herbicides or grazing.

Non-compliance

187 If the Statutory Management Requirements or Good Agricultural and Environmental Conditions are not complied with your single farm payment and other direct payments can be reduced.

188 Any reduction will be applied to the overall amount of direct payments that have been or will be granted following the submission of an aid application in the calendar year that the non-compliance was found.

Codes of practice, good practice and guidance have been produced from time to time by working groups and statutory agencies such as Defra and the Environment Agency (Appendix A3).

For example a working group comprised of government, the horticultural sector, and environmental and conservation organisations developed a horticultural code of practice, which contains advice on the safe use, control and disposal of invasive non-native plants for everyone involved in horticulture and other related fields (*Helping to prevent the spread of non-native species: horticultural code of practice* (Defra, 2005)).

Defra produced a code of practice on how to prevent the spread of ragwort, which is admissible as evidence in court under the Ragwort Control Act 2003 (*Code of practice on how to prevent the spread of ragwort* (Defra, 2004)).

The Environment Agency produced *The knotweed code of practice: Managing Japanese knotweed on development sites* (Environment Agency, 2006). This contains guidance on identification and eradication of Japanese knotweed in a development setting (see also Box 1.12 for *Wild boar*).

Box 1.12 ***Authoritative advice on feral wild boar***

- *Guidance for land managers on the impacts of wild boar and their management* (Deer Initiative and Natural England)
- *Guidance on welfare such as minimum recommended firearm calibers* (Deer Initiative and Natural England)
- *Guidance on best practice and safe shooting* (Deer Initiative)
- *Guidance on carcass handling including meat for human consumption and waste disposal* (Deer Initiative and Food Standards Agency)
- *Advice to aid hunters, gamekeepers and stalkers in disease identification* (Deer Initiative, Food Standards Agency and Defra)
- *Public awareness of wild boar including safety advice* (Deer Initiative and Natural England)
- *Advice on dealing with wounded wild boar* (Deer Initiative)
- *Advice for keepers of wild boar and local authorities to minimise the risk of further escapes* (Deer Initiative, Natural England and Local Authorities Coordinators of Regulatory Services).

(source: Feral wild boar in England: An action plan <http://britishpigs.org.uk/feralwildboar.pdf>)

Box 1.13 ***An environmental information system for managing invasive species in a highway network***

EnvIS is the Highways Agency's environmental information system. It is a consistent system for defining and categorising the man-made or natural assets that comprise the environment within and surrounding the trunk road network. It consists of specific environmental data (air, water, noise, landscape, cultural heritage, waste management and biodiversity) supplied by service providers, the Highways Agency and other bodies that is collated and displayed in Highways Agency GIS. These data are used to assist in managing the environmental estate, within and surrounding the existing and proposed trunk road network, and in the review and reporting of the environmental performance of both service providers and the Highways Agency.

Within the biodiversity data set EnvIS contains details of invasive species including where they are located, when they were last surveyed and what is the next planned action. This process is monitored to ensure each area is dealt with appropriately.

1.3 A model response to dealing with invasive species for a given landholding or asset

This section summarises the various stages that a land manager might go through in a model response to dealing with invasive species with respect to a given landholding or asset. While most of the process can be completed using a paper based system or basic IT facilities, GIS provides a particularly valuable tool for informed management of invasive species. This section provides the essential elements, while also drawing attention to the benefits of a GIS based process, much of the latter being drawn from a GIS tool being developed by the Highways Agency (Box 1.13). Overall, the aim is to encourage land managers to work to an evidence-based decision-making process that helps the understanding and sharing of data. A GIS system provides just such a tool.

The starting point is an assessment of the hazards and risks associated with invasive species already present or that could potentially invade the landholding. Criteria should be established on which species should be considered and at what point the process starts to consider them. The criteria are often linked to legislation and policy, for example the latter could be national or corporate. From this, basic rules would be agreed as to when data would need to be collected for a given species. For example, when a certain threshold is exceeded it would then need to be registered on the system, eg an infestation of rabbits. In this latter example, the rabbits at a particular density could be considered a benefit in terms of biodiversity (see *Rabbit* in Part B). However, once their burrowing puts bank stability at risk, the database needs to register the population with associated information.

The rules would trigger a survey, with data being collected on distribution and for example, abundance location of breeding sites, or age of stand. These data would be presented as a map and could be supported by GPS readings where accuracy is needed or areas marked out, eg a stand of Japanese knotweed or a rabbit warren. The map could then be marked up to indicate whether or not the species exceeded defined criteria, eg colouring in the distribution using green, amber and red, to cover the range acceptable to unacceptable.

The distribution data could be related to other information such as aerial photography, habitat surveys, sites of nature conservation value, watercourses, built infrastructure and development plans. The map or plan could include

appropriate buffer zones, eg a 7 m zone around Japanese knotweed stands to prevent ground disturbance and the risk of spread (see *Japanese knotweed* in Part B).

While a paper based or basic IT system might be able to deal with a select number of these sets of information (or layers), a GIS system can be used to store and represent considerably more information, which can be easily manipulated. Such a system could also link into other databases, eg the National Biodiversity Network that shows locations of the species being assessed in the surrounding area, and Magic (Natural England's database of statutorily protected sites of nature conservation value and other designations). A GIS system could also be used by other interested parties to respond to the presence of invasive species, eg erecting appropriate fencing to encourage deer away from a highway improvement. Where incompatible actions were proposed, eg routing a public footpath through an area infested with brown-tail moth, the GIS system could generate an alert response to draw attention to the issue.

Management intervention would be prioritised by triggering action for important areas. Such alerts could be shared across a team involving not just the land manager but consultants and contractors who would have access to maps showing where treatment was necessary. If the details of responses had been agreed beforehand, action could follow swiftly. Such a process would provide a good control mechanism to target treatment in a strategic manner.

Once management had been completed following an alert, the information would be recorded and the priority for that particular invasive species incident downgraded. The system would trigger follow up monitoring at an appropriate time, undertaken to check that the management had been successful and the priority changed if necessary. Consultants and contractors using the system would need to contribute relevant information into the system in a timely fashion, eg details of management and results of monitoring surveys.

Using a GIS system, it is possible at any point in time to obtain a report on the condition of the various invasive species across a landholding such as the highways network. Reports produced of the condition of the asset could provide priorities for any given species. A land manager could then respond if necessary to follow up on outstanding site management. As a result the process affords accountability and asset assessment, enabling it to be used as a defence tool in relation to conformity to legislation and policy (internal and external), or in response to government initiatives such as Defra's Infrastructure for Spatial Information in Europe (INSPIRE) project data specification requirements.

The development of such systems have shown value added benefits by encouraging others, eg consultants and other government agencies, to link with other existing systems, or to link to the system by building new systems.

B1 Brown rat
(Common rat, Norway rat, sewer rat)

Species facts

Scientific name	*Rattus norvegicus*
Year of origin in UK	c1720
Place of origin	Central Asia
Habitat preference	Urban environment, farmland, watercourses, sewers
Identification difficulty	Low
Impact – environmental	High negative
Impact – economic	High negative
Impact – social	High negative
Land-use most likely to be affected	Land owners, general public, building managers

Survey times

	When surveys can be conducted											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brown rat												

Key	
Not possible	
Suboptimal	
Optimal	

Briefing

Brown rats are a common site in urban areas although they have also colonised some rural habitats such as the banksides of watercourses. They are small brown mammals with almost hairless tails (brown/grey along back and flanks and pale grey underside).

Brown rats can be confused with the rarer black rat and water vole. Water voles are protected by law and so caution should be taken during management to avoid accidentally injuring and killing water voles.

Brown rats carry bacteria called Leptospira, which causes Weil's disease in humans. It is transmitted to humans through contact with the urine of rats or with water containing their urine. Brown rats can become a serious health problem particularly when they are present in large numbers.

Brown rat problems can be reduced through good housekeeping: reducing access to food sources and clearing away cover for the rats. Lethal control methods such as laying poisoned bait and trapping in combination with good housekeeping usually successfully resolves problems.

Legislation

The following is not an exhaustive list of all legislation that affects rodent control, but includes those most relevant to the day-to-day practice of controlling rats.

Under the Prevention of Damage by Pests Act 1949, local authorities are required to keep their districts free from rats and mice. Local authorities may issue notices under the Act requiring owners/occupiers to control infestations if they refuse to do so voluntarily.

The Control of Pesticides Regulations 1986 and 1987 govern the sale, supply, storage and use of pesticides, including rodenticides. No rodenticide product can be sold or used without being approved. The regulatory authority in the UK is the Health and Safety Executive. The Biocidal Products Directive 1998 should supersede these regulations in the future.

Under the Pests Act 1954, only certain types of spring traps are approved for killing or taking animals. These are listed in the Spring Traps Approval Order 1995 issued by Defra. Break-back traps used to control rats and mice are exempted from the requirement to be approved.

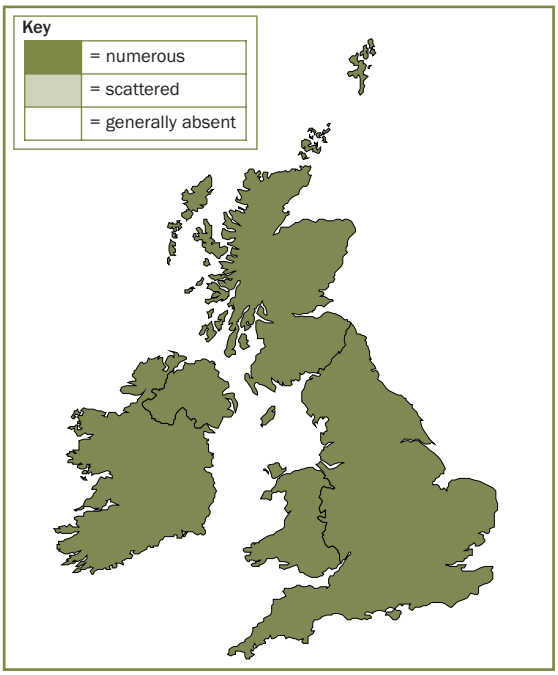
Following an EU Directive, the Hazardous Waste (England and Wales) Regulations 2005 were introduced to ensure that waste is recovered and disposed of without endangering human health or the environment. Uneaten rodenticide bait recovered at the end of treatments and dead rats that have been poisoned are covered by these regulations. Waste bait should be disposed of through a licensed waste disposal contractor. Some companies that sell rodenticide products also provide a waste disposal scheme. Dead rats are classified as controlled waste and should be disposed of at a suitably authorised incinerator or landfill, although other options, such as on-site incineration or burial may be allowed in some circumstances.

Legislation is subject to change and so before making any decisions based on the law it is always advisable to check whether legislation related to the species has been altered.

Size

28cm

UK distribution



What does it look like?

Brown rats are the most common rat species found in the UK. They have:

- body fur, which is brown/grey along back and flanks and pale grey underside (animals with black fur (melanic) occur in some populations)
- a long body and hairless tail (Figure B1.1)
- head and body (excluding tail) up to 28 cm long
- tail just shorter than combined head and body length
- pointed muzzle
- ears relatively large, furry and erect
- young rats differ from adult mice by hind feet being proportionally larger and tail relatively much thicker
- droppings are large and cylindrical, tapering to a point.

Figure B1.1 ***Brown rat (adult)***

Similar species

Black rat (scientific name: *Rattus rattus*) is rare in the UK, mainly found in port areas and off-shore islands.

Compared to the brown rat, the black rat:

- has black fur
- has very pointed muzzle, more so than brown rat
- seldom leaves tail swipes
- has a tail that is usually 20 per cent longer than combined head and body length (brown rat tail is shorter)
- has relatively large eyes and ears (ears are thin and almost hairless)
- occasionally burrows, but in urban areas prefers buildings with cavity walls or false ceilings, does not enter water
- leaves short and thin droppings with rounded ends, tend to be deposited singly.

Figure B1.2 ***Black rat (adult)***

Water vole (scientific name: *Arvicola terrestris*) is an uncommon species always associated with waterbodies, particularly streams, rivers and ditches.

Compared to the brown rat, the water vole has:

- a blunt muzzle and a furrier tail
- small inconspicuous ears close to its body that are barely visible
- a habit of entering the water with a plop
- droppings that are smaller with rounded ends and smooth texture
- burrows that tend to be close to the water's edge and sometimes below the water-line.

Figure B1.3 ***Water vole (adult)***

Identification throughout the year

Brown rat is present year-round in urban areas due to the relatively constant food supply. In rural areas population density tends to cycle annually. Signs may be difficult to spot in summer if density is low and vegetation cover high and in contrast easily found in winter when density is high and vegetation has died back.

Field signs/key identification features

Field signs

- **droppings:** large and cylindrical, tapering to a point. When in a house or dwelling, droppings found in corners and along walls
- **foot print:** adult hind foot print 4 cm to 4.5 cm long including heel, which is rarely seen in tracks in mud or snow: four toes visible on forelimb prints, five on hind limb
- structural damage, eg gnaw marks
- **tail swipes:** brown rats tend to drag their tail along the ground leaving swipes or lines especially in dusty environments unlike black rats, which tend to carry the tail off the ground
- **runs in vegetation:** 5 cm to 10 cm across grassland or along walls, usually close to cover
- **earth freshly dug from burrows heaped near entrances**, although it gradually disperses over time
- burrows under cracked paving, drain covers or damaged masonry can be identified from greasy smear around the entrance.

Box B1.1 ***Leptospirosis and Weil's disease***

Leptospirosis is the condition caused by Leptospira bacteria. It is spread from cattle, pigs and rats to humans, through contact with urine, water containing urine or tissue secretions. Rats carry the strain or serovar of Leptospira icterohaemorrhagiae, which causes a condition known as Weil's disease that can be fatal in humans.

Symptoms are usually flu-like after an incubation of around 7–12 days, exceptionally 3–30 days. Headache, chills, aches and vomiting are often experienced leading to jaundice and kidney failure.

If you suspect you have been infected with the bacteria, you should always seek medical advice, informing the doctor of your possible exposure to brown rat.

(source: various)

Negative impacts

Brown rats can carry several dangerous diseases including:

- leptospirosis (Weil's disease) (Box B1.1)
- toxoplasmosis
- Q-fever
- hantaan fever
- cryptosporidiosis.

In general, these diseases are spread by direct contact with the animals, their droppings or their urine. Water, particularly in ditches, canals and rivers can be contaminated by brown rat urine and so should be avoided where possible. Hygiene measures should be taken in all cases where brown rat may be present, including regular hand-washing and wearing gloves where possible. Never enter water with any exposed areas of broken skin – ensure that any broken skin is covered with a well-sealing, waterproof plaster or dressing.

If staff become ill without explanation, illnesses resulting from contact with brown rats or their excreta should be considered. Medical help should be sought and the doctor informed of potential exposure to brown rat.

Brown rats are also a significant pest to agriculture, mainly through damage to stored commodities, less so to standing crops.

Where rats have been introduced to areas of sensitive ecology, particularly breeding areas for rare bird species, they can have a significant negative affect on biodiversity.

Is the species likely to be present?

Is it likely to be in my region/area?

Brown rat is widely distributed and can be found in any part of the UK except exposed mountain regions and some off-shore islands.

Is the habitat on my site appropriate for it?

Brown rats are adaptable and versatile, prefer dense groundcover near water and can survive independently of humans. Sustainable populations tend to develop in habitats where the food supply is supplemented by human activity. They are most likely to be attracted to:

- domestic gardens, especially where pets or wild birds are fed outdoors
- commercial food premises
- farm buildings (eg grain stores, pig sheds, chicken sheds)
- rubbish tips
- sewers
- field margins adjacent to cereal or root crops and game-rearing activities
- canals, streams, ditches, ponds.

Shelter for brown rat includes:

- in urban areas, accumulating piles of rubbish, compost heaps in gardens, sheds, which they will often burrow underneath, broken sewers
- in rural areas, banks of watercourses, hedgerows, dead spaces between buildings.

Brown rats will eat almost anything. They are particularly likely to eat:

- cereal grains, root crops (eg swede)
- meat, fish, bones, insects and earthworms
- vegetable matter
- other animals, but also cannibalistic.

Are there corridors of spread to allow it to gain access to the landholding?

Pathways of spread and introduction include:

- watercourses, particularly canals, rivers, ditches, damaged sewers
- railway lines that allow rats to penetrate into urban areas from the countryside
- nearby permanent food supply (eg rubbish tips, farms and, in urban areas, hen coops kept in gardens)
- waste ground left undisturbed for long periods
- vehicles including lorries, trains and boats.

Undertaking a survey

Survey effort should focus on areas likely to be infested by brown rats, for example:

- areas of human habitation
- areas with suitable food sources
- areas of shelter and suitable nest sites.

When assessing land for the presence of brown rat, consideration should be given to the shelter and food requirements of the animal as well as likely pathways of introduction. Look for burrows (6 cm to 8 cm across) greasy smears, footprints in dust or mud, faeces deposited in corners or along walls of rooms or other areas, continuous runs 5 cm to 10 cm wide across grassland or along walls, evidence of structural damage, eg gnaw marks, stored food that has been eaten and fouled by droppings and urine.

Management techniques

Prevention

- reducing habitat suitability and food sources.

Suppression

- rodenticide
- trapping.

Eradication

- rodenticide
- trapping.

Management

Prevention

The most important way of preventing rats is good site hygiene. Food should not be accessible to the rats, and rubbish, particularly food waste, should always be stored in metal (not plastic) bins to prevent access by gnawing. Providing site hygiene is maintained and rats have nothing to feed on, the likelihood of them colonising a new area is greatly

reduced. Where rats are believed to be present locally and there is a risk of invasion, frequent monitoring should be undertaken.

If fresh droppings (shiny and moist in appearance) or gnawing are found, a rapid response should follow.

Suppression and eradication

Effective management of brown rats requires an integrated approach through proofing, good hygiene, trapping and baiting (Box B1.2).

Poisoned baits

Rodenticide treatments (Figure B1.4) are the most cost-effective method of reducing rat populations quickly. Most approved rodenticides are toxic to humans, pets and wildlife. Employers must ensure that employees who use rodenticides are given appropriate training and are competent to use them. Anybody using rodenticide formulations must take all reasonable precautions to protect baits from non-target interference. There are many companies that offer professional pest control services.

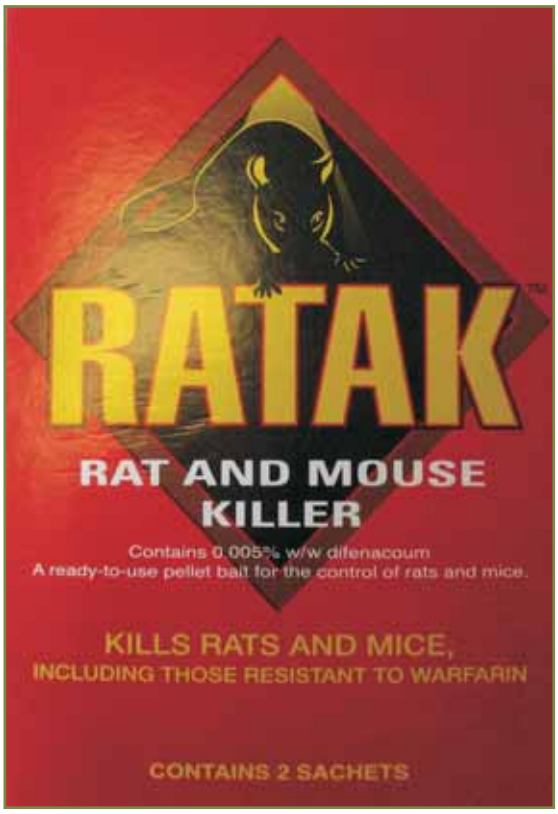


Figure B1.4 ***A packet of rodenticide***

Predominantly, rodenticide formulations contain an anticoagulant, which reduces clotting factors resulting in fatal haemorrhages. Rats need to feed on bait for two or more days to ingest a lethal dose and they normally die five to seven days after the first meal. In response to the development of resistance to warfarin, one of the first anticoagulants manufacturers introduced more potent variants, such as difenacoum and bromadiolone, to which rats also became resistant, although only in highly localised parts of the UK. The most potent anticoagulants, brodifacoum and flocoumafen, can be fatal after a single feed, but their toxicity to other animals has led to their use being restricted to indoor locations only. Anticoagulant baits are presented as loose cereal grains, pellets or wax blocks and contain a warning dye (typically blue or red). Baits are usually applied inside specially made containers – some are tamper-resistant (Figure B1.5):

- **advantages:** cost-effective, slow-acting, so no poison shyness, antidote available for humans
- **disadvantages:** dead rat odour, death is not immediate, toxic to other animals, resistance to the poison can develop.

Figure B1.5 ***A box containing rat poison***

Under the Biocidal Products Directive 1998, all rodenticides are reviewed and decisions are made on which rodenticides, formulations and methods of use are approved, eg several non-anticoagulant products have been withdrawn recently, although powdered corn cob is still registered.

Trapping

Most suitable for small populations, or where risk of contamination precludes use of poison baits (Figure B1.6). Rat traps are designed to either kill rats or catch them alive for subsequent humane despatch. The latter option provides a safeguard for non-target animals, which can be safely released if caught. Traps should always be visited at least once every 24 hours. Use of glue boards is controversial and should only be used as a last resort and users should follow the British Pest Control Association's code of practice <http://www.bpca.org.uk>.

- **advantages:** effective if located properly, less health and safety risk as no toxic chemicals are used, live trapping can be used to safeguard non-target species
- **disadvantages:** labour intensive, risk of harm to animals if not undertaken sensitively.

Health and safety

Due to the pathogens potentially carried by brown rats, hands should be washed immediately following any contact with the animals or the areas where they are living. If possible, gloves should be worn. No hand to mouth contact should occur within risk areas and cuts or broken skin should be covered with plasters or dressings (see *Negative impacts*). Do not while working in such areas and do not put your hands to your mouth or any cuts/scrapes.

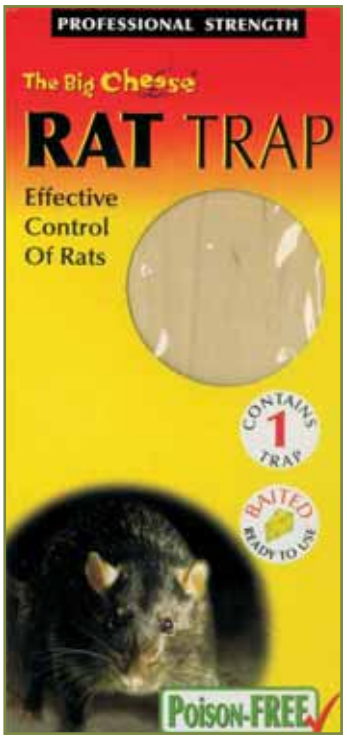


Figure B1.6 ***A typical lethal rat trap***

Box B1.2 ***Brown rat eradication***

1 Free eradication

Some local authorities such as Oldham Metropolitan Borough Council, offer free rat eradication. This is due to rats being classed as a public health pest, and they can be controlled regardless of whether it is a private dwelling or private business or development. Local authorities also have enforcement powers to ensure that rodent control is carried out. If necessary, enforcement notices can be served on the persons responsible for any land that is infested, requiring that they are eradicated. If these notices are not complied with then powers are available to either carry out the works required directly and charge the costs or to initiate court proceedings.

2 Pest control provided by a private control company

Scenario 1: 4-5 houses on a plot, 2-3 bedroom houses

- survey of site: free
- each house would require two rat boxes: plastic boxes are £35 per box, stainless steel boxes are £66 per box
- additional monthly visits would be required to inspect the boxes, approximately £50 per house per visit (a minimum of three months monitoring would usually be advised).

Scenario 2: Supermarket sized building

- survey of site: free
- supermarket sized building usually requires approximately 20 plastic boxes (£35 per box)
- additional monthly visits are required to inspect the boxes at approximately £150 per visit (a minimum of three months monitoring would usually be advised).

(source: Oldham Metropolitan Borough Council)

Further information

Publications

Buckle, A P and Smith, R H (eds) (1994)
Rodent pests and their control
CAB International, Oxford (ISBN: 0-85198-820-2)

Mehan, A P (1984)
Rats and mice: their biology and control
Rentokil Ltd, East Grinstead, UK
(ISBN: 0-90656-405-0)

Strachen, R and Moorhouse, T (2006)
Water vole conservation handbook
Wildlife Conservation Research Unit, Oxford
(ISBN: 0-95463-764-X)

Websites

British Pest Control Association
<www.bpca.org.uk>

Health Protection Agency

<http://www.hpa.org.uk/>

Health and Safety Executive
<http://www.hse.gov.uk/>

Web downloads

Leptospirosis:

Health Protection Agency (2007)
Leptospirosis and Weil's disease
<http://www.hpa.nhs.uk/web/HPAwebFile/HPAweb_C/1194947413135>

Rodent control and rodenticides:

HSE information sheet MISC515: *Urban rodent control and the safe use of rodenticides by professional users* <http://www.hse.gov.uk/pubns/misc515.pdf>

HSE Agriculture information sheet no. 31:
Safe use of rodenticides on farms and holdings
<http://www.hse.gov.uk/pubns/ais31.pdf>

Guidelines on control of rodents:

Central Science Laboratory (2002)
The control of rats with rodenticides: a complete guide to best practice
<http://www.csl.gov.uk/newsAndResources/resourceLibrary/articles/RatControlGuidelines.pdf>

Acts, Directives, Regulations and Orders

- The Prevention of Damage by Pests Act 1949 (c.55)
- Pests Act 1954
- The Spring Traps Approval Order 1995
- Statutory Instrument 1995 No. 2427
- The Control of Pesticides (Amendment) Regulations 1997
- Statutory Instrument 1997 No. 188
- Biocidal Products Directive 1998
- The Hazardous Waste (England and Wales) Regulations 2005
- Statutory Instrument 2005 No. 894

Office of Public Sector Information
<http://www.opsi.gov.uk/>

C1 Edible dormouse

Edible dormouse

Scientific name: *Glis glis*. A non-native mammal causing a range of problems but only in one part of the UK. A good candidate for preventative measures.

Edible or fat dormouse is twice the size of the native dormouse but smaller than a squirrel. Primarily nocturnal in its activities, it is difficult to see. A native of continental Europe, it was introduced to the UK in 1902 as part of a wildlife collection at Tring, Hertfordshire. Mainly concentrated in a 520 km² triangle between Beaconsfield, Aylesbury and Luton but is slowly expanding its range and in the late 1990s there were at least 10 000. Outlying records exist, eg Sandy, Bedfordshire, and persist because of the animal's long lifespan and loyalty to a particular area. They can remain in an area undetected for a long time. Spread is considered to be both natural, which is very slow, and by people trapping an animal and reluctant to kill it, releasing it, sometimes at a considerable distance, spreading them beyond natural barriers. Such action is illegal (see *The law*).

Current status

Present in the UK, causing problems in only one area.

Description

Length of the body (excluding tail) is 14–20 cm. Silvery grey back and head with dark, narrow rings around the eyes. Under-parts are yellowish-white and fur is short, soft, and thick. Overall, somewhat squirrel-like in appearance with large and rounded ears, small eyes, and a long bushy tail (11–19 cm) (only mammal in the UK with a squirrel-like tail apart from squirrels). Hands and feet have hard pads. The four digits of the forefeet and the five digits of the hind feet have short, curved claws.

Impact

A pest of orchards and forestry, can damage fruit crops and its habit of bark stripping (typically spiral bark stripping at branch bases), especially conifers and young trees in plantations, and is very destructive. Timber losses in Forestry Commission woods (1990) were up to £2000 per hectare in some areas. Stripping bark from beech trees in lowland beech and yew woodland (a UK Biodiversity Action Plan habitat) can result in tree death, disruption of normal age structure and shifts in species composition. Also causes damage to stored fruit, gnaws electric cabling and wood in roof spaces and has been found drowned in water

tanks, fouling the water. Deposits offensive amounts of droppings and urine.

Management

In residential and industrial property, control is by trapping and humane destruction, which must be undertaken by a licensed individual. One council charges £85 per treatment and a £35 refundable deposit to hire the trap. This involves setting the trap for 12 weeks with edible dormouse being humanely removed.

The law

Edible dormouse is protected under Section 11(2) of the Wildlife and Countryside Act 1981 in that certain methods of killing or taking are prohibited unless a licence has been issued. Occupiers of land may kill or take edible dormice by any non-prohibited method without needing a licence. If an edible dormouse problem cannot be resolved without resorting to a prohibited method (such as trapping), a licence may be issued to permit this method. The Natural England Wildlife Licensing Unit administers all licence applications for edible dormice. This includes licences to prevent damage to forestry and to residential and industrial property. It is an offence under Section 14 of the Wildlife and Countryside Act 1981 to release or allow the escape of edible dormice into the wild.

Since 1 January 2008, general licence WMLGen-LO27 has been available for killing and taking edible dormice using cage traps and approved cage and spring traps for purposes including protecting public health and safety. The licencee must notify Natural England's Wildlife Licensing Unit of intentions to carry out the activities permitted by the licence, on the first occasion intended to do so.

Legislation is subject to change and so before making any decisions based on the law it is always advisable to check whether legislation related to the species has been altered.

Problems involving dormice may be resolved without recourse to a licence. For advice contact the Natural England Wildlife Licensing Unit, your local authority, or a reputable pest control firm or consultant, for help (look under pest and vermin control services in the Yellow Pages).

Further information

Wildlife management and licensing advice:

Defra: <http://www.defra.gov.uk>

Publications

For map of distribution in UK see:

MacDonald, D (2005)
Collins field guide to the mammals of Britain and Europe
Harper Collins, London
(ISBN: 978-0-00219-779-3)

Websites

Natural England Wildlife Licensing Unit
<http://www.naturalengland.org.uk/conservation/wildlife-management-licensing/contacts.htm>

Acts, Directives, Orders and Regulations

Wildlife and Countryside Act 1981
<http://www.opsi.gov.uk>

C2 Elephant grasses

Elephant grasses

Scientific name: *Miscanthus*. Elephant grasses are non-native plants being used as a new biomass crop and as an ornamental species in various parts of the UK. If they were to become established outside of cultivation, their size alone could become a problem.

Elephant grasses are perennial grass species native to subtropical and tropical regions of Africa and south Asia, with one species (scientific name: *Miscanthus sinensis*) extending north into temperate eastern Asia. Elephant grass species have been introduced to Europe and North America as ornamental grasses and for use in biomass production. Sterile crossbreeds are usually used in biomass fuel production (eg *Miscanthus giganteus*, a hybrid between *Miscanthus sinensis* and *Miscanthus sacchariflori*s). These species are unlikely to be invasive as spread by rhizomes is slow. Fertile forms are used as garden ornamentals, such as *Miscanthus sinensis*, which has been documented as invasive in parts of the USA, having naturalised and invaded native plant communities.

Current status

Present in the UK under cultivation, not causing problems.

Description

Large (up to 4 m tall) perennial grasses. Have showy flowers composed of several small individual flowers, surrounded by many hairs, white, beige, red or pink in colour. Spread is predominantly by rhizomes but can be by wind-dispersed seeds. Sterile crossbreeds can only spread by rhizomes.

Impact

Potential to out-compete native species due to tall and vigorous growth that shades out other species.

Management

Removal involves either application of a post-emergence non-selective herbicide (eg glyphosate) followed by ploughing, harvesting of rhizomes or continuous mowing to exhaust the rhizome.

The law

There is no legislation relating to elephant grasses at present but legislation is subject to change and so before making any decisions based on the law it is always advisable to check whether legislation related to the species has been altered.