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2010 International Year of Biodiversity

Environment Agency

managing invasive non-native plants

Managing invasive non-native plants in or near fresh water

Revised version April 2010

We are the Environment Agency. It's our job to look after your environment and make it a better place – for you, and for future generations.

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April 2010

Foreword

People living in and visiting England and Wales are able to enjoy and benefit from a wide range of native plant-life. But sometimes the natural diversity is threatened by the introduction and spread of invasive non-native species.

While only a small percentage of non-native plants introduced in England and Wales represent a problem, when they do become established in the wild, certain types can have a dramatic effect. Careless disposal of garden waste, by dumping it over fences, hedges and into lay-bys, ditches, streams and ponds, increases the chances of these plants spreading into the countryside. This can lead to long-term consequences for native biodiversity.

Invasive non-native species can harm the environment in different ways. Whilst Himalayan balsam and water primrose are colourful and attractive, they often become so prolific that they displace native plants. Dense mats of floating pennywort or parrot's feather can choke watercourses leading to increased flood risk, reduced angling opportunities and problems for navigation.

Several non-native species are already well-established and are likely to spread further as a result of climate change. Others that are currently not a problem could become invasive as temperature rises create better growing conditions for them. The Invasive Non-Native Species Framework Strategy for Great Britain launched in May 2008, by Defra and the devolved administrations, has spurred public and private sector organisations, charities, local groups and individuals into action and much good work has been done to tackle local problems. The purpose of this guidance is to increase awareness of some of the invasive non-native plants that are a priority for us and to provide advice on how the problems they cause can be reduced.

We are publishing this revised guidance, in the International Year of Biodiversity, as part of our contribution to the conservation of wildlife along the waterways and fresh waters in England and Wales.

Paul Leinster
Chief Executive, Environment Agency

Contents

What are invasive weeds?

Several types of plant can become invasive weeds. They are either native species that grow well in disturbed or nutrient-enriched conditions, to the detriment of other plant and animal species, or non-native plants that have been introduced to this country by accident or as a consequence of trade or deliberate collection. The latter tend to grow in situations where native plants of similar form do not. Not all non-native species become weeds, but if they do, they become very difficult to control. Native weed species, although troublesome, do not cause as much ecological or physical damage as the non-native variety. This booklet deals with those non-native invasive species that have caused serious problems in the aquatic and riparian environments of Britain.

Invasive non-native species tend to share characteristics that make them successful. These are related to the method of reproduction, growth rate, growth form and persistence, but in particular the absence of pests and diseases and their consequent resistance to control. Species in aquatic plant families are more likely to be both weedy and invaders of natural environments than those of any other plant families. In addition, the frequently disturbed nature of man-made aquatic habitats and artificial nutrient enrichment of aquatic systems makes them more prone to invasion. Successful management of alien invasive species requires an understanding of how they grow and also the ecology of the aquatic systems in which they occur.

The introduction of plant species into new environments carries risks. The danger of species becoming serious weeds in agricultural areas is well controlled, but other potential weeds are not currently recognised and subject to risk assessment and management. The effects of climate change will alter the distribution of weed species in future; already, several aquatic weeds found in Europe originated in sub-tropical areas of the world. The predicted consequences of global warming, including increased temperatures, increased carbon dioxide and stormier weather, make it more likely that additional invasive species will cause problems in future. The huge increase in the distribution of Himalayan balsam since 1962 indicates that conditions are ideally suited for this species. Other species may respond similarly in future if climate change favours their colonisation and rapid growth. Plants that grow in water and on riverbanks can cause flooding if not managed correctly. All the species described in this booklet create serious flood risks.

The consequences and costs of invasive non-native species are huge. The annual cost of invasive non-native species in Europe is estimated as at least 19.1 billion Euros a year. This booklet tells you how to identify seven problem species and how to reduce their threat to aquatic ecosystems.

Existing legislation

When non-native species become invasive they can transform ecosystems, causing a variety of problems including seriously threatening native and endangered species. These problems are acknowledged in several international treaties, European Union Directives and also in domestic legislation. The problems caused by some invasive non-native species occur worldwide, and international obligations to address them are placed on the United Kingdom through regional and global agreements. These include the Convention on Biological Diversity (CBD), International Plant Protection Convention (IPPC), the Bern Convention on the Conservation of European Wildlife and Natural Habitats, and the EC Habitats and Species Directive. The sixth CBD conference adopted a series of Guiding Principles for States to follow as part of their invasive non-native species policies.

The Wildlife and Countryside Act 1981 provides the primary controls on the release of non-native species into the wild in Great Britain. It is an offence under section 14(2) of the Act to 'plant or otherwise cause to grow in the wild' any plant listed in Schedule 9, Part II. The seven plants described within this booklet will all be included in Schedule 9 from April 2010.

Stricter enforcement provisions for wildlife offences were introduced under the Countryside and Rights of Way Act 2000. These include increased penalties available to the courts for offences committed under the Wildlife and Countryside Act 1981.

The Weeds Act 1959 provides for the control of five specified weeds. These are non aquatic species, though ragwort, (*Senecio jacobaea*), can grow in riparian areas. This legislation is directed at clearing weeds that threaten agricultural production.

The Government has acknowledged the problems that can be caused by non-native invasive species. In 2008 the Government launched 'The Invasive Non-Native Species Framework Strategy for Great Britain'. The strategy provides a framework for a more co-ordinated approach to invasive species management. It seeks to create a stronger sense of shared responsibility across government, key organisations, land managers and the public.

Other legislation relevant to non-native species control includes:

- Environmental Protection Act 1990
- Environmental Protection (Duty of Care) Regulations 1991
- Town and Country Planning Act 1990
- Highways Act 1980
- Water Resources Act 1991
- The Environmental Permitting (England and Wales) Regulations 2007
- The Landfill (England and Wales) Regulations 2002

The Non-Native Species Secretariat has been established to oversee the implementation of the strategy. Details of the secretariat are available at **www.nonnativespecies.org**. This site also provides valuable reference material, such as identification sheets, species risk assessments and action plans, and details of local action groups that may be active in your area.

Responsibility for invasive weed control

Responsibility for dealing with invasive weeds rests with individual landowners. Strategic, widespread control is currently not the sole responsibility of any statutory organisation. The Environment Agency may seek to control specific invasive weeds on land that it owns or flood defence structures that it maintains.

Control efforts by individuals can help reduce the spread of invasive non-native species and are most successful if carried out as a catchment wide co-ordinated strategy with collaboration of all relevant parties. Control often needs to be repeated year after year.

General methods of control

There are four basic methods of controlling weeds: mechanical, chemical, natural and environmental. Mechanical control includes cultivation, hoeing, pulling, cutting, raking, dredging or other methods to uproot or cut weeds. Chemical control uses specific herbicides. Natural control uses pests and diseases of the target weed to weaken it and prevent it from becoming a nuisance. Environmental control works by altering the environment to make it less suitable for weed growth, for example by increasing or decreasing water velocity.

In England and Wales the use of herbicides in or near rivers, canals, lakes and drainage channels requires prior agreement from the Environment Agency. Users must follow the instructions on the label.

Health and safety

Take care when using machinery or herbicides. Environment Agency staff, contractors and others should undertake Control of Substances Hazardous to Health (COSHH) assessments for the activity, and others should be aware of the risks of working near water. There is often a high risk of slipping on banks and other muddy surfaces when carrying equipment or chemicals.

All mixing and application of herbicides must be carried out in accordance with the manufacturer's instructions, which will be found on the product label. All precautions recommended by the manufacturer must be followed.

Although most species in this booklet are not toxic to humans, great care should be taken to avoid contact with the sap of giant hogweed, as this can cause serious skin blistering.

Disposal of non-native weeds

Plant material is considered a 'controlled waste' and must be disposed of in accordance with, and environmental permit issued under, the Environmental Permitting (England and Wales) Regulations 2007, unless one of the exemptions set out in Schedule 3 of these regulations applies, although exemptions also require registration with the Environment Agency.

The correct disposal of plant material as part of mechanical control is vital. It is best to contact the Environment Agency for advice on disposal because there are Regulations which cover the composting, burning and burial of plant materials on-site and transfer and disposal of material to permitted landfill sites. Any burning must not produce excess smoke or create a nuisance and must take place on a hot fire consisting of wood or clean timber. Plastic and other rubbish must not be burnt. Tyres and petrol must NEVER be used to start a fire. The Environment Agency can give advice on suitable disposal sites and disposal methods.

Japanese knotweed will survive composting and therefore this method of disposal is NOT advisable. Japanese knotweed must only be buried or burnt in accordance with Environment Agency advice. Failure to ensure safe legal disposal or obtain an appropriate licence or exemption could result in prosecution. Burial on-site may require a licence under the Landfill Regulations 2002, whilst removal of plant material will need to be carried out by a licensed waste carrier and buried at a licensed landfill site. Further advice is available from 'The knotweed code of practice – managing Japanese knotweed on development sites', published by the Environment Agency.

Monitoring

New records of the plants described in this booklet will be helpful in assessing how fast they are spreading and determining local control options. If you see any of these species, please tell Dr Jonathan Newman, Centre for Ecology and Hydrology – **jone@ceh.ac.uk**, or telephone **01491 692556**. Information required is the exact location, with a map grid reference if possible, the extent of the infestation and the kind of water body it is affecting.

What to do and what not to do

Do:

- **take immediate action;**
- contact the Centre for Ecology and Hydrology to confirm identification and the location of the plant;
- seek advice on correct management for your specific location;
- obtain approval from the Environment Agency if planning to use herbicides;
- remove all plant debris from the water after cutting operations;
- seek advice from the Environment Agency on the disposal of plant material;
- alert your neighbours to the problem.

Don't:

- **delay in doing something;**
- allow the plant to spread to nearby water bodies;
- dispose of cut material in the nearest water body;
- use invasive non-native species in habitat restoration projects.

Fact file

Japanese knotweed

Source: NBN Gateway. Check website for current distribution

Japanese knotweed was first brought to Britain in the mid-nineteenth century as an ornamental garden plant. Since then it has caused serious problems in a range of habitats – particularly roadsides, riverbanks and derelict land – by displacing native flora and even causing structural damage. There are three species of invasive knotweed in the UK: Japanese knotweed (*Fallopia japonica*); giant knotweed (*Fallopia sachalinensis*); and hybrid knotweed (*Fallopia x bohemica*), which is a cross between Japanese and giant knotweed. Japanese knotweed is the most widespread and troublesome bankside species, followed closely by hybrid knotweed, which has a similarly high regeneration capacity.

Only female plants are present in the UK. Japanese knotweed forms dense clumps with fleshy, red/green shoots, 2-3m tall, which have hollow green stems with red/purple flecks. Leaves are green, heart or shield-shaped with a flat base, up to 120mm long. Creamy clusters of flowers are borne on the tips of most stems in late summer. The root system consists of rhizomes which are orange/yellow when cut.

The underground rhizome system can extend at least 7m from the parent plant, and reach a depth of 3m or more. A piece of rhizome the size of a little finger nail can grow into a new plant. The crown, located at the base of the stem, will produce new plants. The stems die back in winter and take up to three years to decompose. Japanese knotweed should not be removed from site without a waste licence.

Control

Knotweed should be cut with a single clean cut near the base of the stem. Cutting methods that produce fragments, such as flailing, should be avoided. Stems can regenerate from nodes, or fragments of nodes. If cut stem is dried until it is crisp and brown it can be burnt or disposed of as an inert waste. **If stems have been pulled up, they will have fragments of knotweed crown still attached at their base. This is highly regenerative and will regrow, even after the stem has dried. Avoid pulling stems. Refer to the code of practice for their disposal.**

Chemical control using a biactive formulation of glyphosate approved for use in or near water is the most effective treatment near water. *Spraying both top and underside of leaves improves control*. Chemical treatment is most effective when it is applied in Aug-Sept, particularly when applied to mature uncut growth. This provides the greatest surface area for herbicide to be translocated down to the rhizome. A stem injection method can be used to avoid damage to surrounding sensitive areas.

The knotweed code of practice is available on the Environment Agency website. Copies can also be requested by calling the Environment Agency National Customer Call Centre on 08708 506 506. The code was written to provide advice on the management of Japanese knotweed on development sites, but much of the advice regarding control and disposal may be useful for riparian control.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Cutting

Use a simple scythe method of cutting to prevent stem fragmentation. Flail mowing, or similar methods, should not be undertaken.

Cutting will have to be performed every 2-4 weeks during the growing season if it is the sole method of management. Alternatively, treat regrowth with herbicide.

Burn cut stems on site or remove to landfill (licence required).

Digging

This is rarely an option that is appropriate to riparian situations. If digging is undertaken, refer to the code of practice and ensure that no knotweed material is allowed to enter the watercourse.

Biological

Grazing of shoots by horses, donkeys, sheep and goats may keep the plant in check, provided previous dead growth is removed.

The psyllid bug *Aphalara itadori* will be released in 2010 and should reduce the vigour of Japanese knotweed in the UK.

Chemical control

Glyphosate

Glyphosate is more effective when applied to mature canes in Aug-Sept. If access or the risk of drift is a problem, either cut or spray the stems earlier in the season to restrict regrowth. For formulations approved for stump treatment, a 1 in 10 dilution can be used for stem injection.

2,4-D amine

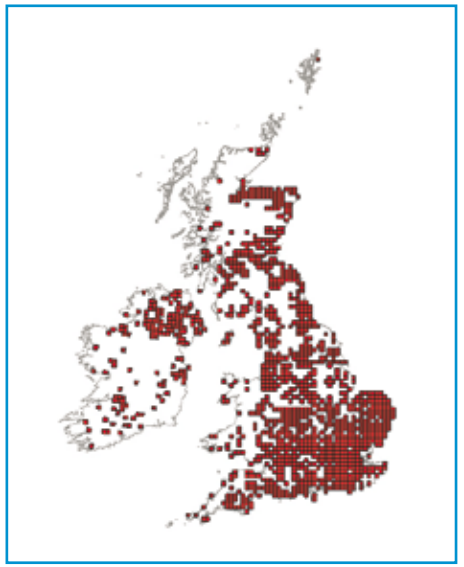
2,4-D Amine is also effective against knotweed and is best applied in May.

In general

Herbicides can be applied using tractor-mounted, knapsack long-lance or CDA applicators. Control is easier if dead winter stems are removed before growth commences. Be careful to avoid spreading knotweed crowns when clearing dead canes. Application in sensitive areas is best achieved by stem injection or weed wiper.

Fact file

Giant hogweed



Source: NBN Gateway. Check website for current distribution

Giant hogweed (*Heracleum mantegazzianum*), is a native of the Caucasus mountains and was introduced to Britain in 1893 as an ornamental plant. It escaped from gardens and now colonises many areas of wasteland and riverbanks. Each flowerhead produces several thousand seeds that are easily dispersed by water, so the plant spreads rapidly along watercourses.

It is a perennial plant, taking up to four years to mature and flower, after which it dies. It forms dense colonies that suppress the growth of native plants and grasses, leaving the banks bare of vegetation in winter and increasing the risk of erosion and recolonisation from seeds washed downstream.

Growth starts in March and the plants reach 5m in height. The leaves are dark green, and form a rosette. The lobes are deeply cut and spiked at the ends. The stems are green with dark red or purple spots or blotches. Stems are ribbed, with sparse spiky hairs on the ridges. The stems are hollow and up to 100mm across. The flowers are white, forming a large umbel. Each plant produces up to 50,000 seeds,

approximately 10mm long by 7mm wide. Seeds may remain viable for up to 15 years.

Control

The aim should be to kill the plant or prevent flowering. Repeated treatment may be necessary during the growing season to prevent flowering.

Chemical control using glyphosate at 6 litres/ha is the most effective method. Spraying can start as soon as the plant is about 1m high, usually in March and continue throughout the summer. More than one application is often necessary and follow-up spraying will be required to kill seedlings in subsequent years.

Cutting down the stems with a sharp scythe or sickle before flowering will help to control this plant. Flail mowing may be carried out, but extreme caution is required to avoid the risk of being sprayed with sap. Strimming is not recommended, unless full protective clothing is worn.

Digging out the crown just below ground prevents regrowth and will provide good control. Alternatively, make a spade cut at 45 degrees to sever the tap root at approximately 15cm below soil level.

Health hazard

Children have been known to use the hollow stems as 'pea shooters' and 'telescopes'. However, the stems, edges and undersides of the leaves bear small hairs containing poisonous sap, and the slightest touch causes painful blistering and severe skin irritation. Unshaded habitats with high soil nitrate levels (for example, riverbanks, roadsides and waste ground) tend to produce greater quantities of toxins in the plant. Contact with the cut material in sunlight produces a skin reaction in almost all cases. Blistering symptoms occur 24-48 hours after exposure, and dense pigmentation is visible after three to five days. This may persist for six years or more. Cut material remains active for several hours after cutting. Protective clothing must be worn when treating this plant because the hairs can penetrate light fabrics.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Cutting

Cut root approximately 15cm below ground using a spade. Wear full protective clothing, especially if strimming. Cut regularly early in the season to prevent flowering. Cutting should be repeated regularly for between 5 and 10 years to eradicate the plant.

Digging

Shallow excavation to about 20cm will remove the growing crown. Spoil should be disposed of at landfill or by piling on site and composting. Any regrowth should be treated chemically.

Biological

Grazing by cattle, sheep, pigs or goats throughout the growing season will suppress growth, but does not eradicate it. There is further research into potential biological controls.

Chemical control

Glyphosate

In mixed stands, use a weed wipe when plants are about 1m tall between March and May. When plants are more than 1.5m tall, proceed with extreme caution. Repeat chemical treatment may be required for up to 10 years.

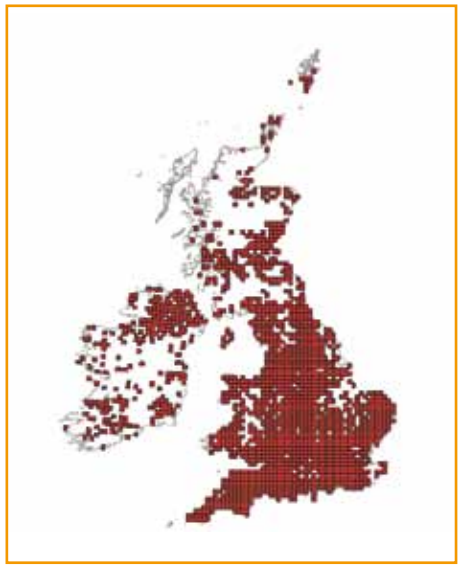
Cutting the stem above ground, followed by injection of 1 in 10 dilution of glyphosate in water below the first node, will give good control. This technique can be used for established plants later in the season.

In general

It is essential to establish vegetation quickly after control measures have been applied. Dense grass sward tends to discourage seed germination. Control should be undertaken on a catchment basis, working from the upstream end to prevent seed recolonisation.

Fact file

Himalayan balsam



Source: NBN Gateway. Check website for current distribution

Himalayan or Indian balsam (*Impatiens glandulifera*) is a native of the western Himalayas. Introduced to Britain in 1839, it escaped from gardens and rapidly colonised river banks and areas of damp ground. It is the tallest annual plant in Britain, growing up to 3m high. The characteristic purplish-pink slipper-shaped flowers appear in June. When the seed pods mature, they explode when touched, scattering the seed up to 7m away. Seeds are also spread by water and they may remain viable for up to two years.

Himalayan balsam plants grow in dense stands that suppress the growth of native grasses and other flora. In autumn the plants die back, leaving the banks bare of vegetation, and therefore liable to erosion.

The stems are pinkish-red, hollow and jointed, often with some branching. Leaves and side branches originate from stem joints. The stem is sappy and brittle. The shiny dark green leaves are lance-shaped, have serrated edges, a dark red midrib and can be up to 150mm long. They grow on the stem in whorls of three. Purplish-pink flowers, held on long stalks, appear from June to October.

The white, brown or black seeds are produced from July to October and are 4-7mm in diameter. There are between 4 and 16 seeds per pod.

Control

Control measures should aim to prevent flowering, and are best carried out before June for maximum effectiveness.

Chemical control near water can be carried out with herbicides containing glyphosate or 2,4-D amine. Glyphosate will also kill grasses, but 2,4-D amine will kill only broad-leaved weeds; for best effect, use when the plant is small and actively growing, particularly in springtime.

Cutting, strimming or pulling on a regular basis for about three years will be effective and may even eradicate the plant from isolated sites. Plants must be cut below the lowest node to avoid reflowering.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Cutting
Cut at ground level using a scythe, machete, flail or strimmer before the flowering stage in June. Cutting earlier than this will promote greater seed production from plants that regrow. Cutting should be repeated annually until no more growth occurs.

Pulling
Shallow-rooted plants can be pulled up very easily and disposed of by burning, or composting unless seeds are present.

Biological
Grazing by cattle and sheep is effective from April throughout the growing season. It should be continued until no new growth occurs. There is encouraging evidence for the potential for biological control.

Chemical control

Glyphosate
Treatment with a weed wipe in mixed stands, or by foliar spray in dense stands, before flowering. If all plants are controlled, then spraying programmes should only be required for two to three years.

2,4-D amine
Treat during early spring at the rosette stage for effective control.

In general
It is essential to establish vegetation quickly after control measures have been applied. Dense grass sward tends to discourage seed germination. Control should be undertaken on a catchment basis, working from the upstream end to prevent seed recolonisation.

Fact file

Australian swamp stonecrop

Source: NBN Gateway. Check website for current distribution

Australian swamp stonecrop (*Crassula helmsii*) was introduced from Tasmania to Britain in 1911. It was first sold as an 'oxygenating plant' in 1927.

The first occurrence in the wild was reported in Essex in 1956. In recent years, it has spread much more rapidly due to the increased availability of the plant at garden centres and aquatic nurseries. It is now widespread across the UK. It is sometimes referred to as *Tillaea recurva*, *Tillaea helmsii*, or New Zealand pigmy weed.

The plant is easily dispersed and, although not always sold by suppliers, it is often found as a 'contaminant' with other water plants. Introductions to new sites are associated with a wide range of human, water-based activities, and awareness and education programmes can dramatically reduce transport of the plant between sites. Local dispersal is aided by the high viability of small fragments, which can be carried on mud to new sites.

The success of *Crassula* lies mainly in its ability to colonise virtually any

suitable static to very-slow-flowing freshwater habitat across a wide range of water chemistry. It has vigorous, year-round growth, and can grow equally well either on damp ground or in water up to 3m deep.

Where *Crassula* invades, it quickly out-competes native vegetation, and maintains its dominance by very rapid growth and uptake of almost all the available nutrients.

There are three typical growth forms: (i) a terrestrial form with creeping stems and aerial, succulent leaves; (ii) an emergent form with densely packed stems, found in water less than 0.6m deep; (iii) and a submerged form that grows from a basal rosette with long, sparsely-leaved stems reaching the surface. The three forms change according to prevailing conditions. The rigid stems have pairs of fleshy leaves that vary in shape from long and narrow in deeper water to slightly elliptical, with sharp or bluntish tips in air. The leaf tip is never notched, which distinguishes it from the native water starwort (*Callitriche* spp.). The leaf bases are joined, forming a distinctive 1mm collar around the stem. In summer, white flowers grow in the axils of the leaves on emergent and terrestrial forms.

Control

This plant is best treated at the early stages of infestation. Delay will make the problem several orders of magnitude worse in each successive year.

Emergent growth can be controlled using a highly dilute, high volume solution of glyphosate (5ml/l), applied at a walking rate of 6 seconds per metre. This provides a treatment of 6l/ha.

Cutting is not recommended, but dredging out marginal and emergent material can be effective, as the plant is shallow-rooted. The area around any infestation should be fenced to prevent movement of fragments by livestock. Dredged material should be piled in heaps and covered with thick black polythene sheeting or at least 20cm of soil.

Shading of terrestrial or emergent forms with opaque material such as black polythene for about three months may be effective, but is difficult to install and manage, and vandalism can be a problem.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Cutting
Not recommended.

Dredging
Dredging of marginal and emergent material throughout the year can be effective, although it is necessary to ensure that plant fragments cannot be transported elsewhere.

Shading
Covering with black polythene or similar for up to 3 months during the growing season.

Chemical control

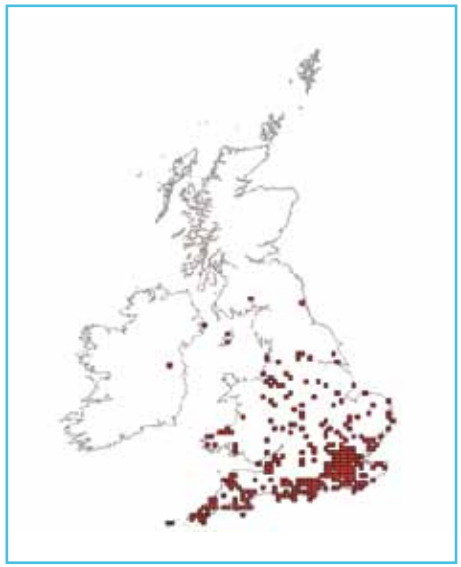
Glyphosate
Application of glyphosate at 6 litres/ha to emergent stands from March to October. Regular treatment is required, and at least two applications may be necessary each year.

Submerged
There is no effective herbicide treatment for submerged *Crassula*. Draw down or drain the waterbody, if possible, and treat as emergent growth.

In general
Regular treatment is necessary. Weed wiping may be appropriate in mixed marginal vegetation. Spot treatment of small patches will prevent complete dominance. Treat early and regularly.

Fact file

Parrot's feather



Source: NBN Gateway. Check website for current distribution

Parrot's feather (*Myriophyllum aquaticum*) is a native of lowland central South America. It was first found in Britain in 1960 and has now spread extensively, particularly in southern England. It grows in ponds, reservoirs, gravel pits, streams, canals and ditches, particularly where eutrophic water occurs. It can grow as a terrestrial plant when a pond dries out, and has even been found growing on the dry bank of a rubbish tip in Cornwall. It produces emergent shoots in addition to submerged ones, which give it the characteristic feathery appearance, hence its name.

Only female plants are established in the UK and it therefore spreads by vegetative means only. The stems are brittle and the plant propagates by growth from small stem fragments. The species is attractive to look at and is widely grown in garden ponds. Introductions to the wild are usually not deliberate, but fragments can be concealed in the soil of other pot plants sold at aquatic garden centres and nurseries.

Contact the Environment Agency for disposal advice on 08708 506 506

Control

Chemical control can be achieved by applying glyphosate with the adjuvant Topfilm to emergent growth. Hand-pulling can be a very effective method of control.

Volunteer groups can tackle large infestations with the use of rakes and forks. Care is needed to ensure fragments do not drift and establish growth elsewhere.

Non-chemical control

Pulling

Material must be removed from the water as soon as possible. Fragmentation must be avoided. Material should be removed as often as necessary and at least every six to nine weeks from March to October to weaken the plant.

Dredging

Dredging shallow areas will remove this plant very effectively. Carefully pulling out stems by hand after mechanical removal will help to eradicate it.

Biological

The plant is not palatable to herbivores; cattle and horses will avoid it. There is virtually no insect damage to plants in the UK, but research into biological control agents is under way.

Chemical control

Emergent

Apply glyphosate at 6 litres/ha to emergent stands from March to October. Regular annual treatment is required, and at least two applications will be necessary each year. The adjuvant Topfilm improves efficacy.

In general

Regular treatment is necessary. Weed wiping with glyphosate may be appropriate in mixed marginal vegetation. Spot treatment of small patches will prevent complete dominance. Treat early and regularly.

Fact file

Floating pennywort

Source: NBN Gateway. Check website for current distribution

Floating pennywort (*Hydrocotyle ranunculoides*) is a native of North and South America. It was first brought to Britain in the 1980s as a plant for tropical aquaria and garden ponds, and was first noted in the wild in Essex in 1991.

Floating pennywort grows in the shallow margins of slow-flowing eutrophic water bodies (particularly ditches, slow flowing dykes and lakes), and forms dense interwoven mats of vegetation. These quickly cover the water surface interfering with both the ecology and amenity uses of the water body. These mats grow up to 15m from the bank in a single season, with stem growth rates of up to 20cm per day.

Floating pennywort roots freely from nodes at approximately 40-150mm intervals. The roots are profuse and hair-like. The leaves are emergent, rising on stalks from horizontally growing stems. Both the stem and the petioles are fleshy. The leaf form ranges from circular to kidney-shaped; they are deeply lobed, and up to 180mm across. Leaves are held above the water surface whilst the interwoven mat of roots and stems sink up to 1.2m into the water.

Reproduction in Britain is thought to be principally vegetative, and the plant is capable of forming extensive mats from the smallest shoot fragment. Introduction by seed from growth in indoor aquaria, however, may also have occurred. Floating pennywort can double its wet weight in as little as three days. The plant exhibits seasonally variable growth in Britain. Maximum growth occurs in the late summer when it typically forms the extensive floating mats of vegetation, whilst it over-winters in the margins and on banks as a much flatter and smaller plant.

The plant is relatively restricted in its distribution, largely in southern England and south Wales. Its appearance is likely to have been as a result of escapes from aquaria and garden ponds. Floating pennywort has already proved to be difficult to control because of its rapid growth rates, its ability to re-grow from a single node, and its resistance to chemical control.

Control

Chemical control can be achieved with herbicides containing glyphosate. Use of the adjuvants Top Film and Codacide Oil improve the efficacy of glyphosate.

Cutting and removal is a very good method of management, but it will not control or reduce the vigour of the plant. The cut or dredged material should be left on site at the top of the bank, well away from water. Manual removal by volunteer groups has proved a successful method of management, particularly for smaller sites.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Cutting

Regular cutting from May to October will prevent complete dominance of this species. Cut material should be removed from the water immediately. Cutting should be followed by hand pulling or by spot treatment with chemicals to reduce the risk of regrowth.

Pulling or dredging

Hand pulling works very well in small infestations and as a follow-up after major mechanical removal. Eradication is possible using this technique.

Biological

Cattle grazing has been seen to damage the emergent stems, but it has no long-term effect on the dominance of the plant. There are no known biological control agents in the UK, but research is underway.

Chemical control

Glyphosate

Applying glyphosate at 6 litres product/ha in 400 litres of water is the most effective treatment with this chemical particularly when used with Codacide Oil. Repeat treatments will be necessary throughout the growing season as soon as regrowth occurs.

In general

The plant does not rot down very quickly after chemical treatment, and treated vegetation in flood-risk areas should be removed after two to three weeks if possible. Follow-up spot treatment after mechanical removal is recommended. Regular treatment is necessary.

Fact file

Creeping water primrose

Source: NBN Gateway. Check website for current distribution

Image: Alain Dutartre

Creeping water primrose has recently been sold in the UK as a pond and aquarium plant. It is traded under a variety of names, including primrose willow and *Jussiaea*. Its correct taxonomic attribution is equally confused and *Ludwigia grandiflora*, *L. hexapetala* and *L. peploides* are among the names that have been applied to it.

Creeping water primrose produces a distinctive yellow flower, approximately 3cm across, in July – September. The stems extend across the water surface, producing round or oval leaves that can be mistaken for native brooklime. The stems also extend across mud, intermittently rooting at nodes. As they mature, the fleshy stems grow upright and the leaves lengthen and become lanceolate, approximately 9cm long. The flowering stems can become quite tall and resemble willow-herb.

Creeping water primrose thrives in ponds, lakes, watercourses, wetlands and wet meadows. It has currently been recorded from thirteen sites in the wild. All of

these infestations are either being managed, or are believed to have been eradicated. Whilst it has only caused minimal damage to our habitats so far, we know from the situation in France, Holland and Belgium that this plant has the potential to cause serious damage to our aquatic environment. An economic study estimated that *Ludwigia* could cost the UK over £150 million per annum if it were allowed to establish.

Whilst it is unlikely that you will find creeping water primrose in the wild, it is very important that any sites at which it is found are reported promptly so that control can be undertaken. This plant is known to be widespread in ornamental gardens, and therefore likely to occasionally appear in the wild if it escapes from ponds or is disposed of inappropriately.

Control

Chemical control can be achieved with formulations of glyphosate approved for use in or near water. Efficacy is greatly increased if it is mixed with an appropriate adjuvant, such as Topfilm at 1 L/ha.

Careful manual removal can be a highly effective method of management. This is the preferred method of management in France where herbicide treatment is not allowed. If *Ludwigia* is well established, mechanical removal may be initially used to reduce the biomass. Dredged or pulled material should be composted at sites away from waterbodies or wetland areas.

Manual, mechanical or herbicide treatment is likely to require at least two years of control. The site will need to be surveyed for any residual growth for at least a year after the last growth has been treated. Care should be taken not to spread the plant by fragmentation using these methods.

Contact the Environment Agency for disposal advice on 08708 506 506

Non-chemical control

Pulling

Hand-pulling works well, particularly with small infestations and as a follow-up to chemical or mechanical control. Material must be composted away from waterbodies.

Dredging

Mechanical removal is effective. Fragments must be contained and removed to avoid further spread. Material must be composted away from waterbodies.

Chemical control

Glyphosate

Apply glyphosate at 6 litres product/ha. Addition of the adjuvant Topfilm at 1 l/ha greatly increases the sticking and uptake of glyphosate through the waxy leaves

Repeat treatments are necessary, and regular monitoring of the site is required for between two and three years.

Glossary

2,4-D amine – a selective translocated herbicide.

Adjuvant – a herbicide additive used to increase absorption of the herbicide through the waxy leaves of aquatic plants.

Axil – the angle where the leaf joins the stem.

Biomass – the amount of plant material produced during growth.

Contact – a herbicide that kills the parts of plants to which it is applied, for example leaves.

COSHH – Control of Substances Hazardous to Health.

Eutrophic – water that has an excess of plant nutrients.

Glyphosate – a non-selective, translocated herbicide.

Hybrid – offspring of closely related species that are often more vigorous than either of the parents.

Node – region of attachment of leaves to the stem and of swelling on rhizomes from which roots and shoots arise.

Petiole – the stalk of a leaf.

Riparian – the area at the edge of watercourses.

Selective – term used for a herbicide that kills only one type of plant, for example only grasses or only broad-leaved weeds.

Succulent – fleshy or swollen.

Translocated – absorbed and distributed throughout the plant to the roots and shoots.

Whorl – a circular set of leaves arising at the same level on a stem.

Further information

There are many sources of information about invasive plants and methods of controlling them. The Centre for Ecology and Hydrology (CEH) provides advice on the control of aquatic and riparian invasive species.

This publication gives invaluable information on managing Japanese knotweed:

Environment Agency (2006)The knotweed code of practice – Managing Japanese knotweed on development sites.

The following websites are very useful sources of information for non-native invasive species in general:

GB non-native species secretariat: **www.nonnativespecies.org**

Centre for Ecology and Hydrology: **www.ceh.ac.uk/sci_programmes/AquaticPlantManagement.html**

CABI: **www.cabi.org**

The Global Invasive Species Programme: **www.gisp.org**

National Biodiversity Network (NBN): **www.nbn.org.uk**

The World Conservation Union: **www.iucn.org**

Plantlife: **www.plantlife.org.uk**

Chemicals Regulation Directorate: **www.pesticides.gov.uk**

The ‘Be Plant Wise’ campaign provides advice to gardeners on invasive pond plant recognition, guidance on how to dispose of pond plants and information on the impacts they may have in the environment. Posters and a leaflet are available from **http://beplantwise.direct.gov.uk/index.html**