

Invasive non-native plants associated with fresh waters

A Guide to their identification

Prepared on behalf of
Plantlife
Royal Botanic Garden Edinburgh
Scottish Natural Heritage
Scottish Environment Protection Agency
Scottish Water

by
Nick Dadds/Sue Bell (Scott Wilson)



Contents

Section 1: Introductory information	2
What is this pack for?	2
How to use this guide	2
Why has it been prepared?	2
What are non-native plants?	3
What species are included in this guide?	3
Why be concerned about non-native plants?	4
What special restrictions apply to non-native species?	4
What should I do if I find one of the plants included in this guide?	5
How do I get rid of the plant?	6
Am I likely to find one of the plants included in this guide?	6
Section 2: Species Accounts.....	8
Section A: Plants Associated With River Margins.....	8
Giant Hogweed <i>Heracleum mantegazzianum</i>	9
Japanese Knotweed <i>Fallopia japonica</i>	12
Himalayan Balsam <i>Impatiens glandulifera</i>	14
Section B: Plants that float on the water surface	15
Water Fern <i>Azolla filiculoides</i>	16
Floating Pennywort <i>Hydrocotyle ranunculoides</i>	17
General notes: management information can be found at www.ceh.ac.uk/sections/wq/CAPMInformationSheets.htm	17
Water-primroses <i>Ludwigia grandiflora</i>	18
Water-hyacinth <i>Eichhornia crassipes</i>	19
Water-lettuce <i>Pistia stratiotes</i>	20
Section C: Plants that are fully or partially submerged	21
Canadian Waterweed <i>Elodea canadensis</i> & Nuttall's Waterweed <i>Elodea nuttallii</i>	22
Curly Waterweed <i>Lagarosiphon major</i>	23
Large-flowered Waterweed <i>Egeria densa</i>	24
Parrot's-feather <i>Myriophyllum aquaticum</i> (also <i>M.</i> <i>brasiliense</i> , <i>M. proserpinacoides</i> and <i>M. propium</i>)	25
Fanwort <i>Cabomba caroliniana</i>	27
New Zealand Pygmyweed <i>Crassula helmsii</i>	28
Bibliography.....	29

What is this pack for?

This pack provides guidance for identifying several invasive non-native plants associated with water, which are either already problematic in Scotland, or may become so.

The pack comprises:

- A PowerPoint presentation and accompanying notes;
- This identification guide.

Section 1: Introductory information

How to use this guide

This guide is divided into two parts. The first provides introductory information about why the pack has been prepared, what species have been included, and general information about non-native invasive plants, their distribution and control. The second part provides detailed accounts for each of the species covered by this guide. The species accounts have been grouped according to the growth form of the plant:

- Section A: Plants associated with river margins;
- Section B: Plants that float on the water surface;
- Section C: plants that are fully or partially submerged.

Each species account contains details of how to identify the plant, other species with which it might be confused, and any special restrictions that may apply to its management.

Why has it been prepared?

The pack has been prepared as part of the Species Action Framework (SAF). The SAF received a Ministerial launch in January 2007 and sets out a strategic approach to species management in Scotland. In addition, 32 species have been identified as the focus of new management action for five years from 2007. Scottish Natural Heritage

(SNH) works with a range of partners in developing this work and further information can be found at www.snh.org.uk/speciesactionframework.

One of the 32 SAF species is the invasive non-native species, New Zealand pygmyweed *Crassula helmsii*. A five-year SAF implementation plan has been developed for this species. However, other invasive non-native plants associated with freshwater also threaten Scotland's biodiversity, and the SAF action for New Zealand pygmyweed is being used to highlight the wider management issues associated with the invasive species covered in this guide.

This training manual has been prepared to raise awareness of particular invasive species, in order that information about their distribution can be obtained, to assist in their management and eradication.

What are non-native plants?

Plants, which have been introduced by humans, on purpose or by accident, into an area where they don't naturally occur, are regarded as *non-native* (or *alien*). There are a great many of these in the UK: of some 3000 flowering plants and ferns living wild in the UK, over 1400 (nearly half!) are non-native introductions.

The vast majority of non-native plants co-exist with our native plants to little or no detrimental effect. A small number of non-native plants are *invasive*, meaning that they are persistent and are able to spread easily and rapidly, with little to control their growth. Whilst some native plants can become invasive ('weeds'), they do not cause as much damage as non-native invasive plants.

What species are included in this guide?

This guide covers fifteen non-native species that are found growing in, or near to, watercourses (See Box 1). It is not intended to provide a

comprehensive guide to either all non-native species, or to all water plants. It does, however, cover some of the species that are considered currently, or potentially, to pose the greatest risk to native species in Scotland and have been identified from three sources:

- Some of the the UKTAG list of species considered to have a high impact in the UK;
- Some of the species listed on Schedule 9 (Sch9) of the Wildlife & Countryside Act 1981 (& amendments);
- Some of the species identified by Plantlife as of particular concern.

Box 1. Species included in this guide

Plants associated with river margins

Giant hogweed (*Heracleum mantegazzianum*)
 Japanese knotweed (*Fallopia japonica*)
 Himalayan balsam (*Impatiens glandulifera*)

Plants that float on the water surface:

Water fern (*Azolla filiculoides*)
 Floating pennywort (*Hydrocotyle ranunculoides*)
 Water primrose (*Ludwigia grandiflora*)
 Water hyacinth (*Eichornia crassipes*)
 Water lettuce (*Pistia stratiotes*)

Plants that are fully or partially submerged

Canadian pondweed (*Elodea canadensis*)
 Nuttall's pondweed (*Elodea nuttallii*)
 Curly waterweed (*Lagarosiphon major*)
 Large flowered waterweed (*Egeria densa*)
 Parrot's feather (*Myriophyllum aquaticum*)
 Fanwort (*Caboma caroliniana*)
 New Zealand pygmyweed (*Crassula helmsii*)

Some of the species included in this guide are widespread and common throughout Scotland, whilst others have a more limited distribution within the UK, or have yet to be recorded from the wild.

Why be concerned about non-native plants?

Invasive non-native plants cause both environmental and economic damage. They often out-compete native plants, causing a loss of biodiversity and changing the structure of habitats. Aquatic or waterside invasive plants can hinder waterway navigation, cause death of native aquatic plants and animals by deoxygenating and shading water, disrupt water flow, impede drainage systems, cause river bank erosion, increase flood risk, damage flood defences and affect drinking water supplies. One invasive non-native plant, Japanese knotweed, can grow through walls, tarmac and concrete. Another, giant hogweed, is hazardous to human health.

It is often difficult to eradicate a population of invasive, non-native plants, owing to the characteristics that make them invasive in the first place. In some cases, particularly with aquatic invasive plants, it may be impossible to eradicate them once they are well-established. In these cases management by control measures and monitoring may be the only option. Eradication or control of invasive non-native plants can be very expensive. For example, the cost of attempting to eradicate Japanese knotweed in the UK was estimated at £1.5 - 2.6 billion¹, and the current *yearly* estimate for controlling floating pennywort is £250 - 300 thousand.

Some invasive, non-native species are controlled through legislation (see below).

¹ *Guidance for the control of invasive weeds in or near fresh water* EA

What special restrictions apply to non-native species?

Some of the species included in this guide are listed on Schedule 9 (Sch9) of the Wildlife & Countryside Act (WCA) 1981 (& amendments).

Section 14 of the (WCA) (as amended by the Nature Conservation (Scotland) Act 2004) makes it an offence to cause to grow any plant listed on Sch9 of that Act. Section 14A of the WCA (& amendments under the Nature Conservation (Scotland) Act) provides powers to the Scottish Ministers to make an order that makes it an offence to sell, offer or expose for sale, or have in one's possession or transport for the purposes of sale species listed on Sch9. In Scotland, a consultation exercise on which species should be covered by such a ban on sale has been undertaken (ended Feb 2007). At the time that this pack was produced no orders banning the sale of plant species has been produced. Readers are advised to check the current legislative situation². Those species included on Sch9 in Scotland, and covered by this guide are included in Box 2.

Additionally, two of the species (giant hogweed, Japanese knotweed) are also covered by the Environmental Protection Act 1990. Under this legislation, any plant material of these species, and any soil contaminated with them, is classed as controlled waste.

² See <http://www.scotland.gov.uk/Topics/Environment/Wildlife-Habitats/InvasiveSpecies/legislation>

Box 2. Plant species listed on Sch9 in Scotland covered by this guide, which it is illegal to plant or spread:

Plants associated with river margins

Giant hogweed
Japanese knotweed

Plants that float on the water surface

Water fern
Floating pennywort
Water hyacinth
Water lettuce

Plants that are fully or partially submerged

Curly waterweed
Parrot's feather
Fanwort
New Zealand pygmyweed

Sch9 is amended at intervals, and readers are recommended to refer to the current list of species included on Sch9 and the restrictions imposed.

What should I do if I find one of the plants included in this guide?

If you find any of the plants included in this guide it is recommended that you do the following:

1. Do not disturb the plants

Many water plants are able to spread from very small vegetative fragments; indeed for many of the plants covered in this guide it is their

only means of colonisation. The stems can be very brittle, so breaking them up increases the chance of their spread.

Other species, such as giant hogweed, produce prolific seeds that can easily become attached to clothing and muddy boots.

2. Ensure that you do not help transport these plants to other water bodies

As noted above, all the species covered by this guide are very successful at colonising new areas. Make sure that any equipment that has been in contact with these plants or water bodies containing them (e.g. boat propellers, boots, plant grabs etc.) is clear of any plant material and washed before using in other water bodies.

3. Note the location

Keep a record of where you found the plant (at least a 6-figure grid reference, or use a GPS), and an estimate of how much of it there was (e.g. one plant, or, it covered 1m²).

4. Check your identification

DO NOT TAKE A SAMPLE! Instead, take a photo if possible to confirm your identification.

5. Submit a record

Submit records of what you have found (including photos) and where, to the local Botanical Society of the British Isles (BSBI) plant recorder. The recorders compile data about the distribution of species in their local area and will be able to confirm your identification. Records can be submitted online at www.bsbi.org.uk.

Alternatively, submit the record to the Local Records Centre, if there is one in the area. Contact details for local records centres can be obtained at <http://www.nbn-nfbr.org.uk/nfbr.php>.

From time to time special recording schemes may be established for particular species. Any schemes in place at the time that this guide was produced are included in the individual species accounts.

6. Tell the landowner

If you know who owns the land you may wish to let them know what you have found, particularly if it is a species listed on SCH9.

How do I get rid of the plant?

Management of aquatic weeds is complex and the best method varies on the species concerned, its location, and how much is present. Even for species that are widespread in the UK (e.g. Japanese knotweed), there is no definitive control method.

This guide is not intended to provide comprehensive details of management of non-native species, but some references to useful sources of information have been provided in the bibliography. General advice can usually be obtained from the local SNH office (see www.snh.gov.uk to find your local office), or from the Scottish Environment Protection Agency (SEPA) (see www.sepa.org.uk to find your local office). Some advice on river-edge (riparian) species and waste issues associated with giant hogweed and Japanese knotweed can also be obtained from the Government website that provides advice on environmental legislation (www.netregs.gov.uk).

For the three terrestrial species included in this guide control measures usually focus on cutting, careful removal of material (including contaminated soil), and sometimes, use of herbicides.

By contrast, cutting of the truly aquatic species can actually exacerbate a weed problem, as many of the species are able to regenerate new plants from stem fragments. A variety of control measures exists including reducing light levels, altering the nutrient regime, use of chemicals (including ones which change water colour in addition to

herbicides) and biological control agents. The choice of appropriate control method has to be carefully considered, on a case-by-case basis, as control methods may be as potentially damaging to other wildlife in the water body as the invasive plant.

DO NOT apply herbicides to control any of the species included in this guide, without first consulting with SEPA. SNH should also be consulted where the water body is within, or near to, a protected area. Consult your local office if there is any doubt.

Am I likely to find one of the plants included in this guide?

As noted above, this guide includes species that are widespread and others that have not yet been recorded from Scotland (but are considered to pose a potential risk). Tables 1 - 3 provide an indication of how likely it is that you will encounter a particular species (refers to records post 1950 included in distribution maps from Preston & Croft, 1997).

Table 1: Plants associated with river margins

Species	Recorded in Scotland?	Comments
Giant hogweed	✓	Widespread
Japanese knotweed	✓	Widespread
Himalayan balsam	✓	Widespread

Table 2: Plants that float on the water surface

Species	Recorded in Scotland?	Comments
Water fern	✓	Mainly restricted to Central belt
Floating pennywort	x	Most records from SE England
Water primrose	x	Distribution survey underway
Water hyacinth	x	Not yet recorded from the wild in the UK
Water lettuce	x	Not yet resident in the wild in the UK, although incidental records of occurrence.

Table 3: Plants that are fully or partially submerged

Species	Recorded in Scotland?	Comments
Canadian pondweed	✓	Widespread throughout lowland Scotland, and also in parts of the Highlands and Islands
Nuttall's pondweed	✓	Mainly recorded from Central Belt, but may be under-recorded.
Curly pondweed	✓	Records from locations in central belt and southern Highlands
Large flowered waterweed	x	Most records from South Lancashire, Wales and South Coast of England
Parrot's feather	x	Appears to be spreading northwards throughout the UK
Fanwort	✓	Limited distribution in the UK, but previous record from Forth & Clyde Canal
New Zealand pygmyweed	✓	Various locations

Section 2: Species Accounts

Section A: Plants Associated With River Margins

Giant hogweed *Heracleum mantegazzianum*

Alias: Giant cow parsnip, cartwheel flower; and numerous Latin synonyms including *H. giganteum* and *H. speciosum*

Taxonomic notes:

Giant hogweed in the UK may represent more than one species, *H. persicum* being the most likely other species present.

The differences

between these species are slight, they are all invasive, and should all be treated in the same way.

Origin: Caucasus Mountains of Georgia and Russia.

Route of introduction: Introduced to Britain as an ornamental plant by the Victorians. First recorded in Europe at Kew Botanic Gardens in 1817, it was frequently planted elsewhere, and is now widely naturalised and increasing throughout northern Europe.

Identification: Mature giant hogweed is often instantly recognised by its enormous size. Prior to flowering it forms rosettes of leaves. The plant

© Jo Long, SEPA



dies after flowering, and the very obvious greyish dead stems can remain standing all winter.

Stems: ≤ 5.5m high and ≤ 10cm in diameter hollow, ridged with red/purple blotches and sparse bristles.

Leaves: lowest leaves ≤ 2.5m long (usually rather less). Leaves are deeply divided but not into separate stalked leaflets (as in native Hogweed); coarsely and sharply toothed giving a rather spiky appearance; the undersides and leaf stalks are shortly hairy, the uppersides are hairless.

Flowers: June/July. Several large umbrella-shaped flower heads ≤ 50cm or more across made of small white flowers on 50-150 rays, which are usually over 15cm long.

Seeds: the flowers can self-pollinate, and each plant typically produces 10-20,000 flattened, elliptical fruits, which are narrowly winged and usually about 10-15mm long.

Not to be confused with:

Other members of the carrot (umbellifer) family, particularly native hogweed (*Heracleum sphondylium*), which is only ≤2m tall, with smaller leaves (≤ 60cm long), usually has at least one pair of stalked leaflets, has hairier leaves (densely hairy beneath with less dense hairs above), which are not as sharply toothed as in giant hogweed. The flower heads have far fewer rays (usually no more than 20 rays), which are usually less than 12cm long. The seeds of native hogweed are usually ≤ 10mm long, and are also more rounded than giant hogweed seeds (which are more elliptical).

Butterbur, which also grows along watercourses, but does not have such strongly toothed leaves, and all its leaves arise from the roots rather than a central stem.

Habitat: edges of watercourses, roads and railways, and on derelict land and rubbish tips.

Prefers high nutrient and moisture levels, but can tolerate a range of soil conditions. It will grow in semi-shade but does not tolerate heavy shading.

It is a pioneer species that greatly benefits from human disturbance of habitats. The seeds have been known to germinate in Britain up to 600m in altitude.

The climate in Britain is ideal, as it prefers temperate, moist conditions, with a cold winter to initiate germination.

Method of dispersal:

Seed - propagation is entirely by seed, which can float on water. Seeds remain viable if dry for 15 years, although in one study of seeds buried in soil, only a small percentage survived beyond 3 years.

What harm does it do?

Health: the primary concern with giant hogweed is its ability to cause recurring painful skin blistering on the slightest touch through sensitisation to sunlight. The habitats it tends to grow in often have high nutrient levels, which increases the toxicity of the plant. Children have suffered facial blistering by using the stems as 'pea shooters'.

Biodiversity: giant hogweed can also cause other problems by growing in dense stands absorbing up to 80% of sunlight, suppressing native vegetation. This has the added consequence of increasing riverbank erosion in winter. Owing to its height, giant hogweed can suppress all plants other than trees and shrubs.

Amenity: dense stands can also restrict access to amenity areas and riverbanks, and reduce sightlines on roads.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, WCA).
- All giant hogweed material or soil contaminated with it is classed as controlled waste under the Environmental Protection Act 1990, which must be dealt with in accordance with waste regulations.
- Giant hogweed is *not*, as often thought, a notifiable weed. SEPA/EA does not have an obligation to control it: management

of giant hogweed is the responsibility of the land owner/occupier, and must comply with SEPA/EA guidelines.

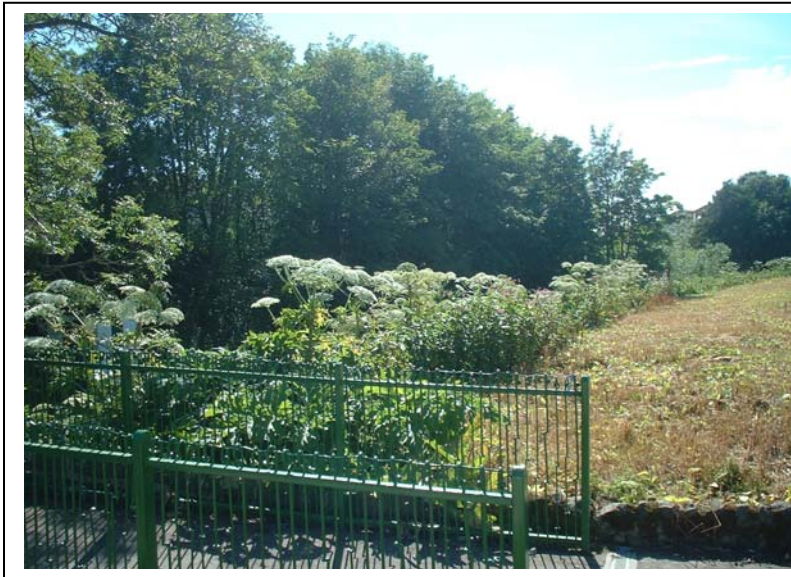
General notes: The first shoots of the year have been seen emerging as early as late January.

Giant hogweed does not flower until the second or third year, or longer if conditions are unfavourable.

The roots of giant hogweed are up to 60cm deep.

Management information can be obtained from Booy, O. and Wade, M. (2007) Giant Hogweed Management in the United Kingdom. RPS Group Plc. & www.netregs.gov.uk

WARNING: Do not touch this plant without protective clothing!
All parts of giant hogweed, including the hairs on stems and leaves which can penetrate light fabric, contain toxic sap which sensitises the skin to sunlight, causing severe blistering which may recur for many years.



© Ian Lorimer, SEPA



© Scott Wilson Ltd.

Japanese knotweed *Fallopia japonica*

Alias: *Reynoutria japonica*,
Polygonum cuspidatum

Taxonomic notes: two other species of exotic knotweed are also found in the UK (see below).

Origin: Eastern Asia

Route of introduction: it was brought to Britain by the Victorians as a garden plant, and soon escaped.

Identification: Japanese knotweed is usually easy to identify.

Stems: 2-3m tall, green with red/purple speckles, hollow, and typically form dense and often extensive stands (although small clumps of only a few short stems do occur). The arching branches have a characteristic zig-zag pattern.

Leaves: shield-shaped, green, up to 12cm long, with a flat base and pointed tip. They are hairless, only slightly longer than wide, and are arranged alternately along the branches.

Flowers: abundant clusters of tiny creamy flowers are produced along the outer parts of most branches from August to October.

Seeds: since fertile male flowers are very rare on British plants, seed is produced only rarely from hybridization with other exotic knotweeds, and rarely survives (although climate change could change this).

As the aerial parts of the plant die in late autumn, the leaves turn brown (along with the rest of the plant) and can remain attached for many weeks. Even when the leaves have dropped, the zig-zag branches and tall bamboo-like stems are easy to identify. The dead canes may remain standing for several years. The dead parts of the plant decompose



slowly, leaving a deep litter under large stands. New red/purple shoots with furled leaves appear in March, and grow up to 40mm per day. They are produced from tough spreading rhizomes (underground stems), which are thick and woody, and snap like a carrot when fresh revealing a yellow/orange centre. They can reach out 7m or more from the parent plant, and up to 3m deep.

Not to be confused with:

Other exotic knotweeds - the two most likely to be encountered are giant knotweed (*Fallopia sachalinensis*) and hybrid knotweed (*Fallopia x bohemica*, the hybrid of Giant and Japanese Knotweeds). Hybrid knotweed is more common than giant knotweed and under-recorded, but not as common as Japanese knotweed.

Giant knotweed differs from Japanese knotweed in that it is even bigger (up to 5m tall), with huge leaves up to 40cm long which have a heart-shaped (cordate) base; also the leaves are often significantly longer than wide, have scattered long hairs on the underside, and don't have such a drawn-out sharp tip. Hybrid knotweed (*Fallopia x bohemica*) has intermediate characters: the leaves are up to 23cm long, slightly cordate, and have scattered short hairs on the underside (of larger leaves).

When the aerial parts of these plants are dead it is not possible to identify them with any certainty unless intact dead leaves can be found (they often can be because decomposition is slow). Smaller dead stems of these knotweeds could be mistaken for dead docks (*Rumex* sp.), but docks don't have the hollow stems and zig-zag branch pattern.

Hybrid knotweed is as invasive as Japanese knotweed, with giant knotweed being less so. Both hybrid and giant knotweeds are to be treated in the same way as Japanese knotweed.

Habitat: Gardens, edges of watercourses, roads and railways, and on derelict land. Hybrid and giant knotweeds can be found in similar situations.

Japanese knotweed prefers a temperate climate, will tolerate low temperatures (to -17°C), high acidity, pollution and low nutrient levels. It prefers high light levels, growth being depressed under shade.

Method of dispersal: Small pieces of rhizome and freshly cut stem pieces can be carried by water or by human activity to new sites where they regenerate.

Whilst it rarely establishes from seed in the UK, this may alter under climate change.

What harm does it do?

Economic: knotweeds can grow through tarmac and concrete, causing structural damage to buildings and surfaces, including flood defences. Stands impede water flow and floating dead stems can cause blockages, increasing flood risk.

Biodiversity: stands of Knotweed suppress native species by casting heavy shade, and producing long-lasting leaf litter. The loss of native species can increase riverbank erosion.

Amenity: access to watercourses, and along paths, is impeded. Knotweed also causes sociological problems by trapping litter and encouraging vermin.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).
- SEPA has set out guidelines for developers and others to avoid spreading Japanese knotweed. Prosecution could result if these aren't followed.
- Japanese knotweed is *not*, as often thought, a notifiable weed. SEPA/EA does not have an obligation to control it: management

of is the responsibility of the land owner/occupier, and must comply with SEPA/EA guidelines.

General notes: Japanese knotweed is the most pernicious terrestrial weed in Britain, causing a huge amount of economic and environmental harm. The IUCN lists it amongst the top 100 worst invasive plants in the world. It is now widespread throughout Britain, and has nearly doubled its distribution in the last 20 years.

Knotweed is difficult and expensive to eradicate because it proliferates from fragments as small as a little finger nail, can persist underground in a dormant state for years, and is extremely resilient to a range of conditions and herbicides. The cost of a development can increase by 10% if knotweed is present, because expensive techniques must be employed including deep burial, use of root barrier membranes, creation of bunds, transport to licensed landfill sites and repeated herbicide applications.

Management information can be obtained from: Environment Agency (2006) The Knotweed Code of Practice: managing Japanese knotweed on development sites. Environment Agency, www.netregs.gov.uk, http://www.cornwall.gov.uk/media/pdf/4/f/main_1_.pdf, http://www.cornwall.gov.uk/media/pdf/h/d/general_1_.pdf and http://www.cabi-bioscience.org/html/japanese_knotweed_alliance.htm

Himalayan balsam *Impatiens glandulifera*

Alias: Indian balsam, policeman's helmet

Taxonomic notes: other species of balsam also occur in the UK (see below).

Origin: South Asia/India

Route of introduction: introduced as an ornamental by the Victorians, in 1839 and first recorded growing wild in 1855. It is now widespread.



© Jo Long, SEPA

Identification: the tallest annual plant in Britain. It is a hairless, robust, rapidly-growing annual.

Stems: the hollow, jointed stems are green or sometimes reddish, and sometimes branch towards the top. The stems commonly reaching 1-2m tall, and is known to reach 3m.

Leaves: The stalked, shiny, simple leaves are normally up to 15cm long, and arranged in opposite pairs or whorls of three. They are usually lance-shaped or narrowly elliptical, with numerous teeth along the edges (more than 20 on each side), and parts of the leaf (especially the midrib) may be red.

Flowers: the slipper-shaped pink/purple (occasionally white) flowers are up to about 4cm long, and are borne with several others on stalks arising from the base of upper leaf whorls.

Seeds: the green seed pods are up to 5cm long, and when ripe become explosive when touched, scattering 4-16 small round seeds up to 7m away. Each plant produces hundreds or even thousands of seeds, which can be transported by water, and can persist for 18 months.

Not to be confused with:

Other species of balsam, which have yellow or orange flowers instead of pink ones. Vegetatively, the most obvious differences are that other Balsams have alternate leaves (instead of opposite pairs or whorls of 3),

their leaf midribs and stems are not usually red, and they only grow to 1m or less. Additionally, the leaves of touch-me-not balsam (*Impatiens noli-tangere*) and orange balsam (*I. capensis*) have less than 20 teeth on each side, which are set further apart. Small-flowered balsam (*I. parviflora*) has leaves with a similar density of teeth and often similar length, but they are broadly elliptical and not as narrow as typical Himalayan balsam leaves, and lack a red midrib.

Habitat: mainly riverbanks, and other damp places such as ditches, wet meadows and waste ground.

It has no tolerance to drought or frost, but is tolerant of a wide range of soil conditions and semi-shade.

As it is an annual, it requires open sites for germination, and is favoured by habitat disturbance.

Method of dispersal

Seed - it spreads to new areas by the explosive scattering of its seeds, by water dispersal or by dumping of garden plants.

What harm does it do?

Biodiversity: it can form dense stands that reduce or suppress native plants.

It has also been suggested that the nectar-rich flowers may attract pollinators away from native plants, possibly reducing their reproductive success.

Amenity: potential for erosion problems in winter in areas where Himalayan balsam has suppressed the native flora as when it dies back it can leave river banks bare.

Special restrictions: none

General notes: its range is likely to increase with global warming. Management advice can be obtained from www.netregs.gov.uk and www.ceh.ac.uk/sections/wq/CAPMinformationsheets.htm

Section B: Plants that float on the water surface

Water fern *Azolla filiculoides*

Alias: fairy fern

Taxonomic notes: the only floating fern in Britain.

Origin: North America.

Route of introduction: sold as a garden pond plant



Identification: water fern looks rather like a floating moss.

Stems: branched, up to 5cm long (occasionally longer) with hanging simple roots.

Leaves: tiny (2.5x1.5mm), two-lobed, overlapping leaves covering the branching stems.

Flowers: N/A

Seeds: N/A

Other: it is usually green in the summer but becomes red later in the year.

Not to be confused with:

Duckweed (*Lemna* spp.), which is unbranched and always green.

Habitat: any stagnant or slow-moving water including ponds, canals, and ditches.

Method of dispersal:

Vegetatively - pieces of frond break away and can be transported naturally or by human activity.

Spores - are produced in this country and can be a contaminant of water plants purchased from commercial sources.

What harm does it do?

Biodiversity: it can cause dense cover of watercourses, reducing light for submerged plants, whose decomposition in turn causes severe deoxygenation and thus further reduction or death of native animals and plants.

Amenity: it easily blocks water pumps and filters, and in large quantity may impede water flow at places such as weirs and locks.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).

General notes: it is widespread in the UK, although it is currently uncommon in Scotland, but there are records from the central belt.

It forms blankets over the water surface like the duckweeds (*Lemna* spp.), and may grow with them.

Management information can be obtained from www.ceh.ac.uk/sections/wq/CAPMInformationSheets.htm

Floating pennywort *Hydrocotyle ranunculoides*

Alias: greater water pennywort; sometimes erroneously called marsh pennywort which is the name for native *H. vulgaris*.

Taxonomic notes: an unusual member of the carrot (Umbellifer) family, like giant hogweed, but looks totally different.

Origin: North America.

Route of introduction: recent introduction as a garden or aquarium plant, which has spread into the wild. First recorded from Essex in 1990; by 1999 had spread to 29 sites, and is now known at 90.

Identification: a large hairless perennial occupying water margins and spreading outwards into the water.

Stems: are horizontal and can float on the water surface with leaves growing upwards from the water. Leaf stalks are up to 35cm long and appear with roots about every 25cm.

Leaves: rounded or kidney-shaped fleshy leaves. They are often broader than long, large (up to 18cm diameter) and may be shallowly or deeply lobed, with shallow rounded indentations around the edge (i.e. the margin is crenate). At the base the leaf margin turns inwards towards the middle of the leaf to where the stalk attaches (i.e. the leaf is cordate).

Flowers: inconspicuous.

Not to be confused with:

The native marshy pennywort (*Hydrocotyle vulgaris*), which is easily distinguished by the peltate leaves (scarcely lobed with no large indentations, and stalks arising from the middle of the underside) which



are no more than 35mm in diameter. Additionally, marsh pennywort never floats on water, being a plant of marshes, swamps and water margins.

Habitat: still or slow-flowing waters, especially ponds, ditches and slow-flowing streams. It will also colonise marshes and lake sides.

It prefers eutrophic water but will invade mesotrophic water bodies.

The species is very adaptable but has a low frost tolerance. Waterside plants can, however, protect it from frost, and climate change may encourage expansion northwards.

Method of dispersal:

Vegetative: spreads mainly through translocation of small fragments, which can produce new plants, either by natural means (e.g. waterfowl have been shown to spread it) or human activity.

What harm does it do?:

It is regarded as a major problem in England, and could spread to Scotland. The growth rate is prolific: in optimum conditions in the UK stems may lengthen up to 20cm per day, and the mat may extend 15m in one season.

Biodiversity: dense mats cause a loss of light and dissolved oxygen, leading to reduction or elimination of native plants and animals, including fish. Since it also grows along water margins, it out-competes native plants there too.

Amenity: chokes waterworks and drainage systems, increasing flood risk, and reduces the recreational value of waterways.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (SCH9, Wildlife & Countryside Act).

General notes: management information can be found at www.ceh.ac.uk/sections/wq/CAPMInformationsheets.htm

Water-primroses *Ludwigia grandiflora*

Alias: creeping water-primrose, primrose-willow, *Ludwigia peploides*, *L. hexapetala*, *L. uruguayensis*, *Jussiaea* spp.



Taxonomic notes: there are several water-primroses forming a complicated group, which is under revision. Consequently any plant with any of the names above should be treated with caution. There is a native *Ludwigia* (Hampshire-purslane), but it is very different in appearance.

Origin: South America.

Route of introduction: introduced as an ornamental plant at an unknown date, it has been recorded wild from 2 sites (New Forest and Greater London).

Identification: can grow as a floating aquatic or terrestrially in marginal mud.

Stems: long horizontal stems which root frequently and can float. **Vertical stems** arise up to about 1m or more high, which may become woody and hairy.

Leaves: **alternate** (not opposite) along the stem and are of two types: leaves on floating stems are rounded or paddle-shaped and somewhat shiny, forming floating **rosettes** at the end of the stems; leaves on emergent stems are narrowly elliptic (rather like the leaves of some willows or willowherbs). Leaves may be up to about 13cm long.

Flowers: conspicuous, bright yellow, 2-5cm wide, with 4-6 petals. Flowers arise singly from the upper leaf axils of emergent stems.

Not to be confused with:

The floating rafts with ascending flowering stems are unlike anything else in this country.

Floating stems alone: -

Pondweed (*Potamogeton* sp.), but they don't form floating rosettes of leaves, and the leaves have **parallel veins** unlike Water-primrose.

Marginal plants:

Willowherbs, but in all willowherbs except rosebay willowherb (*Chamerion angustifolium*) the leaves below the flowering part of the stem are in **opposite pairs**. Rosebay willowherb does have alternate leaves, but it doesn't typically grow on mud by water, and has the well-known dense spike of pinkish flowers, producing seeds with feathery plumes, none of which water-primrose has.

Habitat: slow-flowing or still water such as ponds, lakes, canals, ditches and slow-flowing rivers. It can also colonise river banks.

It has shown reasonable frost resistance in Europe.

Method of dispersal:

Seeds: the viability of seed in the wild in this country is not certain.

Vegetative: by fragmentation of stems.

What harm does it do?

Water-primrose has a high potential to be a problematic invasive plant in the UK, especially if the climate warms.

Biodiversity: the dense rafts cause reduction in aquatic biodiversity and degradation of water quality.

Amenity: can block waterways.

Special restrictions:

- Information on sightings of this plant is requested by Jonathan Newman of the Centre for Ecology and Hydrology (Jones@ceh.ac.uk).

General notes: under appropriate conditions it can double in mass in 15-20 days.

In France, Belgium and the Netherlands it has been highly invasive.

Water-hyacinth *Eichhornia crassipes*

Alias: floating water-hyacinth

Taxonomic notes:

Origin: South America

Route of introduction: it was brought to this country as a garden plant. It is not yet established in the wild in Britain, but could become so, especially as cold water varieties are being developed, and a warming climate would favour it.



Identification:

This free floating plant is unique. It forms dense floating mats.

Stems: branched, with frequent roots, as many as 70 per cm.

Leaves: rosettes of rounded or kidney-shaped thick, waxy leaves 10-20cm across. The distinctive spongy leaf stalks are often greatly inflated to allow the plant to float. **Flowers:** Flower stalks, which are hyacinth-like, are up to 50cm tall with normally 8-15 showy flowers. The flowers are normally lilac with a blue-bordered yellow blotch on the upper petal. The petals are up to 4cm long.

Not to be confused with: this plant does not look like anything else.

Habitat: still and slow-flowing water; in ponds, lakes, reservoirs, canals, swamps and marshes.

It can withstand variability in water level, nutrients, acidity and toxicity. It is frost sensitive, but cold water varieties are being developed, and global warming could increase its range. Growth, which is rapid, is best in nutrient-rich water.

Method of dispersal:

Seeds: production may be limited outside its native range.

Vegetative: from sections of stem. and also by people discarding unwanted plants into waterways.

What harm does it do?

Biodiversity: water-hyacinth has damaged aquatic habitats wherever it has escaped to the wild, and now occurs in 50 countries. The dense mats of this plant cause the usual problems of light, nutrient and oxygen depletion, leading to loss of aquatic biodiversity, including death of fish and loss of their spawning grounds. The mats deposit large amounts of organic matter which accelerates vegetation succession.

Amenity: it can block waterways, increasing flood risk and interfering with recreational and commercial activity. In Zimbabwe it has led to rupture of dam walls.

Special restrictions

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).

General comments: It is considered to be one of the worst aquatic weeds in the world. It grows rapidly, and one acre of it can weigh 200 tons. This makes control difficult and costly: millions of dollars are spent annually in Florida alone³.

³ Invasive plant atlas of New England website

Water-lettuce *Pistia stratiotes*



Alias: tropical duckweed

Taxonomic notes: none.

Origin: South America

Route of introduction: it is grown as an ornamental pond plant, because of its attractive floating rosettes. Whilst not yet established in the wild in the UK it could become a problem if the climate warms, or if it becomes tolerant of cooler climates.

Identification:

Stems: floating stems link rosettes of leaves.

Leaves: light green and fleshy leaves, which are velvety-hairy with parallel veins. They form rosettes up to 15cm across, which can resemble floating lettuce-heads. The rosettes produce many long roots up to 50cm long.

Flowers: inconspicuous.

Not to be confused with: this plant does not look like anything else.

Habitat: still or slowing-flowing water such as ponds, lakes, reservoirs, canals and slow rivers, but can survive in mud.

Thought to prefer slightly acidic water of moderate hardness.

Intolerant of low temperatures (optimum growth is at 30°C).

Method of dispersal:

Vegetative: the plant reproduces mainly by producing daughter plants on brittle stems which break off, and it can spread to new sites by these (or the adult plants) being carried by water flow, or on boats and fishing equipment. Dumping of unwanted ornamental plants is also significant in its spread.

What harm does it do?

Biodiversity: the rosettes of this plant are not large, but connect together to form very dense floating mats. These adversely affect native species, including fish, by reducing oxygen and light in the water, causing loss of biodiversity.

Amenity: the mats impede navigation of waterways and increase flood risk.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (SCH9, Wildlife & Countryside Act).

Section C: Plants that are fully or partially submerged

Canadian pondweed *Elodea canadensis* & **Nuttall's pondweed** *Elodea nuttallii*

Alias: canadian pondweed

Taxonomic notes: these two submerged aquatic plants are discussed together because of their close resemblance to each other.

There is a third naturalised *Elodea* species in the UK, called South American pondweed (*Elodea callitrichoides*, formerly *E. ernstiae*), but it is rare and currently only found in southern England and Wales. Microscopic features are necessary to split it from Nuttall's pondweed.

Origin: both are native to North America.

Route of introduction: both species are commonly sold as oxygenating plants for ponds or aquaria, and can easily escape into the wild if unwanted plants are thrown into rivers and lakes. Canadian pondweed was first recorded wild in the UK in 1842. Its expansion was at first prolific, but slowed down in the 1900s, becoming a more modest component of aquatic habitats. It has often been replaced by Nuttall's pondweed which was first recorded wild in the UK in 1966, and is now known from more than 650 sites.

Identification:

Stems: both *Elodea* species have long rounded, branching stems up to 3m long.

Leaves: both species have strap-like stalk-less leaves in **whorls of 3** (occasionally 4 or 5). If the leaves are mostly in whorls of four or five, or



are arranged spirally (do not look near the tip of a shoot to ascertain this, but lower down the stem), then it is not *Elodea* (see below).

Nuttall's pondweed can normally be distinguished by having some leaves which are strongly **recurved**, so that they curve backwards and point to the stem below. The leaves are also often strongly **twisted**, and typically narrow (to 3mm wide) with sharp tips. Canadian Waterweed does not exhibit recurved or twisted leaves, and the leaves are typically broader (to 5.5mm wide) with blunt tips. The most reliable measurement to separate these species has been found to be leaf width 0.5mm below the tip: in Nuttall's pondweed it is 0.2-0.7mm (rarely 0.8mm), whilst in Canadian Waterweed it is 0.8-2.3mm (rarely 0.7mm). If you find material where this measurement is intermediate, and it does not exhibit strongly recurved or twisted leaves, then it is not possible to name the species.

Not to be confused with: two other invasive non-native plants, also in this guide:-

Curly pondweed (*Lagarosiphon major*), which has leaves in a **spiral** arrangement along the stem instead of whorls (they may appear to be whorled, especially near the tips of stems where the leaves crowded).

Large-flowered pondweed (*Egeria densa*), which is rare, has leaves in **whorls of 4 or 5**, instead of three; and the leaves are more pointed and longer (10-30mm long, whereas Canadian pondweed leaves are 4.5-17mm).

Native species:

Submerged mare's-tail (*Hippuris vulgaris*), which has pale-green, weak leaves in whorls of 6-12; usually mare's-tail has upright emergent stems which are immediately recognisable.

Slender naiad (*Najas flexilis*), which is rare, has narrow (<1mm) leaves typically 1-2.5cm long, but unlike in *Elodea* they are irregularly arranged in **pairs** as well as **whorls of 3** (sometimes four), and at their base form an angle with the stem of less than 45 degrees. Also unlike *Elodea*, inconspicuous flowers and fruits are formed in the angle between the leaves and stem.

Esthwaite Waterweed (*Hydrilla verticillata*) was known in the UK only from Esthwaite Water but has not been seen since 1945. It might occur elsewhere. It looks a lot like Nuttall's pondweed, but the leaves are in whorls of 4 or 5; it is also more slender, bluish-green and semi-translucent.

Habitat:

Canadian pondweed: static and slow-moving water, such as ponds, lakes, ditches and canals.

Nuttall's pondweed: similar to Canadian pondweed, but it prefers more nutrient-enriched water than *E. canadensis*.

Method of dispersal: Canadian pondweed does not set seed in this country, where plants are all female.

Vegetative: fragments of plant can be readily transferred on equipment, boats etc. There can also be inadvertent introductions as a result of aquaria and pond material being dumped in the wild.

What harm do they do?

Biodiversity: although Canadian pondweed has slowed its expansion, it is still capable of colonising and rapidly expanding in new sites, and can out-compete many native aquatic plants.

Nuttall's pondweed prefers more eutrophic waters to Canadian pondweed. In several sites it has been seen to rapidly displace Canadian pondweed, in as little as 1-3 years. It can form extensive beds, which have a detrimental impact on native species, and may also impede boat traffic.

Special restrictions: N/A

General notes: none

Curly pondweed Lagarosiphon major

Alias: curly water thyme; often mis-labelled *Elodea crispata*



Taxonomic notes: Often called *Elodea* but is not a member of that family. N.B Curled pondweed, *Potamogeton crispus* is an un-related native species that is not physically similar to *Lagarosiphon*.

Origin: Southern Africa

Route of introduction: like *Elodea*, it is often sold as an oxygenating plant for ponds and aquaria, and can spread into the wild if unwanted plants are dumped in or near water.

Identification: this plant is like a large *Elodea* (about twice the size of *Elodea*).

Stems: up to 3m.

Leaves: arranged in a spiral along stem, although they can sometimes appear to be whorled, and are characteristically strongly recurved. The spiral leaf arrangement is best seen away from the tips of the stems where the leaves are too crowded. Leaves are 6-30mm long, and 1-3mm wide; 0.5mm below the leaf tip the width is 0.2-0.5mm.

Not to be confused with:

Canadian/Nuttall's pondweeds (*Elodea* spp.), which are smaller, with leaves in whorls of 3 and not so regularly recurved.

Large-flowered pondweed (*Egeria densa*), which does not have strongly recurved leaves, and they are in whorls of 4 or 5; *Egeria* leaves are also significantly wider at the leaf tip (0.5mm below the leaf tip they are 0.5-1mm), and maximum width is larger (to 4mm).

Submerged mare's-tail (*Hippuris vulgaris*) might appear superficially similar, but the pale-green, weak leaves are in whorls of 6-12; usually

Mare's-tail has upright emergent stems which are immediately recognisable.

Habitat: still and slow-moving water, such as canals, ditches, ponds, lakes and slow-flowing rivers

Method of dispersal: like *Elodea* there are no male plants in the UK, and it reproduces by fragmentation or vegetative reproduction.

Vegetatively: from fragments of stem which can be transported naturally by flowing water or by boats. Colonisation of new sites isolated from current ones is thought to occur by human introduction.

What harm does it do?

This plant can out-compete even *Elodea* species, and has displaced them from some sites.

Biodiversity: it can form dense masses in still water which are detrimental to native plants and animals, and may impede boats. Owing to the way it photosynthesises it can increase the alkalinity of a water body, which can negatively affect native species.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).

General notes: It is currently most common in southern England but is present in Scotland.

Curly pondweed can become encrusted with chalky material (calcium carbonate) owing to the way it absorbs carbon.

Management information can be obtained from www.ceh.ac.uk/sections/wq/CAPMInformationsheets.htm

Large-flowered pondweed *Egeria densa*

Alias: giant Elodea, Brazilian Elodea, giant pondweed, Brazilian pondweed, *Elodea densa*

Taxonomic notes: none

Origin: South America

Route of introduction: it is sold as an oxygenating plant for ponds and aquaria, and can spread into the wild if unwanted plants are dumped in water. First found wild in the UK in 1953, it is not currently present in Scotland.



Identification: this plant is like a large *Elodea* (up to three times the size of *Elodea*).

Stems: up to 2m or more long and 3mm thick.

Leaves: like *Elodea* the leaves are in a whorls, but typically whorls of 4 or 5, along stems. The leaves are not strongly recurved and are 10-30mm long, and up to 4mm wide; 0.5mm below the leaf tip the width is 0.5-1mm.

Flowers: this plant only flowers in warmed water, and there are only male plants in the UK.

Not to be confused with:

Elodea spp., but *Elodea* is smaller with leaves in whorls of 3.

Curly Waterweed, but that plant has strongly recurved leaves in a spiral arrangement; the leaves are also narrower than large-flowered pondweed (maximum 3mm), and 0.5mm below the leaf tip they are a maximum of 0.5mm wide (often less). *Submerged mare's-tail (Hippuris vulgaris)* might appear superficially similar, but the pale-green, weak leaves are in whorls of 6-12; usually mare's-tail has upright emergent stems which are immediately recognisable.

Habitat: still or slow-moving water that is warmer than the preceding waterweeds require.

It was until recently found only in a few canals and mill-lodges, but has spread rapidly over the last few years. Climate change may enable it to widen its range.

Method of dispersal:

Vegetatively: from fragments.

What harm does it do?

Biodiversity: competes with native species and may cause them to decline or die out.

Amenity: It may also impede movement of boats.

Special restrictions:

None.

General comments; None

Parrot's-feather *Myriophyllum aquaticum* (also *M. brasiliense*, *M. proserpinacoides* and *M. propium*)

Alias: water milfoil, water feather, Brazilian water milfoil

Taxonomic notes: there are native species of milfoil (see below).

Origin: South America

Route of introduction: this plant has an attractive feathery appearance, and for this reason is commonly sold in aquatic garden centres. Unfortunately it is extremely invasive. It is now known from about 300 sites in the UK, and is present in southern Scotland.

Identification: as the name implies, parrot's-feather has a feathery appearance.

Stems: smooth, hairless, up to 2m long. It is characteristic in having emergent stems as well as submerged ones, which rise vertically out of the water for up to 30cm, and have been likened to miniature Christmas trees.

Leaves: look like feathers (a central 'stem' with numerous hair-like leaflets on either side), arranged in whorls of 5 (occasionally 4 or 6). Leaves are usually 2.5-4cm long, vivid blue-green, and on close inspection emergent leaves are densely covered in glands.

Flowers: inconspicuous flowers in spikes at the tips of the emergent shoots, and the bracts (leaf-like appendages immediately below the flowers) are deeply divided.



Not to be confused with:

Native *Myriophyllum* species, of which there are two in Scotland. Neither of these has emergent stems (only the flower spikes emerge from the water), nor deeply divided bracts, and leaves are in **whorls of 3 or 4** (rarely 5). Although the native species can grow in a dwarf state on damp ground at the edge of water, they cannot grow on dry ground, which parrot's-feather can (so it can withstand drying out of ponds). *Myriophyllum verticillatum* is a third uncommon native species absent from Scotland; it is larger than the other native species, but again does not have emergent leafy stems

Mare's tail (*Hippuris vulgaris*), which is the only other plant in the UK which has emergent stems with dense whorls of leaves, but this is easily identified by the **simple narrow leaves**, which are not at all feathery and in whorls of 6 to 12.

Hornworts (*Ceratophyllum demersum* and *C. submersum*) never have emergent stems or survive on mud. These plants usually have more leaves per whorl than parrot's-feather (usually 6 to 8, sometimes as few as 3 or as many as 12), and they are not pinnate, and so don't look feather-like. Instead, each very narrow leaf divides into two segments, like a **tuning fork**, and each segment may divide a second time (or more in *C. submersum*).

Water-violet (*Hottonia palustris*), which is absent from Scotland, also has superficially similar leaves. They look more like 'herring bones' than feathers, the 'bones' being clearly **flattened**. Also the leaves are not in whorls (they may superficially appear so at the base of the flower spike), but are **alternate** along the stems.

Habitat: ponds, reservoirs, gravel pits, ditches, swamps and canals. It is most common in eutrophic water, and will persist in dried-up water bodies.

Occasionally it is found on completely dry ground (such as a council rubbish tip in Cornwall).

It is known to have some frost tolerance. Its range may increase with climate change.

Method of dispersal: There are only female plants in the UK.

Vegetatively: it can easily propagate from stem fragments which may be spread naturally or by human activity. Fragments of parrot's-feather are sometimes unwittingly purchased as a contaminant of other water plants.

What harm does it do?

Biodiversity: parrot's-feather can effectively smother a water body which is suitable habitat for it. In still water it can be very aggressive, affecting native plants and animals by deprivation of oxygen, light and nutrients, and causing reduction or even elimination of native species. It currently threatens the Red Data Book species *Cyperus fuscus*, which only occurs at six UK sites.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).

General comments: it forms dense mats on solid ground, and floating rafts on water.

Management information can be obtained from www.ceh.ac.uk/sections/wq/CAPMInformationSheets.htm

Fanwort *Cabomba caroliniana*

Alias: Carolina water-shield, *Cabomba australis*, *Cabomba pulcherrima*

Taxonomic notes: none

Origin: North and South America

Route of introduction: fanwort was brought here for gardens and aquaria. In the UK it was known in the Basingstoke Canal from 1991-1995, and formerly from the Forth and Clyde Canal near Glasgow. It could be overlooked.



Identification

Stems: branched stems up to 10m long. Young stems are hairy.

Leaves: finely-divided submerged leaves are 3-5cm wide, with stalks 1-3cm long. They look fan-like and are arranged in opposite pairs along the stems. If the plant flowers, then some floating leaves appear, which are small (0.6-2cm) and linear or narrowly elliptic, with the stalk attached in the middle of the under-surface.

Flowers: solitary and up to 1cm across, with 6 white 'petals'.

Not to be confused with:

Water-crowfoots (*Ranunculus* spp.), the finely divided submerged leaves of some Water-crowfoots are similar to those of Fanwort, but the leaves are arranged spirally along the stems, and are never in opposite pairs as in fanwort. Some crowfoot species also have floating leaves, and flowers that resemble those of buttercup.

Water-milfoils (*Myriophyllum* spp.), which have leaves which are in whorls of 3-5 and never in opposite pairs. The finely divided leaves are also pinnate, and so look feather-like.

Hornworts (*Ceratophyllum* spp.), which have leaves in whorls of usually 6-8 instead of opposite pairs. The leaves are also divided differently,

each fine leaf splitting into two like a tuning fork, the subsequent segments splitting again in the same way.

Habitat: artificially warmed water in the UK - it formerly grew in factory-heated water in the Forth and Clyde Canal and from 1991 it was found in unheated eutrophic water in the Basingstoke Canal, and was still there in 1995.

Elsewhere in the world it grows in still or slow-moving water up to 10m deep.

In Canada it survives through winter under snow and ice.

Method of dispersal:

Vegetative: it is capable of regenerating from small fragments, which enable the plant to spread.

What harm does it do?

Although not currently a problem in the UK, it has the potential to cause harm.

Biodiversity: in the Netherlands it has obstructed a canal and smothered native vegetation. In other parts of the world it has infested entire water bodies, causing the usual problems of deoxygenation and shading, harming aquatic life including fish. **Amenity:** Heavy infestations have impeded boating and swimming.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (Sch9, Wildlife & Countryside Act).

New Zealand pygmyweed *Crassula helmsii*

Alias: Australian swamp stonecrop; often mis-labelled *Tillaea recurva*, *Crassula recurva* or *Tillaea helmsii*

Taxonomic notes: none

Origin: Tasmania



Route of introduction: It was sold as an 'oxygenating plant' for ponds and aquaria even though it ends up doing the opposite. It was first found wild in the UK in 1956 in Essex. It is extremely aggressive, and the number of invaded sites has more-or-less doubled every two years. It is now known from over 1000 sites all over the UK, including Scotland.

Identification: a small hairless perennial. The plant forms dense mats rising above the water surface, or on damp adjacent ground.

Stems: up to 30cm long, which root frequently, and can emerge from the water surface, remain submerged in deeper water, or creep on damp ground. Submerged stems are more sparsely-leaved.

Leaves: arranged in opposite pairs along the stem. The leaves are light green, small (usually 4-15mm long), linear or only slightly widened, pointed, fleshy, stalk-less, and fused together at the base where each pair joins the stem into a 1mm 'collar' around the stem.

Flowers: small and white with four petals, and appear singly on stalks up to 8mm long growing from leaf axils (where leaves meet the stem).

Not to be confused with:

Water-starworts (*Callitriche* spp.), most species have narrow-leaved submerged forms that could resemble Pygmyweed, but they can be immediately distinguished by the notched or spanner-shaped leaf tips. Their flowers are very inconspicuous.

Blinks (*Montia fontana*), (which is a plant of damp places or shallow water) has fatter leaves which are elliptical or paddle-shaped, whereas New Zealand pygmyweed's leaves are linear or only slightly widened in the middle. Unlike New Zealand pygmyweed, the pairs of leaves are not fused into a 1mm collar at the base. Blinks also has flowers with 5 petals instead of 4, and often several arise together from the same point instead of singly.

Waterworts (*Elatine* spp.), which are uncommon, also have elliptical or paddle-shaped leaves, which are 2-8mm long, instead of 4-15mm in Pygmyweed. Unlike pygmyweed, the pairs of leaves are not fused into a 1mm collar at the base. *Elatine hexandra* has single white flowers arising on stalks from leaf axils like pygmyweed, but there are usually only 3 petals instead of 4. In *Elatine hydropiper* there are 4 petals like pygmyweed, but the flower stalks are very short or absent.

Native pygmyweed (*Crassula aquatica*) which grows on mud by water, is currently known from only one place in western Scotland, but could occur elsewhere. It is easily distinguished from New Zealand pygmyweed because the stems are only up to 5cm long, the leaves are only up to 5mm long, and the flowers are stalk-less.

Habitat: owing to its variable growth form and wide ecological tolerance this plant will grow in any still or slow-moving water up to 3m deep, and also on surrounding damp ground, including marshes and swamps. It can tolerate a wide range of climatic variation including drying for extended periods, and is frost-resistant.

Method of dispersal:

Vegetative: it propagates easily from tiny fragments which can be spread naturally or by human activity, the latter including planting, when New Zealand pygmyweed is included as a contaminant of other purchased water plants.

What harm does it do?

Biodiversity: New Zealand pygmyweed forms very dense mats which out-compete all other aquatic vegetation in any still or slow-moving water up

to 3m deep, and also forms mats on adjacent damp ground. It grows rapidly and may cover 100% of the surface area of the supporting water body. In addition, owing to a special method of photosynthesis it can grow all year. The mats smother other plants, and cause severe oxygen depletion in the water, so that native plants and animals are reduced or eliminated. Left uncontrolled, it is capable of completely destroying the habitat in a pond. It threatens rare plants such as Hampshire purslane (*Ludwigia palustris*), and has been shown to reduce the breeding success of protected great crested newts.

Health: floating mats are dangerous, as children and animals have mistaken them for solid ground.

Amenity: mats clog drainage systems and may increase flood risk, and also reduce the recreational value of water bodies.

An estimated cost for controlling New Zealand pygmyweed across the UK was over £3 million.

Special restrictions:

- It is prohibited to plant, or allow the spread in the wild of this species (SCH9, Wildlife & Countryside Act).

General comments: New Zealand pygmyweed is one of the worst aquatic invasive species in Britain.

Management information can be obtained from www.ceh.ac.uk/sections/wq/CAPMInformationSheets.htm

General information can be found at www.snh.gov.uk/speciesactionframework

Bibliography

Bailey, J.P., Child, L.E. & Conolly, A.P. (1996) A survey of the distribution of *Fallopia x bohemica* (Chrtek & Chrtkova) J. Bailey (Polygonaceae) in the British Isles. *Watsonia* 21: 187-198.

British Ecological Society (2007) Invasive non-native pond plants - teachers' notes.

http://www.britishecologicalsociety.org/articles/education/resources/curriculum/pond_poster/Invasive_species/

CABI Bioscience (undated) *Azolla control* webpage

(<http://194.203.77.76/AzollaControl/default.htm>) (accessed Feb 2008).

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 3 *Impatiens glandulifera* Himalayan Balsam. *Centre for Ecology and Hydrology*

(http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 4 *Heracleum mantegazzianum* Giant Hogweed. *Centre for Ecology and Hydrology*

(http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 5 *Fallopia japonica* Japanese Knotweed. *Centre for Ecology and Hydrology*

(http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 7 *Elodea canadensis* Canadian Pondweed. *Centre for Ecology and Hydrology*

(http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 11 *Crassula helmsii* Australian Swamp Stonecrop. *Centre for Ecology and Hydrology* (http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 22 *Azolla filiculoides* Water Fern. *Centre for Ecology and Hydrology* (http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 23 *Lagarosiphon major* Curly Water Thyme, Curly Waterweed. *Centre for Ecology and Hydrology* (http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 24 *Myriophyllum aquaticum* Parrot's Feather. *Centre for Ecology and Hydrology* (http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Centre for Aquatic Plant Management (CAPM) (2004) Information sheet 25 *Elodea canadensis* Nuttall's Pondweed. *Centre for Ecology and Hydrology* (http://www.nerc-wallingford.ac.uk/research/capm/information_sheets.htm)

Clapham, A.R., Tutin, T.G. & Moore, D.M. (1989) *Flora of the British Isles* (Ed 3). *Cambridge University Press*.

DEFRA (2005) Helping to prevent the spread of invasive non-native species - Horticultural code of practice. *DEFRA* (<http://www.defra.gov.uk/wildlife-countryside/non-native/pdf/non-nativecop.pdf>)

Environment Agency (undated) Managing Japanese Knotweed on development sites: The Knotweed Code of Practice. *Environment*

Agency (<http://www.environment-agency.gov.uk/subjects/conservation/840870/840941/>)

Environment Agency (undated) Invasive species factsheets. *Environment Agency* (<http://www.environment-agency.gov.uk/subjects/conservation/840870/840941/>)

European and Mediterranean Plant Protection Organisation (EPPO) (2007) *Crassula helmsii* data sheet. *EPPO Bulletin* 37: 225-229 (http://www.eppo.org/QUARANTINE/ias_plants.htm)

European and Mediterranean Plant Protection Organisation (EPPO) (2007) *Hydrocotyle ranunculoides* data sheet. *EPPO Bulletin* 36: 3-6 (http://www.eppo.org/QUARANTINE/ias_plants.htm)

European and Mediterranean Plant Protection Organisation (EPPO) (2007) *Ludwigia peploides* and *L. uruguayensis* (= *L. grandiflora*) webpage. http://www.eppo.org/QUARANTINE/ias_plants.htm (accessed Feb 2008)

European and Mediterranean Plant Protection Organisation (EPPO) (2008) *Eichhornia crassipes* webpage. http://www.eppo.org/QUARANTINE/ias_plants.htm (accessed Feb 2008)

European and Mediterranean Plant Protection Organisation (EPPO) (2008) *Pistia stratiotes* webpage. http://www.eppo.org/QUARANTINE/ias_plants.htm (accessed Feb 2008)

European and Mediterranean Plant Protection Organisation (EPPO) (undated) *Fallopia japonica* draft data sheet. (http://www.eppo.org/QUARANTINE/ias_plants.htm)

European and Mediterranean Plant Protection Organisation (EPPO) (undated) *Impatiens glandulifera* draft data sheet. (http://www.eppo.org/QUARANTINE/ias_plants.htm)

European and Mediterranean Plant Protection Organisation (EPPO) (undated) *Cabomba caroliniana* draft data sheet. (http://www.eppo.org/QUARANTINE/ias_plants.htm)

European and Mediterranean Plant Protection Organisation (EPPO) (undated) *Heracleum mantegazzianum* draft data sheet. (http://www.eppo.org/QUARANTINE/ias_plants.htm)

Garrard, I. & Streeter, D.T. (1998) The Wild Flowers of the British Isles. *Midsummer Books*.

Global Invasive Species Database *Eichhornia crassipes* webpage. Invasive Species Specialist Group, IUCN (<http://www.issg.org/database/species/ecology.asp?si=70&fr=1&sts=>) (accessed Feb 2008)

Global Invasive Species Database *Ludwigia peruviana* webpage. Invasive Species Specialist Group, IUCN (<http://www.issg.org/database/species/ecology.asp?si=70&fr=1&sts=>) (accessed Feb 2008)

Hill, M. *et al* (2005) English Nature Research Report 662: Audit of non-native species in England. *English Nature* (<http://www.english-nature.org.uk/pubs/publication/PDF/662.pdf>)

Holmes, N. (2004) A Guide to Identifying British River Plants. *Training document*. Invasive Plant Atlas of New England (undated) *Pistia stratiotes* webpage. *University of Connecticut* (<http://nbii-nin.ciesin.columbia.edu/ipane/icat/browse.do?specielf=125>) (accessed Feb 2008).

Invasive Plant Atlas of New England (undated) *Eichhornia crassipes* webpage. *University of Connecticut* (<http://nbii-nin.ciesin.columbia.edu/ipane/icat/browse.do?specielf=124>) (accessed Feb 2008).

[nin.ciesin.columbia.edu/ipane/icat/browse.do?specielf=124](http://nbii-nin.ciesin.columbia.edu/ipane/icat/browse.do?specielf=124)) (accessed Feb 2008).

Newman, J. *et al* (2003) Guidance for the control of invasive weeds in or near water. *Environment Agency* (http://www.environment-agency.gov.uk/commondata/105385/booklet_895604.pdf).

Non-Native Species Secretariat (NNSS) (undated) Australian Swamp Stonecrop webpage. (http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/) (accessed Feb 2008).

Non-Native Species Secretariat (NNSS) (undated) Curly Water Weed webpage. (http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/) (accessed Feb 2008).

Non-Native Species Secretariat (NNSS) (undated) Floating Pennywort webpage. (http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/) (accessed Feb 2008).

Non-Native Species Secretariat (NNSS) (undated) Giant Hogweed webpage. (http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/) (accessed Feb 2008).

Non-Native Species Secretariat (NNSS) (undated) Himalayan Balsam webpage. (http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/) (accessed Feb 2008).

Non-Native Species Secretariat (NNSS) (undated) Japanese Knotweed webpage.

http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/
(accessed Feb 2008).

Non-Native Species Secretariat (NNS) (undated) Water Fern webpage.
http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/
(accessed Feb 2008).

Non-Native Species Secretariat (NNS) (undated) Water Primrose webpage.
http://www.nonnativespecies.org/01_Fact_File/05_Fact_Sheets/
(accessed Feb 2008).

Plantlife (2005) Top 20 alien invasive plants which threaten the UK's flora. *Plantlife* website
<http://www.plantlife.org.uk/uk/assets/campaigning-for-change/invasive-plants/Top-20-most-threatening-invasive-species.pdf>

Preston, C.D. & Croft, J.M. (1997) Aquatic plants in Britain and Ireland. *Botanical Society of the British Isles (BSBI)*.

Preston, C.D., Pearman, D.A. & Dines, T.D. (eds) (2002) New Atlas of the British and Irish Flora. *Oxford University Press*.

Rich, T.C.G. & Jermy, A.C. (1998) Plant Crib 1998. *Botanical Society of the British Isles (BSBI)*.

Rose, F. & O'Reilly, C. (2006) The Wild Flower Key - How to identify wild flowers, trees and shrubs in Britain and Ireland. *Frederick Warne & Co Ltd*.

Royal Botanic Gardens, Kew (2003) Invasive species and the changing flora of the UK. *Royal Botanic Garden, Kew*
http://www.kew.org/ksheets/pdfs/t4invasive_species.pdf.

Scottish Executive (2005) The Wildlife and Countryside Act 1981 (Variation of Schedule) (Scotland) Order 2005. *The Stationery Office*.

SEERAD (2006) Consultation on proposals to amend Schedule 9 and the use of an order made under Section 14A of the Wildlife and Countryside Act 1981. *SEERAD*

Sell, P. & Murrell, G. (1996) Flora of Great Britain and Ireland, Volume 5: Butomaceae - Orchidaceae. *Cambridge University Press*.

SEPA (2008) SEPA Technical Guidance Note: On-site management of Japanese Knotweed and associated contaminated soils. *SEPA*
http://www.sepa.org.uk/pdf/guidance/waste/Japanese_Knotweed1.4.pdf

Simpson, D.A. (1984) A short history of the introduction and spread of *Elodea* Michx in the British Isles. *Watsonia* 15: 1-9.

Simpson, D.A. (1986) Taxonomy of *Elodea* Michx in the British Isles. *Watsonia* 16: 1-14.

Simpson, D.A. (1988) Phenotypic plasticity of *Elodea nuttallii* (Planch.) H. St John and *Elodea Canadensis* Michx in the British Isles. *Watsonia* 17: 121-132.

Stace, C. (1997) New Flora of the British Isles (Ed 2). *Cambridge University Press*.

TCM (R&D) (undated) Creeping Water Primrose webpage.
<http://www.t-c-m-rd.co.uk/invasive-weeds/water-primrose/> (accessed Feb 2008).

Tutin, T.G. (1980) Umbellifers of the British Isles. *Botanical Society of the British Isles (BSBI)*.

Wade, M. (1986) Aquatic Plants - A Guide to Recognition. *ICI Professional Products*.

Wigginton, M.J. & Graham, G.G. (1981) Guide to the Identification of some Difficult Plant Groups. *Nature Conservancy Council*.

Wurzell, B. (1994) *Myriophyllum aquaticum* established on Walthamstow Marshes. *BSBI News* 67: 51.