Hydrocotyle ranunculoides L. *f.*

A guide to Identification, Risk Assessment and Management

Plant Protection Service, Wageningen, NL
Centre for Ecology and Hydrology - Wallingford, UK

June 2011

Background and Ecology

What is it?

Hydrocotyle ranunculoides L.f*,* the Floating Pennywort, is a native of North America but has become naturalised in Central and South America and also occurs in the Netherlands and in southern mainland Europe. It was first brought to Europe in the 1980's by the aquatic nursery trade to sell as a plant for tropical aquaria and garden ponds. The first note of concern over its potential to become a weed was published in 1936 (Mathias, 1936).

Reproduction is thought principally to be asexual and vegetative in northern Europe, and the plant is capable of forming extensive mats from the smallest root fragment, although introduction by seed may have occurred in at least two sites through sewage treatment works. In Australia, *H. ranunculoides* doubles its biomass in 3 days, and in the UK doubling times vary between 4 and 7 days in summer, depending on the availability of nitrate and phosphate. The plant exhibits a seasonally variable growth rate in the UK, with maximum growth in the late summer when it typically forms extensive floating mats of vegetation. It overwinters in the margins below the water surface and as an emergent on banks as a much flatter and smaller plant.

Where does it grow?

H. ranunculoides roots in the shallow margins of slow-flowing water bodies, particularly ditches, slow flowing dykes, canals and lakes and forms dense interwoven mats of vegetation which can quickly cover the water surface interfering with the ecology and amenity uses of the water body. Under European conditions, mats of vegetation have been observed to grow up to 15 metres from the bank in a single season, growing at approximately 20 cm per day.

Morphological description

Amphibious plant, glabrous, up to 40 cm tall. Stem creeping or floating, rooting at nodes. Leaves alternate, held on long fleshy petioles, not peltate, almost circular to kidney shaped, shallowly to deeply 3-7 lobed, lobes rounded, crenate or lobulate and subequal, (20-)40-100(-180) mm diameter. Flowers 5-10(-15), up to 3 mm diameter, grouped on a short stalk in the axil of a leaf, sepals absent, petals 5, white. Fruits suborbicular and flat, divided into 2 halves with a persistent style.

Leaf Details

Usually 8 – 10 veins with small pale spot in centre of leaf. Deeply cut to point of insertion at petiole, often 5 – 6 lobed overlapping at margin, pale to dark green, thin leaves, never succulent.

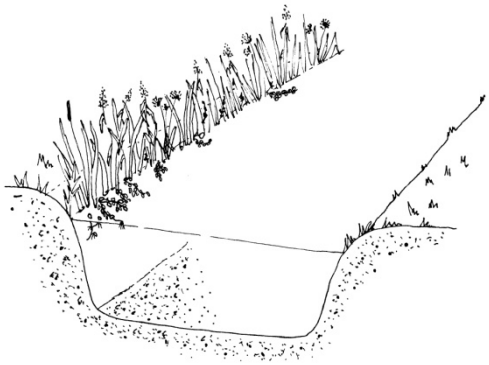
Flower Details

Small umbels of 5 - 15 florets held above water on short stalks, 5 – 15 mm.

Not to be confused with:

Hydrocotyle vulgaris	*Hydrocotyle umbellata*	*Ranunculus spp.*
		
General Appearance On damp mud, rarely in water	General Appearance	General Appearance
		
Leaf detail Never larger than 50mm, leaf not split to petiole, normally 9 – 12 lobed	Leaf detail Normally 12 – 14 lobed	Leaf detail Distinctly triangular lobes
		
Flower Detail	Flower detail Flower stalks longer than petioles	Flower detail White flowers with yellow centre, held above water

Life cycle

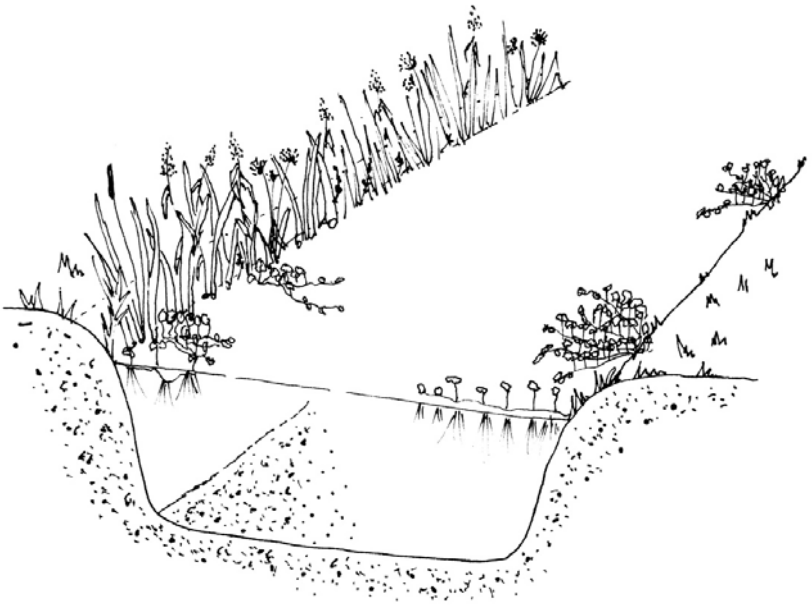


***Hydrocotyle* in Spring**

In spring, single stems grow from overwintering shoots or nodal fragments. Leaves are usually below the water surface or lying flat on the water surface. Usually single stems grow from the bank.

Management Restrictions: There are restrictions on mowing, dredging re-profiling and cutting between the middle of March and the end of May, and these activities are not recommended between June and the middle of July.

Action: Manual removal of small colonies is possible at this stage, but mechanical control using excavators to remove plant material and topsoil is also possible. Chemical treatment using glyphosate mixed with TopFilm is possible at this stage, but only when leaves are floating at the surface. Retreatment will be necessary. See chemical control section later in this document.

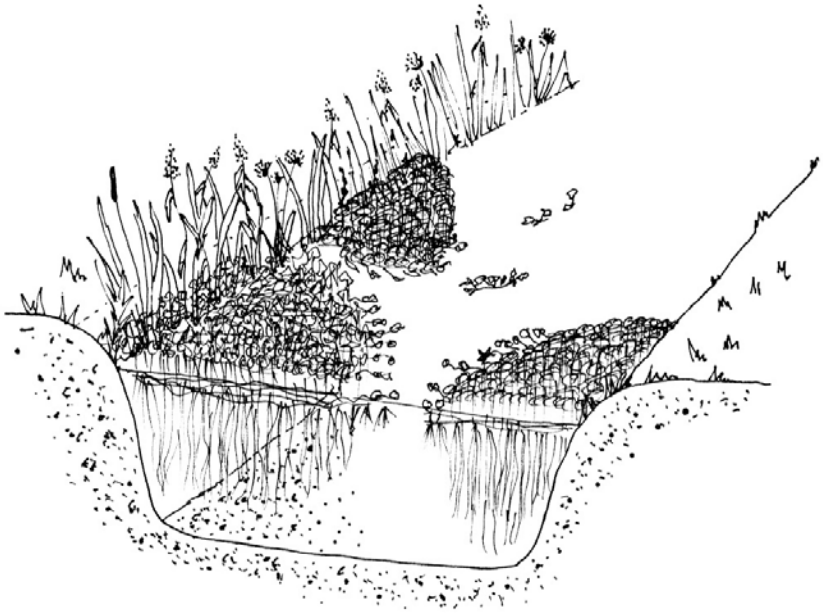


***Hydrocotyle* in late Spring**

In late Spring, the plant is usually well established and emergent stems start to grow from prostrate creeping stems. The stems usually have many branches by now, with creeping prostrate leaves at the edge of the mat, and emergent stems growing from further back for the stem tips.

Management Restrictions: There are restrictions on mowing, dredging re-profiling and cutting between the middle of March and the end of May, and these activities are not recommended between June and the middle of July.

Action: Manual removal of small colonies is still possible at this stage, but mechanical control using excavators to remove plant material and topsoil is recommended. Follow this up by manual checking and removal of any remaining fragments or stems. Chemical treatment using glyphosate mixed with TopFilm is possible at this stage, but retreatment will be necessary. Chemical treatment now is usually more effective than earlier treatment, although is earlier spray have been applied, a retreatment will usually be necessary again. An early application of herbicide tends to delay the climax state of biomass, and may delay this for up to 6 weeks, allowing additional effective management activity later in the season. The main aim of early control is to allow further control. See chemical control section later in this document.

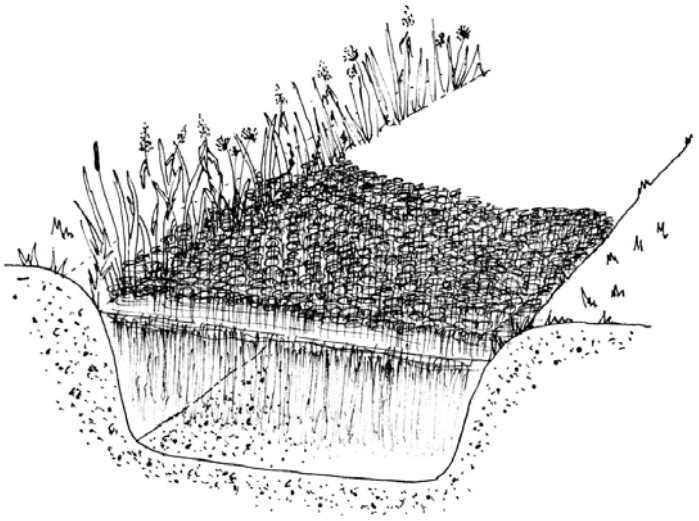


***Hydrocotyle* in early Summer**

Large clumps have developed by this stage, with predominantly emergent leaves and petioles. The clumps are usually distinct and only a few have joined up. Navigation between patches for control purposes is usually still possible.

Management Restrictions: There are no restrictions on mowing, dredging re-profiling and cutting should only be undertaken after the middle of July. Please be aware that cutting has no long term effect on this species and may assist spread. If this is the only method available then be aware that repeat cutting operations will be required at least twice a year every year.

Action: Manual removal of small colonies is usually no longer possible at this stage, with biomass reaching between 20 and 30 kg m^{-2} but mechanical control using excavators to remove plant material is recommended. Follow this up by manual checking and removal of any remaining fragments or stems. Chemical treatment using glyphosate (at least 1.8 kg ha^{-1}) mixed with TopFilm (1.2 l ha^{-1}) is very effective at this stage, but retreatment may be necessary if new growth occurs. Chemical treatment now is usually more effective than earlier treatment, although if an earlier spray has been applied, a retreatment will usually be necessary again. See chemical control section later in this document.

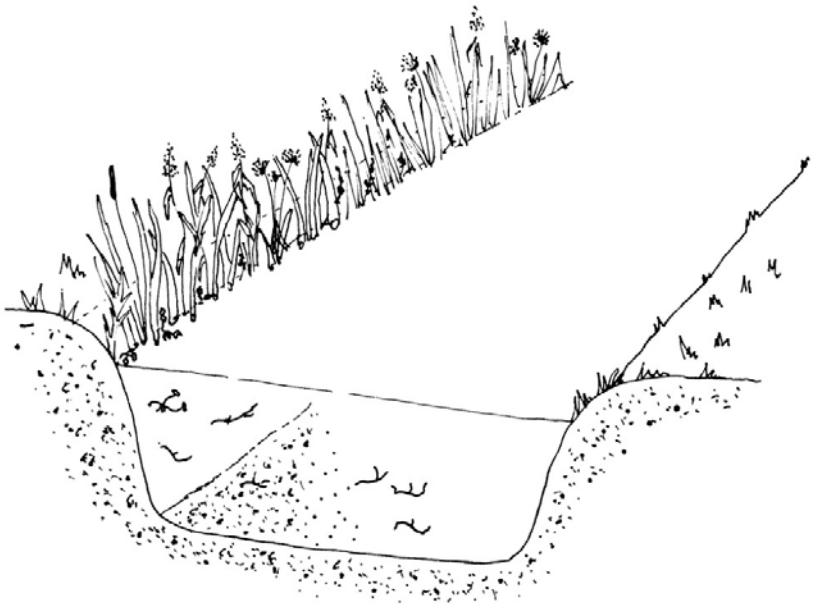


***Hydrocotyle* in late Summer and Autumn (July – November)**

All the separate mats have usually coalesced to produce complete coverage in channels of less than 15 – 20 m in width. In wider channels, often with faster velocities, growth may be restricted to the margins, as the limiting velocity for growth in the centre of the channel is usually exceeded. The limiting velocity is usually reached due to the presence of the dense marginal mats of *Hydrocotyle*, which tend to narrow the effective channel width and increase the discharge in the unimpeded channel area, restricting further growth of *Hydrocotyle*. However, fragmentation due to shear forces at the edge of the mat is usually increased, resulting in rapid spread within this type of large waterbody.

Management Restrictions: There are no restrictions on mowing, dredging re-profiling and cutting should only be undertaken after the middle of July. Please be aware that cutting has no long term effect on this species and may assist spread.

Action: Control at this stage can either be mechanical or by herbicide, although the risk of deoxygenation is very high at this stage and treated patches should be separated by the same length of the treated section, usually 500 m maximum, to avoid deoxygenation of the watercourse. This prevents rapid control and therefore mechanical removal followed by chemical control or manual removal is more effective in reducing biomass fast enough to achieve satisfactory management levels.



***Hydrocotyle* in Winter**

Winter growth form is determined by wash out of the floating mats after storm water surges. The mats become brittle and easy to break up physically when overnight temperatures are close to 0° C. The remaining vegetation is characterised as overwintering vegetation. Usually this takes the form of small rooted plants with leaves that become submerged under rising water levels, or of small leaved semi-terrestrial plants that survive in decaying marginal vegetation. The plants remain green and physiologically active throughout winter in this condition. The plants do not lose leaves or form specialised overwintering structures, they adopt a survival growth strategy that allows rapid regrowth when spring conditions allow.

Management Techniques

Manual Hand Picking

This technique should be used when patches are small in early spring and as a tidying up technique after mechanical or chemical control later in the season. It is an essential part of an eradication campaign as control cannot be achieved by either gross mechanical removal or by herbicides alone.

Mechanical Control

Mechanical control can be either by using an excavator equipped with a cutting bucket, or by using weed boats with rakes. Excavators tend to cut the fringe on the opposite bank, unless dredging and removing topsoil with the bucket, leaving viable fragments that regrow very rapidly. Manual hand picking should follow any mechanical control technique. Weed boats are more often used in Holland, raking the mats out of intermingled marginal vegetation. However, even this technique leaves viable fragments which must be removed to prevent or severely restrict any regrowth.

Weed Boat – raking margins	*Excavator with cutting bucket* *Note inaccessible areas under power lines and behind trees where regrowth can occur*
	

Weed boats often leave an intact marginal fringe and create floating frgaments

Excavators tend to create large piles of weed, although these rot away within 2 – 3 weeks, the risk of reintroduction to the channel is high

© Phil Harding

Mechanical excavation by barge can be used in faster flowing rivers,

©Phil Harding

Cut material is highly palatable to livestock

Chemical Control

Although it is possible to use two active ingredients on *Hydrocotyle*, the use of 2,4-D amine is not recommended due to difficulties caused by rapid translocation and excretion of the herbicide by the plant. The use of glyphosate at normal spray volumes of 200 litres of water per hectare without an approved adjuvant is also not recommended as the herbicide is also rapidly excreted from the plant.

There are two adjuvants suitable for improving control of *Hydrocotyle* when used with appropriate glyphosate formulations[1], TopFilm (www.topfilm-uk.com) and Codacide Oil (www.microcide.co.uk). TopFilm is made from microcrystalline sponges of soya protein, with almost all the oil removed. TopFilm absorbs the herbicide and sticks it to the leaf surface for up to three weeks, resulting in excellent rain-fastness and a long slow release pattern. This prevents the herbicide being excreted rapidly and results in better control early in the season (before mid August). After August, better control is achieved by using Codacide Oil, a vegetable oil that rapidly dissolves the waxy leaf cuticle and results in very rapid absorption of the herbicide, overwhelming the plant's ability to excrete the herbicide, and a disruption of the ability to regulate transpiration by the leaves, resulting in fairly rapid cell necrosis and plant death.

Using herbicides with a long lance and non-hazardous glyphosate formulation reduces the need for PPE to a minimum

Symptoms (leaf yellowing) are usually visible within days of application using glyphosate and adjuvants

Large areas can be treated in short time

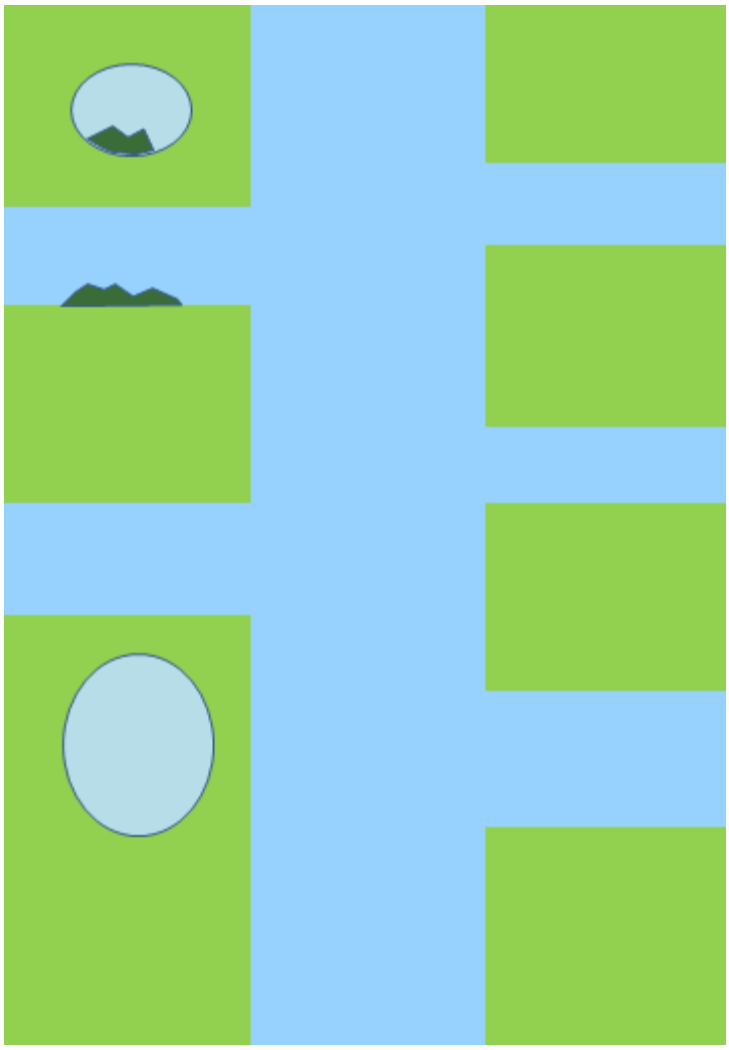
Collapse of the mat usually occurs in 4 – 7 days

[1] Please see www.pesticides.gov.uk for formulations registered for aquatic use

	
Easy access to marginal fringes is possible using small boats or canoes	*Plant death occurs with 3 – 4 weeks after treatment*

Although initial assessments may give the impression that herbicide treatment has been successful, the ability of dormant nodes to produce new shoots should not be underestimated. Often regrowth from apparently dead mats of plant material occurs within 6 – 8 weeks after treatment, requiring retreatment or mechanical removal of dead mats. Continuous monitoring should occur in the first year of treatment, followed by monitoring of any regrowth in the following spring and summer. Overwintering of untreated material should be avoided at all costs, as this results in very rapid spread within a catchment.

Risk Assessment

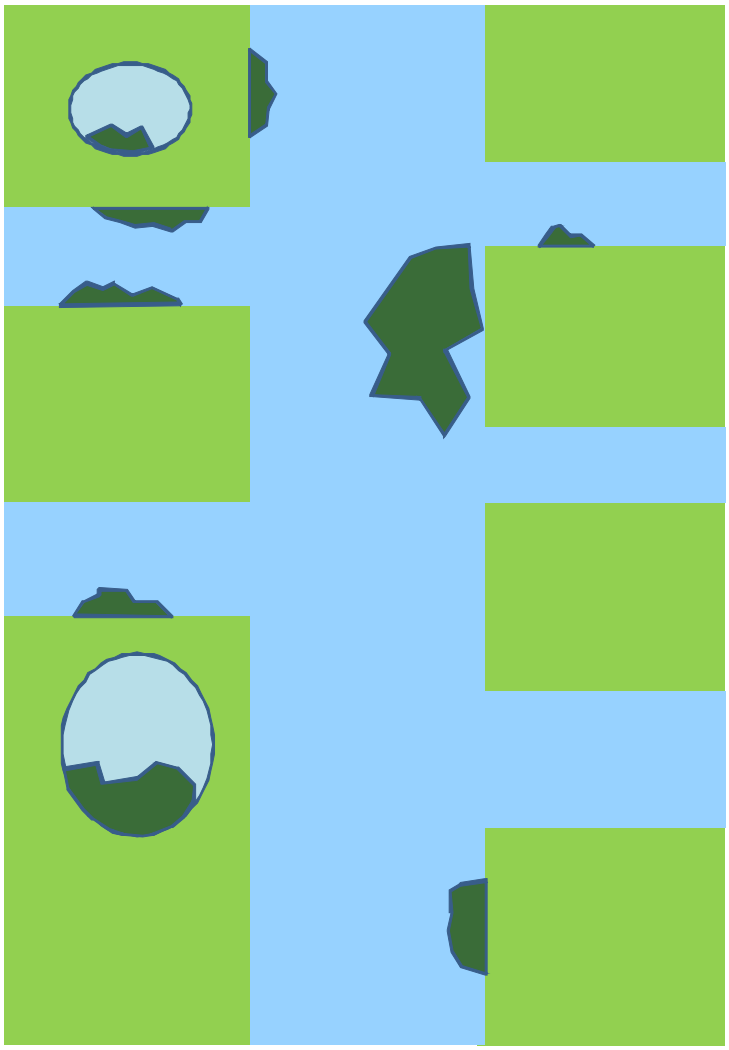


Low Risk High Priority

The occurrence of an invasive species in a new area should always be a case of low risk, because the isolated presence of a small amount of biomass does not present a risk to watercourse function or ecology. However, it should be a high priority to remove or isolate the infested area and to eradicate the species from the area as soon as possible.

In the situation described in the diagram to the left, eradication from the pond would be relatively easy. The patch in the channel should be isolated from the rest of the ditch network and removed as soon as possible. The isolation can take the form of a temporary dam, weighted net or other structure that does not represent a flood risk.

Isolation must take place as soon as possible after the species has been noted and should remain in place until after the plant has been eradicated, and probably for at least 1 year after no more plants have been observed in the area. This is to ensure that a re-occurrence does not occur, caused either by fragmentation of upstream patches, or by deliberate planting.

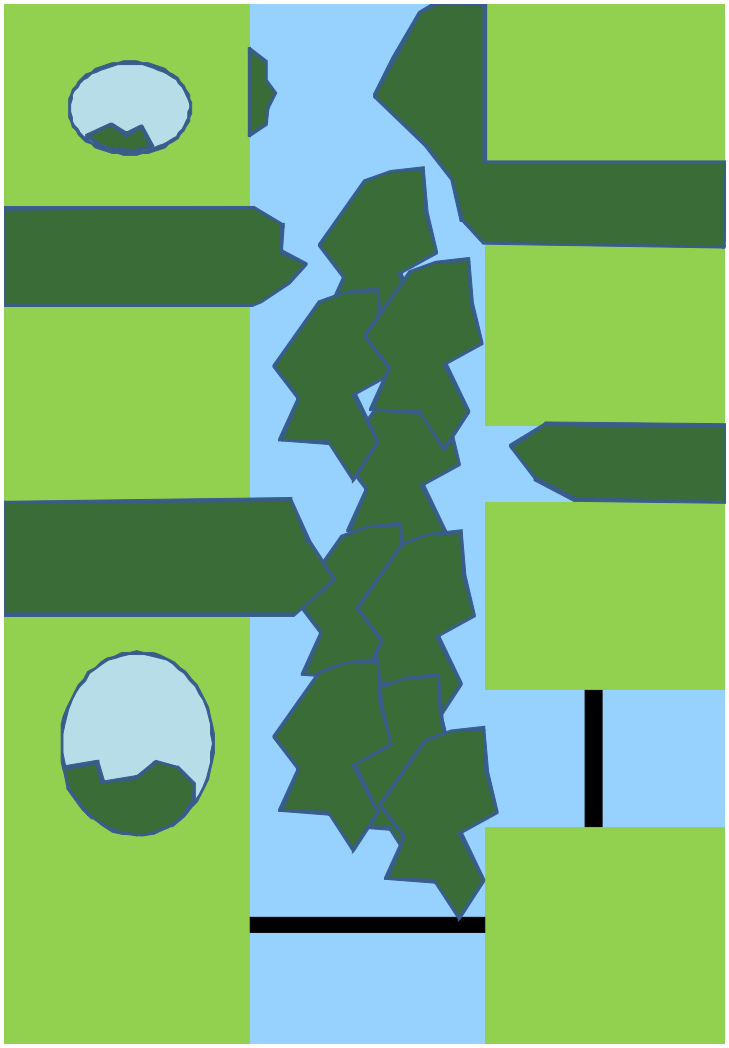


Medium Risk

There are several small patches of less than ten square meters spread within a short distance, but in different parts of the channel and in nearby ponds.

This situation represents a greater risk to watercourse function and to the ecosystem of the ponds. The infestation has probably been present for at least one year and has completed a life cycle. The ability to spread is demonstrated by the occurrence of more than one patch in different parts of the watercourse and action should be taken to remove as much as possible.

Sections of the watercourse that can be isolated must be isolated immediately. Removal of as much as possible of all the patches should be undertaken within 6 months of the first observation. A management plan for removal and eradication of the species could be used to prioritise resources for future observation and monitoring and immediate removal.



High Risk – Low Priority

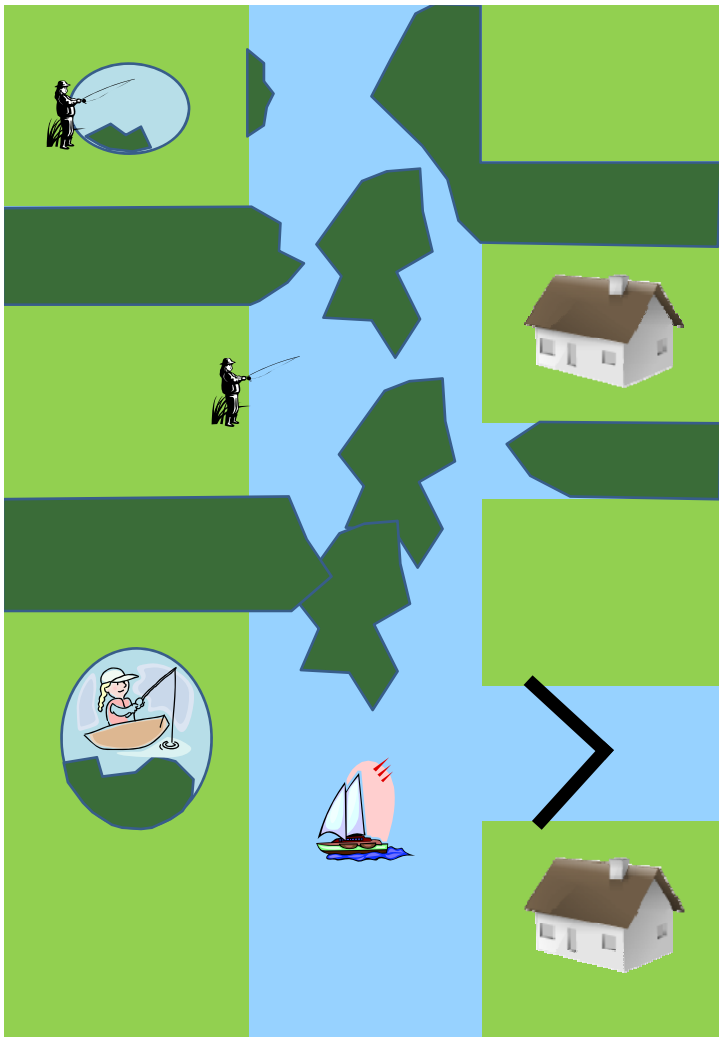
There are several large and small patches spread within a drainage system, spread over a large area, in different parts of the channel and in nearby ponds. The sections can be isolated and there are no critical watercourse functions at risk.

This situation represents perhaps an agricultural drainage network with no pumps, sluices, weirs or risk of flooding to populated areas. The infested section is either contained within an isolated section of watercourse, or can be easily contained.

The spread within this section can be easily monitored and a strategy for eradication or reduction can be implemented as and when resources are available.

Consideration should be given to the impact of the non-native species on the ecology of the drainage network, in terms of angling, bird and invertebrate populations.

Careful disposal of the biomass removed from the watercourse is required to prevent reinfestation of the cleared channel, or any channels along the transport route to the disposal site.



High Risk and High Priority

There are several large and small patches spread within a drainage system, spread over a large area, in different parts of the channel and in nearby ponds. The sections cannot be isolated and there are critical watercourse functions at risk.

This is a situation that should be rare, and results often from inappropriate management of small infestations, the presence of a very aggressive species, or as a result of favourable environmental conditions resulting in rapid spread within a system in less than one year.

Navigation functions are at risk, both from an inability to navigate and because movement of boats and ships will transport fragments of the species elsewhere in the network.

Fishing may be prevented by excessive growth of the target species.

Sluices, locks, weirs, pumps and other critical watercourse management structures may be at risk.

There is a serious risk of flooding of houses and commercial property as a result of the presence of this species.

Rapid and immediate management should take place to reduce the biomass of the target species. Sections, once cleared should be isolated to prevent further spread, and in the main channel a follow up maintenance operation should be undertaken, usually involving manual removal of fragments. Consideration should be given to educational notices and public awareness campaigns in the local are to encourage reporting of additional sites not normally monitored by the responsible authorities.