RAPID

Reducing and Preventing
Invasive Alien Species Dispersal

A holistic approach to Invasive Alien Species management in freshwater aquatic, riparian and coastal ecosystems across England

Invasive Non-native Species: Freshwater Examples

Killer shrimp (*Dikerogammarus villosus* and *Dikerogammarus haemobaphes*)

Dikerogammarus villosus and *Dikerogammarus haemobaphes*, sometimes known as 'killer shrimps', are invasive non-native species that have spread from the Ponto-Caspian Region of Eastern Europe. They are both voracious predators that kill a range of native species, including young fish, and can significantly alter ecosystems and are regarded as some of the most damaging invasive species in Western Europe (DAISIE, n.d.).

The "killer shrimp" *D. villosus*, DAISIE, n.d.


Killer shrimp with a 20p piece, Environment Agency

Dikerogammarus villosus like many such species, was most likely introduced into Western Europe through ballast water and hull fouling after the opening of the Danube Main-Rhine canal in 1992. It is now present in almost all of Western Europe's large rivers. In the UK*, D. villosus* was first discovered in 2010 at Grafham Water in Cambridgeshire, followed by two additional locations in Wales (Cardiff Bay and Port Talbot) in the same year. Biosecurity measures were introduced (e.g. the Check, Clean, Dry campaign) and are believed to have helped slow the spread. Nevertheless it was subsequently discovered in the Norfolk Broads (2012) and has recently been discovered in Pitsford Reservoir, Northamptonshire (2015), which is connected to a tributary of the River Nene.

Another shrimp, *D. haemobaphes*, was confirmed in the River Severn in September 2012. Subsequent monitoring found that this species was fairly well distributed throughout the canal network in England and since 2012 has spread rapidly throughout the network and to connected rivers.

Dikerogammarus proliferate on artificial bank structures with high oxygen saturation, typical of many GB canals, rivers and reservoirs. They like other man-made materials as well, such as nets, ropes and waders. This makes them highly likely to spread to other areas or be repeatedly introduced via ballast water or possibly through recreational boat traffic between mainland Europe and the UK (GB NNSS, 2010).

Killer shrimp on waders, Environment Agency

There is no known means of effectively managing *Dikerogammarus* species at this time and the strategy remains to slow the spread of both species by improving biosecurity supported by an effective awareness campaign. Those who manage waterbodies are encouraged to improve biosecurity, for example by increasing awareness and providing wash down facilities, while water users are encouraged to adopt good biosecurity practice, specifically 'Check, Clean, Dry' (www.nonnativespecies.org/checkcleandry). The Environment Agency is working closely with NGOs such as The Angling Trust and the Royal Yachting Association to encourage better biosecurity amongst water users and has increased monitoring of canals to attempt to slow the spread of this highly invasive species.

References

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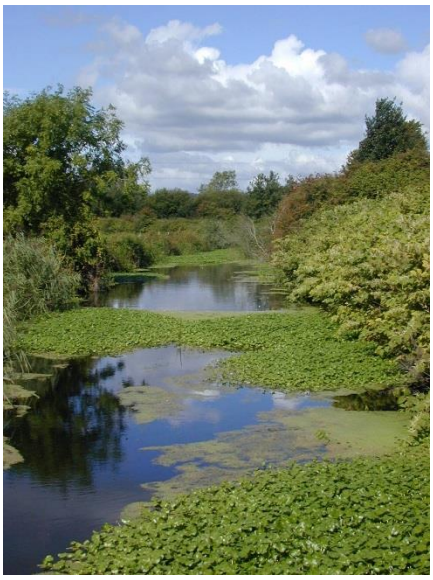
Floating pennywort (*Hydrocotyle ranunculoides*)

Floating pennywort (*Hydrocotyle ranunculoides*) an aquatic plant native to the southern coastal United States, as well as Central and South America. It was introduced into the UK as an ornamental pond plant, but quickly escaped and spread across southern England. It is considered one of the worst aquatic invasive plants in the UK, growing up to 20cm in a day and able to establish from tiny fragments (CABI, 2017). It is now widespread around the north of London and Norfolk in canals, ditches and slow-flowing rivers as well as in ponds and gravel pits.

The plant can quickly clog waterbodies and drainage channels, resulting in a number of detrimental effects including disruption of navigation and angling, damage to waterworks, and increased flooding. Livestock and other animals can become trapped and drown when attempting to walk over what may look like solid ground. The thick mats of floating pennywort can shade out other native plants, reduce aquatic life due to lowered oxygen levels and reduce access to the water margins for terrestrial animals and birds. In 2008, £1.93 million were spent for the management and disposal of *H. ranunculoides* in the UK (GB NNSS, 2011). Boats can easily spread plants by traversing through mats of floating pennywort and anglers could pick up small fragments on kit. Not travelling through mats and following the “Check, Clean, Dry” procedure are the best ways to prevent spread by these means.

Floating pennywort have been banned for sale in the UK since 2014. It is also listed as an ‘EU species of concern’ under the Alien Invasive Species Regulation 2015. In the UK, it is listed on Schedule 9 of the Wildlife & Countryside Act (WCA) 1981, making it an offence to plant or allow this species to grow in the wild. In short, landowners are obliged to prevent the spread of this species from their property.

Boat surrounded by floating pennywort, GBNNSS with thanks to British Waterways



Floating pennywort clogging waterway, CCW

Swan in floating pennywort, GB NNSS

Control options

Manual or mechanical control of floating pennywort with manual removal of any visible remaining fragments may offer a tool for localised population eradication. For example, it is reported that floating pennywort has been eradicated from the upper reaches of the River Chelmer and the River Lee by removing as much plant biomass as possible then handpicking remaining fragments (Newman & Duenas 2010). A study in 2005-2006 by the Broads Authority (Kelly 2006) found that removal of floating pennywort using a mechanical digger and extensive hand picking, greatly reduced the cover of the plant but did not completely eradicate it. It is important to carefully manage any mechanical removal efforts as floating pennywort demonstrates high regeneration capacity, and is able to regenerate from small shoot fragments and spread.

Most floating pennywort management has been performed using glyphosate-based herbicides, often in conjunction with adjuvants such as 'Topfilm', provided regulatory approvals are in place. This method has proved effective in reducing biomass, but requires repeated applications and often results in tiny fragments surviving.

Removal of floating pennywort from one location, Norrington, 2016

Biocontrol methods include testing a weevil and fungal species from the native range of floating pennywort, but these are not in widespread use at this time (CABI, 2017). The most effective control at the moment is to prevent spread by raising awareness of users such as boaters and anglers and encouraging the public to report sightings via Plant Tracker (Norrington, 2016).

References

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Water Primrose (*Ludwigia grandiflora hexapetala*)

Water Primrose (Ludwigia grandiflora hexapetala) is an aquatic plant native to South America. It was introduced into the UK as an ornamental plant and has now been found in the UK in ponds, drainage channels, lakes and reservoirs. This species, along with L. peploides (a similar species which is also invasive in Europe, but has not yet reached the UK) have been banned for sale in the UK since 2014. It is also listed as an 'EU species of concern' under the Alien Invasive Species Regulation 2015. In the UK, it is listed on Schedule 9 of the Wildlife & Countryside Act (WCA) 1981, making it an offence to plant or allow this species to grow in the wild. In short, landowners are obliged to prevent the spread of this species from their property.

Water primrose has been found in over 30 sites in the UK, (predominantly in southern England), and some of these sites have been eradicated succesfully (GB NNSS, 2010).

This species grows out from the margins of a waterbody, creating dense, floating mats of growth that give these plants a significant competitive advantage over other native vegetation at the water's edge. It primarily spreads by vegetative fragments. Water primrose can grow rapidly, doubling biomass in a couple of weeks. They can disrupt navigation and angling, exclude native biodiversity, damage waterworks and increase flood risk and siltation. Water primrose also decomposes quickly, giving off a sulphur smell and removing oxygen from the water as it breaks down (Norberg, 2011). The mats can be so dense that they can be colonised by other plants such as sedges and grasses and can even form floating islands with shrubs and trees, if left undisturbed. Boats can easily spread these plants by traversing through mats of water primrose and anglers could pick up small fragments on kit. Not traversing through mats and following the "Check, Clean, Dry" procedure are the best ways to prevent spread by these means.

Large mat of water primrose, GB NNSS

Water primrose can grow up to a metre high, GB NNSS

Control options

Most control methods are relatively ineffective. Based on good practice in the Netherlands, mechanical removal is the preferred option for management, where the site conditions allow. However, this method can break off fragments which can quickly re-establish and spread if not contained during removal. Consideration should be given to the appropriate treatment and disposal of plant material. A new Regulatory Position Statement (2016)

allows the burial of invasive non-native plants without a permit requirement. Manual removal has proved effective in areas where water primrose has recently become established, but has had limited efficacy on larger sites, or where the plant is well-rooted or established amongst dense vegetation. Manual removal efficacy is improved if the roots are teased out with hand tools and other vegetation is cut back to allow good access and inspection.

Chemical treatment is detrimental to other organisms in the water bodies, but is more effective, achieving a 97.8% reduction in trials (RAFTS, 2006). Most water primrose management has been performed using glyphosate-based herbicides, often in conjunction with adjuvants such as 'Topfilm'. This method has proved effective in reducing biomass, but requires repeated applications over a number of years and often results in tiny fragments surviving in the soil. Fluctuating water levels, particularly during the wet summer and autumn periods, complicates treatment and reduces efficacy.

Both these methods are generally used to control small areas slow and the spread rather than removing the plant entirely. Although, in 2014, the largest infestation of water primrose was removed (though not completely eradicated) from Braemore Marsh SSSI.

Biocontrol methods including weevils and beetles from the native range are being tested in the United States, but are not in widespread use at this time (USDA, 2006).

Preventing further spread is a crucial aspect of the programme. Each known water primrose site in the UK has a biosecurity plan, reducing the risk of further spread and seeking to minimise propagule loss where sites discharge to watercourses. Management plans also have a biosecurity element, particularly if the work involves mechanical excavation and disposal. More research is being carried out into the ecology and potential impacts of water primrose in the UK.

The most effective control at the moment is to prevent spread by raising awareness and practicing good biosecurity, as well as encouraging the public to report sightings. The best way to report a sighting is by emailing: alertnonnative@ceh.ac.uk

You can also submit records via apps such as Plant Tracker, or iRecord and also on this weblink: http://www.brc.ac.uk/risc/water_primrose.php.

More information on Water Primrose (such as identification and its invasive species action plan) can be found here: http://www.nonnativespecies.org/alerts/index.cfm

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