

Water Fern (*Azolla filiculoides*) Invasive Species Action Plan

1. Introduction

The risk assessment undertaken as part of the Invasive Species Ireland project prioritised *Azolla filiculoides* for preparation of an Invasive Species Action Plan. *A. filiculoides* has negative impacts on the environment and biodiversity in aquatic ecosystems. This species acquired a score of 20 out of a possible 25 from stage 1 of the risk assessment process owing, in part, to its potential impact on protected habitats and species leading to non-compliance with EU legislative obligations under the Water Framework and Habitats Directives.

2. Aim of plan

The aim of this Invasive Species Action Plan is to prevent further spread of *A. filiculoides* in Ireland and put in place mechanisms to prevent new introductions to the island. This plan sets out actions required for successful implementation and guidance on methods for eradication/control of *A. filiculoides* populations in Ireland. This can be achieved through the implementation of control options, raising awareness of this species, developing policy and identifying actions needed to deal with further spread.

3. Key priorities

3.1. Prevention of further spread

- Restrict the sale of *A. filiculoides* through garden centres, supermarkets, aquarists and other retail outlets.
- Raise public awareness of the economic and environmental impacts *A. filiculoides* could have in Ireland in combination with education efforts targeted at key stakeholder groups linked to the import and spread of this and other aquatic plant species.
- Encourage the removal and proper disposal of domestic plantings in ponds and aquaria and promote the use of native species.
- To inform management by recommending methods to gather accurate baseline distribution of this species. This can be achieved by encouraging recording of the plant by the general public, gardeners, naturalists and water course users such as agriculturalists, anglers and canoeists.

3.2. Eradication

- Guide the eradication of the plant at its known wild populations.
- Engage with stakeholders to provide advice and help, where appropriate, to eradicate populations in private gardens.

4. Invasion history

A. filiculoides has been established in Ireland for nearly a century. It originates from South, Central and North America. The water fern was probably introduced as an ornamental fishpond plant. Although fossil records indicate that *Azolla* species were once native to Europe it was deliberately re-introduced into Europe in 1880.

5. Nomenclature

Common name: Water fern

Also known as: None identified

Synonyms: *Azolla rubra*

5. Identification features

A. filiculoides is a floating aquatic fern that is almost moss-like in appearance. It is bright green in colour with a noticeable fine red border round each leaf (Figure 1 A and B). Often acquires a rusty red colouration in winter, or when stressed. It consists of a branched stem with attached leaves divided into two lobes. The upper lobes floating on the water surface, c.1-1.5 mm across, overlapping and concealing the stem. The lower, submerged lobes are larger but not overlapping so that the stem is visible. Individual roots originate from the lower surface of the stem at the junctions with the side branches. Sori are in one or two pairs on the lower lobe of the first leaf of a lateral branch (Habitas, 2009).

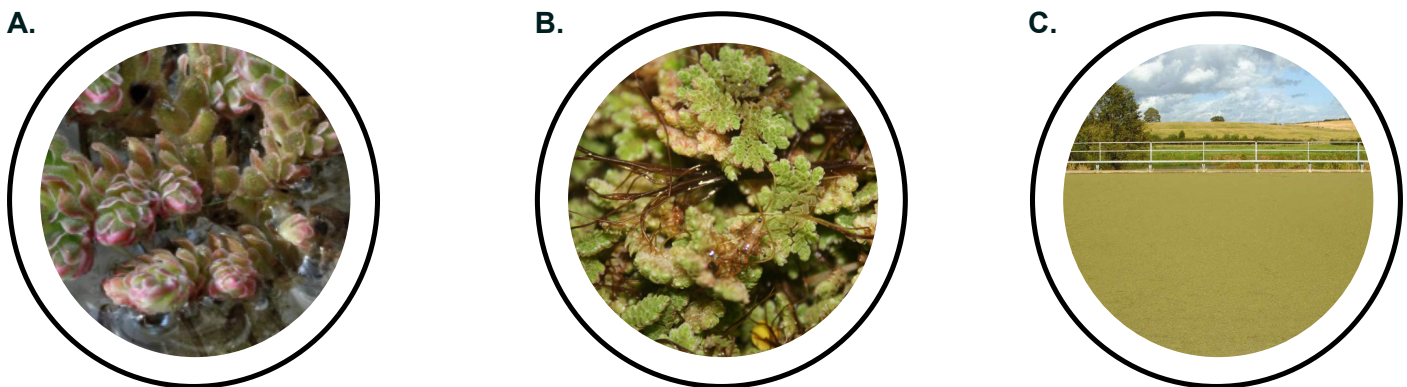


Figure 1: A and B. *A. filiculoides* leaves showing red edge along margin; **C.** *A. filiculoides* at site in Ireland. Photos A and B courtesy of the GB Non-native Species Secretariat. Photo C. courtesy of Joe Caffrey.

7. Impacts

Found in freshwater systems such as lakes, rivers, and canals. Slow moving, or low energy sites are particularly vulnerable to infestation by this species. It is not tolerant of turbulence or waves, and is usually flushed out of fast-flowing rivers and streams.

Where infestations persist floating mats (Figure 1C) of the water fern can form a complete cover on the water surface and obstructs sunlight from entering the freshwater habitat. The water fern is capable of doubling its biomass in a very short space of time and can out compete native plants as a result. Thick mats form barriers to normal access and infestations can have negative implications for all aspects of water utilization.

Dense infestations, which completely cover the water surface, are a danger to children, pets and livestock who may attempt to walk onto the apparently dry land without appreciating that there is deep water underneath. The dense cover of floating weeds can impact oxygen levels in the water by reducing diffusion between air and water and reducing light levels beneath the surface so that submerged weeds and algae die off causing serious deoxygenation problems. Free-floating weeds can also be drawn into water intakes, blocking pumps and filters, and can mat together forming floating rafts, which cause flow problems and obstructions to weirs, locks and other structures (CEH, 2004).

8. Distribution and spread potential in Ireland

A. filiculoides is known to be dispersed through natural and human mediated vectors such as gardening, the horticulture trade, recreational and industrial boats, clothing and equipment, animals and water currents. Single fragments of this plant are capable of colonising an entire water body within a few years. The known distribution of *A. filiculoides* in Ireland is shown in Figure 2.

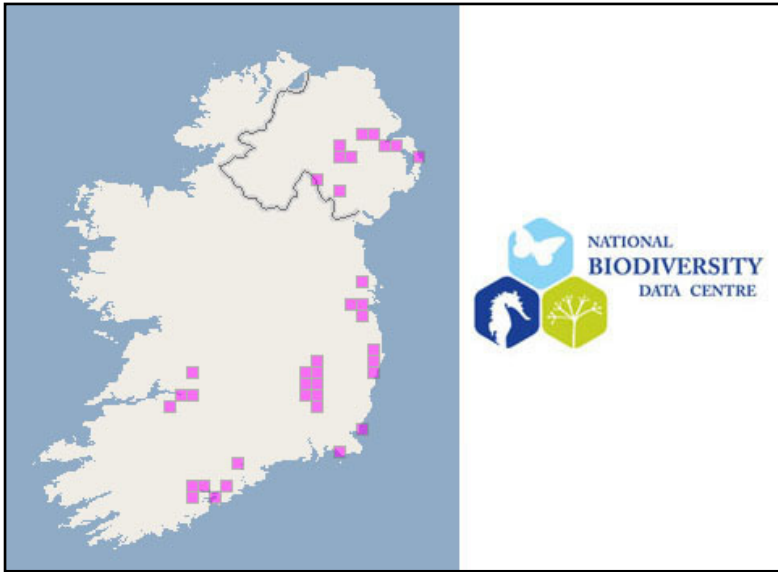


Figure 2: June 2009 known distribution of *A. filiculoides*. For up-to-date maps, please refer to the National Biodiversity Data Centre www.biodiversityireland.ie.

The geographic distribution of *A. filiculoides* in Ireland is widespread but it is naturalised in relatively isolated localities, with the exception of the River Barrow and associated canals where pockets of plants can be found throughout the system. Small isolated populations have undoubtedly been overlooked, such as those present between emergent marginal vegetation where they can be quite inconspicuous.

Predictions based on our current knowledge of the habitats most susceptible to invasion will allow us to identify priority areas for control and prevention. Proximity to known populations of *A. filiculoides* should be used to prioritise local preventative measures but on a national scale, remote and isolated populations are likely to occur at geographically distant sites due to the vectors and pathways associated with this species.

If eradication is the ultimate goal all locations must be known. Plants left untreated/removed will facilitate reintroduction. If a site is chosen for *A. filiculoides* eradication or management other invasive aquatic plants should be included in the plan.

Action 1. Establish accurate baseline distribution

In order to progress action on the ground, it is essential to have information on its distribution easily available. Recording programmes for invasive species should be encouraged on an annual basis and records should be submitted to the National Invasive Species Database and made readily available through the two biodiversity record centres on the island of Ireland. The biodiversity record centres should be resourced to gather information on invasive species and disseminate this information on request and/or online methods to key stakeholders for example, Local Biodiversity Officers and site managers.

9. Prevention of further spread

Action 2. Enforcement and raise awareness of legislative powers

Legislation is already in place to prevent the release of invasive species in both Northern Ireland and the Republic of Ireland:

Northern Ireland - under Article 15 (2) of The Wildlife (Northern Ireland) Order 1985 if any person plants or otherwise causes to grow in the wild any plant which is included in Part II of Schedule 9, he shall be guilty of an offence.

Republic of Ireland - under Section 52 (7) of The Wildlife (Amendment) Act 2000 any person who plants or otherwise cause to grow in a wild state in any place in the State any species of flora, or the flowers, roots, seeds or spores of flora except under and in accordance with a licence granted in that behalf by the Minister shall be guilty of an offence.

Action 3. Amend existing legislation

Legislation should be strengthened to ensure a total ban on import and possession of *A. filiculoides*. To this end:

- *A. filiculoides* should be added to schedule 9 of the Wildlife (Northern Ireland) Order 1985.
- The Minister of the Environment in the Republic of Ireland has power to prohibit the possession or introduction of any species that may be detrimental to native species. *A. filiculoides* should be brought to the attention of the Minister and the required prohibition enacted.

Action 4. Highlight, support and promote Invasive Species Codes of Practice

A priority action to prevent the spread and release of invasive species is to promote the uptake of the Invasive Species Codes of Practice and support these with literature and information leaflets for both industry and the general public.

Action 5. Public sector bodies adopt Invasive Species Codes of Practice

All public sector organisations should lead by example and adopting Invasive Species Codes of Practice in their relevant work areas. This is a key priority to the success of each of the codes. Government agencies should also incorporate the sentiment of the codes into tenders and procurement procedures and ensure that suppliers are abiding by the codes, where possible.

10. Eradication and control

Action 6. Prioritise sites for eradication across the island of Ireland and initiate programme of measures

A. filiculoides has a widespread distribution across the island of Ireland (Figure 2) but we are still at an early stage of colonisation with impacts still remaining largely unreported. Action is needed sooner rather than later to prevent widespread economic impacts, loss of biodiversity and a need for large scale and expensive programmes in the future. State agencies and local authorities should prioritise sites for eradication based on a transparent framework to guide a co-ordinated eradication programme. It would be cost effective to undertake this for all the high risk invasive aquatic plant species identified in the Invasive Species Ireland risk assessment

10.1 Biological control

The water fern has been a target of a biological control programme in South Africa since 1995, where natural enemies from the fern's native range were assessed for release. One biocontrol agent, a frond feeding weevil *Stenopelmus rufinasus* (Figure 3) was considered safe after extensive host specificity testing. Following release, the water fern was brought under complete control within a few years and no further intervention has been required. Although not deliberately released, the weevil is known to occur in the UK since 1921, where it offers periodic control of the water fern (Baars and Millar, 2009).

The weevil was first reported in Ireland in 2007 from collections made in County Fermanagh. It was subsequently recorded in County Cork in late 2007, associated with an infestation of the water fern. Since its discovery in County Cork the weevil populations have been monitored monthly to understand the insect-plant interactions under Irish conditions (Baars and Millar, 2009). The delayed build up of the weevil populations in the UK has required the mass rearing of beetles for deliberate release as an augmentative biocontrol agent (Baars and Caffery, 2008).

When initiating a programme to tackle an invasion by *A. filiculoides*, managers have the opportunity to achieve a high degree of success and at low cost to the organisations involved. The primary recommended approach to tackle *A. filiculoides* infestations is by biological control using this weevil. It is understood that the weevil is now ordinarily resident in the UK and Ireland and may survive at low densities, spreading to new sites when they become infested. Field populations have been monitored at several sites in Ireland to assess the need for similar augmentative control to be considered as a management strategy to control this alien invasive plant. For more information on this biological control agent in Ireland please refer to Case Study 4 available from the Invasive Species Ireland website <http://www.invasivespeciesireland.com>.



Figure 3: *S. rufinasus* feeding on *A. filiculoides*

Biological control is a viable option for the management of some invasive non-native species in Ireland. There is a policy gap in this area. Protocols for introducing a control agent to Ireland are not clear. A specific review should be undertaken to establish the mechanisms by which an agent can be released legally to the island of Ireland. Biological control should always be implemented in line with national regulations, international codes and the Convention on Biological Diversity principles concerning intentional introductions of invasive alien species (Turner, 2008).

10.2 Chemical control*

Herbicides are an effective form of control for this species. The floating fronds can be sprayed with glyphosate. Glyphosate will kill almost all emergent and floating weeds onto which the spray is directed. Surviving fronds may require a second or subsequent treatment if the weed is to be eliminated. This is best carried out when a gentle wind or currents have collected floating fronds together at suitable points. Herbicides should be applied before a complete surface cover has developed to increase effectiveness. If this is not possible a repeat application may be necessary to kill any surviving plants (CEH, 2004). Subsequent programmes must be compliant with the Pesticide Product Label.

Note: Prior to undertaking any spraying operation in or near water in Northern Ireland the NIEA Water Management Unit must be contacted. It is essential that the user is fully trained to the required pesticide spraying level (e.g. PA1, PA6 aw). The user must fully comply with the Pesticide Product Label. In

* When considering chemical control options always refer to the Invasive Species Ireland policy on this management procedure. A brief statement on this policy can be found in Section 11. For a more detailed outline of the policy please refer to the Invasive Species Ireland website.

the UK the use of Pesticides is regulated by the Pesticide Safety Directorate (PSD). The Pesticide Control Service (PCS) of the Department of Agriculture and Food is responsible in Ireland. Historically several pesticides have been available for aquatic use in the UK and Ireland. It is expected that certain chemicals will be subject to restrictions in the near future. Please refer to PSD website (<https://secure.pesticides.gov.uk/pestreg/ProdSearch.asp>), the PCS website (<http://www.pcs.agriculture.gov.ie/pest.asp?searchType=functCrop>) or contact the relevant organisation directly for the most up-to-date list of herbicides approved for aquatic use.

10.3 Mechanical control

The Centre for Ecology and Hydrology (2004) has stated that conventional cutting equipment has no effect on this plant. It can be harvested with weed buckets and flushing out the weed using baffle boards or barriers to raise the water level temporarily and then removing the barrier when wind and currents have collected the weed against the barrier. This technique is generally effective only in smaller water bodies and requires frequent operation. If spores have already been released in the current or previous year, it may be necessary to carry out repeated control operations until all the spores have germinated and been controlled.

11. Invasive Species Ireland: Policy statement on chemical control

1. The Invasive Species Ireland Steering Group do not support unjustified general, non-specific chemical control of aquatic invasive species due to potential impacts on non-target species; residual impact and persistence in the environment; the lack of associated rigorous monitoring to appraise effectiveness of control methods; and the potential noncompliance with the Water Framework Directive.
2. Targeted and appraised chemical control does have a role to play in management of aquatic invasive species, but should be seen as a last resort; after all other alternative control options have been thoroughly considered and assessed.
3. Before undertaking a chemical control programme, a transparent cost/benefit analysis identifying the risks associated with intervention options and risks of non intervention must be carried out.
4. A transparent cost/benefit analysis of management options should include the following:
 - Knowledge of the invasive species occurrence/distribution at and around the location.
 - Thorough knowledge of the invasion ecology and life history of the species.
 - An assessment of the potential impacts based on invasive history elsewhere and similarity of Irish habitats. This should include the identification of:
 - The sensitivity of native species, habitats and ecosystems present in respect to international, European and domestic legislative obligations and concerns.
 - Impacts on economic and amenity values
 - Potential impact of both the invasive alien species and the proposed control methodology.
 - Other human, animal and plant health issues.
 - The need for appropriate assessments.
 - Efficacy of control and eradication methods available based on assessment of experience elsewhere and on site, if applicable.
 - Assessment of known impacts of potential control methods on non-target species and residual impacts in the environment.
 - Due consideration of the legal status of the options considered.
 - A planned schedule of works with disposal procedures for waste predetermined.

- The identification of competent authority with the capacity and budget to complete the programme.

5. If the analysis concludes that other control options are not sufficient the Invasive Species Ireland Steering Group recognise that in these circumstances, chemical control has a role in the management of the aquatic invasive species.

12. Resourcing the plan

Action 7. Ensure adequate resources are in place to facilitate implementation of this plan

The priority action in regards of implementing the eradication and management options identified in this Invasive Species Action Plan is to review legislation on the use of biological control agents and determine protocols by which biological control utilising non-native species can and should be considered.

If biological control is not an option, small scale control programmes for this species i.e. garden ponds are estimated to cost less than £500. Larger ponds or river systems will required additional funding on a continuous basis until eradication. This is estimated to cost up to £5,000 annually. Should a lake, canal, or river system become colonised, costs associated will increase and are estimated to fall between the £50,000 - 100,000 in the first year. If funds are dedicated early in the invasion of a system this will reduce the overall cost of the programme and provide the greatest value for money in terms of commitment of resources and preventing economic impact in Ireland.

13. Recommended actions and timetables

No.	Action	Responsibility	Timescale
1	Establish accurate baseline distribution	Government Agencies in partnership with the National Biodiversity Data Centre, Cedar and other stakeholders engaged in the collection of biodiversity data	Annual programme required. Programmes should aim to build on that of the 2009 Invasive Species Survey co-ordinated by the National Biodiversity Data Centre
2	Enforcement and raise awareness of legislative powers	State agencies in partnership with relevant stakeholders	Initiate in 2009
3	Amend existing legislation	State agencies	2009 - 2010
4	Highlight, support and promote Invasive Species Codes of Practice	State agencies, Invasive Species Ireland, relevant stakeholders	Initiate in 2009
5	Public sector bodies adopt Invasive Species Codes of Practice	All public bodies	2009
6	Prioritise sites for eradication across the island of Ireland and initiate programme of measures	NPWS, NIEA, local authorities and other relevant stakeholders	2009/2010
7	Ensure adequate resources are in place to facilitate implementation of this plan	NPWS, NIEA, local authorities and relevant stakeholders	Immediately after successful completion of Action 6

14. Template management plan

Use this template to help formulate a management plan outlining how you are going to proceed and what you will need.

Site Manager(s)/Owner(s): _____

Site Name(s): _____

Central grid reference: _____

License to proceed with plan acquired? Yes No

Site details

Address:	
Telephone:	
Email:	
Agencies/persons involved:	
Date:	
Species of concern:	

Invasion history

Date of introduction:	
Original location of introduction:	
Date of first report to competent authority:	
Method of introduction:	
Additional information on introduction event:	

Site information

Total site area:	
Total area colonised:	
Total area of relevant habitats:	

Designation	On site	Near site	None present
Details: Establish if there is a requirement to apply for a license/notify before proceeding with plan.			

Rare and threatened species	On site	Near site	None present
Red Data Book or BAP species:			
Other rare or threatened species:			

Current identified impacts

Impacts	Minimal	Moderate	Severe

Human sensitivities/vested interests at site

Issue	Human receptor

Identify requirements and best practice for collaboration with stakeholders

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Actions and resources

Management options	Responsibility	Date to undertake

Resources needed	Responsibility	Date to undertake

Monitoring and evaluation

Name of person/s	Date to undertake	Report to	Additional treatments date (if required)

15. Summary of actions needed for effective management

1. Confirm identification of species. Refer to recognised experts to confirm identification, if required.
2. Develop and produce a site specific management plan. Use the template provided in this document to guide you. A key part of this will involve surveying and producing a distribution map indicating the species distribution on the site.
3. Consider all designated sites on or nearby the management area. You may need to apply for a license under nature conservation legislation to proceed and/or undertake an Appropriate Assessment under the terms of Article 6 of the Habitats Directive. Remember that actions taken outside a designated site may have an impact on a nearby designated site and are thus subject to the same considerations.
4. Consider surrounding properties and households. Talk to adjacent land owners and make them aware of the issues and what you plan to do. It may not be possible but always attempt to get their support. Control programmes will have a higher chance of success with support from the local community. Raise awareness of the issues and ensure alerts are placed in appropriate media e.g. the Invasive Species Ireland website.
5. Consider if you can successfully and safely carry out the work or if professional practitioners, with relevant training and certificates should undertake the work. Also consider if the programme can be co-ordinated with voluntary clubs and local societies and ensure their support and understanding of the issues.
6. Ensure safe disposal of plant material, including the cleaning of any machinery or equipment that may be contaminated.
7. Remember relevant health and safety legislation and procedures.
8. Identify if sufficient resources are/will be available to complete the work within the planned timescale. If work will take more than 1 year to complete, ensure you have sufficient funds to complete the work.
9. Monitor for missed plants/reintroduction during site visits. If applicable, ensure new members of staff are aware of the action plan and report sightings.

16. References

Baars, J.R., and Caffery, J. (2008). Water fern, *Azolla filiculoides* – Under biological control in Ireland. [online] Available from <http://www.invasivespeciesireland.com/information/>. [accessed 12 June 2009].

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The Invasive Species Ireland Project is undertaken, in partnership, by
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www.envirocentre.co.uk



www.quercus.ac.uk

and is funded by the National Parks and Wildlife Service and the Northern
Ireland Environment Agency.



www.ni-environment.gov.uk



www.npws.ie

For more information on the Invasive Species Ireland Project please see the
website at www.invasivespeciesireland.com