WATER FERN *(Azolla filiculoides)*

Species Identification

Aquatic free-floating fern that forms dense mats.

Stem: Dark brown/black branched stems <5cm long with hanging simple roots beneath floating leaves.

Leaf: Small (2.5mm x 1.5mm), branching, two-lobed bright green leaves which are fern like, have a rough granular appearance and water proof surface. Leaves turn red during cold weather in autumn/winter when the plant is stressed.

Ecology

Habitat Description: Water fern is present throughout low lying areas of the southern half of Britain. The plant will grow in any depth of slow moving or static freshwater including in ponds, canals, lakes and dykes. It does not tolerate turbulence or waves and is flushed away in strong currents. It can tolerate a range of environmental conditions including pH ranging from 3.5-10, heavy metal and salt pollution, low available nitrogen and temperatures ranging from -5°C to 35°C. It is not however tolerant of harsh winters.

Reproduction & Life Cycle: Water fern grows all year round and most prolifically in the warm summer months. It reproduces mainly between May and November both vegetatively as the fronds grow, and sexually by producing spores. Spores can remain viable in moist soil for up to 3 years. The plant has a symbiotic relationship with nitrogen fixing cyanobacterium, transferred during various stages of sexual reproduction.

Dispersal and Spread: Water fern is capable of rapid vegetative growth, doubling its surface area in 7 - 10 days. Natural dispersal occurs by transportation of the plant and spore infested soil by water currents, on machinery and on the feet/skin of birds, people or wildlife. It is also transferred unintentionally on the hulls and ballasts of boats and other leisure equipment and by grazing livestock.

Impact

Native Habitats: Water fern frequently forms dense monospecific floating mats which affect aquatic ecosystems by outcompeting submerged plants and algae. Dense infestations can reduce light levels beneath the water surface, deoxygenate the water, increase carbon dioxide levels, reduce the water pH and increase the siltation of water bodies, negatively impacting the floral and faunal composition of the water body.

Human Health Effects: Water fern is not toxic to humans however it can be hazardous at public sites where dense mats completely cover the water surface making it appear a safe surface to walk on.

Economic and Societal Effects: Dense populations of water fern can cause livestock drowning, reduce the water flow in irrigation canals and reduce the water surface available for water transport and recreation. Free-floating weeds can also be drawn into water intakes, causing pump and filter blockages and obstructing weirs, locks and other structures. The aesthetic value of infested water bodies is reduced, affecting recreational use and adjacent property values.

Legislation

Listed under Schedule 9 of the Wildlife and Countryside Act in England and Wales (2010) as on offence to plant or otherwise cause to grow in the wild.

Management Approaches

Prevention Methods - Early detection and rapid response

1. Map the distribution of all extant populations
2. Identify areas that are 'at risk' to new invasions:

- Within downstream flood zone of invaded watercourses
- Wetlands connected to infested sites by public access routes
- All ponds and slow flowing water body in close proximity to infested areas and urban areas
- Boat launch and recreational angling sites

3. Use GIS to map 'at risk' areas utilising land use spatial layers to improve predictability
4. Implement a management plan to prevent further spread of the plant including:
    - Restrict sales of Water fern through garden centres, supermarkets, aquarists an retail
    - Increasing public awareness of the ecological and economic impacts of infestations
    - 'Booming' of surface water to hold back floating biomass and slow its downstream spread
    - Avoiding unintentional transportation of plant fragments by:
        - Increasing public awareness at infested sites
        - Ensuring recreational (boats, boots, angling) equipment is drained and cleaned off before leaving any infested water body
        - Prevent livestock grazing on banks of infested water bodies
    - Managing extant stands along waterways and transport corridors to prevent dispersal
    - Monitoring 'at risk' sites to enable fast eradication if invasion occurs
    - Prohibiting planting in public access gardens, parks or in the wild

Eradication, Control and monitoring effects

It is difficult to achieve complete control of Water fern infestations. Treatment is usually ongoing until all spores have germinated and been controlled at all known sites. **Treatment in the early stages is highly recommended and eradication is normally more successful in smaller patches.**

Method	Description	Time of Year	Limitations
Biological Control	A frond feeding weevil, *Stenopelmus rufinasus* which is considered resident in the UK is considered a safe augmentative biocontrol agent which feeds exclusively on *Azolla filiculoides.*	Plant is eaten by weevil during the summer growing season. Weevil best released early in the spring growth season after winter die back	International trials have deemed this biological control agent safe, having no impact on non-target species and does not require a licence. It is currently used by the Environment Agency. It is impossible to be sure that biocontrol agents will not adversely affect native wildlife however. Biocontrol may take a number of years to be fully effective and may need to be re-introduced to sites if plant dies off but re-appears at a later date from spores.
Manual Removal	Harvest using weed buckets and flushing out the weed using baffle boards or barriers to temporarily raise the water level, removing the barrier when plant has accumulated against the barrier. Repeat until all the spores have germinated and been controlled.	Anytime and repeated	Only suitable on small patches and requires frequent operation so labour intensive and costly.
Dredging	Dredging bottom sediment.	Conducted after mechanical or manual removal.	For use in shallow areas and can alter the characteristics of the water body, however an effective method in conjunction with initial removal of plant material
Herbicides	Apply Glyphosate + Topfilm to emergent and floating weeds.	April - May (sometimes to August)	Glyphosate will require a license from the Environment Agency. Can only be used ON or near water. No pesticide is approved for use IN water. May impact non-target species.

References:

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