MARIE PATINET - ETIENNE BRANQUART - ARNAUD MONTY

Myriophyllum heterophyllum

Species description

Broadleaf watermilfoil (*Myriophyllum heterophyllum*) is a perennial aquatic or semi-aquatic plant that has both a submerged and an emergent form. The species, native to North America, was introduced to Europe, including Belgium, through the aquarium industry as a popular ornamental plant for aquarium and garden ponds. The first record of broadleaf watermilfoil's presence in the environment in Belgium dates from 1993. Disposal of aquarium or pond waste in water systems is probably at the origin of its escape in the wild. Today, broadleaf watermilfoil represents a problematic aquatic invasive species in many countries worldwide and is listed as IAS of Union concern under the (EU) Regulation No 1143/2014. At vegetative stage, the species can be confused with other plant species of the same genus. Its distribution on the Belgian territory is still very limited but probably remains underestimated.

Fig 1. *Myriophyllum heterophyllum*. Photo: Q-Bank

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Photo: Penguin

Myriophyllum heterophyllum

Broadleaf watermilfoil thrives in nutrient-rich stagnant or slow-moving freshwater such as ponds, ditches and canals. As a highly competitive invasive species, the plant has diverse environmental, social and economic impacts. This invader can form dense mats and extensive populations that can completely cover the water surface. This has significant detrimental impacts on the ecosystem and biodiversity, including light exclusion, native plant community displacement, and water quality modification. Social and economic effects include restriction of recreational activities (angling, boating), and management related costs.

Biological characteristics, reproduction and spread

Broadleaf watermilfoil overwinters and experiences rapid growth during spring, although emergent leaves may only become apparent in late summer. As an evergreen species, it can be observed throughout the year and is highly resistant to both high summer or cold winter temperatures. The plant, which can take root at depth of 2 to 3 meters, produces flowers between June and September, although flowering appears to be exceptional under Belgian conditions.

Reproduction of broadleaf watermilfoil in western Europe is probably exclusively vegetative. When the plant breaks into fragments, either naturally or due to human activity, those small fragments can form a new plant, and therefore a new population, away from the initial invaded area. While the plant is also known to produce viable seeds in some cases, seed production has not yet been observed in Europe. The spread of broadleaf watermilfoil can occur through flooding events, fragment drift within water systems or via fragments attached to boats and other water equipment. Fragments can remain viable for a considerable amount of time, and are able to regenerate, even under moist and dry conditions, as the species is highly tolerant to desiccation. Those high regeneration and dispersal abilities highlight the importance of the implementation of effective management measures.

Fig 2. Population of broadleaf watermilfoil covering the water surface. Photo : Matt Keevil

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General considerations about management

A wide range of management options have been used to control or eradicate broadleaf watermilfoil. Local eradication of both small and large infestations is considered challenging but achievable due to the species' ability to regenerate from small fragments and to take root at important depths. The eradication feasibility must always be assessed on a case-by-case basis, considering site specificities, and be thoroughly discussed within the management team.

Due to the species' ability to reproduce vegetatively by fragmentation, precautionary measures must be implemented before undertaking management activities to prevent fragment spread within the managed area or to other water systems. Managed areas are, therefore, isolated by physical barriers.

The harvested plant material must be safely disposed of away from water systems and is either dried and incinerated, buried (on dry land) or composted off- site. If transported to refuse facilities, it is recommended to dry the harvested material on a tarpaulin to avoid leaving the plant material in contact with the ground. Material that has been in contact with the plant (e.g. machinery, clothing) should be checked, cleaned and dried before being taken to another site. It is also recommended to restrict public access to the managed area to isolate the infestations as much as possible and limit the risk of spread.

Managed and downstream sites must remain under enhanced surveillance for a 5-year period after the implementation of the last treatment.

Fig 3. The emergent growth form. Photo : Jean-Marc Vallières

Fig 4. The submerged growth form. Photo : Matt Keevil

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Manual removal

- v Local eradication can be achieved
- v Good control can be expected
- v Manual removal is highly selective and will have minimal disturbance and impact on ecosystems and other organisms
- x The method is only suitable for small infestations
- x There is a risk to create and spread fragments to uninvaded areas
- x Manual removal is time-consuming, labor intensive and requires skilled operators

Method description

The principle is to remove the whole plant from the ecosystem. Plants are pulled out by scuba divers or operators walking in the water, working from the bank or from a small boat. Manual removal is implemented in recently invaded sites, areas with low vegetative abundance and shallow waters. It is strongly recommended to repeat the operation shortly after the initial manual removal, once sediments have settled, to ensure that no plants have been overlooked. This management strategy is conducted between March and October, and is repeated every 6 weeks during spring, summer and fall for the first year of the management programme. It is then followed by a 5-year manual aftercare to eliminate regrowth. Operators must pay great attention not to fragment the plants and to remove most of the plant material for this method to be worth implementing.

Material

Management: Small boats, waders, rakes, diving equipment

Transport and stocking: Buckets or mesh bags

Precautionary measures: Hand net, containment nets. A hardware cloth screen must also be placed at the upstream and downstream parts of the managed area and remain in place for 5 days following the operation.

References

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Mechanical removal: floating machines

- v Rapid control can be expected
- v Depending on the machinery used, mechanical removal is suitable for most situations
- x This method can only be implemented in sites where the vast majority of the invaded area is accessible to the machines
- x Mechanical removal can create vast numbers of plant fragments with the risk to spread the species to uninvaded areas and other parts of the managed water system
- x Depending on the type of machinery used, mechanical removal can negatively affect fish communities through oxygen depletion

Method description

The principle is to mechanically remove the whole plant from the ecosystem. Plants are uprooted by a weed conver boat. One concrete example of machine used is the harkboot, a boat equipped with a large rake on one side and another rake with inserted mesh on the other. The large rake scrapes up the bottom of the water body while the rake with inserted mesh is used to collect the uprooted plant material and discharge it temporarily on the bank. The selection of rake tines should be based on the type of substrate and the targeted species.For the management of broadleaf watermilfoil, coarse tines will be preferred in clay beds while small tines will be favoured in sand beds. As different boat dimensions are available, this method can be conducted in large or small infestations present in deep or shallow waters (at least 0.6 m deep). If the method is implemented in running waters, it is recommended to work in accordance with the direction of the current to prevent re-infestation of cleaned-up areas to occur. Similarly, if mechanical removal is implemented in stagnant waters, the direction of the wind or the presence of hydraulic infrastructures, which may influence current, must be taken into account. As the weather and wind direction can change throughout the day, the working method must be adjusted accordingly. Mechanical control is preferably implemented in late fall to preserve native macrophytes and eliminate the competitive advantage of *M. heterophyllum*.

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Mechanical removal is immediately followed by the manual removal of plants that were inaccessible to the machines (e.g. plants rooted near the bank or obstacles). Remaining drifting plant fragments are also removed. Operators must pay great attention to remove as much plant material as possible. Repeated mechanical removal is often required (at least once a year), over a few years, and regular site surveys must be conducted. Once a good level of control is achieved and that the infestation is limited, manual aftercare is implemented to remove regrowth.

Material

Management: Adequate boat

Transport and stocking: Containers and trucks

Precautionary measures: Hand net, containment nets. A floating net with lead-line must also be placed at the downstream part of the managed area and remain in place for 5 days following the operation.

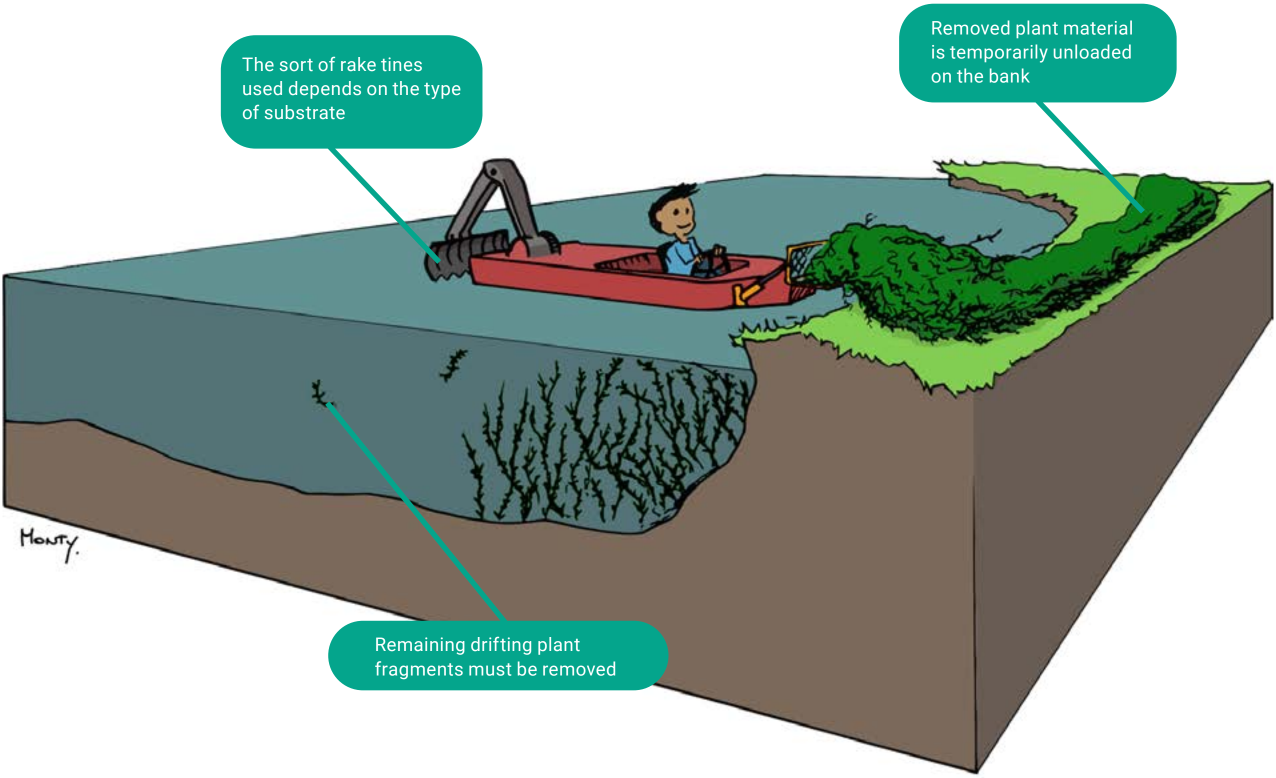

Fig 5. Mechanical removal of broadleaf watermilfoil using the harkboot

Substrate removal: mechanical dredging

- v This is one of the fastest methods to achieve good levels of control
- v This method is suitable for large infestations
- v Mechanical dredging can be implemented when maintenance dredging of the water body is required
- x High costs are expected due to use of machinery and the need to move sediments to dedicated disposal sites
- x Disposal sites must be found for the storage of contaminated sediments before the start of the work
- x This method can only be implemented in sites where the whole area is accessible to the machines and where drawdown can be implemented
- x Dredging can create vast numbers of plant fragments with the risk to spread the species to uninvaded areas
- x This method can have high negative impacts on aquatic living organisms

References

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Method description

The principle is to remove the bottom sediments contaminated with all parts of the invasive plant such as roots and stems. Excavators equipped with cleaning bucket thumb are used for excavation and the removal of at least 15 to 25 cm of sediment to prevent regrowth. This method is preceded by a water drawdown (< 0.5 m) or a complete drainage (if possible) during which care should be taken not to spread plant fragments to other areas via the sewage systems. Mechanical dredging is conducted when the plant is prostrate (around March). Operators must pay great attention not to fragment the plants and to remove as much plant material as possible. Follow-up methods such as repeated manual removal to progressively eliminate regrowth or the placement of light-blocking sheeting over the substrate are implemented.

Material

Equipment: Excavators with cleaning bucket

Transport and stocking: Buckets, trucks, dumpers and containers

Containment: Hand net, containment nets, biofilters

Light deprivation: benthic jute matting

v Local eradication or really good control can be achieved within a few months

v The method is suitable for both limited and large invaded areas

v The material is solid and biodegradable, thus does not require to be removed (eco-friendly and no removal costs)

v The jute enables native vegetation to grow through it, which allows native plant species to reestablish. It also enables gas to escape

x This method is limited to stagnant waters

x The placement of jute matting can be impracticable or impossible in sites where obstacles are present

x The method is likely to be detrimental to benthic organisms and affect fish spawning

Method description

The principle is to install bottom covers that both compress vegetation and exclude sunlight, causing the death of the plants. Jute matting, a natural and biodegradable vegetable fiber, is placed by divers or operators on the bottom of the water body. For large populations of broadleaf watermilfoil in deep waters, long strips of jute are deployed from a boat on the water surface and rapidly sink to the bottom. For smaller populations, sheets are manually placed on the weed bed by divers or operators. It is really important that no light reaches the plants from any adjacent area, gaps or the edges of the sheeting. Divers or operators must ensure the adequate placement of the matting and that strips overlap correctly. The use of large continuous pieces of sheeting is therefore recommended, whenever possible. The sheets must then be secured to the bottom using weights. Benthic covers are placed during winter, when the plants are prostrate, and are never to be removed as jute eventually disintegrates after 1 or 2 years. Eradication is, however, achieved within a few months. Once the jute has disintegrated, inspections and manual removal are conducted to remove any plant regrowth, until none is found.

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Material

Management: The adequate quantity of jute matting rolls. It is important to ensure that the plant does not grow through the holes of the fabric. Jute textile with mesh size 0.5 mm, 300 $g.m^{-2}$, is therefore recommended. Weights, rocks, concrete blocks or sandbags. Boat and skilled operators or scuba divers.

Non-biodegradable materials such as PVC plastics, woven synthetics or fibreglass 'stabilising paper' have commonly been used as benthic covers for the management of broadleaf watermilfoil. However, this type of material presents many significant disadvantages. For non-permeable material, gases can accumulate and lift the blankets, allowing light to reach the plants. Non-biodegradable material also requires to be removed, which generates additional costs. It also has a greater negative impact on living organisms and the ecosystem.

While available information on the use of jute matting as a successful measure to manage broadleaf watermilfoil is quite limited, it is likely that this technique will be effective on this invasive weed.

Fig 6. The placement of covers is preferably implemented in small areas as covering large areas can rapidly become expensive. Photo : Eric Keith

DID YOU KNOW?

Hydro Venturi, an effective tool

The hydro-venturi system consists in applying a powerful water jet to uproot the plants. The floating plants are then removed from the water. The hydro venturi has successfully been used for the control (significant reduction in plant biomass) and the eradication of diverse invasive aquatic weed species such as *Cabomba caroliniana* and *Myriophyllum* spp. The system also displays significant advantages over similar mechanical removal techniques including fragment reduction, reduced plant regrowth, high level of acceptability by stakeholders, etc.

Some limitations of such system must, however, also be acknowledged. While expensive and non-selective, the use of hydro venturi requires skilled operators and preparatory work. Its efficiency is also highly dependent on sediment type and water depth.

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The impact of management actions on ecosystem services

While the adverse effects of IAS are well-known and provide strong incentives for implementing management actions, the impacts of these management actions on ecosystems and the services they provide are less considered. The matrices are the result of expert assessments of the evolution of relevant ecosystem services (ES) from a highly invaded situation towards a managed situation. ES evolution is considered over 2 given periods of time: 1 year and 5 years after the initiation of management.

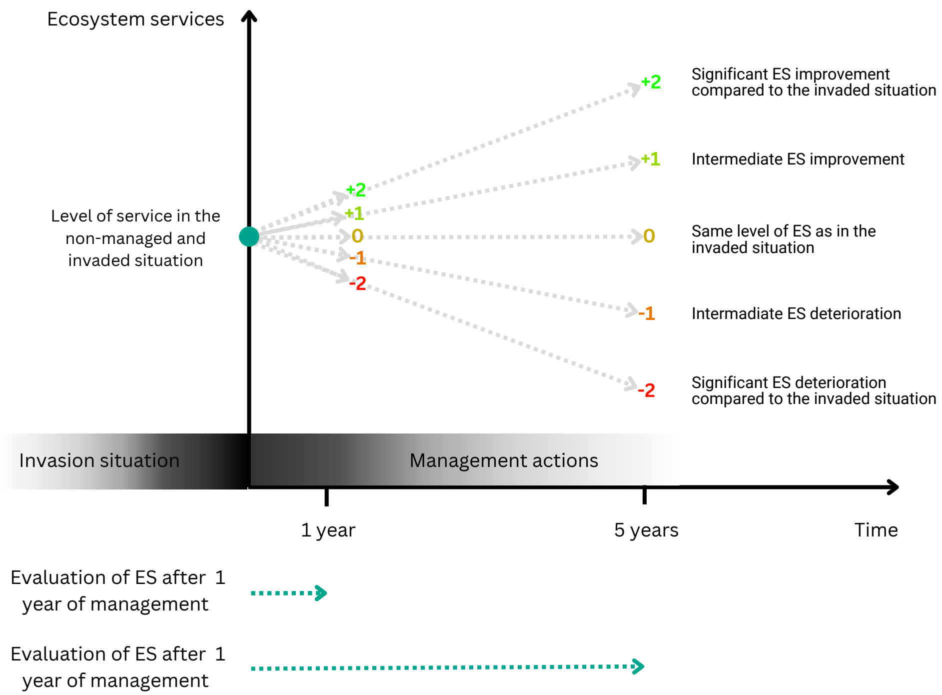

Fig 7. Representation of the survey process

Each matrix displays the average impact scores of management methods on ecosystem services. These scores have been associated to colours to facilitate the visualization of the impacts of every method on every relevant ecosystem service. Green indicates a significant improvement in the ecosystem services (ES) due to management, orange represents no or minimal effect, and red signifies a negative impact of the method on the ES.

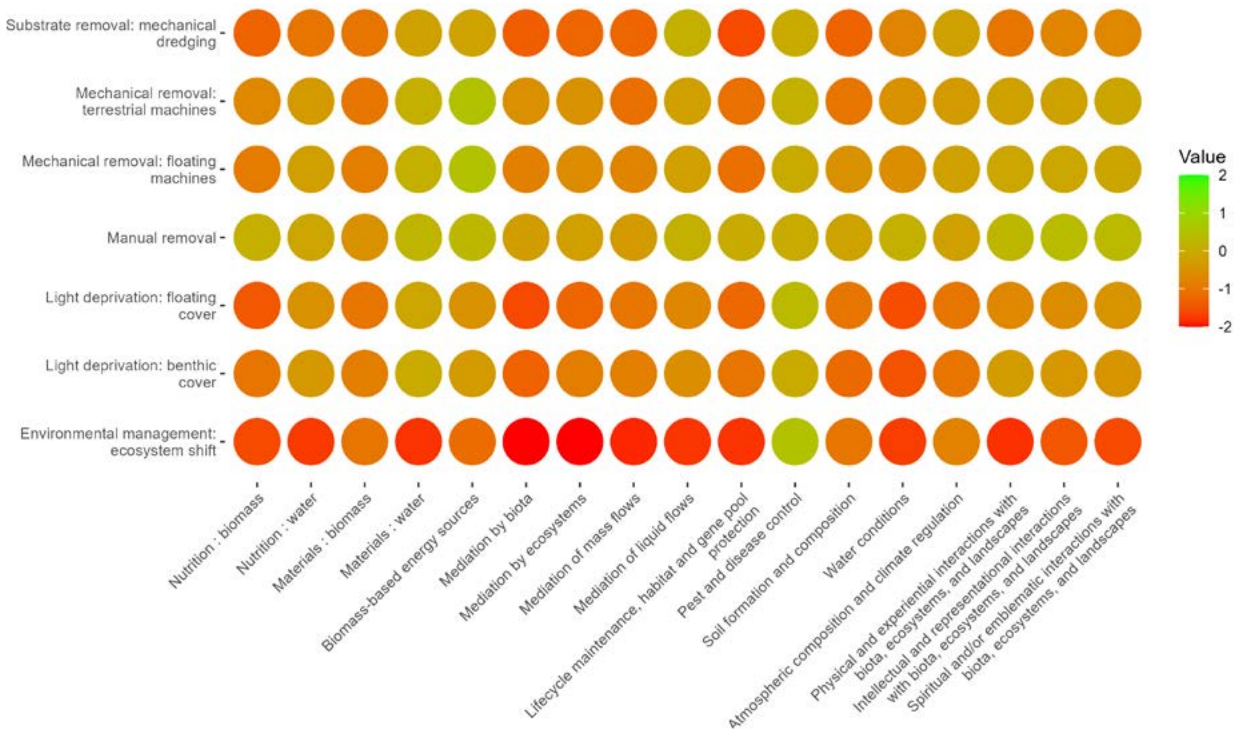

Fig 8. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 1 year

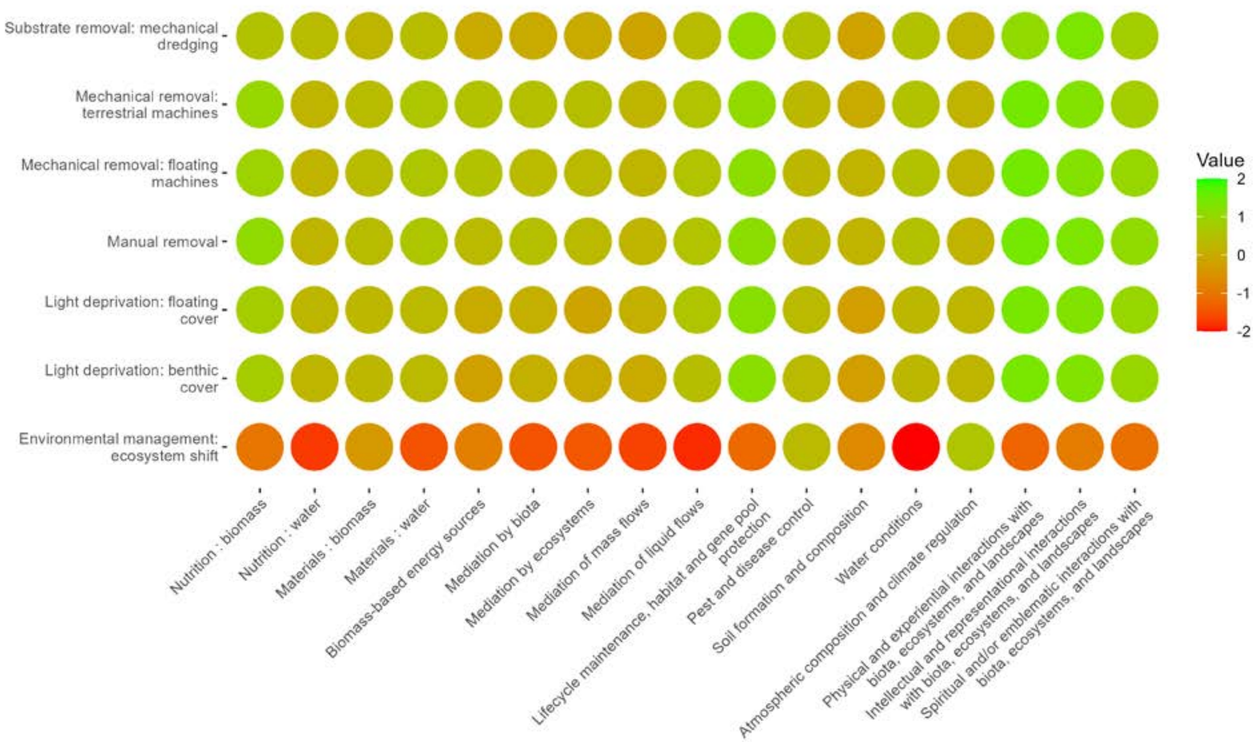

Fig 9. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 5 years

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Reaching Integrated and Prompt Action in Response to Invasive Alien Species

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