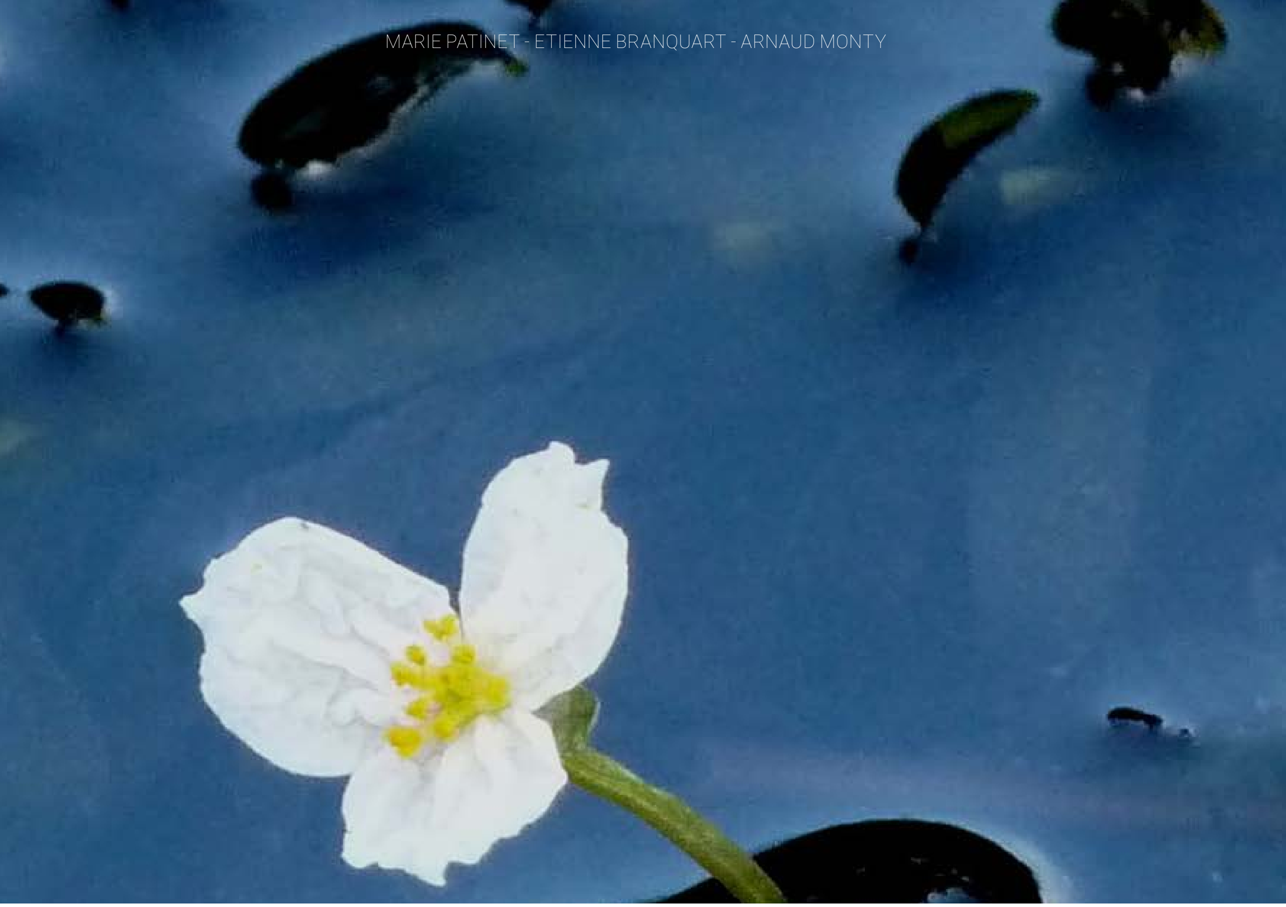
MARIE PATINET - ETIENNE BRANQUART - ARNAUD MONTY



Elodea densa

Fig 1. *Elodea densa*. Photo : LIFE RIPARIAS

Species description

Greater pondweed (*Elodea densa*, syn. *Egeria densa*) is a perennial submerged aquatic plant native to South America. The species was introduced to Europe, including Belgium, through the aquarium industry as a popular plant for aquariums and garden ponds. The first records of the greater pondweed's presence in the environment in Belgium date back to 1999. Disposal of aquarium waste in water systems is probably at the origin of its escape into the wild. Today, while emerging in some countries, the plant is already a problematic aquatic invasive species in several countries worldwide. As a result, it has been included in the LIFE RIPARIAS alert list. The distribution of greater pondweed on the Belgian territory is likely underestimated as the plant can easily be confused with other non-native species such as *Elodea nuttallii*. Additionally, its submerged form makes it challenging to detect.

Guide de gestion complet en version française

Volledige beheergids in Nederlandse versie

Photo: harrylurling

Elodea densa

Greater pondweed thrives in a wide variety of freshwater habitats, ranging from acidic to alkaline conditions, but mostly develops in shallow, still or slow-moving waters such as rivers, streams, ponds or lakes. Although light demanding, the plant has the ability to grow in deep (taking root up to 10m deep) and turbid waters. As a highly competitive invasive species, greater pondweed has diverse environmental, social and economic impacts. This invader can form dense and monospecific populations and colonise the whole water column. This has detrimental impacts on the ecosystem and biodiversity through light exclusion, native plant community displacement and water movement restriction. Social and economic effects include restriction of recreational activities (angling, boating), swimming hazards, increased land flooding risks and management related costs.

Biological characteristics, reproduction and spread

In its introduced range, including Belgium, flowering of greater pondweed occurs in late spring (June) and once again in autumn (October), with flowers extending above the water surface. These 2 flushes are then followed by a reduction of the plant's biomass as branches decompose.

Greater pondweed is a dioecious species. Its reproduction in western Europe is probably exclusively vegetative via male plants only. When the plant breaks into fragments, either naturally or because of human activity, those small fragments (containing double nodes) can form a new plant, and therefore, a new population away from the initial invaded area. In its native range, the plant can also reproduce by seeds. The spread of this invasive weed mainly occurs through fragment drift within water systems, flooding events or via human activities with fragments being attached to boats, waders or other water equipment. These fragments can remain viable in water for a considerable period and can withstand desiccation for up to 10 hours. The species' high regeneration and dispersal abilities emphasize the importance of implementing effective management measures.

Fig 2. Greater pondweed invasion

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General considerations about management

Various management options have been used to control or eradicate the species. Local eradication of greater pondweed is considered complicated once the species has established. However, highly effective and promising management methods such as jute matting have successfully been used for the control and eradication of similar species, such as *Lagarosiphon major*. Although not yet documented in the literature for the management of greater pondweed populations, this technique is likely to be an effective measure. Nevertheless, the eradication feasibility of greater pondweed populations must 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 through fragmentation, precautionary measures must be implemented prior to management to prevent fragment spread within the managed area or to other water systems. The 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 or composted. Material that has been in contact with the plant (e.g. diving equipment, 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.

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Manual removal

v Local eradication can be achieved

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 and early-detected infestations

x There is a risk to create and spread fragments to uninvaded areas

x Scuba diving requires qualified operators

Method description

The principle is to remove the whole plant from the ecosystem. Plants are pulled out by the roots by scuba divers or operators walking in the water, working from boats or from the bank. Operators must pay great attention not to fragment the plants. This method is implemented in autumn, when the plant is more prostrate but still visible, in recently invaded sites or areas with low vegetative abundance. This management method generally needs to be frequently repeated over a period of 3 to 5 year. The managed site is surveyed 8 weeks after the initial manual removal to check for regrowth orw plants that would have been overlooked.

Material

Management: Diving equipment (deep water) or operators with waders (shallow water), boats. Buoys to demarcate the managed area

Transport and stocking*:* Buckets or mesh bags

Precautionary measures: Hand net, floating booms, containment nets or bubble curtains

References

Lafontaine, R.M. *et al.* (2013) *Risk analysis of the Brazilian Waterweed* Egeria densa Planch. The Royal Belgian Institute of Natural Sciences.

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Mechanical removal: floating machines

v Rapid good control can be expected

v Mechanical removal is suitable for many situations, even well-established and large populations in deep or shallow waters

x Eradication is probably unlikely or hardly achievable

x Mechanical removal can create plant fragments with the risk to spread the species to uninvaded areas and other parts of the managed water system

x 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 to a depth of 10 to 15 cm 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. Mechanical control is preferably implemented several times per year (up to 4 times) between April and October, when the plant is visible. As different boat dimensions are available, this method can be conducted for large or small infestations in deep or shallow waters (at least 0.6 m deep). If the method is implemented in running waters, it is recommended to take into account the direction of the current to prevent re-invasion of cleaned-up areas.

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Similarly, if mechanical removal is implemented in stagnant waters, the direction of the wind or the presence of hydraulic infrastructures, which may influence the current, must be considered. As the weather and wind direction can change throughout the day, the working method must be adjusted accordingly. The harkboot must be stopped and management postponed when hypoxia is observed by the operators. Mechanical removal is immediately followed by 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. Repeated mechanical removal is often necessary (at least once a year) over a few years (4 years) to notice a drastic reduction of the population. Regular site surveys must be implemented. Once a good level of control is achieved and the infestation is limited, manual aftercare is implemented to remove regrowth.

Material

Management: The adequate boat

Transport and stocking: Buckets 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 at least 5 days following the operation.

Fig 3. Depending on the type of machine, the harvested plant material can either be stocked on board or unloaded on the bank. Photo: Matt Green

Light deprivation: benthic jute matting

v Local eradication or really good control can be achieved

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

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

v The jute enables native plants to grow through it, allowing vegetation 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 if important obstacles are present

x This 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 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 adjacent area, gaps or the edges of the sheeting. Divers or operators must ensure the adequate placement of the matting and that the strips overlap correctly. The use of large continuous pieces of sheeting is therefore recommended whenever possible. Weights are attached to the side of the jute to secure the covers to the bottom and assist with accurate placement. Jute must not be removed as it disintegrates after 1 or 2 years. Eradication is, however, achieved after 5 to 7 months. Benthic covers are placed in winter when the plants are prostrate. If not possible, mechanical cutting can be implemented before the placement of the jute to reduce the biomass and facilitate the fixing of the material to the bottom. If cutting is implemented, operators must ensure that no fragment remain, as there is a high risk that new plants will grow on top of the matting. Once the jute has disintegrated, inspections and manual removal of remaining plants or any regrowth are conducted until the complete disappearance of the species.

Material

Management: The adequate quantity of jute matting rolls. Weights, rocks, concrete blocks or sandbags. Boats. Buoys to demarcate the managed area.

Precautionary measures: Hand net, floating booms, retention nets or bubble curtains (if mechanical cutting is conducted).

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DID YOU KNOW?

Introduction of living organisms: sterile grass carp, a good idea?

The introduction of sterile grass carp (*Ctenopharyngodon idella*) has proven to be an effective method to achieve good control or, in some cases, eradication of some aquatic invasive species such as *Egeria densa*. However, this method remains controversial due to the severe impact this non-native fish can have on the ecosystem. Great care should be taken if introduction of grass carp is undertaken.

The principle is to introduce a generalist herbivore to control invasive plant populations amongst other plant species. Sterile grass carp (triploid), sourced from certified fish farms that provide pathogen-free animals, are introduced into closed, secured and controlled water bodies for a limited period of time. The fish must be removed when the expected result is achieved. The timing for removal will depend on the evolution of invasive plant populations. The efficacy of grass carp in controlling invasive plant species populations is dependent on its feeding preferences. Studies have found that while greater pondweed is highly palatable to grass carp, fanwort and curly waterweed are among the least preferred food choices. An appropriate stocking density is therefore important to mitigate the risk of selective feeding on other plant species. The recommended stocking density is a minimum of 25-30 adult triploid sterile grass carp ha^{-1} (evaluation for fanwort). This is, however, only an estimation as the appropriate stocking density depends on many variables such as fish availability, fish weight, size, and the invasion state. If a correct stocking density is chosen, a single application of grass carp is sufficient for effective control. This method is not recommended for sites with high conservation value due to the significant negative impacts of grass carp on plant communities and invertebrates. If the targeted invasive plant persists after fish removal, further follow-up techniques must be implemented until no regrowth occurs.

Fig 4. Sterile grass carp (*Ctenopharyngodon idella*). Photo : Rostislav Stefanek/Shutterstock

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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.

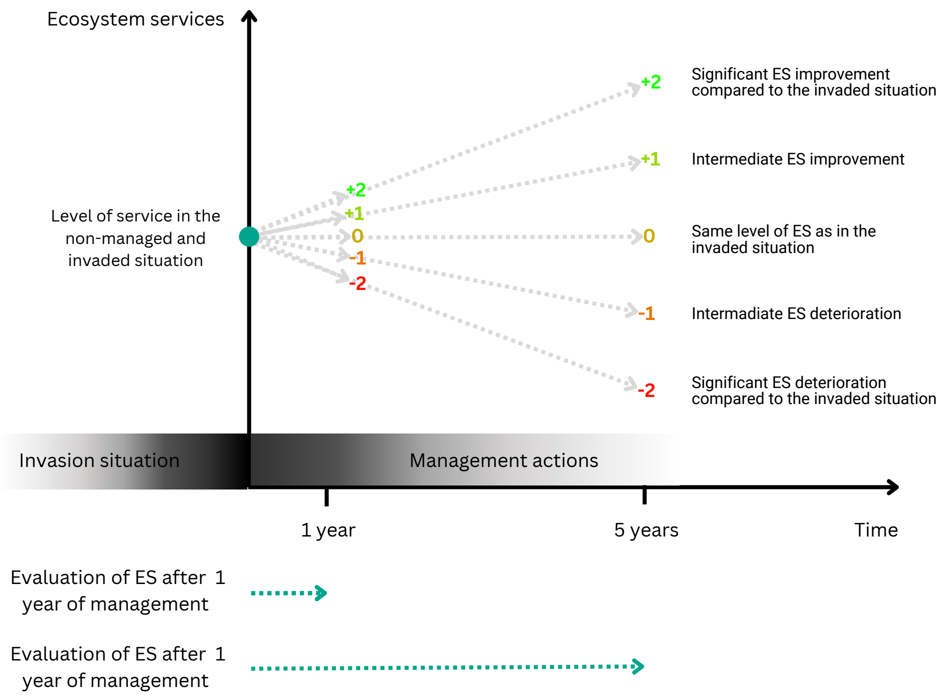

Fig 5. Representation of the survey process

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.

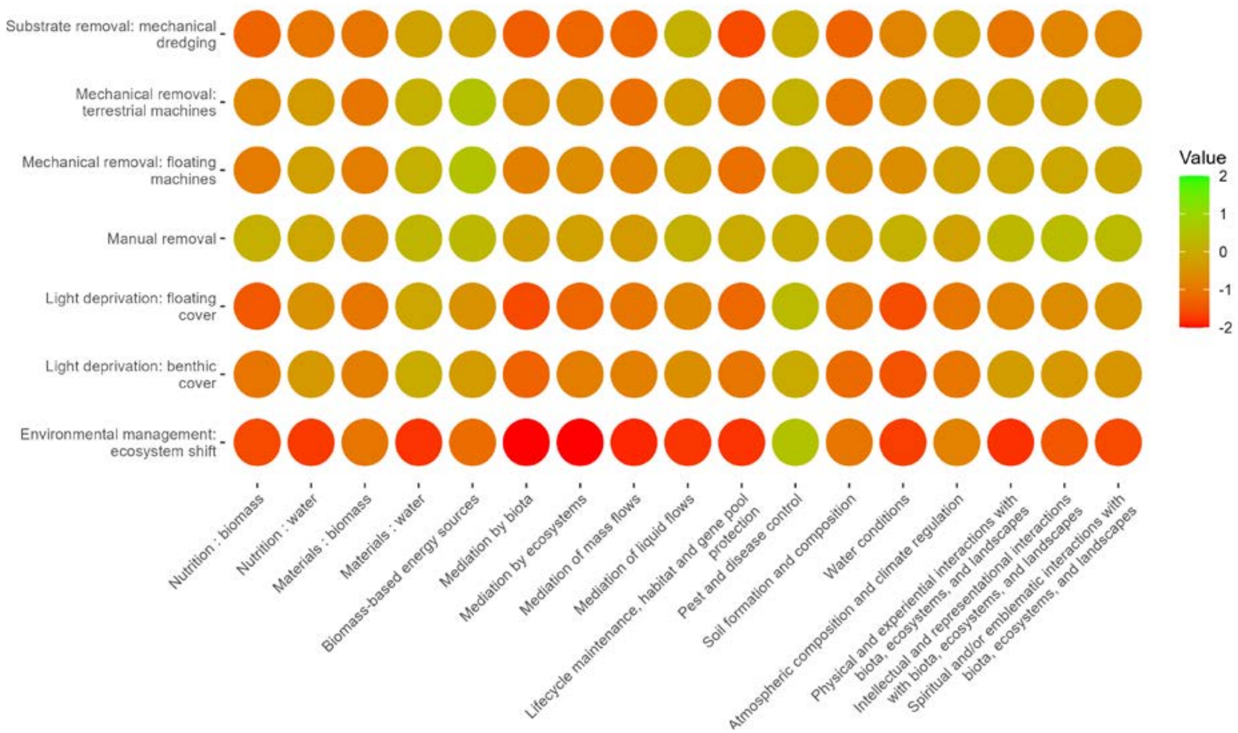

Fig 6. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 1 year

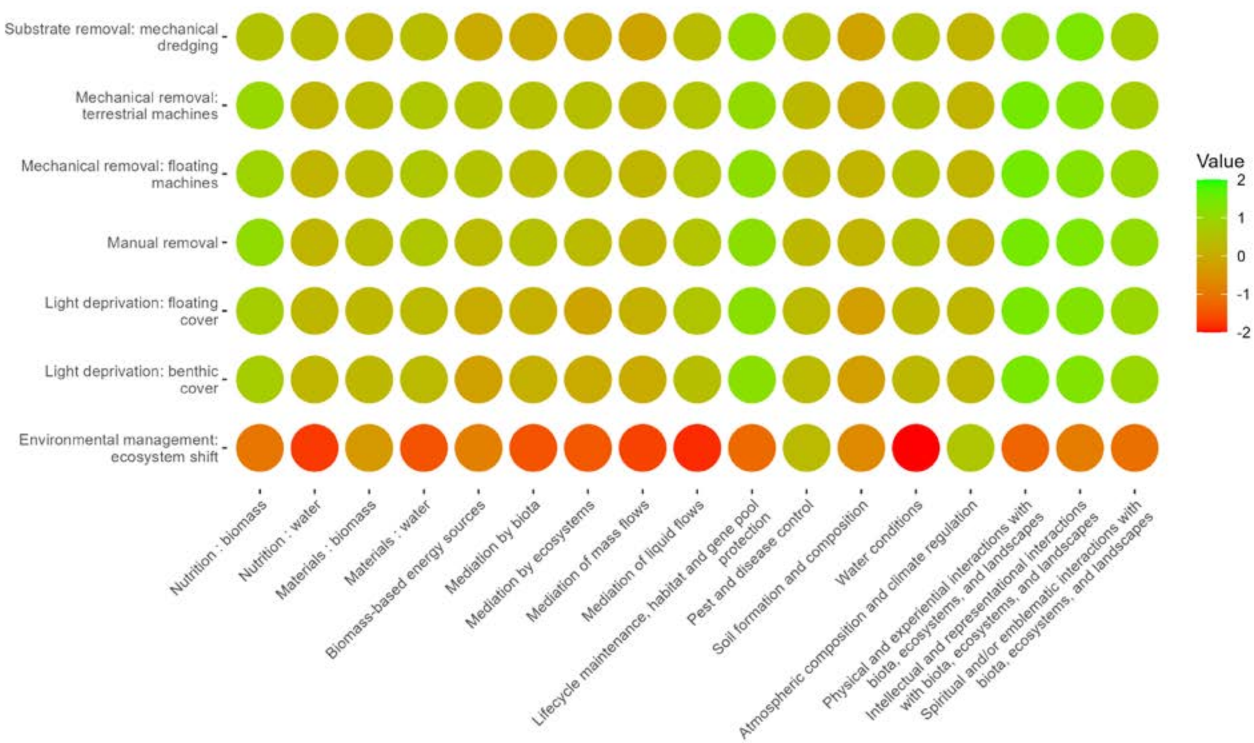

Fig 7. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 5 years

LIFE RIPARIAS

Reaching Integrated and Prompt Action in Response to Invasive Alien Species

Citation

Patinet, M., Branquart, E. and Monty, A. (2024). Management fact sheet - *Elodea densa*. LIFE RIPARIAS project, 12p.

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