



NATIVE FRESHWATER PLANT CULTIVATION

**Guidance on the nursery cultivation and
restoration of native submerged plants
in lakes, ponds and rivers**

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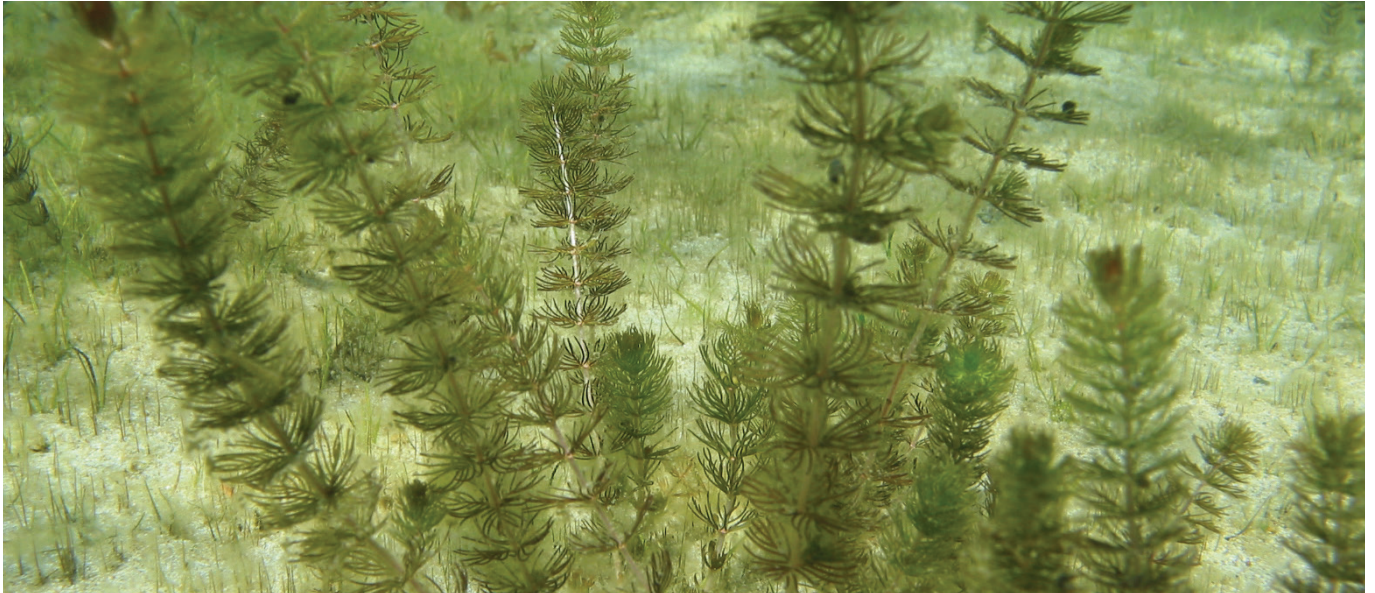
Front cover: Shoot of *Elatine gratioloides*.

This page: Underwater bed of native milfoil.

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The native milfoil *Myriophyllum triphyllum*.

WHAT ARE MACROPHYTES AND WHERE ARE THEY FOUND?

Macrophytes are aquatic plants large enough to see with the naked eye, growing in freshwater and brackish waterbodies.

A companion booklet covers brackish and salt-water species.

WHY ARE AQUATIC PLANTS IMPORTANT?

Aquatic plants are important because they support ecosystem processes such as primary productivity, nutrient sequestration, sediment aeration and stability and the provision of habitat for aquatic animals. This publication focuses on submerged aquatic plants – those that grow mostly beneath the water surface.

PURPOSE OF THIS PUBLICATION

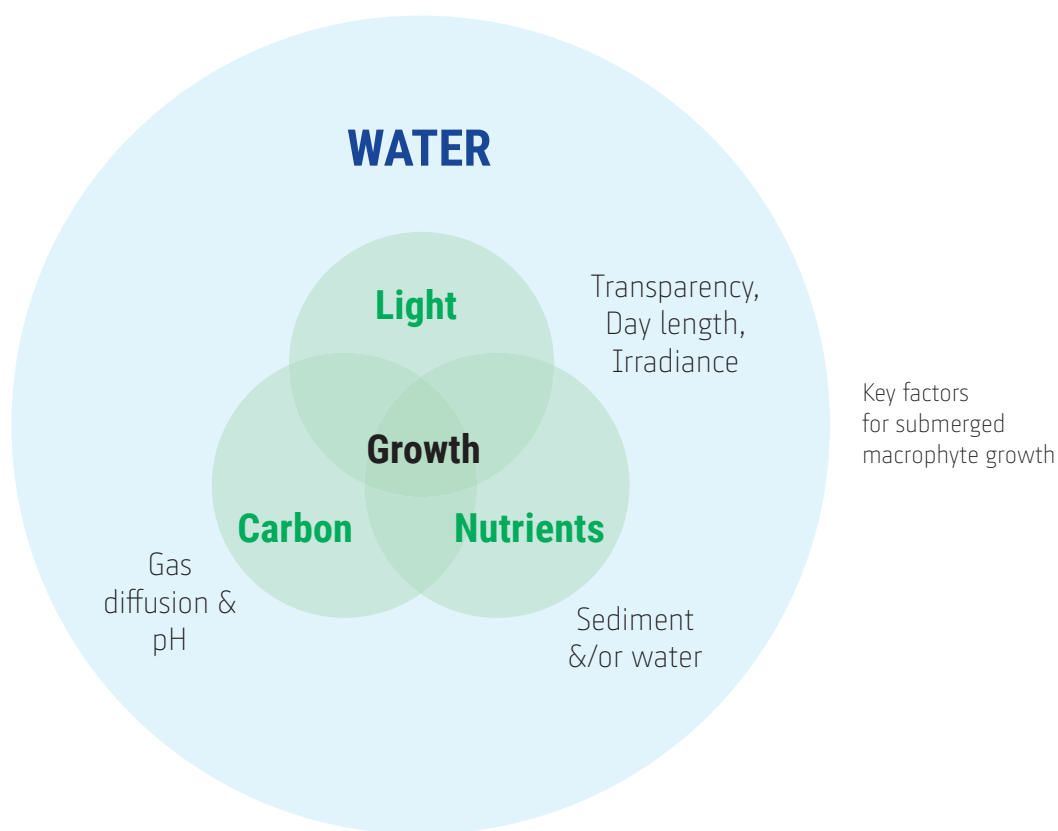
The purpose of this booklet is to help provide guidance on the cultivation and restoration of native submerged macrophytes for environmental rehabilitation initiatives in freshwaters.

WHAT DO SUBMERGED AQUATIC PLANTS REQUIRE?

Submerged aquatic plants require immersion in water for long-term survival, but some life-forms (e.g., amphibious plants) have different tolerances to emersion.

Three key factors are needed to support aquatic plant growth:

- **Light** is essential and is strongly influenced by water transparency, but also by fouling of plant surfaces and shading by other plants and algae. Light needs to reach plant leaves in order for photosynthesis and growth to occur.
- **Carbon** must be available as dissolved carbon dioxide or bicarbonate depending on water pH. Carbon is needed for growth and can sometimes be limiting, especially in still waterbodies (ponds and lakes).
- **Nutrients** and trace elements are required and are accessed by submerged plants from the water or sediments. Favoured sediments are usually fine, soft and stable, enabling penetration of plant roots.





Example of a culture facility.

CULTIVATION OF AQUATIC PLANTS

Culture facility / tanks. Culture environments are based on tanks, shallow ponds or flowways lined to retain water. Water needs to be of a depth sufficient for the macrophyte species. For example, species commonly growing over 1 m will need a water depth of about 1.5 m, while low growing species (<0.2 m) can be cultured in shallow water of about 0.3 m.

Water source. Submerged macrophytes require immersion in water for long-term survival. An adequate clean water source (ideally free from chlorine) is needed to allow for filling and potential flushing of culture tanks. Chlorinated water can have a negative impact (cause injury or even death) to aquatic plants.



Shade cloth used to reduce the light level in the culture tank.

Cultivation of aquatic plants continued

Light. Natural light is best but artificial lighting can also be used. Plants use photosynthetically active radiation (PAR) in wavelengths 400 to 700 nm. Lighting that provides submerged plants with PAR of more than $10 \text{ mol m}^{-2} \text{ d}^{-1}$ is recommended. PAR can be measured with a special measuring instrument (i.e. a quantum sensor). Shade cloth can be used to limit algal growth, if this is an issue, but low light may also constrain plant growth requiring more time to reach the target size.

Nutrients. Using water that is generally low in nutrients (e.g. tap water) can help to avoid algal growth. If nutrients in water are relied upon to support plant growth then at least 0.1 mg/L of phosphorous (P) and 1 mg/L of nitrogen (N) is recommended. Alternatively, low nutrient water can be used in combination with a substrate nutrient supply (see below).

Substrate. Suitable substrates include fine-textured soils or sediments with a low to moderate organic content up to 20%. Substrate sources could either be a donor sediment from an aquatic site that supports macrophytes, the recipient environment (substrate from the area you are going to plant e.g., for testing suitability) or commercially available products. Screened topsoil modified with washed sand in about a 50:50 mix can work well. Slow-release fertilizer may be added for prolonged culture periods (>2 months). Potting mixes that contain wood chip, peat, vermiculite or perlite are generally unsuitable as they initially float and dirty the water. A 3 to 5 cm cap of washed sand over the surface of the substrate helps to retain nutrients and prevent suspension of fine particles.

Temperature. Water temperature can influence the rate (speed) of plant growth but is likely to be less important than daylength and light. Natural light availability varies seasonally with day length, being less in winter, and more in summer. Optimal water temperatures are usually in the range from 15 to $25 \text{ }^{\circ}\text{C}$.



Culturing macrophytes in pots, grouped on a tray for ease of handling.

Plant pots

Submerged macrophytes can be difficult to repot so it may be best to grow the plants directly in the container for transplanting. Containers should be of a size adequate for the macrophyte species and for handling. Also, because retrieving and depositing containers from tanks can be difficult, it is helpful to group them on trays (e.g., nursery shuttle trays) with a means of retrieval (e.g., handles, strings (example above)).

Plastic nursery pots or trays are suitable for macrophyte culture, but thought needs to be given to transferring the rooted plant during transplantation. For example, cotton, hessian or coconut fibre liners could be used in trays for transplanting macrophytes.

Suitable compostable pots are available in the form of wood chip (e.g., Fertipots), peat or coconut-coir fibre (see image below).

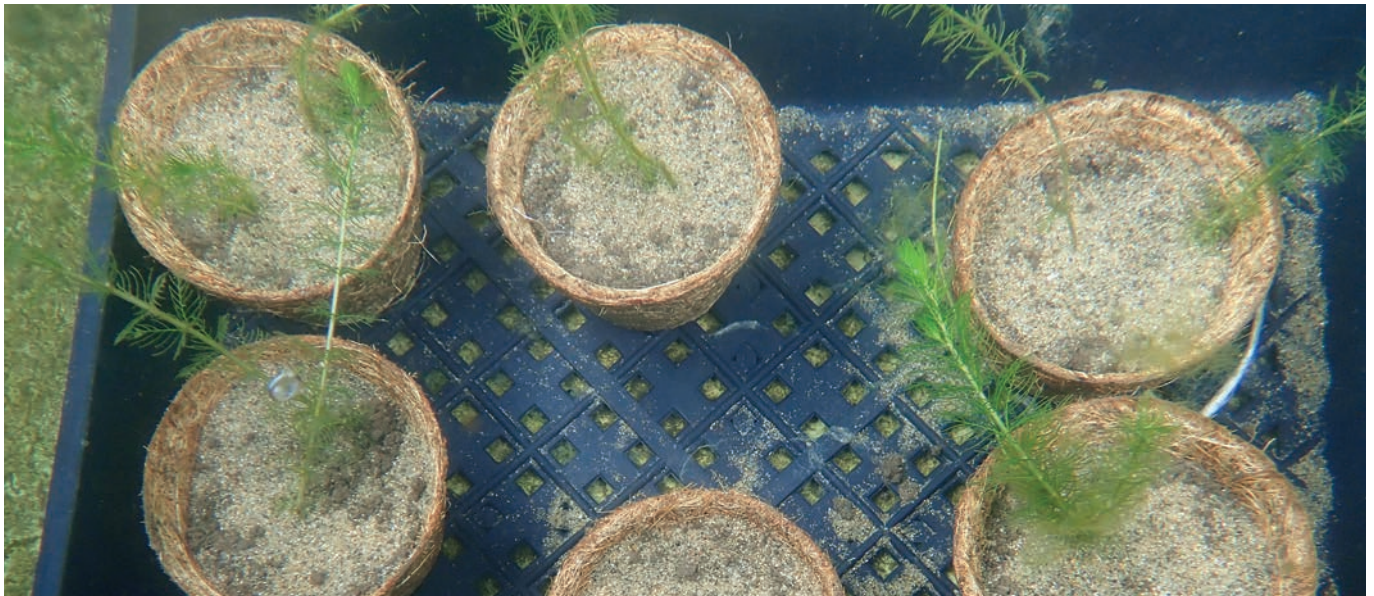
Note some compostable pots (e.g., bamboo) require specific conditions for breakdown, and others may release tannins in the water and initially reduce water clarity. It may be possible to reduce staining by pre-soaking pots.



Using compostable materials in culturing macrophytes will allow direct transplanting without disturbance of root systems.



Trays of native plants in cultivation.



Milfoils growing in biodegradable pots.

Cultivation of aquatic plants continued

Plant propagules – seeds or vegetative propagules

Seeds can be obtained from the sediments from waterbody margins (the shallows) and can be concentrated (removed) from the sediment by sieving.

Sieve aperture (hole) sizes need to match the size of the seed sought (e.g., with aperture in the range of 250 to 500 μm for charophyte oospores and c. 700 μm sufficient for seed of most vascular species).

Sieved material can be spread on top of topsoil then covered with a thin layer of washed sand in shallow trays or pots. These should be placed within 0.2 to 0.3 m of water under 30 to 50% sunlight levels and warm temperatures (15 to 20°C) for germination.

Germination of most species occurs in a few weeks, but some seed (e.g., oospores of charophytes) will benefit from drying for a few days. Identification of emerging plants is necessary to remove any unwanted terrestrial or shallow water reeds and rushes.

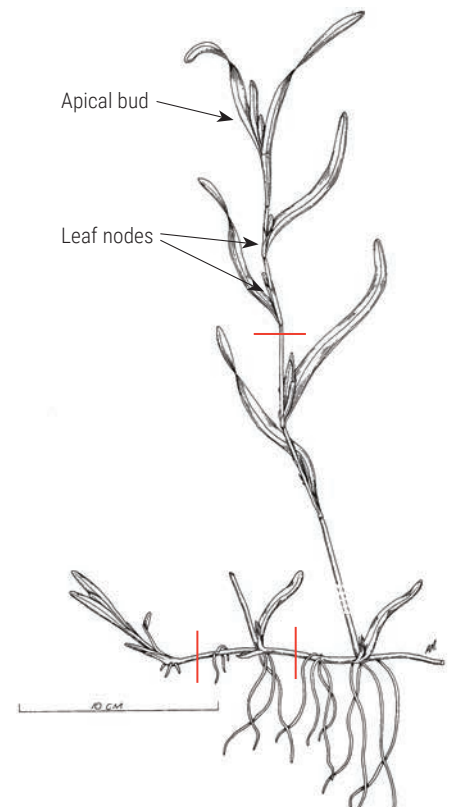
Submerged macrophytes generally propagate well from vegetative fragments. Vegetative propagules may be a shoot section or horizontal rhizome that includes several upright shoots, or entire small plants. Best results are obtained if the apices are intact (apical bud) and there are numerous leaf nodes (axillary buds) on the stem from which roots or additional branches can develop.

Shoot sections should be inserted 5 to 10 cm deep in the substrate to encourage rooting and secured in the substrate with a little pressure.

Production timeframes – when to cultivate

The production schedule for macrophyte culture, is informed by the timing of the planned restoration and the required development of macrophyte root and shoot systems. For instance, a long culture period may be required for material destined for high energy environments (i.e., waves, flowing waters) that will need more substantial root anchorage, or where taller material is needed to 'escape' light limitation, if this is likely to occur at the lake, river or pond bed.

Growth rates for native New Zealand submerged macrophytes will vary depending on the availability of the key factors required to support growth (see page 4). However, usually a minimum of two to three months should be used for planning to produce suitable transplants for translocation.

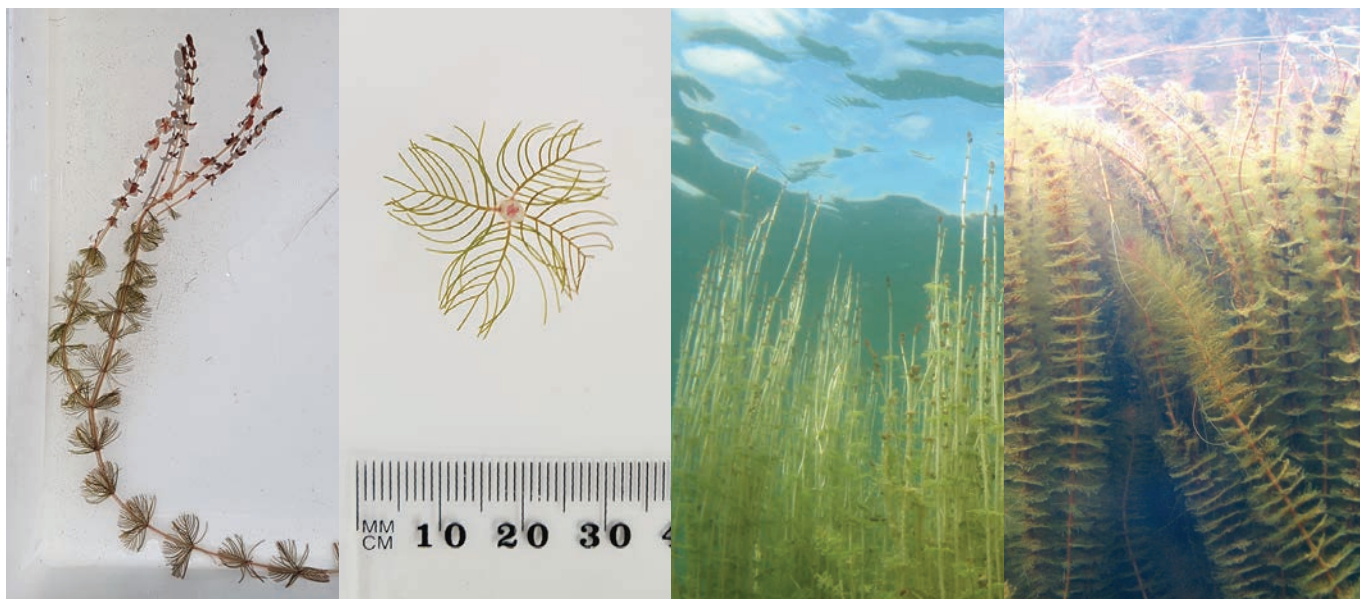


This plant could easily be divided (cut) where the red lines indicate to create four new individual plants.

SUITABLE SPECIES

A resource to support the collection of suitable species and as a high-level guide to the conditions required for culture.

Ten easy to cultivate and source species are illustrated in this booklet.



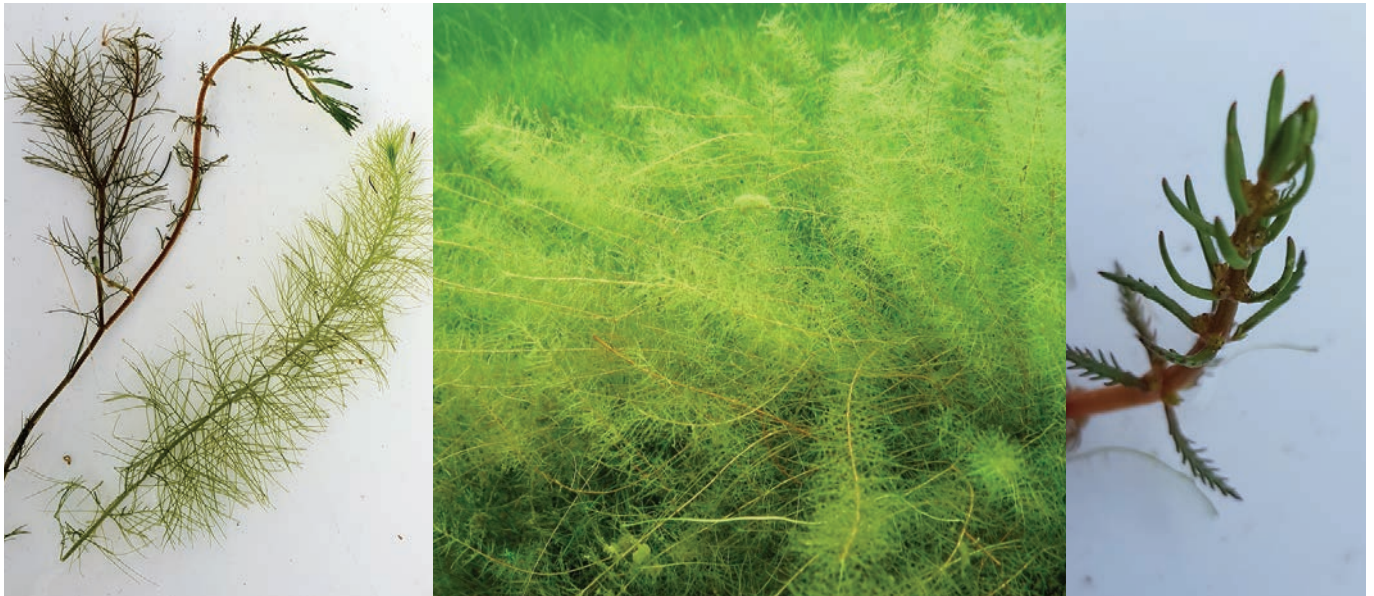
Milfoils

Myriophyllum triphyllum

Freshwater. Submerged or partially amphibious.

Pinnate or feathered leaves in whorls of normally 3, but whorls can also have 4 leaves (as in the photo above).

Don't confuse with weed *Ceratophyllum demersum* that has forked leaves with teeth on margins or parrot's feather (*Myriophyllum aquaticum*) that is bluish-green and usually grows semi-emergent.



Milfoils

Myriophyllum propinquum

Freshwater. Submerged or partially amphibious.

Pinnate or feathered leaves in whorls, finely divided in submerged leaves.

Don't confuse with weed *Ceratophyllum demersum* that has forked leaves with teeth on margins or parrot's feather (*Myriophyllum aquaticum*) that is bluish-green and usually grows semi-emergent.

SUITABLE SPECIES continued



Pondweeds

***Potamogeton cheesemanii* (mānihi; rērēwai, retoreto)**

Freshwater. Submerged only.

Rhizomes, leaves tapered at each end, often translucent, with distinctive vein, some apical leaves may be oval. Oval leaves may be observed floating on the surface of the water.

Don't confuse with weed *Potamogeton crispus* that has leaves with teeth on the margins.



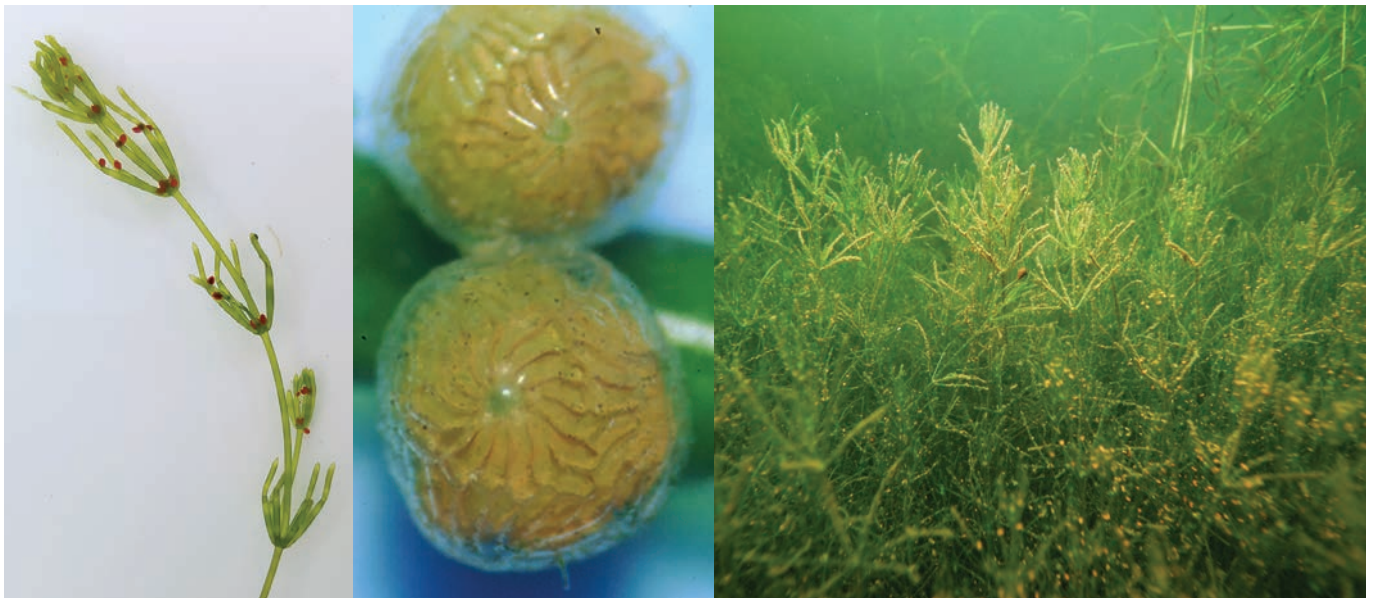
Pondweeds

Potamogeton ochreatus

Freshwater. Submerged only.

Rhizomes, leaves long and grass-like, with parallel sides and a blunt tip, numerous fine longitudinal veins.

Don't confuse with weed *Potamogeton crispus* that has leaves with teeth on the margins.



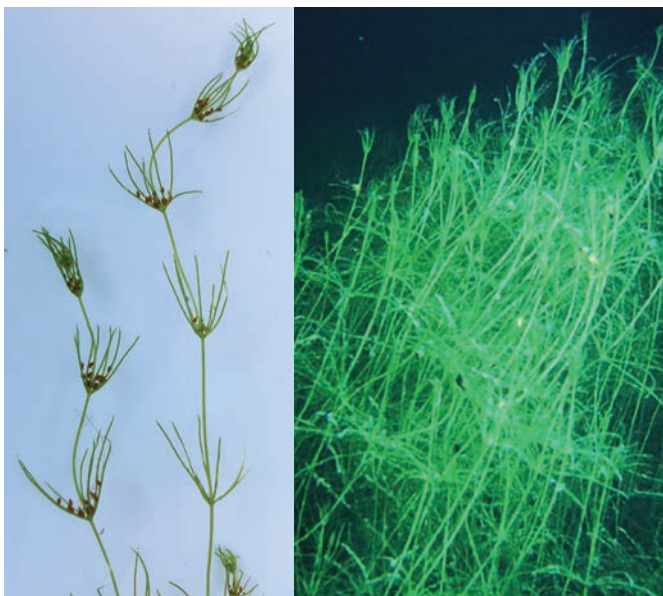
Charophytes

Chara australis

Freshwater. Submerged only.

Stem with whorls of unforked branches arising from colourless rhizoids (root like and thin), single cells and simple appearance.

Distinctive orange fruiting bodies on male plants.



Charophytes

Chara globularis

Freshwater. Submerged only.

Stem and whorls of unforked branches arising from colourless rhizoids, single cells, complex cell pattern (cortication) on stem and branches.



Nitella sp. aff. cristata

Freshwater. Submerged only.

Stem and whorls of forked branches arising from colourless rhizoids, single cells, often opaque cells clustered at stem tips.

SUITABLE SPECIES continued



Amphibious plants

Glossostigma diandrum

Freshwater. Amphibious.

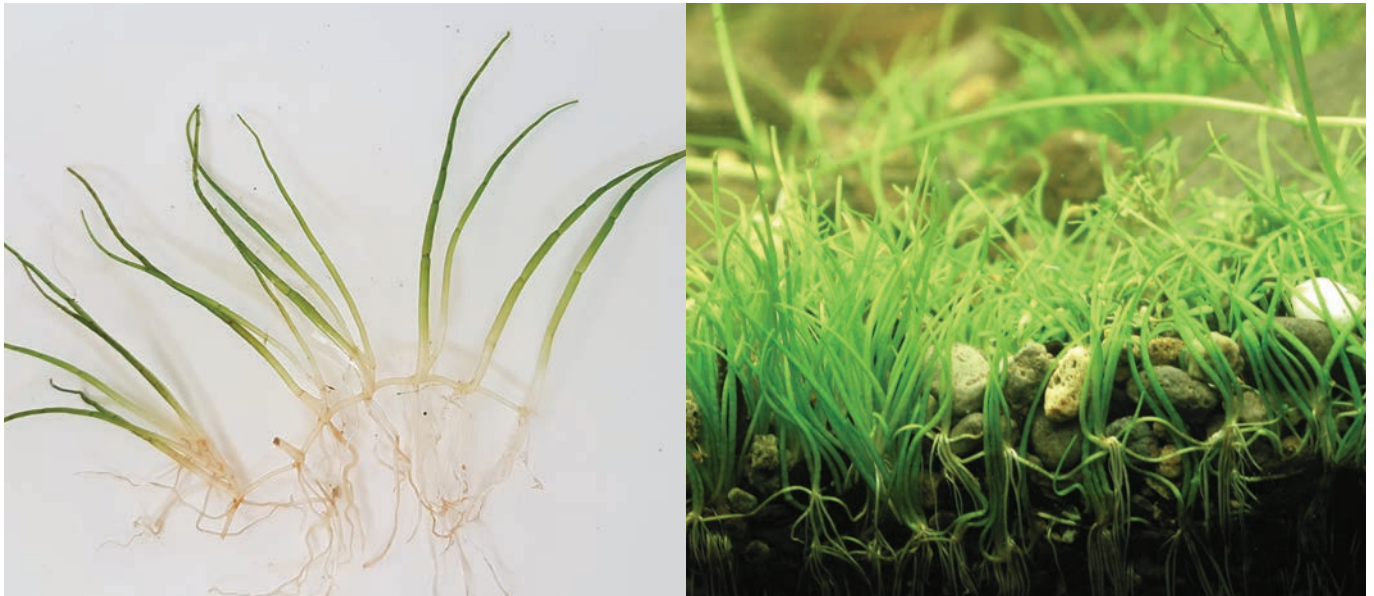
Leaves are basal, linear to spatulate (broad tip and narrow base, like a spatula).



Elatine gratioloides

Freshwater. Amphibious.

The round or oval leaves are almost stalkless and in pairs, on short creeping or occasionally upright stems.



Amphibious plants

Lilaeopsis ruthiana

Freshwater. Amphibious.

Leaves are basal from the rhizome, with septae (distinct lines across the leaf), and the leaves are cylindrical with a tapered tip.



Diver collecting submerged aquatic plants from a lake.

SOURCING MACROPHYTES FOR CULTURE

Sourcing and collecting macrophytes should consider:

- plant availability and potential importance of eco-source principles,
- the ability of the source environment to sustain collection,
- biosecurity considerations, and
- regulatory requirements or permissions.

Some native freshwater submerged species are used in the aquarium and pond plant trade and these could be sources for culture.

Record keeping on the plant collection sources can be useful for future decision-making (e.g., suitability and performance of sourced material).

For sustainable collection ideally no more than 10% of the plants present in the targeted harvest area should be removed unless appropriate controls are in place (e.g. careful monitoring of donor population recovery). Harvesting should not be from a locality that might be critical for population recovery. If there are concerns about the sustainability of wild harvesting of whole plants, then seed or limited propagules could be sourced and further propagated under culture.



Collecting amphibious turf plants from a lake margin.

ECO-SOURCE PRINCIPLES

Eco-sourcing for restoration, generally means collecting from the local area, or same region as the site where the plants will be eventually planted.

Local collection of plant materials considers both local adaptation and the likely genetic relatedness of populations of plants and is recommended wherever possible.

BIOSECURITY

Biosecurity and nuisance pests developing under culture conditions or being transferred by direct translocation should be considered. Any risk of spreading pest plants or fish should be minimised by identifying plants carefully and minimising unintentional transfer of water or sediment between the source and the eventual recipient environments.

It may be necessary to decontaminate wild collected freshwater plants so as to remove hitch-hiking algae, insects or snails that may otherwise proliferate under culture conditions. Any algal material or animals that can be seen should be removed and plants rinsed vigorously under running water.

Prepare a solution of 1 part unscented bleach in 20 parts of water, adding bleach to the water and using gloves for protection. Prepare a second solution of dichlorination product (e.g., commercially available tap water conditioner). Soak times in the bleach solution for plants should be 90 seconds for delicate plants, 120 seconds for average plants, and up to 150 seconds for hardy plants. Immediately rinse under running water for at least 1 minute and soak in the dichlorination solution for at least a couple minutes. Although it is impossible to provide algal free culture conditions, initial precautions do help.



Identifying amphibious turf plants on an emersed lake shore.

COLLECTION OF PLANTS FOR CULTIVATION

Permissions and/or approvals* need to be sought for both the collection and the translocation of submerged macrophytes. No regulations apply to their maintenance in culture. Of prime importance is that there is support for the intended restoration and appropriate involvement of iwi, hapū and whānau and other parties with authority and interests in the collection and recipient sites, for example councils. Status of these sites (i.e., ownership, designations, status) will guide this approval and consultation process.

*For example: Collection of aquatic life for research purposes requires a fisheries special permit (*How to apply for a fisheries special permit* | MPI | NZ Government).

Permits for collection of aquatic plant samples from public conservation land (e.g., National Parks, reserves) are required from DOC (<https://www.doc.govt.nz/get-involved/apply-for-permits/research-and-collection/>).

The Aquatic Life Transfers Standard Operating Procedure (SOP) provided by Department of Conservation sets out the process for applications to transfer and release live aquatic life to freshwater under several pieces of legislation. Special considerations apply to national parks, plants with protected status, and possibly other Acts according to s26ZM(3)(a) Conservation Act 1987 (*Conservation Act 1987 No 65 (as at 07 August 2020), Public Act – New Zealand Legislation*).

TRANSPLANTATION

Transport of submerged macrophytes to the recipient site requires ways to prevent their desiccation, for instance, by covering or spraying with water or with lightweight coverings that are maintained wet.

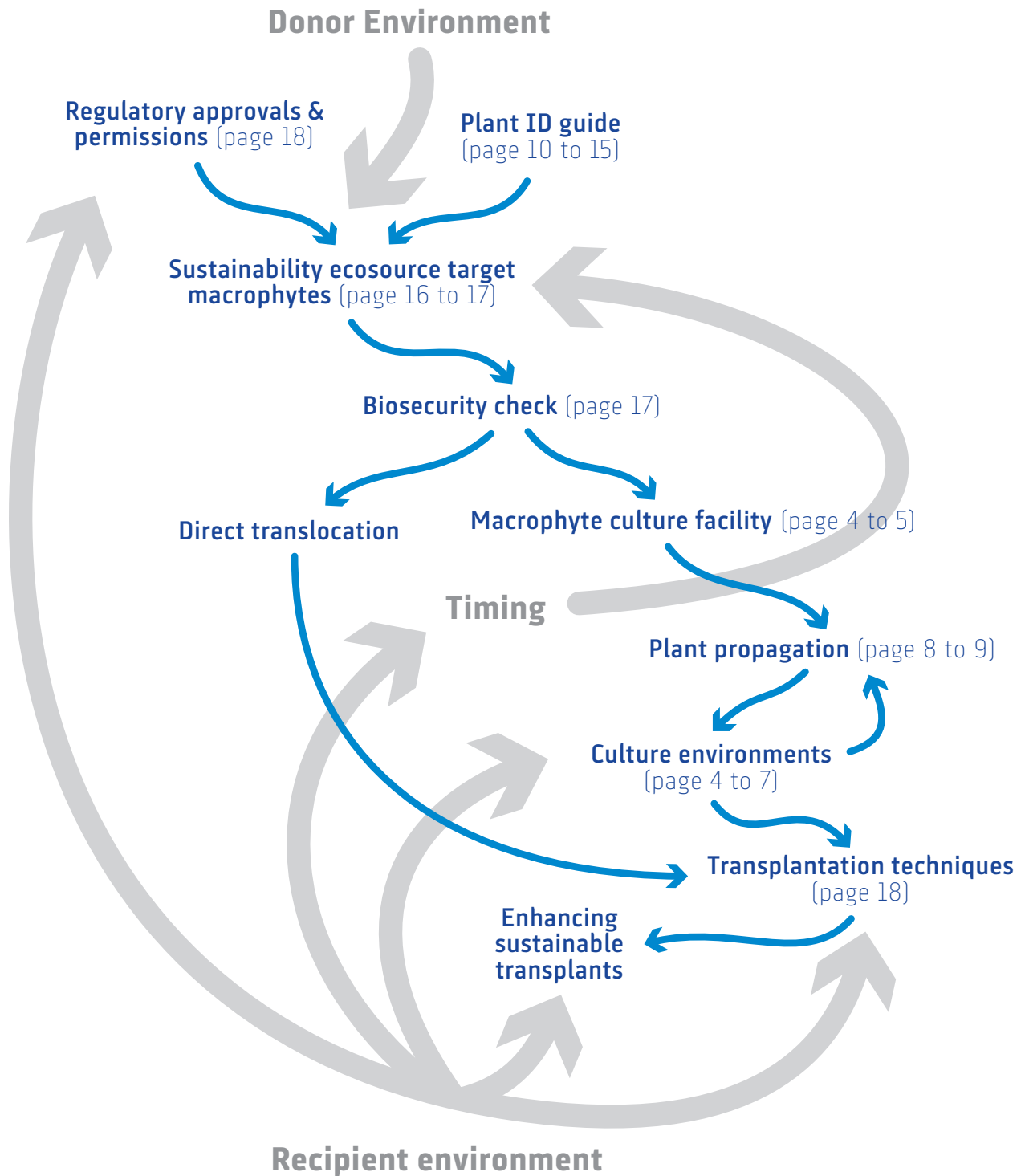
Key considerations for the recipient site include:

- that growing conditions match the requirements of the plant as far as possible,
- timing of transplantation such as a window of better water clarity,
- water level,
- flow conditions,
- season - the end of winter or early spring is usually best, and
- safe sites i.e., out of high energy wave wash zone, if possible, and protection from grazers if necessary.

IMPLEMENTATION

Flow diagram for major steps in macrophyte rehabilitation.

Blue text and arrows are main action steps, grey text and arrows represent feedbacks determining the nature of key steps or decisions.



ACKNOWLEDGEMENTS

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For more go to:

niwa.co.nz/freshwater-and-estuaries/management-tools