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Aquatic weed management in waterways and dams

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Introduction

Aquatic plants serve a variety of uses in a water system, some of which are vital to the overall health of the aquatic environment. There are numerous aquatic plants that grow in farm dams, streams and waterways and fortunately most are rarely a problem. However, when water becomes rich in nutrients aquatic plants can grow vigorously to a point where they become a nuisance or are considered a weed.

This information is intended for both property owners and officers of public authorities.

Aquatic plants should only be controlled when they interfere with the use of a particular aquatic environment or when there is a statutory obligation (see 'Legislation').

An assessment of the plant's ecology and the problem it poses are necessary before taking any action, to ensure that the most cost-effective and environmentally sound control techniques are used.

When managing the problem several factors need to be considered. These include the source of the plant, the reason it poses a problem, the use made of the waterway (e.g. dam supplying irrigation or stock water), the management options available, and ongoing costs and benefits.

It may be possible to reduce or eliminate an aquatic weed through well planned management strategies, such as diverting inflow of nutrients. The weed problem may also be seasonal and naturally fluctuate and disappear over time. Often the best option for controlling aquatic plants is to take the necessary actions described in this Primefact to prevent the problem from occurring in the first place (Figure 1).

Impact

Some aquatic plants fulfil many beneficial functions and play a vital role in aquatic environments. Removal of these plants may result in destroying water quality and habitat with no real benefit.

Many edge plants play an important role in nutrient buffering, bank stabilisation and sediment trapping. Oxygen is the single most important water quality parameter and submerged plants help to oxygenate the water.

Aquatic plants also play an important role in providing habitat for many organisms, particularly birds, amphibians, fish and many insects and other small pond creatures. Floating plants give shade, reduce evaporation rates and keep the water temperature more constant.

In many cases a water body is a diverse and balanced ecosystem and care needs to be taken to keep this balance at an advantage. Excess growth may indicate an imbalance and lead to a deterioration of the ecosystem.

Aquatic plants become a problem when they:

- Blanket the entire water surface, causing oxygen depletion – this may destroy the under-surface ecosystem and kill aquatic species (Figure 2);
- As introduced species, compete with native species and reduce biodiversity;
- Impact on the aquatic habitat of bird species and cause them to relocate;
- Interfere with commercial and recreational activities;
- Cause blockages or impede water intake to pumping equipment – mesh cages may have to be made to house the foot valve away from the weed.

Figure 1. Take action in the early growth stage to prevent the problem getting out of hand. Photo: P. Gorham.

Figure 2. Total cover of a water body by water lettuce. Photo: P. Gorham.

- Contaminate and taint drinking water supplies;
- Cause pungent odours;
- Accumulate debris;
- Impede the access of stock to water;
- Interfere with flow in irrigation channels;
- Increase transpiration rates.

Managing aquatic weeds

A successful weed control program depends on the resources available, the weeds present and the ability to carry out effective control methods. The decision-making process, with regard to managing aquatic weeds, needs to follow a number of steps.

Determining the cause of the problem will allow the selection of the best management techniques to address the problem. Consider a number of other factors. Do you need to get rid of the plant entirely, or only partially?

Some plants may grow prolifically in some seasons but not in others and are therefore only a short-term nuisance. Others may proliferate because of temporary conditions, such as low water levels due to drought, but in normal circumstances are less problematic.

If a weed is covering a dam and preventing stock from watering you may think the weed is the problem, but look at what is causing the weed to grow. Nutrient runoff and lack of shading around the dam may be allowing the weed to expand due to high nutrient levels and sunlight exposure. In this case treat the cause of the problem, by preventing nutrient rich runoff going into the dam – plant appropriate vegetation around the dam.

If aquatic weed growth is depleting oxygen levels in the water and causing fish to die it may be appropriate to treat the weed. However, using control techniques that leave dead and decaying plants in the water can also cause deoxygenation of the water. Large amounts of decomposing plant material lower the dissolved oxygen levels in the water affecting fish and other aquatic organisms.

Consider the long-term consequences of any control method. Using the wrong method could make the problem worse. To prevent a recurrence of the problem, you must be prepared to manage the water body and its surrounds well into the future. It is also best to use an integrated approach when managing aquatic weeds. Individual control methods used in isolation rarely provide adequate long-term control.

Integrated management combines two or more techniques in a unified program. An integrated program usually provides more efficient and stable control in the long term with fewer undesirable side effects. The advantage of integrated management is that it maximises the benefits of the methods and minimises their limitations.

Following is a step-by-step example of integrated control of weeds in a small dam.

1. Mechanically or physically remove plants when they first appear.
2. Treat any remnants with spot applications of a recommended herbicide.
3. If practical, take advantage of dry periods by dredging the dam to deepen it. Deeper water discourages growth of plants rooted in the bottom by limiting sunlight penetration.
4. Divert nutrient run off away from the dam as nutrient rich waters encourage aquatic weed growth.
5. Plant trees to shade the dam and therefore, as with dredging, reduce available light to the plant.
6. Use biological control agents if they are available and are suitable to the particular situation.
7. Strategic placement of barriers or booms to contain the weeds and to prevent them from spreading can be highly effective.
8. Continual monitoring of the site is necessary.

Identification of the plant

To select the most appropriate management option, it is essential that the plant is correctly identified. In most situations, several species of aquatic plants are present. If one problem species is removed this might lead to the proliferation of other less desirable species.

There are a number of books and advisory services available to identify plants, and a list of websites can be found at Royal Botanic Gardens website http://plantnet.rbgsyd.nsw.gov.au/. If the plant is declared noxious you are required by law to control it. However it may be the opposite – a rare or threatened species you are lucky to have.

The most common aquatic plants can be divided into four groups depending on how and where they grow.

1. Free floating plants

These plants float on the water surface with their roots gaining nutrients directly from the water. Native free floating plants include *Azolla* species and duckweeds including *Lemna* species, *Wolffia* species and *Spirodela* species. Some free floating plants that are declared noxious weeds include the introduced salvinia (*Salvinia molesta*), water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) (Figure 3).

2. Floating attached plants

These plants are rooted into silt at the bottom of the water body, but with some or all leaves floating on the surface. Examples include waterlilies (*Nymphaea* species) (Figure 4) and the noxious weed alligator weed (*Alternanthera philoxeroides*) (this may also grow on land).

3. Submerged plants

These plants live completely under the water, although their flowers may float on the surface. They include the native ribbon weed (*Vallisneria americana*) and the introduced elodea (*Elodea canadensis*), dense waterweed (*Egeria densa*) and water milfoils (*Myriophyllum* species). Cabomba (*Cabomba caroliniana*) is a submerged plant that is declared noxious (Figure 5).

4. Emergent plants

These plants are rooted in shallow water, around the edges of water or in damp situations. Their stems and leaves appear above the water surface. Plants in this group include the rushes (Figure 6). This group also includes a number of noxious weeds that have been introduced, such as *Ludwigia peruviana*, *L. longifolia*, *Hygrophila costata* (Figure 7), Senegal tea (*Gymnocoronis spilanthoides*) and horsetails (*Equisetum* species).

Figure 3. Water lettuce, a free floating plant. Photo: P. Gorham.

Figure 4. Waterlilies, a floating attached plant. Photo: P. Gorham.

Aquatic plant reproduction

Once you have identified the aquatic plant species, knowledge of its reproductive mechanisms will also assist with determining the best management technique.

Not all aquatic plants produce viable seed but spread and multiply from fragments of stem, root or leaves. Examples include salvinia and alligator weed. Other aquatic weeds produce seed and are also able to propagate from stem, root or leaf fragments. Examples include water hyacinth and water lettuce.

When planning a weed management program for aquatics weeds, managers must decide what is possible or necessary. For aquatic weeds that reproduce by fragments, every piece of plant material must be removed or killed. This requires intensive follow up control until there is no presence of the weed at all. For plants that produce seed, control must be carried out until the soil seed bank is exhausted (this may take many years). In some situations some level of weed presence can be tolerated and management should consist of controlling priority areas or keeping the presence of the weed at suppressed levels.

Aquatic weed management techniques

Prevention

The best option for controlling aquatic plants in a body of water is to take the necessary steps to prevent the problem from occurring. It is easier and more cost

Figure 5. Cabomba, a submerged plant. Photo: P. Gorham.

Figure 6. *Juncus acutus*, a type of rush, is an emerged plant. Photo: P. Gorham.

Figure 7. *Hygrophila costata*, a semi-aquatic plant. Photo: P. Gorham.

effective to prevent an aquatic weed problem than to treat one. Even when preventative measures are only partially effective, they often promote the effectiveness of other control measures.

Preventative measures include monitoring and early detection of new infestations; the use of booms and fences to prevent spread; hygienic practices when moving boats, trailers, watercraft, fishing nets and traps from one waterbody to another; and proper management of a waterbody and uses of its surrounding land to minimise nutrient loads and disturbances to banks and riparian vegetation.

At home, if you have aquatic plants growing in a fish tank or garden pond and you wish to dispose of them, place them on plastic and leave them to completely dry out in the sun. Never throw aquatic plants into drains, dams or water courses. Also become familiar with aquatic plants that can become weedy in your area and avoid buying these plants from nurseries and aquarium suppliers.

Monitoring and early intervention

The water body must be inspected two or three times a week especially during the warmer months, which is the peak growing period for most aquatic weeds. Under favourable conditions salvinia and water hyacinth can double their mass every 7–10 days.

Control small infestations before the plants have reached a mature stage, when their mass can make removal difficult. Early intervention can also avoid the application of high volumes of herbicides and expensive labour intensive methods. Removal of small infestations by hand may be the only control that is necessary.

Water quality

Maintaining good water quality is essential for users and also inhibits the establishment of aquatic weeds.

For information on maintaining good water quality in farm dams see *Farm Water Quality and Treatment* available from the NSW DPI at www.dpi.nsw.gov.au/agriculture/resources/water/quality

Aeration of water is a proven method of maintaining good oxygen levels. It has been shown to keep some aquatic plants dispersed enough to prevent them from forming a dense cover over the water surface.

Maintenance control

Maintenance control is a system of not allowing water courses, dams or any water body to become completely covered with aquatic weeds. If allowed to get out of control all aquatic weeds can have extreme impacts on the natural aquatic environment. The importance of control, reporting and getting advice if you have an aquatic weed problem cannot be stressed enough.

An example of the devastation that can result from uncontrolled aquatic weeds is the salvinia infestation that occurred in the Hawkesbury–Nepean River in 2004, which cost $1.6 million to control.

Mechanical and physical removal

Mechanical removal involves the removal of the plant biomass from the water body using specially designed harvesters or equipment (Figure 8). Mechanical harvesting can be difficult in and around overhanging trees and can be expensive to implement.

Physical control includes the removal of plant material by hand. Mechanical and physical removals are often a good first option, particularly where the water is used for animal or human consumption and herbicide control is undesirable.

There are many other advantages of physical removal.

- There is less plant material to break down and provide nutrients for aquatic weed growth.
- The removed material, except for alligator weed, can be recycled as mulch, provided it is used where it will not be washed back into water.
- Mechanical or physical removal has the advantage that the water can be used immediately, compared to the restricted use following herbicide applications.

Booms

The use of booms to catch and concentrate floating aquatic plants and attached floating plants after they have been severed can be effective in appropriate situations. A boom can be placed across a waterway to either harvest or spray the bulk of the weed. Commercial booms (Figure 9) can be expensive; a simple and relatively less expensive boom can be made from a piece of shade cloth and a few star posts; or unslotted agricultural pipe fitted with a mesh sleeve and suspended on wire rope (Figure 10).

To be effective, booms must be checked, cleared and maintained on a regular basis.

A permit under the *Fisheries Management Act 1994* is needed if a boom is likely to impact fish movement. When considering placing boom on a waterway consult with a Fisheries Conservation Manager. They can help to ensure that the design and layout does not impact on fish movement and can advise whether a permit is needed. This will also ensure the local Fisheries Officer is aware of the boom's location, in case they receive reports of possible illegal fishing in the area. For contact details see www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats

Free floating plants

Free floating plants such as red azolla, duckweed, water lettuce, water hyacinth and salvinia begin their growth around the water's edge. If measures are taken at an early growth stage (usually around September–October) they can be successfully removed before the growth becomes excessive.

Submerged plants

Where practical, submerged plants such as ribbon weed or cabomba can be cleared by dragging a wire rope, chain or similar device along the bottom of the water body between two vehicles on either side. The chain or rope follows the bed, severing the plants close to the bottom, and the plant material floats to the surface where it can be removed.

Emergent plants

Emergent plants such as cumbungi (*Typha* spp.) and phragmites (*Phragmites australis*) can be cut below the waterline in autumn, but this will only retard their growth for a short time. In some cases it may be possible to burn emergent plants at certain times of the year and then follow up by treating young re-growth with a recommended herbicide.

Weeds that are anchored to the banks are difficult to control by mechanical means which may destabilise the bank structure. Mowing may be used in some situations to reduce the bulk of the material. Great caution should be taken when mowing as this practice may also spread the problem. It is important to know about the plant you are mowing to ensure that this practice does not create a bigger problem.

Environmental control

Control can be achieved by altering the water body in some way to limit the growth of aquatic plants.

- For submerged plants, lowering the water level to expose them to the sun can be effective.
- Dredge or excavate to a depth where the plants will not grow, or will only grow at reduced densities due to lack of light. This approach is most successful in very turbid water.
- Limit the inflow of nutrients by diverting effluent from stockyards or feeding areas.
- Do not allow stock direct access to waterways; provide a watering point below the catchment area. Trials have shown this increases water quality and stock health as the water is not polluted by traffic and manure.
- Provide a buffer zone around waterways and between water storages by way of long, dense grass or a strip of native shrubs and trees. This can impede or trap the movement of aquatic plants from one water source to another.

Chemical control

Choosing the correct herbicide is not a guarantee of success.

It is important to adhere strictly to the following procedures.

- Identify the problem plant correctly.
- Select a herbicide registered for use in water and for the specific plant.
- Read the herbicide label carefully and observe all special precautions. Take particular note of toxicity to other plants, fish or wildlife, residual activity and withholding periods for treated water. Where the water is for stock, for domestic supplies, or for garden or crop irrigation, it is imperative that you observe the withholding period for the particular herbicide being used.

Figure 9. Commercially manufactured boom. Booms can catch and concentrate floating aquatic plants to prevent spread and make harvesting easier.
Photo: R. Coventry.

Figure 8. Mechanical harvesting of aquatic weeds.
Photo: R. Coventry.

Figure 10. Low cost boom made from shade cloth.
Photo: P. Gorham.

You must also make an accurate measure of the water volume or surface area to be treated in order to calculate the correct application rate and volume of herbicide to be used (Figure 11).

Infestations should be treated in sections so that the risk of water contamination is minimised, and the decay of smaller amounts of vegetation will not reduce oxygen levels in the water sufficiently to kill fish.

Legal considerations

There are many restrictions on the use of herbicides in aquatic areas. The *Pesticides Act 1999* requires chemical applicators to read and obey ALL label instructions every time a pesticide is used.

Labels and permits sometimes have grey areas with regards to 'situations' in 'directions for use' tables. Many labels say 'margins of streams, lakes and dams'. This means the weeds that grow on the edges and into the edges of the water. Where the label says 'aquatic areas', then this means weeds that grow primarily in the water but also invade the edges of the land.

Also read 'critical comments' and 'restraints' as most aquatic herbicides may not be used in potable water and others may not be used in water for irrigation or stock.

Notification Plan for public authorities

If the herbicide is to be applied to aquatic weeds in waterways owned or controlled by public authorities (such as councils or National Parks & Wildlife Service) to which the public has legal access, then the Notification Regulation under the Pesticides Act applies. Such water bodies are 'prescribed public places' as defined in the Notification Regulation. This means that any spraying in these areas must be in accordance with the authority's Notification Plan, including prior notification and sign posting.

Environmental considerations

Take care to avoid or minimise herbicide entering the water. Herbicide must be applied to the target plant

Figure 11. Guide to estimating dam capacity

The following formulas have been taken from the publication 'Farm Dams Assessment Guide' with the permission of The NSW Department of Infrastructure Planning and Assessment (now the Department of Water & Energy).

Estimating the capacity of a dam under ten megalitres:

Step 1. From the options below decide the shape of the dam.

Step 2. Measure in metres the width and length at the **top water level**.

Step 3. Measure the maximum depth of the dam.

Step 4. Use the formula relevant to the dam shape (see below) to calculate the surface area of the dam in square metres.

Step 5. Using the following formula, calculate the volume in cubic metres.

Volume = 0.4 x Surface Area x Depth

Note: The conversion factor of 0.4 takes into account the slope of the sides of the dam.

Step 6. Divide this volume by 1000 to convert cubic metres to megalitres.

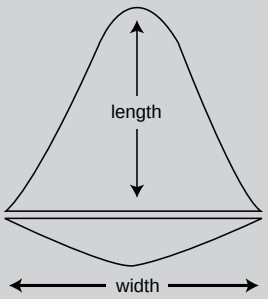
This is the dam capacity in megalitres.

1 Megalitre (ML) = 1000 cubic metres (m^3) = 1 000 000 litres

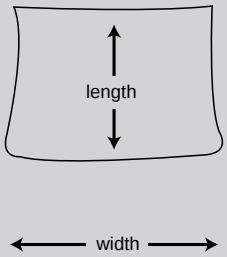
Example recording sheet

Dam	Width (m)	Length (m)	Surface area (sq. m)	Max depth (m)	Storage factor (0.4)	Approx volume (cubic metres)	Dam capacity (ML)
Example	30	40	1200	3	0.4	1440	1.44

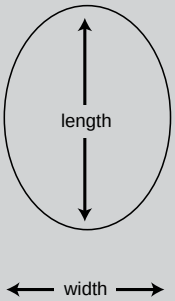
Dam shape



Triangular Surface Area = $\frac{\text{width x length}}{2}$



Rectangular Surface Area = width x length



Round Surface area = 0.8 x width x length

material, not to the water. The New South Wales Department of Environment and Climate Change (DECC) regards the application of herbicides to water as polluting.

Under the *Protection of the Environment Operations (POEO) Act 1997* a licence is required from DECC for the application of herbicides in certain aquatic situations. Licences are issued on a seasonal or annual basis, provided the DECC agrees that the weed needs to be controlled and that chemical control is acceptable. Certain conditions may be set before a licence is issued.

If application is made to an area likely to harm a threatened species, population or ecological community or damage their habitat, an additional licence will be required under the NSW *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994*. This licence is available from either the National Parks and Wildlife Service (part of DECC) or the NSW Department of Primary Industries (NSW DPI).

Fish kills

Any spraying of waterways has the potential to result in fish kills. Contact your regional Fisheries Conservation Manager (phone 02 4982 1232) for information and advice on how to avoid fish kills. Any incidents of fish kills must be reported to NSW DPI immediately. See www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats for contact details and for further information on reporting fish kills.

Best practice for using herbicides near water

Only use products registered or permitted for aquatic situations. Some products have different formulations for use in aquatic areas.

A list of registered herbicides for control of aquatic weeds can be found in the *Noxious & Environmental Weed Control Handbook*, available from NSW DPI or at www.dpi.nsw.gov.au/weeds. Contact your local council or Catchment Management Authority for more information about control in your local area.

Mix and load herbicides away from the water. When cleaning equipment, wash down away from the water. Leave a buffer of vegetation between the wash down area and the water.

Use low pressure (2–4 bar) to apply the herbicide. High pressure can submerge the target weeds and create fine droplets which increase the risk of drift.

Do not apply herbicide around or in aquatic areas if it is raining or if rain is expected.

Biological control

Biological control uses the natural enemies of the plant to attack, weaken or kill it. Biological control programs are the end result of several years of overseas exploration and testing of organisms. Before introducing a biological control agent to Australia, researchers must demonstrate that the organism is host specific and does not attack crops or native plants.

Biological control is rarely the complete solution for an aquatic weed problem and must usually be supported by other control methods. Biological control agents are only available for a limited number of species, and may not be successful in some areas due to climatic and other constraints.

Biological control has shown some success on a number of aquatic plants in NSW, including water hyacinth, alligator weed, salvinia and water lettuce.

Water hyacinth

The most successful insects for controlling water hyacinth have been two weevils, *Neochetina eichhorniae* and *N. bruchi*, which are best suited to large, deep bodies of still water. They are unlikely to provide adequate control in small dams. This program has been moderately successful in Queensland but in northern NSW it has only achieved suppression. South of Kempsey it has had little effect.

Salvinia

Successful control of salvinia has been obtained in northern Queensland using a weevil (*Cyrtobagous salviniae*) (see Figure 12). In NSW it is more effective in the sub-tropical areas on the North and Far North Coast. Further south in cooler climates it can still be effective but populations need to be monitored and managed according to conditions.

Alligator weed

The flea-beetle (*Agasicles hygrophila*) (Figure 13) is present and active in the Sydney and Newcastle regions, particularly in the Hawkesbury–Nepean and Hunter River catchments. The flea-beetle suppresses the growth of alligator weed and therefore has limitations as it cannot be used for infestations growing on land. Further studies are under way in Argentina by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to investigate other agents that could be released into the Australian environment.

Legislation

Noxious weeds

All noxious weeds are listed under the NSW *Noxious Weeds Act 1993*. Weeds classified under the Act are divided into 5 classes. Some weeds are classified differently depending on the location. For instance, water hyacinth is listed as a Class 4 in northern NSW and as a Class 2 in western areas of NSW.

Figure 12. The salvinia weevil imported from Brazil has been successful in controlling the weed. Photo: Mic Julien, CSIRO.

Figure 13. Flea-beetle (*Agasicles hygrophila*) on alligator weed. Photo: P. Gorham.

Figure 14. Aerators can help disperse some aquatic weeds to re-oxygenate water. Photo: P. Gorham.

The responsibility for the control of noxious weeds on private land rests with the land owner or occupier of the land. This responsibility extends to the middle line of any adjacent watercourse, river or inland water (tidal or non-tidal). The classification of a weed varies between local control authority boundaries.

A full list of noxious weeds, their classifications in your area and legal requirements under the NSW Noxious Weeds Act can be found at www.dpi.nsw.gov.au/weeds

Booms

If a boom is to be placed across a waterway (not a farm dam) it may require a permit under the *Fisheries Management Act 1994* if it is likely to restrict the movement of fish. Contact a NSW DPI Fisheries Conservation Manager for advice on the need for this permit – see www.dpi.nsw.gov.au/fisheries/habitat/aquatic-habitats for contact details.

Recommended reading

The publications from NSW DPI are available at www.dpi.nsw.gov.au/weeds

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Publications available

A complete list of NSW DPI weed publications can be found at www.dpi.nsw.gov.au/weeds

Printed copies can be obtained by contacting the NSW DPI bookshop on 1800 028 374.

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