# APPENDIX A

# Recommended Species for Use in Revegetation Programs Within Each Biodiversity Protection ELUC

## Recommended species for use in revegetation program within each Biodiversity Protection ELUC

| Scientific Name | Common Name | Stratum |
|---|---|---|
| **VMU 1 – Blackbutt-Tallowwood-Needlebark** | | |
| *Eucalyptus microcorys* | Tallowwood | Overstorey |
| *Eucalyptus pilularis* | Blackbutt | Overstorey |
| *Eucalyptus planchoniana* | Needlebark stringybark | Overstorey |
| *Acacia longifolia* | Sydney golden wattle | Understorey |
| *Banksia integrifolia* | Coastal banksia | Understorey |
| *Banksia serrata* | Old man banksia | Understorey |
| *Centella asiatic* | Swamp pennywort | Groundstorey |
| *Dianella caerulea* | Blue flax lily | Groundstorey |
| *Lomandra longifolia* | Spiny-headed matrush | Groundstorey |
| *Glycine microphylla* | Small-leaf glycine | Groundstorey |
| *Histiopteris incisa* | Batswing fern | Groundstorey |
| *Oplismenus aemulus* | Basket grass | Groundstorey |
| *Pteridium esculentum* | Bracken fern | Groundstorey |
| *Eustrephus latifolius* | Wombat berry | Groundstorey |
| *Smilax australis* | Native sarsaparilla | Groundstorey |
| *Smilax glyciphylla* | Sweet sarsaparilla | Groundstorey |
| *Themeda triandra* | Kangaroo grass | Groundstorey |
| **VMU 2 – Dry Blackbutt** | | |
| *Corymbia intermedia* | Pink bloodwood | Overstorey |
| *Eucalyptus pilularis* | Blackbutt | Overstorey |
| *Eucalyptus planchoniana* | Needlebark stringybark | Overstorey |
| *Eucalyptus resinifera* | Red mahogany | Overstorey |
| *Eucalyptus robusta* | Swamp mahogany | Overstorey |
| *Melaleuca quinquenervia* | Broad-leaved paperbark | Overstorey |
| *Acacia longifolia* | Sydney golden wattle | Understorey |
| *Banksia integrifolia* | Coastal banksia | Understorey |
| *Banksia serrata* | Old man banksia | Understorey |
| *Centella asiatic* | Swamp pennywort | Groundstorey |
| *Dianella caerulea* | Blue flax lily | Groundstorey |
| *Lomandra longifolia* | Spiny-headed matrush | Groundstorey |
| *Glycine microphylla* | Small-leaf glycine | Groundstorey |
| *Histiopteris incisa* | Batswing fern | Groundstorey |
| *Oplismenus aemulus* | Basket grass | Groundstorey |
| *Pteridium esculentum* | Bracken fern | Groundstorey |
| *Eustrephus latifolius* | Wombat berry | Groundstorey |
| *Smilax australis* | Native sarsaparilla | Groundstorey |
| *Smilax glyciphylla* | Sweet sarsaparilla | Groundstorey |
| *Themeda triandra* | Kangaroo grass | Groundstorey |
| **VMU 3 – Grey Ironbark – Grey Gum** | | |
| *Allocasuarina littoralis* | Black she-oak | Overstorey |
| *Corymbia intermedia* | Pink bloodwood | Overstorey |
| *Eucalyptus microcorys* | Tallowwood | Overstorey |
| *Eucalyptus siderophloia* | Northern grey ironbark | Overstorey |
| *Eucalyptus umbra* | White mahogany | Overstorey |
| *Lophostemon confertus* | Brush box | Overstorey |
| *Breynia oblongifolia* | Coffee bush | Understorey |
| *Exocarpus cupressiformis* | Cherry ballarat | Understorey |
| *Notolaea longifolia* | Mock olive | Understorey |
| *Rapanea howittiana* | Brush muttonwood | Understorey |
| *Centella asiatic* | Swamp pennywort | Groundstorey |
| *Glycine microphylla* | Small-leaf glycine | Groundstorey |
| *Gymnostachys anceps* | Setller's flax | Groundstorey |
| *Hardenbergia violacea* | False sarsaparilla | Groundstorey |
| *Lomandra longifolia* | Spiny-headed matrush | Groundstorey |
| *Oplismenus aemulus* | Basket grass | Groundstorey |
| *Themeda triandra* | Kangaroo grass | Groundstorey |
| *Viola hederacea* | Native violets | Groundstorey |

| Scientific Name | Common Name | Stratum |
|---|---|---|
| **VMU 4 – Paperbark– Swamp Mahogany – Swamp She Oak*** | | |
| *Casuarina glauca* | Swamp she-oak | Overstorey |
| *Corymbia intermedia* | Pink bloodwood | Overstorey |
| *Eucalyptus resinifera* | Red mahogany | Overstorey |
| *Eucalyptus robusta* | Swamp mahogany | Overstorey |
| *Melaleuca quinquenervia* | Broad-leaved paperbark | Overstorey |
| *Acacia elongata var dilatatum* | | Understorey |
| *Acacia suaveolens* | Sweet-scented wattle | Understorey |
| *Allocasuarina littoralis* | Black she-oak | Understorey |
| *Babingtonia pluriflora* | | Understorey |
| *Epacris pulchella* | Wallum heath | Understorey |
| *Exocarpus cupressiformis* | Cherry ballarat | Understorey |
| *Leptospermum laevigatum* | Coastal tea tree | Understorey |
| *Leptospermum polygalifolium* | Slender tea tree | Understorey |
| *Leucopogon lanceolatus var gracilis* | Wallum beard heath | Understorey |
| *Melaleuca linariifolia* | Narrow-leaved paperbark | Understorey |
| *Melaleuca styphelioides* | Prickly-leaved paperbark | Understorey |
| *Melaleuca ericifolia* | Swamp paperbark | Understorey |
| *Melaleuca sieberi* | Sieberi's paperbark | Understorey |
| *Pultenaea retusa* | | Understorey |
| *Pultenaea villosa* | Hairy bush pea | Understorey |
| *Blechnum indicum* | Swamp fern | Groundstorey |
| *Calochlaena dubia* | False bracken fern | Groundstorey |
| *Elepcharis acuta* | Common spike rush | Groundstorey |
| *Gahnia sieberiana* | Red-fruited saw-sedge | Groundstorey |
| *Ischaemum australe* | Large bluegrass | Groundstorey |
| *Isachne globosa* | Swamp millet | Groundstorey |
| *Lomandra longifolia* | Spiny-headed matrush | Groundstorey |
| *Parsonsia straminea* | Monkey rope | Groundstorey |
| *Persicaria decipiens* | Slender knotweed | Groundstorey |
| *Pteridium esculentum* | Bracken fern | Groundstorey |
| *Restio tetraphyllus* | | Groundstorey |
| *Themeda triandra* | Kangaroo grass | Groundstorey |
| *Thysanotus patersonii* | Twining lily | Groundstorey |
| *Xanthorrhoea fulva* | Grass tree | Groundstorey |
| **VMU 5 – Swamp Oak*** | | |
| *Casuarina glauca* | Swamp oak | Overstorey |
| *Eucalyptus tereticornis* | Forest red gum | Overstorey |
| *Melaleuca quinquenervia* | Broad-leaved paperbark | Overstorey |
| *Cupaniopsis anacardiodes* | Tuckeroo | Overstorey |
| *Acacia implexa* | Hickory wattle | Overstorey |
| *Acronychia oblongifolia* | Common acronychia | Understorey |
| *Alphitonia excelsa* | Red ash | Understorey |
| *Callistemon salignus* | Willow bottlebrush | Understorey |
| *Glochidion ferdinandi* | Cheese tree | Understorey |
| *Myoporum acuminatum* | Coastal boobialla | Understorey |
| *Notolaea longifolia* | Mock olive | Understorey |
| *Cissus antarctica* | Kangaroo grape | Groundstorey |
| *Doodia aspera* | Rasp fern | Groundstorey |
| *Gahnia clarkei* | Saw sedge | Groundstorey |
| *Oplismenus aemulus* | Basket grass | Groundstorey |
| *Parsonsia straminea* | Monkey rope | Groundstorey |
| *Themeda triandra* | Kangaroo grass | Groundstorey |
| *Viola hederacea* | Ivy-leaved violet | Groundstorey |
| **VMU 6 – Wallum Froglet Habitat** | | |
| *Acacia elongata var. dilatata* | Wattle | Understorey |
| *Callistemon pachyphyllus* | Wallum bottlebrush | Understorey |
| *Leptospermum liversidgei* | Olive tea tree | Understorey |
| *Baumea articulata* | Jointed twig-rush | Groundstorey |
| *Carex appressa* | | Groundstorey |
| *Fimbristylis dichotoma* | | Groundstorey |
| *Isachne globosa* | Swamp millet | Groundstorey |
| *Oplismenus aemulus* | Basket grass | Groundstorey |
| *Restio tetraphyllus* | | Groundstorey |

| Scientific Name | Common Name | Stratum |
|---|---|---|
| **VMU 7 – Disturbed Heathland** | | |
| *Acacia elongata* | Swamp wattle | Understorey |
| *Acacia suaveolens* | Sweet-scented wattle | Understorey |
| *Baeckia frutescens* | Bundled baeckia | Understorey |
| *Banksia robur* | Swamp banksia | Understorey |
| *Callistemon pachyphyllus* | Wallum bottlebrush | Understorey |
| *Epacris microphylla* | | Understorey |
| *Epacris pulchella* | Wallum heath | Understorey |
| *Leucopogon lanceolatus var gracilis* | Wallum beard heath | Understorey |
| *Leucopogon pimeloides* | Lance beard heath | Understorey |
| *Melaleuca ericifolia* | Swamp paperbark | Understorey |
| *Cyperus polystachyos* | | Groundstorey |
| *Eleocharis acuta* | Common spike rush | Groundstorey |
| *Ischaemum australe* | Large bluegrass | Groundstorey |
| *Juncus polyanthemus* | | Groundstorey |
| *Juncus continuus* | | Groundstorey |
| *Ptilothrix deusta* | Horned sedge | Groundstorey |
| *Xanthorrhoea fulva* | Grass tree | Groundstorey |

* Endangered Ecological Community (EEC) pursuant to the *Threatened Species Conservation Act 1995*.

Recommended species derived from field observations and information contained within:

- Biolink Pty Ltd (2006) '*Figure 2 – Vegetation Communities*: *Area 14 KPoM'*;
- Darkheart (2008) '*EPBCA –MNES 1999, Seven Part Tests, SEPP 44 – Koala Habitat Assessments of Proposed Constructed Wetland and Filling on Part Lot 92 DP1078055, Ocean Drive, Lake Cathie';*
- Kemp, B (2004) '*Wildflowers of the North Coast of New South Wales'* New Holland Publishers; and
- EEC identification guidelines produced by the NSW Department of Environment and Climate Change.

# APPENDIX B

# Port Macquarie-Hastings Council Lantana Weed Control Management Plan

# Lantana
# Class 4
# Weed Control
# Management Plan

**Family Name:** *Verbenaceae*

**Scientific Name:** *Lantana spp*

**Common Names:** Common Lantana, Creeping Lantana

**Weed status:** *The above mentioned weed is a noxious weed declared under section 7 of the Noxious Weeds Act 1993.*

This plan was reviewed in: July 2006. If this date is more than 2 years old details may have changed - Please contact your Weeds Officer for an updated version.

**Plan Period**

**Starting Date:** 01 March 2006

**Completion Date:** 30 June2011
(Unless otherwise revoked)

**Control Requirements:** For Red *Lantana camara*: Individual plants and small infestations must be totally controlled.

For large infestations, Contain the existing infestation(s) and decrease the weeds incidence through implementation of control programs, as directed by the local control authority. The weeds numbers and distribution must be reduced annually.

For other *Lantana camara* varieties on rural land: Participation in a biological control program (when available) is recommended as a minimum.

Sale, propagation and wilful distribution of all Lantana species is an offence.

**Control Methods/Techniques:** (Any combination of the following methods is suitable)

**Manual:** Manual removal (hand pulling), slashing, burning, bulldozing, stick raking, ploughing or grubbing by hand.

**Chemical:** There are a number of registered herbicides that successfully combat the growth of Lantana.

**Biological:** Because of the magnitude of the Lantana problem, inaccessibility of many sites and costs associated with many controls, biological controls have been in progress for over 70 years. Research is ongoing. Consult your weeds officer for details.

**Area of Operation:** The area of the Mid North Coast Weeds Advisory Committee encompassing the Gloucester Shire, Great Lakes, Greater Taree City, Port Macquarie-Hastings and Kempsey Shire Councils.

**References:** Auld,B.A, and Medd. R.W, 1996 Weeds Inkata Press Melbourne; Parsons, W.T, and Cuthbertson, E.G, 2001 Noxious Weeds of Australia CSIRO Publishing; Noxious and Environmental Weed Control Handbook 2004-2005 and Lantana Agfact NSW Department of Primary Industries; WONS Lantana Control Manual NHT 2004 Queensland Natural Resources Mines and Water.

**Photos:** Terry Inkson; Queensland Natural Resources Mines and Water

**Registered Herbicide Application Rates:**

Triclopyr-Picloram (various trade names) at 350ml or 500ml per 100L of water.
Metsulfuron Methyl (various trade names) at 10 grams per 100L water, Add surfactant.
Glyphosate 360 g/L (various trade names) at 1L per 100L water.
(Note: Not all herbicides registered for these purposes may be listed. Consult weeds officer for more options.)

**Optimum months for control:**

| J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | ■ | ■ | ■ |

**Critical Comments:** Thoroughly wet all foliage and stems when plants are actively growing. Do not apply during stress periods.

Read MSDS and Label of respective herbicides.

**Linkages to Other Plans/Strategies:** MNCWAC Bird Lolly Weeds Regional Weed Control Plan, National Weed Strategy and control plans, NSW Weed Strategy and control plans, MNCWAC Weeds Strategy & control plans.

***Section 12 Obligations:***
***Private Occupiers of land must control noxious weeds on land.***

*An occupier (other than a public authority or a local control authority) of land to which a weed control order applies must control noxious weeds on the land as required under the order.*
*Maximum Penalty: 40 penalty units.*
*Note: If an occupier fails to comply with obligations under a weed control order, those obligations may be enforced against the owner of the land as well as the occupier by a weed control notice issued under section 18.*

**Council:** Port Macquarie - Hastings Council

**Contact Person:** Paul O'Conner

**Position:** Vegetation Management Officer

**Plan Endorsement:** Bernard Smith - General Manager

**Signature:**

# Lantana Weed Profile Sheet

**Family Name:** *Verbenaceae*

**Scientific Name:** *Lantana spp*

**Common Names:** Common Lantana, Creeping Lantana

**Country of Origin:** Central America

## Habit

**Life Span:** Woody perennial (summer active)

**Life Form:** Heavily branched shrub, can grow as a compact clump, dense thicket or scrambling climber up to 5m high.

## Habitat

Tolerates a wide range of conditions, thriving in both dry and humid climates. Mainly found on richer soils as a weed along roadsides, stream banks, fence lines, neglected pastures and open forests.

**Environmental/economic Impact:**

**Existing:** An invasive and toxic weed that can kill stock when eaten. Also causes photosensitivity in live stock with white fur. Destruction of natural wildlife habitats and transport corridors. Increases management costs of agriculture, forestry and recreation areas, restricts access and replaces desirable pasture grass species. Creates hotter bushfires. Lantana is listed as a **Weed of National Significance**.

**Potential:** Can greatly interfere with the existence of some rare and endangered plant species.




## Reproduction

**Flower:** Funnel form in shape. Mixed coloured changing with age (oranges, reds whites, pinks, purples and yellows). Corolla a slender, curved tube 9 to 12mm long with a corolla limb of 4 spreading lobes 4 to 8mm diameter, crowded into flat topped or slightly domed heads 2 to 3cm across.

**Fruit:** Drupe (berry). 5 to 8mm in diameter Succulent and one seeded, green at first ripening to glossy black grouped in clusters of 1 to 20.

**Seed:** Ovoid, pale straw coloured, hard and stony, 2 to 4mm long. Some species, cultivars and varieties are reported to have a low pollen count. The facts remain that all species are capable of cross pollination and seed set.

## Characteristics

**Leaves:** Simple, yellow-green to dark green, opposite, mostly shortly and roughly haired but sometimes glossy, ovate 2 to 10cm long by 2 to 7cm wide, strongly veined with a bluntly pointed apex narrowing at the base. Margins are variably toothed and strongly odorous when crushed.

**Stem/Bark:** Much branched, woody, brittle, with arching, sprawling or scrambling canes. 4 angled 2 to 4 mm diameter when young, rounded and grey brown up to 5cm in diameter when mature. With sharp recurved prickles on the angles of young stems inconspicuously

**Underground Structures:** A robust, woody, brown rootstock with numerous shallow laterals that sucker when damaged.

**Dispersal:** In close proximity to thickets by suckering and seedlings. Longer distance spread via birds and animals eating the fruit and passing seed in their faeces. Originally distributed through the nursery trade.

## Confusing Species

Other Lantana species, Viburnum, Rondeletia, Verbena

# APPENDIX C

## Weed Management Guides

AGFACTS
AGFACTS
AGFACTS

www.dpi.nsw.gov.au

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

# Water hyacinth *Eichhornia crassipes*

Agfact P7.6.43, third edition, 2005
Jeff Burton, Project Officer,
Pastures and Rangelands, Orange

## INTRODUCTION

Water hyacinth – *Eichhornia crassipes* – is the world's worst aquatic weed. It infests rivers, dams, lakes and irrigation channels on every continent. It devastates aquatic environments and costs billions of dollars every year in control costs and economic losses.

Water hyacinth is a native of the Amazon basin in South America and was brought to Australia in the 1890s as an ornamental plant for ponds and aquaria. The first record of water hyacinth in NSW was in 1895. In 1897, the government botanist Mr JH Maiden noted that the water hyacinth had spread rapidly in all the ponds in the Royal Botanic Gardens in Sydney. At that time, he warned that the plant should be kept away from the northern rivers where it 'may very rapidly become a serious pest...'. Tragically, this warning went unheeded and by the early 1900s it had spread along the east coast of Queensland and the north-eastern regions of NSW.

Water hyacinth is a major weed in India, Pakistan, Bangladesh, Burma, Thailand, Malaysia, Indonesia, Papua New Guinea, the Philippines, Japan and several African countries.

**Water hyacinth forms dense impenetrable mats which block waterways, restrict animal access and damage the aquatic ecological habitats.**
***(Photo courtesy of Hawkesbury River County Council)***

In NSW, water hyacinth is declared noxious in many control areas as a W1, W2 or W3 weed. To determine the declaration status and control of water hyacinth in your area, contact your local weeds officer or see the NSW Department of Primary Industries website: www.dpi.nsw.gov.au

## DISPERSAL

Water hyacinth infestations increase in size and spread most rapidly by the production of new daughter plants. Infestations may also break up and during high water flows and flooding can be moved to new locations.

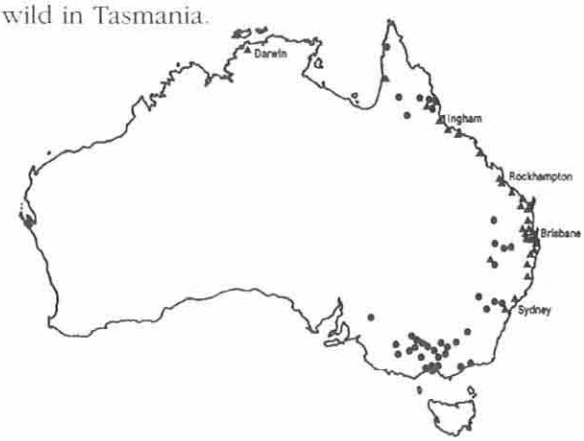
Most spread can be attributed to human use such as the deliberate planting of water hyacinth in ponds or dams as an ornamental, or use in aquariums. Unwanted plant material that is discarded into creeks, rivers and dams is a major mode of dispersal. Water hyacinth can also be spread by contaminated boating and waterway equipment.

Seeds are the main source of new infestations and are carried in water flow, mud (for example, on machinery or boots) and by birds.

## CURRENT DISTRIBUTION

Water hyacinth currently occurs along the east coast of Australia from Kiama in NSW to southern Cape York Peninsula in Queensland. In the early 1900s dominant infestations in northern coastal rivers of NSW were a major hindrance to river navigation. In inland NSW, water hyacinth was identified on the Gingham Watercourse near Moree in 1955. By 1976 it had become a major

infestation covering 7000 hectares, threatening the Murray-Darling system. These infestations are now under control but require annual monitoring and maintenance. Populations are also known to occur in Darwin, Perth, and the Mitchell River on western Cape York Peninsula, Mt Isa and Georgetown in Queensland. Infestations in Victoria and South Australia have been eradicated. It has never been found in the wild in Tasmania.




**Distribution of water hyacinth – *Eichhornia crassipes*, in Australia 1995.**
**(Source Groves, Shepherd and Richardson 1995)**

- ▲ **Infestations where insect agents have been liberated.**
- ● **Includes many historical infestations eliminated by control measures.**

## WHY IT IS A WEED

Water hyacinth can justifiably be called the world's worst aquatic weed. The greatest problem with this plant is its ability to rapidly cover and block waterways. In Australia, it usually forms a dense, impenetrable mat over the water surface. Specific damage includes:

- blocking hydroelectric schemes, irrigation channels and rivers
- restricting livestock access to water
- destroying natural wetlands
- eliminating other aquatic plants
- reduced infiltration of sunlight
- changing the temperature, pH and oxygen levels of water
- reducing gas exchange at the water surface
- increasing water loss through transpiration (greater than evaporation from an open water body)
- altering the habitats of aquatic plants, fish, amphibians and waterfowl
- restricting recreational use of waterways
- reducing aesthetic values of waterways
- reducing water quality, from decomposing water hyacinths.

Water hyacinth is capable of explosive rates of spread. Under favourable conditions it can double its mass every 5 days, forming new plants on the ends of stolons. It also grows from seed which can remain viable for 20 years or longer. This enormous reproductive capacity causes annual reinfestation from seed and rapid coverage of previously treated bare water, presenting major problems for control authorities.

Water hyacinth will rapidly take over an entire waterway and if access is limited it will be difficult to use available control options.

## HABITAT

*E. crassipes* grows worldwide in fresh, static or slow-flowing water in tropical and temperate climates. For optimum growth, water hyacinth requires water temperatures of between 28° and 30°C and abundant nitrogen, phosphorus and potassium. Although this plant will tolerate a wide range of growth conditions and climatic extremes including frost, it is rapidly killed by sea strength salinity.

## LIFE CYCLE

Water hyacinths reproduce from seeds and horizontal stems. Flowers open for only one or two days from mid to late summer before beginning to wither. When all the flowers on a spike have withered, the stalk gradually bends into the water and after two to three weeks the seeds are released and sink.

The cooler temperatures in autumn and winter frosts cause the plant's leaves to die off but the crowns are left to overwinter. These will commence new growth in the following spring along with the germination of the dropped seeds.

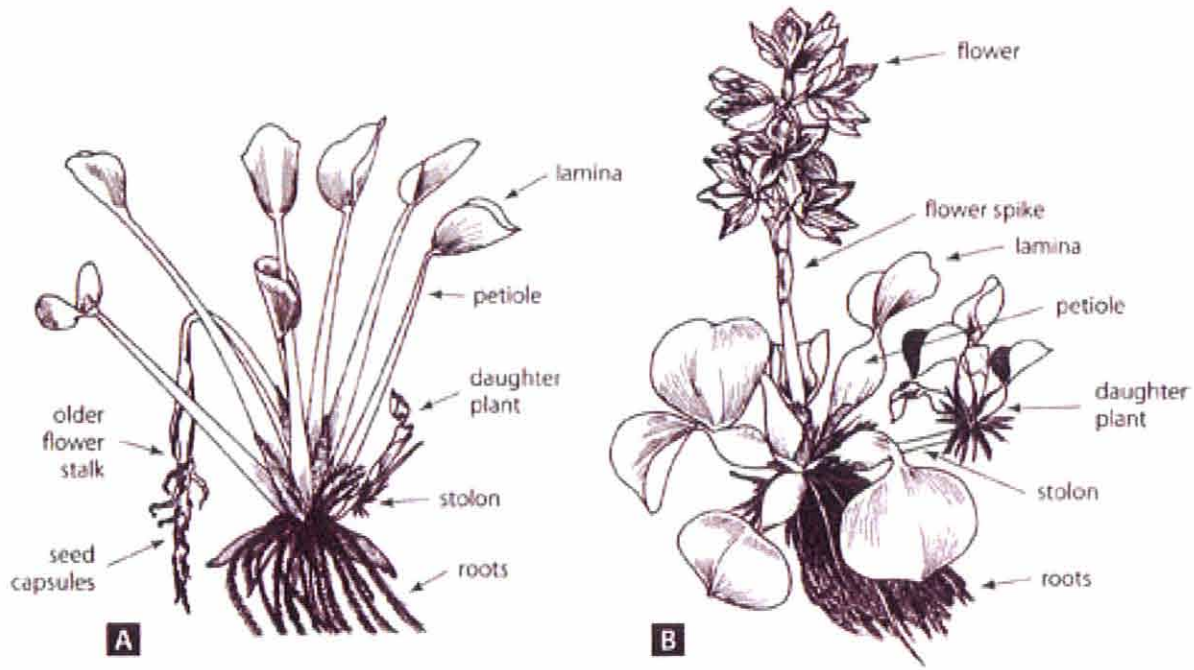
## DESCRIPTION

Water hyacinth is a free-floating perennial waterweed that forms large, dense rafts on the water surface. Each plant consists of several broad, leathery leaves, spongy inflated petioles (leaf stalks), a crown and a mass of slender, hairy roots. Water hyacinths show considerable variation in both leaf and flower form.

### Leaves

Leaves are smooth, hairless and glossy. They are generally a dark green colour or can be tinged with a rusty yellow on their edges. There are two types of leaves:

A. leaves with non-bulbous petioles. Leaves are up to 60 cm long (including the petiole), narrow and erect – this leaf type is typical of plants in dense, crowded infestations.




**Water hyacinths vary considerably depending on their growth conditions.** (Source: Julien, Griffiths & Wright 1999)

**Water hyacinth will rapidly take over an entire waterway. Where access is limited, so are the available control options.**

B. leaves with bulbous petioles. Leaves are thick stemmed, circular and up to about 30 cm in diameter. The stems may be 50 cm long and contain variable amounts of air, which enable the plant to float. This leaf type is typical of plants in open water or on the open-water edge of large infestations.

### Stems

There are two types of stems:

1. erect stems to about 60 cm long, with flowers.
2. horizontal vegetative stems (stolons) about 10 cm long, which produce new daughter plants.

### Seeds

Seeds are 1 to 1.5 mm long and roughly egg-shaped with ridges from end to end. They are long-lived and may survive in mud for 5 to 20 years.

### Roots

*E. crassipes* roots are fibrous and featherlike. In deep water they may trail below the plant and can grow up to 1 metre in length. In shallow water the roots may take hold in the substrate of mud or sediment.

### Flowers

Flowers are 4 to 7 cm across, funnel-shaped, light bluish-purple or dark blue with a yellow centre and six distinct petals. The upper petal is darker purple with a yellow mark in the centre.

R. TROUNCE

**Water hyacinth flower**

Flowers can self-fertilise and are formed on upright stems with between 3 and 35 but commonly 8 flowers on each spike.

## CONTROL

Water hyacinth is difficult to control in all freshwater aquatic environments. It is essential that any new infestations be controlled as soon as possible using a range of control techniques. If allowed to become established, the seed bank rapidly expands, increasing costs and the duration of the program.

Early control attempts concentrated on removing plants from the water with pitchforks, then dumping the accumulated mass on land to die. Control of water hyacinth now centres on an integration of chemical, biological and cultural control techniques.

As part of a control program, nutrient run-off into infestations should be minimised. Heavy nutrient loadings in water come from erosion of cultivated land, cattle yards, domestic and municipal sewerage outfalls and wastewater discharges from factories. This nutrient inflow can be reduced or prevented by treating water before discharging it into waterways and using conservation farming techniques to divert cattle yard effluent and minimise soil erosion.

Drainage or reduction of water levels will also reduce the area of water hyacinth plants. But it is important to note that seeds will remain viable in the soil and will germinate when the area refills with water.

Simply removing plants from *small areas* of water such as farm dams and drains is a good way of controlling water hyacinth, as long as the rate of removal is faster than the weed's rate of germination/regrowth.

On a larger scale, manual removal is less likely to achieve eradication of water hyacinths. Most attempts usually result in little more than a culling of the weed population, which causes a return to exponential growth. But there are instances where harvesting large infestations can be effective although time consuming. As a guide, it takes between 600 and 900 hours to harvest one hectare of dense water hyacinth – which should be undertaken prior to flowering and seed set. Fifty million tonnes of water hyacinth are removed from the White Nile annually, and the Panama Canal is kept clear of the weed by mechanical harvesting.

**Where control options are well integrated, the results can be magnificent. Above: Insects released November 1977, Mt Spencer, Australia; below: control achieved by November 1981. (*Photos courtesy of Queensland Government, Department of Natural Resources and Mines*)**

## Chemical control

Users of agricultural (or veterinary) chemical products must always read the label and any permit before using the product, and must strictly comply with the directions on the label and the conditions of any permit.

In NSW, numerous herbicides are registered for the control of water hyacinth. The most commonly used techniques for applying herbicides include: high volume spraying with knapsacks and power sprays, and boomspraying.

When spraying water hyacinth with herbicides always:

- Ensure that spray does not drift onto desirable plants.
- Maintain operator safety.
- Follow the herbicide label, any associated permits and withholding periods.
- Obtain all relevant permits/licences and comply with all relevant state and federal legislation, such as the *Protection of the Environment Operations Act 1997* and the *Pesticides Act 1999*. Contact your local control authority, local council and the Environment Protection Authority.

Many plants, both aquatic and terrestrial, are susceptible to the herbicides registered for water hyacinth control, therefore extreme care must be taken.

Spraying an entire heavy infestation can cause water hyacinth to sink and result in pollution from the rotting weed. Large masses of the rotting weed will use all the oxygen in the water, killing fish and wildlife. This problem can be avoided by spraying strips or mechanically removing as much of the weed as possible prior to spraying.

For further information on control see the *Noxious and Environmental Weed Control Handbook 2004/2005*.

## Biological control

**Source: Queensland NRM factsheet**

Four insect species have been introduced from South America and released by CSIRO since 1975. There are two weevil species, *Neochetina eichhorniae* and *Neochetina bruchi*, and two

***Neochetina* spp. weevils are proving to be very successful biological control agents but should still be used in conjunction with other control methods. The moth *Niphograpta albiguttalis* (below) has established and causes damage in warmer climates of Australia.**

***(Photos courtesy of Dr Mic Julien, CSIRO, Qld)***

moth species, *Niphograpta albiguttalis* (previously *Sameodes albiguttalis*) and *Xubida infusella*.

The weevil *Neochetina eichhorniae* has been the most successful, playing a key role in destroying large water hyacinth infestations in tropical and temperate areas of Australia. The adult is black, 5 mm long, and feeds on leaves, making small scars. Eggs are laid in the bulbous leaf stalks and the larvae tunnel through the plant tissue, which is then attacked by bacteria and fungi. This causes the plant to become waterlogged and it can die under heavy attack.

The lifecycle of *N. eichhorniae* takes three months but it is inactive during winter. The other weevil, *N. bruchi*, is active through the winter, and was first released in 1990 with seeming success. It appears that introducing both weevils is the best option, because of their lifecycles are complementary, but they are much less effective in subtropical and cooler areas.

The moth *Niphograpta albiguttalis* is well established in northern NSW and Queensland. Its larvae tunnel into the petioles and buds in the same way as *X. infusella*, which was first released in 1981. New stocks of the latter were released by CSIRO in Queensland but its success is currently unknown. Both species are very damaging to young plants and luxuriant weed growth but their impact is often temporary and patchy.



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We acknowledge the assistance of Dr Mic Julien for details on biological control.



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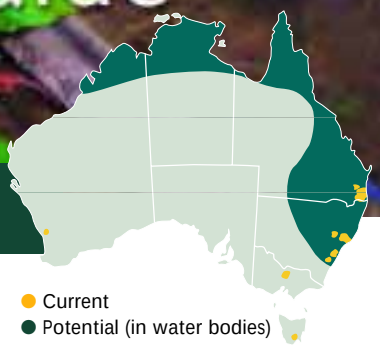
# Weed Management Guide

Senegal tea plant –
*Gymnocoronis spilanthoides*




# Senegal tea plant (*Gymnocoronis spilanthoides*)

## The problem

Senegal tea plant is on the *Alert List for Environmental Weeds*, a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems.

Senegal tea plant can float on still or very slow-moving fresh water or grow as a bush on wet, marshy soils. It has been recorded at localised sites in most states. It is mainly spread by the careless disposal of aquarium plants or deliberate cultivation for sale.

Because Senegal tea plant grows very quickly, it can rapidly cover water bodies with a floating mat, excluding other plants and the animals that rely on them. The effects of flooding are made much worse because infestations block drainage channels. Recreational activities, irrigation and navigation may also be affected. Water quality may decline if large amounts of Senegal tea plant die off and rot under water.

## The weed

Senegal tea plant can grow as an erect, rounded bush up to 1 m tall, but is more commonly found as a scrambling form extending from the edges of waterways and forming dense tangled mats in open water. Young stems are 5–10 mm in diameter, increasing to 20 mm with age. Larger stems are hollow between the nodes (the joints between segments of stem) and float on water, and can reach a length of 1.5 m. The leaves are dark green, 50–200 mm long and arranged in opposite pairs along the stem. The edges of the spearhead-shaped leaves are serrated.

The numerous, white, ball-shaped flowers, 15–20 mm in diameter, occur at the ends of stems. The ribbed seeds are yellow–brown and 5 mm in diameter. Thin, fibrous roots can develop at any node that is in contact with moist soil or immersed in water.

Senegal tea plant is mainly spread through human activities, particularly the careless disposal of aquarium plants in creeks and drains.
Photo: Jim Wilding, Goulburn–Murray Water

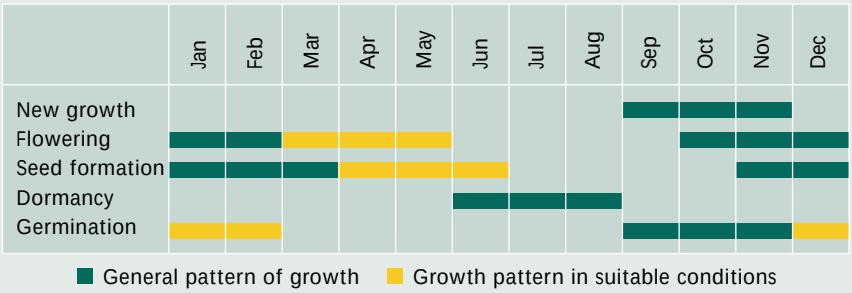
## Key points

- Senegal tea plant is a highly invasive aquatic weed occurring in scattered infestations around the country.
- It blocks drainage channels and degrades natural wetlands by displacing native plants and animals.
- Preventing its further introduction and spread will require greater public awareness of how to identify it and the risks that it poses.
- Contact your state or territory weed management agency or local council if you find Senegal tea plant. Do not attempt control on your own, as it can spread very easily from dislodged fragments.

Natural Heritage Trust

ALERT

### Growth calendar




Flowering in Senegal tea plant commences in late spring or early summer and continues until the cooler weather of late autumn. Seed formation occurs about one month after flowering. Plants become dormant during winter and new growth reshoots from the crown and nodes during the following spring.

Most seeds germinate in spring, although some germination may continue into summer. Seedling growth is rapid, and plants quickly reach the surface if submerged in shallow water.

Senegal tea plant is a perennial that lives for at least several years.


The importation of Senegal tea plant into Australia is not permitted as, among other reasons, increased genetic diversity could lead to increased seed production ability.
Photo: Jim Wilding, Goulburn–Murray Water

## How it spreads

Senegal tea plant can reproduce by seeds and vegetation. The seeds are quite heavy and most drop near the parent plant or can be spread by flowing water. Seeds can also be spread in mud attached to animals or machinery. Recent research has shown that seed production in infestations near Brisbane is extremely low, less than 1% of its potential, which indicates that spread of Senegal tea plant by seed is not very important there.

Vegetative spread occurs when any part of the stem that includes a node breaks away from the main plant, eg in fast flowing water. When the stem fragment settles on the stream bed it sends out fine roots from the node, and can grow into an entire new plant. This new plant can spread quickly and create a colony by producing roots where nodes come in contact with moist soil. Stem fragments can also be accidentally spread by transport of machinery (eg boats, trailers, lawnmowers) or in animals' hooves.


The dark green leaves are long (up to 200 mm), spearhead-shaped and serrated on the edges.
Photo: Graham Prichard, Port Stephens Council, NSW

Senegal tea plant was introduced into Australia from India by the aquarium industry. It was first recorded as growing in the wild in the Manning River near Taree, New South Wales, in 1980. Several other infestations have been recorded throughout New South Wales and Tasmania, with more recent spread recorded at several sites in and around Brisbane. Infestations were recently recorded from Perth and at Lake Nagambie and Cranbourne South in Victoria.

## Where it grows

Senegal tea plant grows in wetlands, particularly degraded waterways. It can flourish in still or slow-moving fresh water, rooted in the bank and floating out into the waterway. It survives and continues growing even when completely inundated. It also grows on wet marshy soils near water.

Senegal tea plant grows very quickly in fertile environments, with growth rates exceeding 150 mm a week.

It is a native of tropical and subtropical regions of the Americas, from Mexico to Argentina, where it has also been recorded as a weed. New Zealand and India are other countries where it has become weedy.

## Why we need to be 'alert' to Senegal tea plant

Senegal tea plant poses a significant risk to the health of wetland ecosystems. It can quickly take over wetlands and detract from their environmental value, natural beauty and recreational potential. In New Zealand it has caused flooding by blocking streams and drainage channels.

### If not controlled, Senegal tea plant will become a major weed of wetlands around Australia

It could potentially infest wetlands throughout much of Australia. It has a wide climate tolerance and has been found in cultivation well outside its predicted range.

It is also very difficult to control because it can spread by both seed and vegetative reproduction. Even tiny pieces of vegetation can give rise to new colonies. Because it is found mainly in water, the potential impacts of herbicides on non-target plants and animals must also be carefully managed.


Senegal tea plant can grow out from riverbanks and cover the surface of still or slow-moving waterways. Photo: Graham Prichard, Port Stephens Council, NSW

## What to do about it

### Prevention is better than the cure

As with all weed management, prevention is better and more cost-effective than control. The annual cost of weeds to agriculture in Australia, in terms of decreased productivity and management costs, is conservatively estimated at $4 billion. Environmental impacts are also significant and lead to a loss of biodiversity. To limit escalation of these impacts, it is vital to prevent further introduction of new weed species, such as Senegal tea plant, into uninfested natural ecosystems.

## The Alert List for Environmental Weeds

The Federal Government's *Alert List for Environmental Weeds* was declared in 2001. It consists of 28 weed species that currently have limited distributions but potentially could cause significant damage. The following weed species are therefore targeted for eradication:

| Scientific name | Common name | Scientific name | Common name |
|---|---|---|---|
| *Acacia catechu* var. *sundra* | cutch tree | *Koelreuteria elegans* | Chinese rain tree |
| *Acacia karroo* | Karroo thorn | *Lachenalia reflexa* | yellow soldier |
| *Asystasia gangetica* ssp. *micrantha* | Chinese violet | *Lagarosiphon major* | lagarosiphon |
| *Barleria prionitis* | barleria | *Nassella charruana* | lobed needle grass |
| *Bassia scoparia* | kochia | *Nassella hyalina* | cane needle grass |
| *Calluna vulgaris* | heather | *Pelargonium alchemilloides* | garden geranium |
| *Chromolaena odorata* | Siam weed | *Pereskia aculeata* | leaf cactus |
| *Cynoglossum creticum* | blue hound's tongue | *Piptochaetium montevidense* | Uruguayan rice grass |
| *Cyperus teneristolon* | cyperus | *Praxelis clematidea* | praxelis |
| *Cytisus multiflorus* | white Spanish broom | *Retama raetam* | white weeping broom |
| *Dittrichia viscosa* | false yellowhead | *Senecio glastifolius* | holly leaved senecio |
| *Equisetum* spp. | horsetail species | *Thunbergia laurifolia* | laurel clock vine |
| *Gymnocoronis spilanthoides* | Senegal tea plant | *Tipuana tipu* | rosewood |
| *Hieracium aurantiacum* | orange hawkweed | *Trianoptiles solitaria* | subterranean cape sedge |

## Weed control contacts

| State / Territory | Department | Phone | Email | Website |
|---|---|---|---|---|
| ACT | Environment ACT | (02) 6207 9777 | EnvironmentACT@act.gov.au | www.environment.act.gov.au |
| NSW | NSW Agriculture | 1800 680 244 | weeds@agric.nsw.gov.au | www.agric.nsw.gov.au |
| NT | Dept of Natural Resources, Environment and the Arts | (08) 8999 4567 | weedinfo.nreta@nt.gov.au | www.nt.gov.au |
| Qld | Dept of Natural Resources and Mines | (07) 3896 3111 | enquiries@nrm.qld.gov.au | www.nrm.qld.gov.au |
| SA | Dept of Water, Land and Biodiversity Conservation | (08) 8303 9500 | apc@saugov.sa.gov.au | www.dwlbc.sa.gov.au |
| Tas | Dept of Primary Industries, Water and Environment | 1300 368 550 | Weeds.Enquiries@dpiwe.tas.gov.au | www.dpiwe.tas.gov.au |
| Vic | Dept of Primary Industries/Dept of Sustainability and Environment | 136 186 | customer.service@dpi.vic.gov.au | www.dpi.vic.gov.au<br>www.dse.vic.gov.au |
| WA | Dept of Agriculture | (08) 9368 3333 | enquiries@agric.wa.gov.au | www.agric.wa.gov.au |

The above contacts can offer advice on weed control in your state or territory. If using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

It is illegal to cultivate Senegal tea plant in most states and territories as it is a declared noxious weed. Unfortunately, as with many aquatic weeds, there is evidence that Senegal tea plant has been deliberately planted and farmed on public lands. These activities must be stopped to prevent its introduction and further spread throughout Australia. Notify the vendor or state or territory weed control contacts if you find Senegal tea plant for sale.

Early detection and eradication are also important to prevent the spread of Senegal tea plant. Small infestations can be eradicated if they are detected early but an ongoing commitment is needed to ensure new infestations do not establish.

## Quarantine to prevent further introductions

The importation of Senegal tea plant into Australia is not permitted because of the risk of further spread, and the potential introduction of new genetic diversity that could make future control more difficult. For plants, such as Senegal tea plant, which have low seed production, this new genetic diversity could potentially increase its ability to produce seeds or survive in Australian conditions, and make it more weedy than it already is.

Do not buy seeds via the internet or from mail order catalogues unless you check with quarantine first and can be sure that they are free of weeds like Senegal tea plant. Call 1800 803 006 or see the Australian Quarantine and Inspection Service (AQIS) import conditions database <www.aqis.gov.au/icon>. Also, take care when travelling overseas that you do not choose souvenirs made from or containing seeds, or bring back seeds attached to hiking or camping equipment. Report any breaches of quarantine you see to AQIS.

## Raising community awareness

Some 65% of weeds, including Senegal tea plant, which have recently established in Australia have escaped from ornamental planting in gardens and aquaria. The detrimental impacts of these weeds far outweigh any potential horticultural benefits. The public should be made more aware of these impacts, and other issues such as how to identify Senegal tea plant and what to do if they find it.

A quick identification aid is that any water plant with white, ball-shaped flowers is likely to be a weed, either Senegal tea plant or the *Weed of National Significance*, alligator weed (*Alternanthera philoxeroides*). Senegal tea plant has serrated leaf edges whereas alligator weed has rounded leaf edges.


The white ball-shaped flowers are a distinctive feature of Senegal tea plant.
Photo: Graham Prichard, Port Stephens Council, NSW

## New infestations of Senegal tea plant

Because there are relatively few Senegal tea plant infestations, and it can potentially be eradicated before it becomes established, any new outbreaks should be reported immediately to your state or territory weed management agency or local council. Do not try to control Senegal tea plant without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread the weed and worsen the problem.

5

...case study

## Controlling Senegal tea plant around Brisbane

Brisbane City Council is responsible for controlling about a quarter of the 20 or so infestations of Senegal tea plant in the Brisbane area. Infestations up to 1.5 km long were found along degraded sections of urban creeks, such as Ithaca, Lota and Wynnum creek's in the mid 1990s. Most are thought to have been the result of the careless disposal of aquarium plants into Brisbane's waterways. However, a few infestations were probably illegally planted for harvest and subsequent sale to the aquarium plant industry.

The infestations have been targeted for eradication due to their invasiveness and impacts on natural ecosystems. However, the eradication program being conducted by the Council's Vegetation and Pest Services has had mixed results. Several different methods have had to be trialled because the traditional approach for dealing with such weeds was not working. Council staff consider it to be one of the most difficult plants they have ever had to deal with.

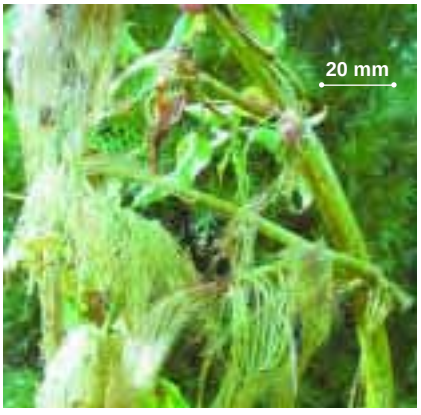
However, one aspect of Senegal tea plant's biology is making control easier than it might otherwise be. Council staff have found that the seed has not been contributing to its spread. The pattern of spread can be attributed to vegetative reproduction and deliberate plantings. In fact, in the early years an uninformed landholder had caused a major infestation by using a whipper-snipper to mow a small patch of a hundred or so plants. The resulting fragments floated downstream and took root, creating several new colonies and making the problem much worse.

Apart from the ease with which it spreads from small fragments, the other main difficulty in dealing with Senegal tea plant is that it is very hard to kill. Herbicides traditionally effective on most other similar plants kill only the upper parts of the plant. Any material that is below the water line is not killed, and can regrow and form new plants. Herbicides are now used only when the creeks and streams are not flowing and the Senegal tea plant is completely above water. Council workers carry 5 L backpack sprayers and treat infestations during weed surveys or other work. This method gives good kill rates. There are several herbicides registered for 'minor off-label use' on permits issued by the Australian Pesticides and Veterinary Medicines Authority.

Other methods of weed control have also been trialled. Hand pulling of small patches did not remove all plant parts, and infestations were able to regenerate and spread further. Mechanical removal of infestations has been used where de-silting operations were also required to clear drains. First, infestations are sprayed with herbicide to reduce the risk of spreading plant parts. Then, 7–10 days later, all silt and plant material up to a depth of 1 m is removed by heavy machinery and taken away to be spread out and dried. Depending on the local weather, all plant material is dead after about a month of drying and the silt and soil can be reused. This reduces the costs of weed control and allows better drainage for the creek system.


Flowering occurs in spring and summer.
Photo: Jim Wilding, Goulburn–Murray Water

Despite these successes, controlling and hopefully eradicating Senegal tea plant requires an ongoing commitment, particularly if this weed continues to be illegally planted.




The fibrous root system develops at any node in contact with water or moist soil.
Photo: Jim Wilding, Goulburn–Murray Water

## Legislation

Senegal tea plant is a declared weed in all states and territories except Victoria and the Northern Territory. Where it is declared, landholders are required by law to control Senegal tea plant or notify state or territory governments or local councils of its presence.

## Acknowledgments

Information and guide revision: Tom Anderson (Qld DNRM), Steve Csurhes (Qld DNRM), Lalith Gunasekera (Vic DPI/Weeds CRC), Sandy Lloyd (WA Agriculture/Weeds CRC), Rod Wood (Brisbane City Council) and John Thorp (National Weeds Management Facilitator).

Maps: Base data used in the compilation of actual and potential distribution maps provided by Australian herbaria via Australia's Virtual Herbarium and Queensland DNRM, respectively.

# If you find a plant that may be Senegal tea plant

**Quick reference guide**

## Identification

You will first need to confirm its identity. Contact your state or territory weed management agency for help in identifying the plant. You will need to take note of the characteristics of the plant in order to accurately describe it. Some important features of Senegal tea plant are:

- white, ball-shaped flowers, which occur in groups at the ends of stems and appear mainly between October and February, but sometimes until May
- spearhead-shaped leaves with serrated edges, occurring in opposite pairs
- growth forms that include buoyant stems extending out from creekbanks and scrambling or erect bushes in wet, marshy swamplands.

## Reporting occurrences

Once identified, new occurrences of Senegal tea plant should be reported to the relevant state or territory weed management agency or local council, who will offer advice and assistance on its control. Because Senegal tea plant spreads so easily and poses such a serious threat, its control is a matter that should be undertaken with the appropriate expertise and adequate resources.

## Follow-up work will be required

Once the initial infestation is controlled, follow-up monitoring and control will be required to ensure that reinfestation does not occur.

## Collecting specimens

State or territory herbaria can also identify plants from good specimens. These organisations can provide advice on how to collect and preserve specimens.

| State/Territory | Postal Address | Phone | Web |
|---|---|---|---|
| Australian National Herbarium | GPO Box 1600<br>Canberra, ACT, 2601 | (02) 6246 5108 | www.anbg.gov.au/cpbr/herbarium/index.html |
| National Herbarium of New South Wales | Mrs Macquaries Rd<br>Sydney, NSW, 2000 | (02) 9231 8111 | www.rbgsyd.nsw.gov.au |
| National Herbarium of Victoria | Private Bag 2000 Birdwood Avenue<br>South Yarra, Vic, 3141 | (03) 9252 2300 | www.rbg.vic.gov.au/biodiversity/herbarium.html |
| Northern Territory Herbarium | PO Box 496 Palmerston, NT, 0831 | (08) 8999 4516 | http://www.nt.gov.au/ipe/pwcnt/ |
| Queensland Herbarium | c/- Brisbane Botanic Gardens<br>Mt Coot-tha Rd Toowong, Qld, 4066 | (07) 3896 9326 | www.env.qld.gov.au/environment/science/herbarium |
| South Australian Plant Biodiversity Centre | PO Box 2732<br>Kent Town, SA, 5071 | (08) 8222 9311 | www.flora.sa.gov.au/index.html |
| Tasmanian Herbarium | Private Bag 4 Hobart, Tas, 7000 | (03) 6226 2635 | www.tmag.tas.gov.au/Herbarium/Herbarium2.htm |
| Western Australian Herbarium | Locked Bag 104<br>Bentley DC, WA, 6983 | (08) 9334 0500 | http://science.calm.wa.gov.au/herbarium/ |



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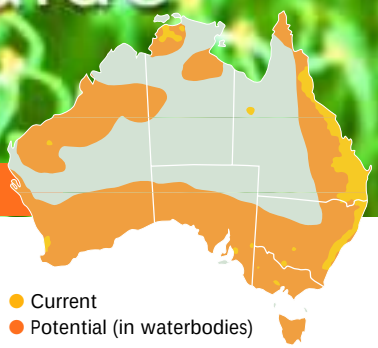
CRC Weed management

# Weed Management Guide






# Salvinia (*Salvinia molesta*)

## The problem

Salvinia is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Salvinia is an aquatic weed that can choke waterways. It floats on still or slow-moving water and can grow rapidly to cover the entire water surface with a thick mat of vegetation. This shades out any submerged plant life and impedes oxygen exchange, making the water unsuitable for fish and other animals. Salvinia infestations reduce the natural beauty and biodiversity of wetlands.

A salvinia infestation can reach up to 400 tonnes of wet weight per hectare. Infestations are a major obstacle to the enjoyment and use of water. They block irrigation, cause flooding, pollute drinking water, and prevent recreational activities such as swimming, fishing and boating. Infestations can be dangerous to animals and people because the mats look like solid ground, and they provide an ideal breeding environment for disease-carrying mosquitoes.

Salvinia forms dense mats that can cover entire waterbodies.
Photo: Colin G. Wilson

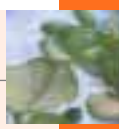
## The weed

Salvinia is a free-floating fern that forms dense mats on water. It consists of many-branched horizontal stems, 1–2 mm in diameter, which float just below the water surface. At each node, or joint, on the stem is a pair of floating, green, oval-shaped hairy fronds. A brown frond, consisting of many hairy filaments, also occurs at each node and trails in the water, looking and acting like a root.

Salvinia changes as it matures and becomes more crowded. In low densities the primary invading plants have a few small floating fronds (10–15 mm wide) which lie flat on the water. However, in the dense infestations that cause mats, the many floating fronds are folded, up to 60 mm wide, overlapping and tightly packed together in a concertina-like fashion.

The surfaces of the floating fronds have numerous distinctive egg-beater-shaped hairs that repel water and assist floatation. This hair shape is characteristic of *Salvinia molesta*.

## Key points



- Salvinia is a major aquatic weed threatening waterways around Australia.
- Infestations are widespread on the east coast of Australia but could spread elsewhere.
- Public education will help to prevent spread because infestations are caused by human activities.
- Because of salvinia's ability to rapidly spread from single plants, only small infestations are likely to be eradicated.
- In warm temperate, sub-tropical and tropical areas, biological control is very effective.
- Biological control can be integrated with chemical and physical control in cooler areas.

Natural Heritage Trust

### Growth calendar

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New growth | | | | | | | | | | | | |
| Active growth | | | | | | | | | | | | |
| Spore formation | No viable spores yet found in Australia | | | | | | | | | | | |
| Spore drop | | | | | | | | | | | | |
| Germination | | | | | | | | | | | | |

■ General growth pattern ■ Growth pattern under suitable conditions

Salvinia grows best when the water temperature is between 20 and 30°C; growth is limited or absent under 10°C. As salvinia is found throughout tropical, sub-tropical and temperate regions, these climatic conditions will occur at different times of the year. It grows faster when nutrients are abundant, often after rainfall has washed nutrients from the land into water bodies.

Salvinia is a fern and does not produce flowers. Although many ferns do produce spores, salvinia has never been known to produce spores in Australia and is considered to be a sterile clone.

Mature salvinia, showing the overlapping and deeply folded fronds.
Photo: Matthew Brown

## How it spreads

Salvinia can increase its density by growth (stems can grow up to 300 mm long) or vegetative reproduction. It grows extremely quickly and infestations can double in size every two to three days. Uninfested areas can quickly become completely covered with salvinia, even when only small amounts are introduced to a waterway.

Reproduction occurs when mature plants produce buds at the stem node (the join between sections of the stem) which develop to form daughter plants. It may also occur if a part of the stem containing a node breaks away from the main plant and grows into a new plant. One pair of fronds can start an entire new infestation.

Salvinia spreads easily downstream during flooding, but moves into new catchments by human activities. It has been intentionally spread throughout the world as an ornamental pond or aquarium plant, and has escaped or been placed into waterways on numerous occasions. It can also be unintentionally introduced into new catchments attached to boats and other aquatic equipment.

## Where it grows

Salvinia grows best in still or slow-moving fresh water. It can survive being frozen and water temperatures up to 43ºC, and salinities up to one-tenth that of sea water. Additionally, plants protected as part of dense mats can survive for many months if the water body dries up, particularly in shaded environments or on soils that hold water. Salvinia also thrives in nutrient-rich waters such as agriculture run-off or wastewater. These attributes allow it to colonise most water bodies.

Salvinia is a native of southeastern Brazil. It has become a serious weed throughout Africa, India, Sri Lanka, South-East Asia, the Philippines, Papua New Guinea, New Zealand, Fiji, Hawaii and mainland United States.

In Australia it was recorded as a weed near Sydney in 1952, and a year later near Brisbane. Since then it has infested most coastal streams from Cairns in northern Queensland to Moruya on the south coast of New South Wales. It has spread from backyards in all capital cities, and remote infestations affect the Top End of the Northern Territory and regions of Western Australia. There is a belief that many infestations have been deliberately spread in order to harvest the plants for sale in the aquarium and horticulture industries.


The submerged frond is feathery and acts like a root.
Photo: NSW Dept of Agriculture

## Potential distribution

Based on its temperature tolerance, the potential distribution of salvinia includes waterbodies in every Australian state and territory. Although the climate would not be suitable for rapid growth, salvinia could probably survive in Tasmania and Victoria, which are currently free from major infestations.

Still or slow-moving waterways are threatened by salvinia: Finniss River, NT, in November.
Photo: Colin G. Wilson

## What to do about it

### Prevention of spread

Preventing the further spread of salvinia outside core infestations is a key management objective. It is far easier and cheaper to prevent the introduction of a weed than to try and control it, particularly something that is as difficult to eradicate as salvinia.

Preventing salvinia's spread will only be achieved by educating the public, as it is most commonly spread (either deliberately or accidentally) by people. Although it is illegal to import salvinia or to sell it in Australia, both of these activities occur. The sale or dumping of the weed should be reported to the authorities, and people who have unknowingly cultivated it should contact local councils or state/territory weed management agencies for information on how to properly dispose of salvinia. Burial is the quickest means of disposal. Drying in the sun and/or use as garden mulch is also suitable, providing there is no risk of accidental spread into a waterway.

### Alternative species

In ornamental situations such as ponds and aquariums, use local native species instead of salvinia because they are unlikely to cause problems if they escape cultivation. However, in confined, nutrient-rich areas, these native species may also completely dominate the water surface of ponds, dams or wetlands. Check with your local council or weed management agency about alternatives to salvinia.

### Controlling salvinia

Because of its extremely rapid growth rate, eradication of salvinia is only likely very early in its spread. Therefore, monitoring and early detection should be undertaken in catchments at risk from salvinia invasion, especially after floods because this is one way it spreads to new areas.

### Smaller infestations – a chance of eradication

Although the success rate of eradication attempts is very low, best results are achieved with an integrated mechanical and herbicide control program. Careful removal of all salvinia by hand is particularly useful for clearing irrigation blockages. Any material physically removed from the water should be left to dry and preferably burnt or buried some distance from the water. Floating booms or nets can be used in the short term to restrict small infestations, although these are likely to be breached during floods.

Manual removal of salvinia also has the advantage of removing nutrients from the water, in comparison to herbicide control in which the nutrients from dead salvinia are released into the water, potentially affecting water quality and helping to fertilise new salvinia growth. Herbicides are effective however, and there are several that are registered for spraying on salvinia. Some herbicides act by reducing salvinia's buoyancy, causing it to immediately sink just below the surface. The plants darken, die and sink completely after several days.

Eradication of smaller infestations is possible but requires a concerted effort with vigilant follow-up. The follow-up control should be conducted soon after the initial treatment, and repeated and monitored regularly until no salvinia is left.

### Larger infestations – biological control in warm climates

Large infestations are virtually impossible to eradicate. Biological control with the salvinia weevil *Cyrtobagous salviniae* is very effective in warm temperate, tropical or sub-tropical climates. Following research by CSIRO, the 2 mm long weevil was first released in 1980 into Lake Moondarra near Mount Isa. It was a spectacular success – an estimated 800 ha infestation weighing tens of thousands of tonnes was reduced to less than one tonne in a little over a year. This weevil has since been released from Sydney to Kakadu and elsewhere around the world, providing very successful control of salvinia in specific climates.

Weevil larvae feed inside the stems and adults feed on buds, both contributing to plant death. Eventually the whole mat turns brown and begins to sink and decompose; this process generally takes between one and three years to control an infestation.

The Howard River near Darwin, NT. (*Left*) Before salvinia infestation in July 1984. (*Centre*) One month after salvinia infestation. (*Right*) The infestation dying after attack by the salvinia weevil *Cyrtobagous salviniae* in February 1985.
Photos: Colin G. Wilson

## Weed control contacts

| State / Territory | Department | Phone | Email | Website |
|---|---|---|---|---|
| ACT | Environment ACT | (02) 6207 9777 | EnvironmentACT@act.gov.au | www.environment.act.gov.au |
| NSW | NSW Agriculture | 1800 680 244 | weeds@agric.nsw.gov.au | www.agric.nsw.gov.au |
| NT | Dept of Natural Resources, Environment and the Arts | (08) 8999 4567 | weedinfo.nreta@nt.gov.au | www.nt.gov.au |
| Qld | Dept of Natural Resources and Mines | (07) 3896 3111 | enquiries@nrm.qld.gov.au | www.nrm.qld.gov.au |
| SA | Dept of Water, Land and Biodiversity Conservation | (08) 8303 9500 | apc@saugov.sa.gov.au | www.dwlbc.sa.gov.au |
| Tas | Dept of Primary Industries, Water and Environment | 1300 368 550 | Weeds.Enquiries@dpiwe.tas.gov.au | www.dpiwe.tas.gov.au |
| Vic | Dept of Primary Industries/Dept of Sustainability and Environment | 136 186 | customer.service@dpi.vic.gov.au | www.dpi.vic.gov.au<br>www.dse.vic.gov.au |
| WA | Dept of Agriculture | (08) 9368 3333 | enquiries@agric.wa.gov.au | www.agric.wa.gov.au |
| Australia wide | Australian Pesticides and Veterinary Medicines Authority | (02) 6272 5852 | contact@apvma.gov.au | www.apvma.gov.au |

For up-to-date information on which herbicides are registered to control salvinia and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environmental Protection Authorities may be required if herbicides are to be sprayed directly onto water.

Salvinia in open water can be difficult to reach with conventional herbicides.
Photo: Scott Robinson, Georgia (USA) Dept of Natural Resources

However, the weevil does not perform as well in cooler climates; in Australia it is effective about as far south as Grafton on the New South Wales coast. Spring is the best time to introduce weevils to a new infestation of salvinia in cooler climates. This gives them the chance to breed up to take advantage of the warmer weather in summer. Their life cycle lasts only about 6 weeks at 30°C, but is longer at lower temperatures.

The weevils will be most effective on a healthy population of salvinia, so control with other methods is not desirable unless the weed is so dense it has become multi-layered. In such situations the mats should be thinned (eg strip sprayed) to encourage the rapid new growth that is preferred by the weevil. About 100 weevils should be released in the same warm, sunny spot in permanent water. In the tropics this release site should start to turn brown after 4–5 months, equivalent to two life cycles. Most of the remainder of the infestation, at least in warm environments, should then quickly turn brown and die within a year to 18 months. Not all salvinia will be killed, which will ensure that some weevils remain to prevent significant regrowth of the weed. Eventually, a balance of sorts is reached, and the weevil numbers will cycle with the amount of salvinia.

Control using other methods should not be attempted where biological control is contributing to significant reduction of salvinia, because most herbicides kill the weevils. Eradication is rarely achievable and the attempt may merely disrupt the biological control, allowing the weed to regrow.

Weevils are established in salvinia infestations throughout the Northern Territory, Queensland and New South Wales. Although the weevil can fly, it will probably need to be introduced into a new infestation. Local councils and state/territory weed management agencies in affected areas will either be able to provide the weevils for release, or advise where to find them and how to translocate them. If weevil-bearing salvinia is translocated, care must be taken that other weeds are not also spread.

### Other methods will be required in climates not suited to the weevil

Mechanical and chemical control techniques should be integrated to manage large salvinia infestations where biological control is less effective. This may be necessary in the cooler climate of parts of New South Wales; and in some shallow tropical freshwater systems which can heat up to over 40°C, killing the weevil eggs. Mechanical methods, as previously outlined, can help to remove blockages and contain infestations. Herbicides, though relatively expensive, can be very effective.



...case study

## Eradication of salvinia in Kununurra, Western Australia, on track

In 2000 salvinia was discovered by a resident in Lily Creek Lagoon, Kununurra, probably after being dumped into a drain, or the lake itself, from a fish tank. The weed posed a significant risk to the horticulture industry, which extracts water downstream of the lake via the Ord River Irrigation Scheme. It also threatened the Ramsar-listed Ord River Floodplain, which is a wetland of international significance supporting saltwater crocodiles and a large number and diversity of waterbirds.

Fortunately, the salvinia infestation was relatively small, occupying only about 15 square metres. A naturally occurring barrier of cumbungi reeds (*Typha* species, considered to be weedy itself) had helped to contain it by separating the salvinia from the rest of the waterway. It is probable that the salvinia would have escaped from this contained area if it had not been found and controlled before the next wet season.

The effort to eradicate the salvinia involved cooperation from a range of government agencies and community groups including the Department of Agriculture, Water Corporation, Waters and Rivers Commission, Department of Conservation and Land Management, Shire of Wyndham East Kimberley, and the environment groups Save Endangered East Kimberley Species and Ord Land and Water.

Firstly, booms were used to further contain the infestation and prevent spread. The next stage involved removing as much salvinia as possible by hand, using flat bottomed boats to help reach the infestation. Approximately 100 kg of weed removed in this initial attempt was spread out and dried in the sun for one week before burial in a safe place.

Follow-up control has been ongoing, involving regular monitoring (initially every fortnight, then on a monthly basis) and the use of chemicals to spray any material that was not collected by hand. Biological control was not considered because the aim was to eradicate the infestation quickly. An education program targeted the general community via press releases and displays throughout the project.

The results so far have been the prevention of salvinia spread, an enhanced public awareness of the threats posed by salvinia and other aquatic weeds, and the almost complete eradication of the infestation. This project has been successful because of the involvement of a wide range of organisations, early detection of the problem, and the natural barrier that initially prevented the salvinia's spread.

case study

### Herbicide application

Herbicides that reduce buoyancy are most effective on light infestations because salvinia plants must be in contact with the water. The mixture should be applied at low pressures to ensure that droplets are kept as large as possible. One of the drawbacks of the use of chemicals is that water quality can be detrimentally affected if a large amount of salvinia is killed and decomposes at once.

### Other management strategies

Reducing the amount of nutrients entering a water body will help to reduce salvinia growth. Agricultural run-off, sewage, stormwater and erosion run-off are the main preventable forms of nutrient input that could be targeted for control.

Salt water has been used to kill off salvinia in the Canning River, Western Australia. However, other impacts on the ecosystem must also be considered. Another possibility is to drain affected waterways and dry out the salvinia before refilling. Note, however, that densely matted salvinia can survive many months of dry conditions.

## Legislation

Landholders across Australia are required by law to control salvinia when it occurs on their property. Most regions restrict its importation and sale. Check with your local council or state/territory government agency about its requirements for salvinia control.


## Acknowledgments

Information and guide revision: Rod Randall (Dept of Agriculture WA/Weeds CRC), Michael Storrs (Northern Land Council), Ian Miller (Northern Territory DBIRD), Mic Julien (CSIRO/Weeds CRC), Sandy Lloyd (Dept of Agriculture WA/Weeds CRC), Richard Carter (NSW Agriculture/Weeds CRC), Noel Wilson (Dept of Agriculture WA/Weeds CRC) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.



The different growth stages of salvinia: (*right*) primary invading form with small flat fronds, (*left*) open water secondary form with larger, slightly curved fronds and (*centre*) mat-forming tertiary plants with folded fronds.
Photo: Colin G. Wilson



# How to control salvinia

Quick reference guide



## Preventing salvinia's spread

Preventing salvinia's spread into uninfested catchments is the most cost-effective management strategy. As spread is mostly caused by people accidentally or deliberately releasing the weed, there needs to be greater public awareness about the problems it causes. Do not dump salvinia into drains or waterways. Small amounts should be buried, or dried and burnt. Check with your local council or state/territory weed management agency for advice about dealing with salvinia.

The aquarium and nursery industries must enforce the laws banning the sale and trade of salvinia, and encourage the use of alternative native species.

## Eradication is rarely achievable…

It is extremely difficult to eradicate salvinia once it becomes established. Because it reproduces and grows so quickly, even small amounts can quickly take over large water bodies. Eradication is usually only possible in very small, accessible infestations.

## …but salvinia can be managed with biological control…

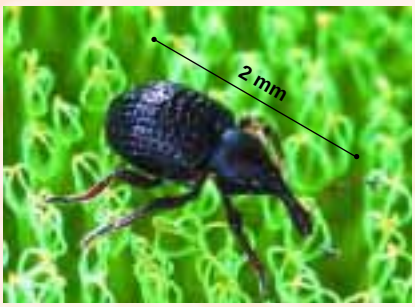
Very successful biocontrol of salvinia has been achieved in warm parts of Australia using the weevil *Cyrtobagous salviniae*.

## …and/or integration with physical and chemical control

Physical and chemical controls are used in cooler areas where biological control is not effective. Manual removal may be used to clear small areas but extreme care must be taken not to leave behind any salvinia pieces. Herbicides can be quite effective but can cause water quality degradation if large amounts of salvinia are killed simultaneously.

## Follow-up

Monitoring and vigilant follow-up control are required to contain salvinia where biological control is not effective.




The salvinia weevil *Cyrtobagous salviniae* and the egg-beater-shaped hairs that repel water from the upper surface of a salvinia frond.
Photo: Scott Bauer@USDA

## Control options

| Type of infestation | Physical | Mechanical | Chemical | Biological |
|---|---|---|---|---|
| Small (few plants, small area) | Manually remove by hand. Booms or nets can be used to prevent short-term spread. | Not suitable. | Several herbicides are registered for use on salvinia. Note: do not spray large infestations all at once, as this causes a mass die-off and pollutes water. Avoid this problem by removing most salvinia by hand or machine. All herbicides must be applied strictly in accordance with the directions on the label. Check with your local council or state/territory weed management agency for more details. | Biological control is unlikely to result in eradication, and is therefore not recommended for small infestations. |
| Medium (medium density, medium total area) | Not suitable. | Aquatic weed harvesters are available to regularly remove salvinia. However the results are similar to mowing a lawn, as it will regenerate. | | The salvinia weevil *Cyrtobagous salviniae* is extremely effective in destroying the weed. In warm environments control should take 1–3 years. Cooler climates may require a longer time or repeated introductions, or may not be suitable for the weevil.<br>Contact your local council or state/territory weed management agency for help in finding and releasing weevils onto salvinia. |
| Large (many plants, many ha) | Not suitable. | | | |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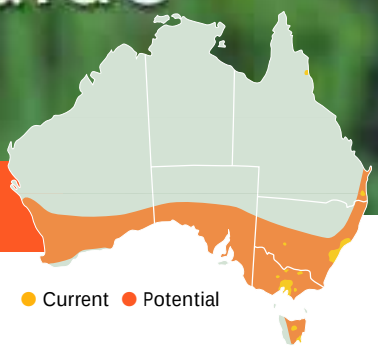
CRC Weed management

# Weed Management Guide

Alligator weed –
*Alternanthera philoxeroides*




# Alligator weed (*Alternanthera philoxeroides*)



## The problem

Alligator weed is a *Weed of National Significance.* It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. It is an especially troublesome weed because it invades both land and water, and is very hard to control.

When growing on land it displaces other more favourable plants such as crops or native vegetation, and can be harmful to animals. When growing in fresh water, alligator weed can cover the entire water surface, preventing flow, blocking up drainage channels and potentially increasing flood damage. Weed mats can also reduce oxygen exchange, affecting instream plants and animals and reducing water quality.

Alligator weed caused the failure of small crop and turf farms in parts of the lower Hunter region in New South Wales. Another infestation, in Barren Box Swamp, would have cost irrigation farmers in the Murrumbidgee Irrigation Area up to $250 million annually if left unchecked. So far, more than $3 million has been spent controlling this infestation alone.

## The weed

Alligator weed can grow with roots embedded in the bank or on the bottom of shallow water bodies, or float freely on the water surface. It spreads its leaves across the water surface, forming dense mats. The long spreading stems are hollow, helping it to float. The roots are thin and stringy, and trail in the water from the joints between plant segments (the nodes).

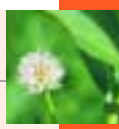
When growing on land alligator weed is quite different in structure. The stems are shorter and barely hollow. Reddish-brown tap roots can reach depths exceeding 500 mm.

Whether it grows in water or on land, the shiny, dark green leaves occur in opposite pairs along the stem. The leaves are 20–70 mm long and 5–40 mm wide, with smaller veins almost perpendicular to a characteristic mid-line along the length of the leaf. The silvery-white flower is small (12–14 mm wide) and papery, with a short stalk growing from either the axil (where the leaf joins the stem) or the very end of the stem.

Infestations can take over wetlands such as creeks and drainage channels and spread onto adjacent land.
Photo: Graham Prichard

## Key points

- Alligator weed poses a significant economic and environmental threat.
- It can grow in water or on land, and has been mistakenly grown in the past as a food.
- Prevention is the most cost-effective form of weed control. Quarantine, early detection and good hygiene within infestations will prevent its spread.
- Mechanical and chemical control, integrated with biological control, is effective on established aquatic growth forms.
- However, care must be taken because it spreads easily from fragments.
- Ongoing follow-up control will be required.



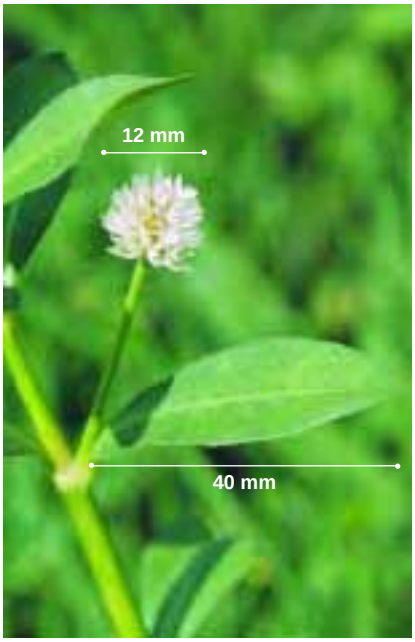
Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

### Growth calendar

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New growth | | | | | | | | | ■ | ■ | ■ | |
| Active growth | ■ | ■ | ■ | | | | | | ■ | ■ | ■ | ■ |
| Flowering | ■ | ■ | ■ | | | | | | | | | |
| Seed formation | No viable seed yet found in Australia | | | | | | | | | | | |
| Seed drop | | | | | | | | | | | | |
| Germination | | | | | | | | | | | | |

■ General growth pattern

Growth in alligator weed commences during spring and continues in the warmer weather. New stems formed in spring grow quickly during summer, producing flowers by mid-summer. Flowering continues until the weather becomes cooler and the days shorter. In cooler climates leaves drop off and frost kills off most of the exposed vegetation during winter. However, some roots, rhizomes and protected stems survive and recommence growth during the following spring.




Silvery-white flowers are borne on short stalks during mid-summer.
Photo: Colin G. Wilson

## How it spreads

Alligator weed does not produce viable seed in Australia, although it can in its native range. It spreads in Australia through vegetative reproduction, when fragments containing at least one node are moved from one place to another and take root in suitable habitat. It is commonly spread downstream when the plant is broken up into smaller fragments (eg by floods, or following mechanical or chemical control). Movement between river catchments is most commonly due to human activities. It has been spread in garden mulch and landfill, and attached to machinery and vehicles (eg bulldozers, trailers, boats and other watercraft). Animals may also spread the fragments (eg by transport of nesting material by ducks or in cows' hooves).


In water fine roots grow from the nodes.
Photo: Rebecca Coventry

It is believed that alligator weed first reached Australia near Newcastle in the 1940s in ballast. It has since spread to infest many waterways in New South Wales, including the lower Hunter region, Barren Box Swamp, the Sydney region, Griffith, Albury (which threatens the Murray River) and infestations in Brisbane, Cairns and Canberra.

## Where it grows

One of the reasons that alligator weed poses such a dramatic threat is its ability to live in both aquatic and terrestrial habitats. It can tolerate brackish (slightly salty) water but thrives in nutrient-rich water. Ideal terrestrial habitats include places that are regularly inundated or that have high rainfall or irrigation. Alligator weed can survive in tropical and sub-tropical regions such as Darwin and Brisbane, and also cooler climates such as Victoria and Tasmania where the survival of some stems and rhizomes over winter allows it to regenerate during the warmer months.

Alligator weed is native to temperate regions of South America, especially Argentina. It is now found as a serious weed throughout tropical and warm-temperate regions, including the US, China, India, South-East Asia and New Zealand.

## Potential distribution

The potential range of alligator weed, based on climate, includes waterways throughout most of southern Australia, extending south from Bundaberg in Queensland, through New South Wales, Victoria, Tasmania and South Australia, and north to Kalbarri in Western Australia. However, a different model predicts that alligator weed could also survive in the tropics, which may explain an infestation surviving in Cairns.

## What to do about it?

### Early detection is most cost-effective

Alligator weed has rarely, if ever, been successfully eradicated once it has infested a water body, despite numerous costly attempts. For this reason, the highest priority for the management of alligator weed in Australia is an effective system of early detection and eradication before infestations become established.

In the past alligator weed was mistaken as a traditional Sri Lankan herb and planted in gardens around Australia.
Photo: Lalith Gunasekera

The success of an early detection and eradication program depends on:

- maintenance of quarantine to prevent further introductions
- enhanced awareness and education to reduce the risk of spread
- the identification and monitoring of high-risk sites
- adherence to weed hygiene protocols (eg not removing material from infestations, carefully washing down equipment after contact with alligator weed)
- coordination between stakeholders and local and state/territory governments.

## Some successes with small infestations

Much of this work is ongoing but significant inroads have recently been made. For example, alligator weed was being cultivated in backyards and mistakenly used in traditional Sri Lankan cooking instead of another herb known as 'mukunewenna' or 'pononcarni'. A campaign was initiated to educate the Sri Lankan community about the dangers of alligator weed, to eradicate infestations and to replace it with a less weedy species. In Victoria 784 backyard infestations were identified following an awareness campaign that included newspaper articles, radio segments, leaflets and fridge magnets. By working closely with the Sri Lankan community, the infestations have been controlled via repeated herbicidal treatments. An Australian native species, common joy weed *Alternanthera denticulata*, has been accepted as a suitable replacement.

## Don't try and treat alligator weed on your own

The successful control of alligator weed in backyard situations has been achieved using the considerable experience and resources of local councils and state/territory weed management agencies. However, there is still much that is unknown about alligator weed. For example, the effectiveness of different herbicides in different environments is still being examined. For these reasons, and because it can spread so easily from small fragments, you must contact your local council or state/territory weed management agency to help you control alligator weed.

In aquatic situations the hollow stem helps floatation.
Photo: Rebecca Coventry

## It is extremely difficult to control alligator weed in aquatic situations

In some aquatic habitats, alligator weed infestations can be reduced with weed harvesters or by manual removal, but small fragments are inevitably left behind or dislodged. These fragments readily create new infestations. Therefore, any living plant material must be very carefully disposed of to prevent further spread.

In water alligator weed can be treated with a registered herbicide. However, this rarely kills the entire plant, which often breaks up into smaller pieces. These smaller pieces can drift downstream and lead to new infestations. Additionally, there are restrictions on the use of herbicides in waterways, including concerns about impacts to non-target plants and the environmental health of waterways.

Therefore, both the chemical and mechanical control of alligator weed in aquatic habitats is extremely difficult and can lead to further downstream infestations.


Alligator weed has an extensive root system when growing on land.
Photo: Graham Prichard

## Weed control contacts

| State / Territory | Department | Phone | Email | Website |
|---|---|---|---|---|
| ACT | Environment ACT | (02) 6207 9777 | EnvironmentACT@act.gov.au | www.environment.act.gov.au |
| NSW | NSW Agriculture | 1800 680 244 | weeds@agric.nsw.gov.au | www.agric.nsw.gov.au |
| NT | Dept of Natural Resources, Environment and the Arts | (08) 8999 4567 | weedinfo.nreta@nt.gov.au | www.nt.gov.au |
| Qld | Dept of Natural Resources and Mines | (07) 3896 3111 | enquiries@nrm.qld.gov.au | www.nrm.qld.gov.au |
| SA | Dept of Water, Land and Biodiversity Conservation | (08) 8303 9500 | apc@saugov.sa.gov.au | www.dwlbc.sa.gov.au |
| Tas | Dept of Primary Industries, Water and Environment | 1300 368 550 | Weeds.Enquiries@dpiwe.tas.gov.au | www.dpiwe.tas.gov.au |
| Vic | Dept of Primary Industries/Dept of Sustainability and Environment | 136 186 | customer.service@dpi.vic.gov.au | www.dpi.vic.gov.au<br>www.dse.vic.gov.au |
| WA | Dept of Agriculture | (08) 9368 3333 | enquiries@agric.wa.gov.au | www.agric.wa.gov.au |
| Australia wide | Australian Pesticides and Veterinary Medicines Authority | (02) 6272 5852 | contact@apvma.gov.au | www.apvma.gov.au |

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When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed directly onto water.

## …and on land

When it grows on land, alligator weed can be controlled with repeated herbicide treatments. The Queensland Department of Natural Resources and Mines suggests three treatments during the growing season, each consisting of two applications separated by one week. Ideally, the last treatment should be undertaken close to the start of winter to target the rhizomes, which would otherwise allow the weed to survive through winter.

However, there are problems in this approach, including concerns about using herbicides near waterways, expense, and the difficulty of targeting alligator weed when other desirable species are also present.

Physical removal is also difficult because of the depth that roots and rhizomes can reach. It is recommended that all weed material be removed to a depth of one metre, and then be disposed of by deep burial. This is obviously a difficult and time-consuming task requiring mechanical assistance.

Flowering alligator weed in paddocks of the Lower Hunter, NSW, in February.
Photo: Mic Julien

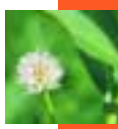

Adult biocontrol agents (the alligator weed flea beetle *Agasicles hygrophila*) feed on leaves and stems.
Photo: Graham Prichard

## Biological control can help manage alligator weed

Three insects have been released in Australia to control alligator weed. The aquatic alligator weed flea beetle *Agasicles hygrophila*, has been quite successful in controlling alligator weed growing in the water. It was first released in 1977 in New South Wales. The adults and larvae reduce the growth of alligator weed by feeding on the underside of the leaves and aerial parts of the plant.

Unfortunately, biological control does not yet offer a cure to the alligator weed problem. The flea beetle is only effective in warm, temperate areas that allow it to breed up to high numbers in early summer, and it does not attack alligator weed growing on land. Therefore, the search continues for new biological control agents in alligator weed's native range, particularly for agents to control the weed in cooler climates and when it grows on land.





Mechanical removal of alligator weed requires careful hygiene to prevent the spread of small fragments.
Photo: Brian Worboys

Given the difficulties and expense associated with chemical and mechanical control, biological control agents are an attractive option to tackle alligator weed in the long term. However, biological control is a complex process, requiring success at a number of separate stages. Once identified, suitable agents must be approved for release, reared in captivity and then become established in the field. The hope for future biological control agents must therefore be balanced by the possibility that they may not be available or successful.

## Legislation

In all states and territories, landholders are obliged by law to control or eradicate alligator weed and to limit its spread and impacts. Most regions restrict its importation. Check with your local council or state/territory government agency about its requirements for alligator weed control.

## Acknowledgments

Information and guide revision: Mic Julien (CSIRO/Weeds CRC), Rebecca Coventry (NSW Dept of Agriculture), Richard Carter (NSW Dept of Agriculture/ Weeds CRC), John Wilson (CSIRO/Weeds CRC), Nimal Chandrasena (Sydney Water), Andrew Storrie (NSW Dept of Agriculture/ Weeds CRC) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

*...case study*

## Integrated management of alligator weed in Botany Wetlands in Sydney

Sydney Water provides drinking water and wastewater services to over four million people in the Sydney, Blue Mountains and Illawarra areas, including the Botany Wetlands which are situated within the metropolitan area of Sydney.

The Botany Wetlands are ecologically and aesthetically significant, but are also historically important as they served as a drinking water supply for Sydney in the mid 1800s. Alligator weed was first noted in waterways around 1985, but only occasionally treated with herbicides until the mid 1990s, by which time the infestation was out of control and posed a significant threat to the wetlands.

Sydney Water has since introduced an integrated weed management approach to deal with alligator weed. This combines vigilant and systematic monitoring for any new infestations, with regular application of suitable herbicides for both terrestrial and aquatic infestations and manual removal of floating masses. Other active management strategies include the lowering of water levels to allow better control, the large scale planting of native water plants in treated areas, and the controlled burning of sedges and rushes in selected infested areas. Additionally, in order to minimise environmental damage from chemicals, herbicides are not applied when the biological control agents are most active.

In terms of actual control efforts, herbicides are applied as spot-treatments to persistent patches at monthly intervals during cooler months, and more frequently in the warmer months (September–May). New infestations are treated with herbicides or are removed by hand picking as soon as practicable, with the ultimate aim of preventing further downstream spread. Disposal of collected live plant material is by burial in the sand in selected locations, following drying and herbicide treatment.

It is estimated that, on average, 90–95% of the previous alligator weed infestation has been controlled and removed since the adoption of the new integrated management plan in 1997. Although this is a relatively successful result, the inability to completely eradicate the weed from the wetlands reflects its resilience to current control measures and its ability to spread even when being carefully managed. It must also be recognised that the current gains made on alligator weed in the Botany Wetlands have been achieved through diligent and committed action, continual assessment, persistent management intervention and investment of labour and other resources.

Impacts of alligator weed include flooding due to blocked drains.
Photo: Rebecca Coventry

# How to control alligator weed

Quick reference guide



## Preventing spread

The main aim of alligator weed management in Australia is to prevent its spread from core infestations into new areas by:

- preventing new plant material entering Australia
- using weed hygiene protocols, such as washing contaminated equipment
- educating people to recognise it and respond to outbreaks.

## The importance of monitoring

Early detection offers the only likelihood of finding infestations that are small enough to hope to eradicate. Monitoring of likely areas is therefore crucial to successful alligator weed management.

## The limitations of current control techniques

Available management techniques for controlling alligator weed include:

- mechanical (eg weed harvesters in water bodies)
- physical (eg digging all material out to a depth of one metre)
- chemical (several herbicides registered for use on land or water)
- biological (eg the flea beetle attacks alligator weed growing in water).

Unfortunately each of these techniques has its limitations. Mechanical, physical and chemical control can all leave small fragments behind and actually increase the spread of alligator weed. These techniques therefore require a great deal of care and should only be conducted with the assistance of experts.

Other issues with these techniques include expense, the intensity of work required (eg spraying land infestations requires three treatments of two sprayings each), concern over residual herbicides in and around waterways and effects on non-target plants and animals, the difficulty of disposing of collected material and the need for continual follow-up work.

This simple screen has effectively prevented the spread of alligator weed into nearby wetlands. Photo: Graham Prichard

## Control options

| Type of infestation | Best way to control |
|---|---|
| Backyard infestations | Backyard infestations should be reported to your local council or state/territory weed management agency. Herbicides have been used successfully in different regions, but will require many repeated treatments. Care must be taken to prevent the spread of weed through fragments escaping from the garden. |
| In a waterway | Alligator weed in waterways should be reported to your local council or state/territory weed management agency. Herbicides are most effective when above water vegetation is greatest. Manual or mechanical removal may also be possible. If not already present, flea beetles should be introduced. Integration of all of these techniques will ultimately provide the best results. |
| On land | Alligator weed on land should be reported to your local council or state/territory weed management agency. Effective herbicides are available; however, treatments must be repeated frequently during the growing season. Biological control does not yet impact on land infestations, but other management techniques such as revegetation or physical removal are useful. |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# Water lettuce

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## Introduction

Water lettuce (*Pistia stratiotes*) is a free floating aquatic plant native to Asia, Africa and equatorial America. There is some debate as to whether the Northern Territory forms part of its native range.

Once established, it has the potential to quickly spread and form a dense mat that can cover an entire body of water.

It is thought to have been introduced to NSW rivers and dams via eel traps from Queensland and as an aquarium plant and water garden specimen sold in nurseries.

Rivers, wetlands, lakes, reservoirs and slow moving streams are most at risk from this weed, especially in the subtropical parts of the State.

## Impacts

Under favourable conditions, water lettuce will produce abundant growth, expand rapidly and form obstructive mats.

These large dense floating mats can have negative impacts on native aquatic plants and animals. They can also interfere with irrigation, boating and water sport activities.

Thick mats of water lettuce are also known to harbour disease-causing mosquitoes.

A large infestation of water lettuce on a dam near Maitland. (Photo: Brian Worboys, Maitland City Council)

## Habitat

Water lettuce grows best on still or slow moving bodies of fresh water such as farm dams, reservoirs, lakes, rivers and creeks.

It will tolerate temperatures between 15°C and 35°C; however optimum temperatures for growth range between 22°C and 30°C. Water lettuce is frost sensitive and growth is limited in temperate zones by long cool winters.

Water lettuce can survive for long periods on mud banks or in other damp locations such as roadside culverts.

## Distribution

While water lettuce is not established in NSW, there have been outbreaks of it throughout the northern coastal part of the State.

Infestations have been located in the Tweed River Catchment at Pigaben and Tyalgum, and the Richmond River Catchment at Bungawalbin, Casino, Bonalbo and Grevillia. Isolated infestations have also been found at Macksville, Taree and Maitland.

At all identified sites water lettuce is currently under active control with the aim of eradication.

## Description

Water lettuce is a free floating plant that has an appearance very much like an open head of lettuce. It can grow up to 15 cm tall and 30 cm wide. Mother and daughter plants are attached by stolons (white root-like structures which link plants together) up to 60 cm long.

Water lettuce resembles an open head of lettuce. (Photo: Brian Worboys, Maitland City Council).


Water lettuce is free floating with submersed feathery roots. (Photo: Rod Ensbey, NSW DPI).

### Leaves

Pale green leaves are ribbed, wedge-shaped and form a rosette. They are spongy to touch and have a velvety appearance due to the small thick hairs that cover them.

### Roots

A large number of unbranched feathery roots up to 80 cm long are submersed in water beneath the leaves of the plant.

### Flowers

The flowers of water lettuce are very small (up to 1.5 cm long) and hidden in the centre of the plant amongst the leaf bases. They are whitish-green in colour. Flowering occurs throughout the year.

### Fruit

The fruit is a greenish berry, 5–10 mm in diameter. Four to fifteen oblong shaped seeds occur in each berry. They are green at first then mature to a brown colour and are about 2 mm long.

## Reproduction

Water lettuce is a perennial plant that reproduces vegetatively and from seed.

Water lettuce can quickly multiply and cover an entire body of water. Photo: Brian Worboys, Maitland City Council.

Each plant produces a number of stolons, with each producing a new rosette or daughter plant at its end. Each daughter plant will then form its own stolons, enabling the plant to increase rapidly.

Once shed, the seeds will float on the water before sinking to the bottom. They germinate in early summer once temperatures rise above 20°C and then float to the surface as seedlings.

Flowering and reproduction can occur as early as the four- to five-leaf stage of development. When conditions for growth are good, the plant can quickly reproduce and cover an entire body of water with a thick mat of connected rosettes.

## Dispersal

This weed is thought to have spread through dumping of water lettuce from aquariums or fish ponds into creeks, rivers and wetlands, or of deliberate cultivation. It is also thought to have been introduced to NSW rivers and dams via eel traps from Queensland.

Water lettuce is capable of being dispersed as broken pieces, buoyant seedlings or whole plants.

Pieces of water lettuce can be spread by boats or fishing equipment moving it from an infested to a clean water body.

Seeds can float downstream providing a seed reserve in uninfested areas. Seeds also create ongoing problems in infested areas.

## Control and management

### Preventing spread

If you find water lettuce, notify the local council so that appropriate control methods can be carried out.

Emptying unwanted aquarium or fish pond plants into dams, creeks or streams is an offence and may harm the environment. When removing plants from an aquarium, remove from the water and let the plant dry out completely before wrapping in paper and disposing of it in the bin.

If you suspect anyone has water lettuce and they are not aware of the problems it poses, you should advise them to contact the local council weeds officer for advice.

If using an area for recreational water sports, prior to leaving, check equipment for water lettuce and remove it.

While water lettuce should no longer be available for sale in NSW, it still does appear in nurseries, pet shops and on the World Wide Web, often being sold

as ‘water rose’. If you notice it being sold, report the instance to the local council weeds officer.

### Mechanical / Physical removal

Physical removal is effective for small infestations. Water lettuce plants cannot survive for long out of the water and can be removed by either raking or being pulled to the bank with an encircling rope.

Once removed, plants must be allowed to dry out and break down. Make sure that all plants removed are placed above the floodline. If possible, place on plastic to prevent them from taking root in mud.

Water weed harvesting craft may be suitable for larger infestations although these can be quite expensive.

### Herbicides

Herbicide may be necessary to control large infestations of water lettuce. When applying herbicides to a water body, it is important to follow these procedures:

- Identify the plant or plants correctly.
- Select a chemical registered for use in water and on that particular plant.
- Read the chemical label carefully and observe all special precautions.

Chemicals registered for control of noxious weeds are listed in the publication *Noxious and Environmental Weed Control Handbook* which is available online at www.dpi.nsw.gov.au. For further information on chemicals and rates, read the product label or enquire at your local NSW Department of Primary Industries office.

A permit may need to be obtained from the Department of Environment and Conservation (DEC) for any herbicide applications applied over or near water.

### Biological control

Insects such as the weevil *Neohydronomus affinus* have been introduced for biological control in Australia.

While this insect has not been released in NSW, it has shown to be effective on dams in south-eastern Queensland.

## Legislation

*Pistia stratiotes* is a Class 1 noxious weed throughout NSW under the NSW *Noxious Weeds Act 1993*. As such, the weed must be eradicated from the land and the land must be kept free of the plant. As a notifiable weed, all outbreaks must be reported to the local council within three days.

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).

This plant is banned from sale in NSW, ACT, Qld, WA and NT.


## Acknowledgements

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Job number 6903

# APPENDIX D

# Guidelines UW9 – Access, Egress & Crossings

# GUIDELINE UW9.

**1. TITLE:** ACCESS, EGRESS AND CROSSINGS

**2. PURPOSE** To establish safety considerations for access and egress to water areas and crossings over water areas.

**3. GUIDELINES**

**3.1 Access**

3.1.1 Where access to the water is available, signage should be provided indicating the type of activity(s) appropriate to the venue. Refer to the Aquatic and Recreation Signage Manual.

3.1.2 Where access is provided, it should be safe and free of obstructions, whether above or below water, visible or hidden.

3.1.3 Where swimming is allowed, there should be appropriate access and egress areas such as steps, ramp, beach or similar.

3.1.4 For a water's edge covered in soft mud, heavy reed beds, mangroves or introduced items such as tree logs, access should be denied, prohibited or restricted.

3.1.5 Dangerous locations such as deep water or quick sand/mud should be appropriately signed and isolated.

**3.2** The edge of any deep open water should not be hidden or obscured by embankment or planting unless measures precluding access are incorporated.

**3.3** Approach batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H) unless there is special landscape edge treatment that will provide appropriate safety measures. Refer to Waterbody and Wetland Safety Requirements.

**3.4 Safety Benching**

3.4.1 No formal access to water shall be invited unless there is appropriate safety benching.

3.4.2 All edges to water bodies and wetlands shall have safety benches of at least 1.5-3.0 metres wide from the edge of normal top water level (NTWL) position, except where transitions to culverts or waterways occur. Refer to Waterbody and Wetland Safety Requirements.

3.4.3 The safety benches shall have a maximum grade of 1:8 (V:H) for the first 1.5-3.0 metres before transitioning through 1:5 (V:H) grade over at least 0.5 metre, prior to any steeper grades with a maximum of 1:3 (V:H) grades. The safety bench shall be densely planted such that casual entry will be difficult and that depths gradually increase beyond 150-200 mm before deepening. Refer to Waterbody and Wetland Safety Requirements.

**3.5 Secondary Safety Benches**

In the case of open water bodies greater than 0.9 metre deep a secondary safety bench will be required at 0.9 metre. This is dependent on the batter slopes from the initial safety bench and depth of the deeper open water. Refer to Waterbody and Wetland Safety Requirements.

**3.6 Fencing**

3.6.1 Interim fencing may be required between the construction and vegetation establishment where any component of the water body is deeper than 350mm. Refer to Waterbody and Wetland Safety Requirements.

3.6.2 Permanent fencing and/or combined fencing and dense impenetrable plantings should be considered for use adjacent to zones of deep water (greater than 350mm at NTWL), areas where safety benches do not meet the width criteria, adjacent to potentially unsafe structures, areas where high velocities may be encountered or batters are steeper than 1:5 (V:H). Refer to the Risk Management section at the front of document, Appendix A – Risk Management Examples and Appendix B – Barriers.

**3.7 Maintenance Access**

Maintenance access areas shall be signed, fenced and gated to discourage access where the basic safety measures above are not met.

**3.8 Non Maintenance Access**

Non maintenance access to the top of weirs, orifice pits and outlet structures shall be restricted by appropriate safety fences and other barriers.

**3.9 Crossings**

3.9.1 Crossings over water bodies and waterways shall have 100 year flood level protection.

3.9.2 All crossings shall have a clear line of sight from the approaches to the water body, allowing pedestrians a clear view of the prevailing water conditions before they use the crossing.

**3.10 Egress**

Appropriate exit or extraction methods should be developed and practiced should someone unintentionally fall into or enter the water.

# APPENDIX B

## BARRIERS

As described in the introduction, people often get into trouble in water when they have entered the water unexpectedly. Barriers between people and water are a very effective way of remote supervision that reduces the likelihood of an unexpected entry into the water.

The barrier around the water body can be a combination of fencing and/or impenetrable planting. It should be noted that if impenetrable planting is used as part of a barrier, the effectiveness of this barrier may be reduced while the plants grow. If fencing is to be used as a barrier, either in the entirety or in part, it should comply with AS 1926.1 Swimming Pool Safety – Fencing for Swimming Pools, as it is designed with the specific intention of remote supervision of water bodies. A guide to the standard follows.

### Fencing

Fencing is to be designed and constructed so that at any point, the outside of the fencing will present an effective barrier by restricting access of young children to a pool or spa or water body as described above.

### Materials

Fencing may be constructed from any type of material, provided that the finished fencing complies with the requirements of the Standard.

### Fencing Height

The effective fencing height shall be not less than 1.2 metres.

### Perforated Material or Mesh Fencing

Perforated Material or Mesh Fencing using perforated materials or mesh requires an opening of 13mm or less.

If the opening used is greater than 13mm, effective fencing height should not be less than 2.4 metres.

NOTE: Fencing using mesh shall include a strainer wire or rail at the top and the bottom of the fencing.

### Horizontal Climbable Members

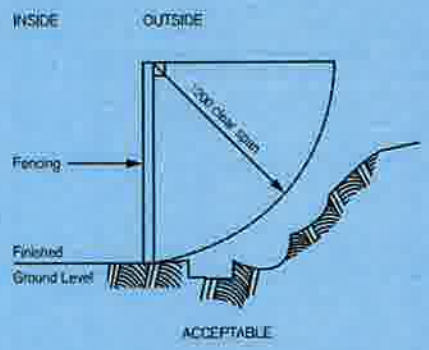
Where fencing components provide a significant horizontal surface, such as rails and rods, that could be used as holds for climbing, they must be situated on the inside of the fencing and at least 900mm apart. If situated less than 900mm apart, the vertical members must be spaced no more than 10mm apart.

### Vertical Members

The space between vertical members shall not exceed 100mm at any point.

### Outside of Fencing

Any substantial horizontal surfaces that are permanently located on the outside of the fence and could be used as holds for climbing must not be within a 1.2 metres arc measured from the top of the fence.

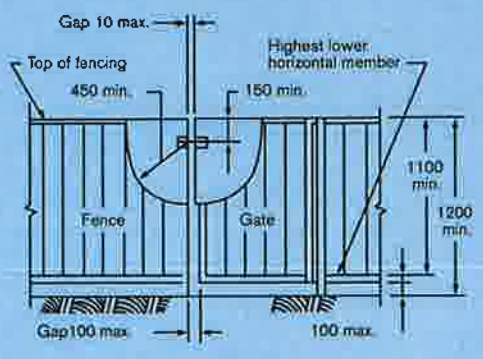



All dimensions in millimetres (mm)

### Shielding of Latching Device

Where the gate is of an open construction and the latch release is below 1.5 metres, the latch must be shielded so that no opening greater than 10mm occurs within an area bound by:

- A circular area with a radius of 50mm from the operating parts of the latch.
- The top of the gate if this intersects the area described in the diagram below.




(a) Basic requirements

All dimensions in millimetres (mm)

## Inside of Fencing

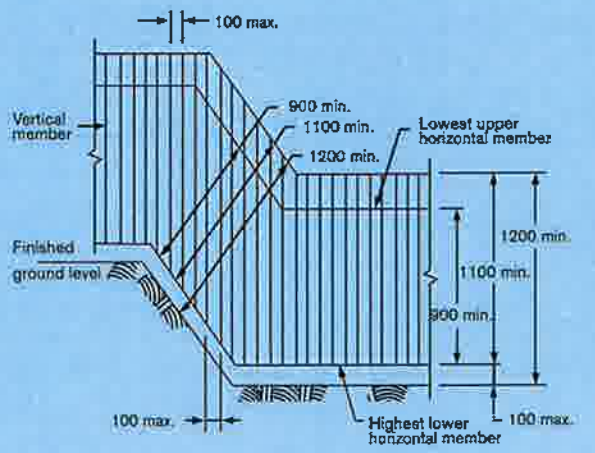
Any substantial horizontal surfaces that are permanently located on the inside of the fence and could be used as holds for climbing, must be at least 300mm clear of the fence.

## Above Ground Pools

The walls of the pool or water body shall be an effective barrier if they are not less than 1.2 metres in height and provide no climbable projections.

## Ground Clearance

The height of any opening between the bottom of the fencing and the finished ground level shall not exceed 100mm.




All dimensions in millimetres (mm)

# GATES AND FITTINGS

## Direction of Opening

Gates shall be hung so that they only swing outwards, eg; away from the pool area.

## Self-Closing Device

All gates shall be fitted with a device that will return the gate to the closed position and operate the latching device from any position with a stationary start without the application of a manual force.

Note: The self-closing device shall be capable of complying with these requirements with the gate at any position from resting on the latching mechanism to fully open.

## Latching Device

Gates shall be fitted with a latching device that will automatically operate on the closing of the gate and will prevent the gate from being re-opened without being manually released.

## Location of Latching Devices

The latch or its release should be located at 1.5 metres above finished ground level. Where the latching device is located at a height less than 1.5 metres above the finished ground level, the location of the latching device and its' release shall:

1. Not be on the outside of the fence.
2. Be in such a position that to release the latching device from the outside it will be necessary to reach over or through the fencing at a height of not less than 1.2 metres.
3. Be at least 150mm below the top of the gate if a hand-hole is not provided, or at least 150mm way from the edge of any if a hand-hole opening is provided.

## Child-Resistant Doorset

Both sliding and hinged swinging doors must be fitted with a self-latching device with the latch located no less than 1.5 metres above floor level. The self closing device should return the door to the closed position and trigger the latch from any position from a stationary start.

## Opening Windows

The window sill must be higher that 1.2 metres, or fixed grill or bars must be provided or a device to prevent the window from opening more then 100mm must be fitted.

NOTE: Key locks are not suitable for this purpose.

# APPENDIX E

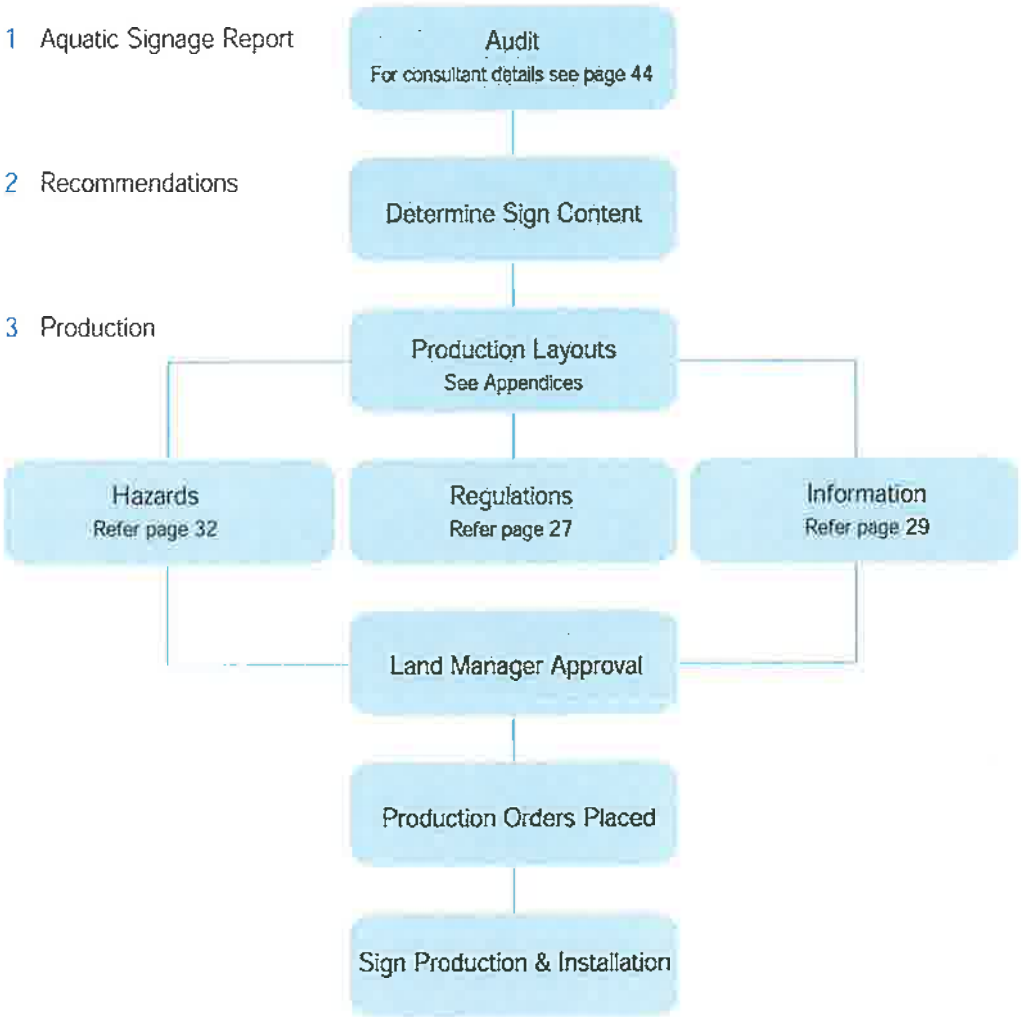
## Water Safety Signs

## Compliance Process

Enjoyment of our aquatic reserves involves varying degrees of risk. Responsible management of the reserves will include alerting potential users to foreseen risks at a particular location. Some hazards are easily identified such as cliff faces and rocky outcrops. Other hazards may be less visible and could include strong currents (rips), submerged rocks or dangerous marine life.

The aquatic and recreational signage system recommends the determination of risk by an independant audit of risk and safety signage.

A qualified aquatic risk and safety consultant will determine, in consultation with land managers, the requirements for signage in line with the current best practices and standards.




## Sign Type Placement

The example above is a best practice model for risk and safety signage. With best practice signage in place, visitors will have a number of opportunities to be informed of hazards, regulations and lifesaving services within the designated area.

There are six sign types included in the best practice model for risk and safety signage:

Level 1 Road Signs

Level 2 Car Park Signs

Level 3 Access Signs

Level 4 Individual Hazards and Regulation Signs

Level 5 Beach Signs, Flags and Symbols

Level 6 Pool Signs


## Level 1
## Road Signs

Most commonly, intersection direction sign formats, as determined by relevant road signage standards, will apply when directing traffic to specific areas. This sign type is categorised as a services sign and consists of white reflective lettering on a blue background. Information symbols for available services may be included. Symbols are to be white on a blue background. Beach emergency access numbers are to be black characters on a yellow triangle.

There may also be a need for warning symbols to be displayed along a road within the reserve. Examples of warnings may include 'Pedestrians', 'Gravel Road' or 'No Lifesaving Service'. These signs shall be comprised of a black symbol and border on a yellow diamond shaped background.

# Level 2
# Car Park Signs

The graphic content for level 2 and 3 signs has been designed using standard symbols for easy recognition and uniformity. The carpark sign has been designed to attract attention and to display important information to visitors so that an informed decision on the suitability of the location can be made prior to undertaking activities

The sign is made up of four sections:

- Designated area and beach emergency location number, if applicable
- Hazards within the designated area
- Lifesaving service information
- Regulations

Most important is the hierarchy of information. Hazards are displayed below the reserve name and the emergency beach location number. Lifesaving service information is listed below the hazards with regulatory information in the lower section.

The height of the sign will depend on the amount of information that is required to be displayed.

Type A signs are used when 3 or 4 hazard symbols are to be displayed.

Type B signs are reduced in height to display 1 or 2 hazard symbols.

[Dimensions shown are a guide only]


Type A
Displays 3 or 4 Hazard Symbols


Type B
Displays 1 or 2 Hazard Symbols


Type A
Aluminium sign panel
fixed to galvanised post

Type B
Recycled Plastic

## Level 3
## Access Signs

Access signs follow the same principles as those of Level 2 car park signs. There are two types of access signs.

1. Defined Access Sign - for use where access to the reserve is controlled via a narrow pathway.

2. Open Access Sign - to be used for areas where access is not limited to pathways or alternatively for wide pathways (See page 8).

[Dimensions shown are a guide only]

## Defined Access Signs

## Level 3
## Access Signs

[Dimensions shown are a guide only]


Type C.
Displays 3 or 4 Hazard symbols


Type D.
Displays 1 or 2 Hazard symbols

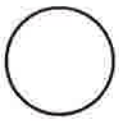
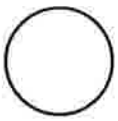
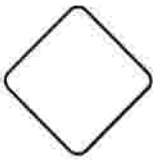
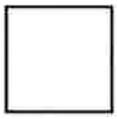
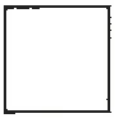
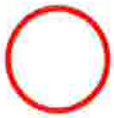
## Open Access Signs


## Level 4
## Individual Hazard and Regulation Signs

Individual Hazard Signs are to be used where a hazard has been identified as a level of risk that warrants sign-posting. Examples may include unstable cliffs and slippery rocks.

Individual Hazard Signs may also be used for displaying regulations for known trouble spots or to indicate regulation boundaries such as 'Dogs permitted off leads past this point'.

For other examples and the display of multiple hazards, refer to Australian Standard AS2416.

| CLASS | REGULATION | PERMISSIBLE | WARNING | SAFETY | INFORMATION |
|---|---|---|---|---|---|
| SHAPE |  |  |  |  |  |
| COLOUR |  |  |  |  |  |
| COLOURS USED FOR VARIOUS ELEMENTS WITHIN EACH SIGN: SYMBOL | Black | Black | Black | White | White |
| BACKGROUND | White | White | Yellow | Green | Blue |
| ENCLOSURE | Red | Green | Black | White | White |
| EXAMPLE |  Mandatory  Prohibited |  Permissible |  |  |  |

## International Symbolic Colours and Shapes Applicable to Structural Elements

WS,1

SKATEBOARD RAMP

WS,2

PLAYGROUND

WS,3

BOAT RAMP

WS,4

PEDESTRIANS

WS,5

CROCODILE

WS,6

STEEP WALKING TRACK

WS,7

UNEVEN GROUND

WS,8

SHAFT

WS,9

UNSTABLE CLIFFS

WS,10

SNAKES

WS,11

SLIPPERY AREA

WS,12

HIGH SURF

WS,13

LIMBS MAY FALL KEEP CLEAR

WS,14

TREES MAY FALL TAKE CARE

WS,15

WARNING

WS,16

STEEP DESCENT

WS,17

SUBMERGED OBSTACLES

WS,18

DAM

WS,19

KANGAROOS

## Warning Signs

Text for symbols may vary from that shown, however, wording should always be used to clarify the hazard represented in the symbols, i.e. "Unstable Cliffs" and "Edge" share the symbol but each defines a varying hazard.

For production purposes, an electronic version of the following symbols is enclosed on CD from Surf Life Saving Victoria.

Numbering relates to filenames for CD cataloguing purposes only.

WS,20

KOALAS

WS,21

WOMBATS

WS,22

BEWARE
EUROPEAN WASPS

WS,23

BEWARE
FERAL BEES

WS,24

SHARKS

WS,25

STINGERS
(UNDERWATER)

WS,26

STINGERS
(FLOATING)

WS,27

WATER

WS,28

STRONG
CURRENTS

WS,29

SHALLOW WATER

WS,30

DEEP WATER

WS,31

DROP OFF

WS,32

SUCTION PIPE

WS,33

UNSTABLE CLIFFS
KEEP CLEAR

WS,34

SUBMERGED
OBJECTS

WS,35

DEEP HOLE

WS,36

SLIPPERY STAIRS

WS,37

STEEP STAIRS

WS,38

TRAILRIDERS

WS,39

EFFLUENT OUTFALL

## Advisory Warning Sign

AWS,1

DANGEROUS CURRENT

RS,1

NO BIKE RIDING

RS,2

NO BICYCLES

RS,3

NO VEHICLES

RS,4

NO TRAILBIKES

RS,5

NO SKATEBOARDS

RS,6

NO JUMPING

RS,7

NO RUNNING

RS,8

SHOOTING PROHIBITED

RS,9

NO FIREARMS

RS,10

NO LITTERING

RS,11

NO ENTRY

RS,12

NO GOLF

RS,13

NO MODEL PLANES

RS,14

NO PARKING

RS,15

NO SPEAR FISHING

RS,16

NO FISHING

RS,17

NO HORSES

RS,18

NO DIVING

RS,19

NO CATS AND DOGS

RS,20

NO GLASS

RS,21

NO FOOD

RS,22

DO NOT DRINK THE WATER

RS,23

NO SMOKING

RS,24

PICKING PLANTS PROHIBITED

## Regulation Signs

RS,25

BODYBOARDS PROHIBITED

RS,26

BOMBING PROHIBITED

RS,27

SURFBOARD RIDING BETWEEN FLAGS PROHIBITED

RS,28

PUSHING PROHIBITED

RS,29

NO SNORKELING

RS,30

FIRES PROHIBITED

RS,31

NO NAKED FLAMES

RS,32

PWC's PROHIBITED

RS,33

NO ALCOHOL

RS,34

WATER SKIING PROHIBITED

RS,35

SAILBOARDS PROHIBITED

RS,36

SURFCRAFT PROHIBITED

RS,37

VESSELS PROHIBITED

RS,38

SCUBA DIVING PROHIBITED

RS,39

SNORKELING AND SCUBA DIVING PROHIBITED

RS,40

NO SWIMMING

RS,41

NO DOGS ALLOWED

RS,42

DOG LITTER MUST BE PICKED UP

RS,43

CAMPING PROHIBITED

RS,44

NO REMOVING SHELLFISH

IS,1

SWIM BETWEEN THE FLAGS

IS,2

LIFEJACKETS

IS,3

DIVING

IS,4

SNORKELLING

IS,5

SCUBA DIVING

IS,6

SNORKELING AND SCUBA DIVING

IS,7

BODYBOARDS

IS,8

SURFBOARD RIDING

IS,9

WATER SKIING

IS,10

SMOKING PERMITTED

IS,11

WINDSURFING PERMITTED

IS,12

PARAGLIDING

IS,13

POWER BOATING

IS,14

NON POWERED BOATING

IS,15

KAYAKING

IS,16

SAILING

IS,17

RAFTING

IS,18

PERSONAL WATER CRAFT

IS,19

BOAT RAMP

IS,20

ANCHORAGE

## Information Signs

Information signs are used to show what areas of a waterway are suitable for certain activities. These signs are also used on the road to inform drivers of areas suitable to their needs.

## Regulatory

RS.1

DOGS MUST BE ON A LEASH

## Permissable

P.1

DOGS ALLOWED

P.2

DOGS OFF LEASH ALLOWED

P.3

SHARED FOOTWAY

P.4

BICYCLES ALLOWED

## Safety

S.1

TELEPHONE

S.2

FIRST AID

S.3


MSDS LOCATED HERE

## Safety - Mandatory

SM.1


SM.2


SM.3


SM.4


SM.5


SM.6


SM.7


SM.8