

Salvinia

Rod Ensbey

Salvinia (*Salvinia molesta*) is a serious aquatic weed that is a declared noxious plant throughout Australia.

It was first recorded at Luddenham near Sydney in 1952 and near Brisbane in 1953 and was thought to have been introduced originally as an aquarium plant. Salvinia is native to Brazil and has now spread worldwide. It is listed as a Weed of National Significance in Australia.

Description

Salvinia is a free-floating aquatic fern with slender stems, floating leaves, and a root-like structure.

Leaves. The leaves of this weed float on the water surface, are paired and round-to-oval in shape, with dense, waxy hairs on the upper surface. The shape and size of leaves vary with age and the degree of crowding. In open water during its

shaped leaves. As the weed begins to increase in density, the leaves start to fold, with only the midrib touching the water surface. Folding of the leaves is very distinct when a mat of salvinia forms.

Stems. Stems are submerged, green, branched, and covered with fine hairs. Their function is to join the paired, floating leaves and to support the roots which develop at each node. Axillary buds are located at each node along the stem.

Roots. Thought to be a modified leaf, the roots form into trailing, hairy strands up to 25 cm long. Under crowded or mat conditions, up to 4 stalks develop among the roots, each bearing a chain of sterile sporocarps (the spore-producing part of the plant).

Distribution

The main infestations of salvinia are found in



The salvinia plant (*Salvinia molesta*), close-up, clearly showing the hairy, folded leaves and hairy roots bearing a chain of sterile sporocarps

primary growth stage, the plant has flat, well-

coastal streams from Cairns in North Queensland

to the South Coast of New South Wales. Infestations have also been recorded near Perth, Darwin, Melbourne and Adelaide. To date, only isolated infestations have been recorded on inland waterways. In New South Wales, salvinia is common in the Tweed, Richmond, Clarence, and Macleay catchments, the Central Coast and metropolitan areas. Significant incursions have and still are posing problems in the Hawkesbury–Nepean system and in Woolloombi Brook near Cessnock. salvinia is still found in aquarium and rockery ponds as an illegally-propagated aquatic plant.

Why it is a weed

Salvinia has the potential to spread to much of Australia and is regarded as a serious threat to waterways and irrigation areas because it:

- disrupts aquatic ecosystems, seriously affecting native animals and plant life;
- decreases the quality of water by causing odours, accumulation of organic matter and stagnation of streams;
- degrades the aesthetic value of waterways;
- reduces or prevents the use of waterways for recreation and transport;
- interferes with the functioning of river control structures, especially during flooding.

Habitat

Salvinia is a weed of still and slow-flowing fresh water. It is very adaptable and will survive in many climates, although low temperatures will reduce its growth rate. It can withstand an occasional frost, but persistent low temperatures and frosts will kill the exposed portions of plants.

Where a thick mat of weed is present and there is enough protection from frosts, regeneration can occur under favourable conditions from unaffected plant portions.

A thick mat, which can protect and insulate the buds, will also help salvinia survive dry spells. Plants have been known to survive for 20 months under these conditions. Salvinia can grow over a wide range of water-nutrient levels. Spectacular growth rates though are generally recorded in warm water with high nutrient levels. Under these conditions, salvinia can double its mass in as little as two days. This ability of the plant to grow rapidly makes it difficult to control. The weed can survive



Salvinia infestation in the Taylors Arm River on the North Coast of New South Wales.

in brackish water, although prolonged exposure to levels of 3000–4000 ppm total dissolved salts will eventually kill the plant. Salvinia will not survive in sea water.

Spread

Salvinia has been spread in Australia mostly by humans. Even though it is a noxious weed in NSW, occasionally it is traded as an aquarium plant. The plant itself has to be physically transported as it cannot move from one aquatic system to another unaided. Animals and water birds are therefore a significant means of spreading the weed. Salvinia doesn't normally produce viable seed in Australia, but anecdotal evidence suggests that a small percentage of spores may be viable.

Occasionally, new infestations re-occur in clean areas with small seedling plants.

Once it has invaded an aquatic system though, salvinia is dispersed by wind and water currents, especially during floods.

Reproduction

Salvinia is capable of vegetative spread in two main ways:

- by breaking into daughter plants;
- by the separation of young growth through death or damage of the parent material connecting these sections.

Daughter plants grow when an abscission layer (where the leaf stem joins the plant stem) develops at each node following stem branching.

This process occurs very quickly in uncrowded, favourable growing conditions.

A number of branches can develop at each node and give rise to individual plants following the separation from the parent plant at the abscission layer. Damaged or dead plant material stimulates the development of buds into branches, and the process continues.

Control

Successful management of salvinia relies on early detection, action and implementation of an integrated control program.

Varying infestations may require a different method or a combination of biological, mechanical and herbicide control techniques. With its high growth rate and ability to adapt to a wide range of environments, salvinia represents a serious threat to Australian waterways.

Before attempting a new control program, land managers should seek expert advice from either the local control authority or NSW DPI.

Mechanical

Floating booms or nets on waterways have been used to help contain salvinia infestations and limit the spread of the plant to other areas or waterways. These barriers, however, give only short-term relief and are best used along with chemical control programs. Mechanical removal is an option for small infestations only (due to their high costs) and care needs to be taken to remove all plants to prevent rapid re-growth.

Chemical

Controlling salvinia with herbicides depends on having good access to the weeds in well-defined waterways. Reedy banks and swampy backwater areas, protect the plant and reduce the effectiveness of chemical control. Reinfestation of a waterway can occur rapidly from these sites. Due to this regenerative ability, infestations of salvinia should be controlled early to prevent them getting out of control.

Dense, mature infestations are also difficult to control with herbicides. In this situation, it is difficult to gain effective herbicide contact with the plant due to the densely-folded and compact nature of the weed.

Detailed information on integrated control is available in the *Salvinia Control Manual* and



Infestation of salvinia totally covering a creek.

Noxious and Environmental Weed Control Handbook available from NSW DPI.

Water management

Vigorous growth rates of any water weed is usually an indication of high nutrient levels in the water. As part of a control program for salvinia, nutrient run-off into an infestation should be minimised. Heavy nutrient loadings in water come from erosion of cultivated land, cattle yards, domestic and municipal sewerage outfalls and waste water discharges from factories. This nutrient inflow can be reduced by using conservation farming practices and by diverting effluent before it enters waterways.

Biological control

An ant-sized weevil is playing a vital role in helping control salvinia in northern New South Wales.



Boom containing salvinia for a biological control release site.



The salvinia weevil imported from Brazil has good success in controlling the weed.

The salvinia weevil (*Cyrtobagous salviniae*) is originally from south-eastern Brazil and was introduced into Australia by the CSIRO in 1980 to combat the growing threat of salvinia.

Salvinia weevils were first released in Australia into Lake Moondarra near Mount Isa and, in less than 12 months, destroyed an estimated 30,000 tonnes of weed to clear the 800-hectare lake.

In the warmer tropical regions of Queensland and in Papua New Guinea, it has been an extremely effective biological control agent.

But in areas south of Grafton in New South Wales, the shorter growing season and cooler climate has produced less-positive results. The success of the weevil in New South Wales depends on the local climate and nutrient status of salvinia.

On the New South Wales North Coast, success has been variable. On occasions, the weevils have

destroyed salvinia within 12 months; at other locations it has taken 2–3 years or longer for effective weevil populations to be established. There have been cases in the Richmond and Clarence River systems where the *Cyrtobagous* weevil has provided spectacular control of salvinia. These results have occurred within a six-month period over spring and summer with nutrient-rich water conditions. Control has been achieved as far south as Sydney, but not at all release sites.

Salvinia weevil description

The adult salvinia weevil is a small, black insect which grows to an average length of 2 mm. The adult weevils feed on the growing tips of the salvinia, suppressing further growth. The larvae also tunnel through the horizontal 'stems' or rhizomes, particularly in younger sections of the plant. The overall effect of the weevil is to prohibit growth by destroying the salvinia's vascular system.

Eventually, the weed breaks apart and sinks, decomposing on the bottom of the waterway.

Temperature and nitrogen

The two main factors influencing the salvinia weevil's success are temperature and nitrogen levels in salvinia plants. When temperatures drop below 19°C, the weevil lays fewer eggs. The ideal temperature for their development is about 30°C, which enables a life cycle to be completed in six weeks. This life cycle takes longer at lower temperatures. Biological control with the *Cyrtobagous* weevil is also best achieved when salvinia is healthy and green and contains



Salvinia infestation with open water and a brownish appearance is evidence of weevil damage.

adequate amounts of nitrogen for growth. New growth of salvinia is promoted by a high uptake of nutrients from the water. This often occurs following rainfall when nutrients leached from the surrounding country are flushed into the water supply, stimulating the salvinia's growth.

When the nutrient supply is low, the plants are light green and brownish, lack new growth, and develop a longer root system in search of nutrients. In this environment, the *Cyrtobagous* weevil is less active due to the poorer-quality available feed.

Establishing the weevil

To achieve effective biological control with *Cyrtobagous salviniae*, proper establishment of the weevil is essential. The best time to introduce the weevil is early spring. Insects that become established during early summer will make better use of the longer period of warmer weather. If the Salvinia is multi-layered or old, some mechanical removal or strip spraying will help to encourage new growth and establish the weevil.

Once the insect is established under favourable conditions, it can rapidly multiply and move across the salvinia in a wave-like fashion. Supplies of the *Cyrtobagous* weevil and further information can be obtained from your local council noxious weeds officer or from NSW DPI.

Noxious weeds

Salvinia is a declared noxious weed in all states of Australia. In New South Wales under the Noxious Weeds Act 1993, the weed must be fully and continuously suppressed and destroyed (for c3 Noxious Weeds). In inland areas, any infestation must be reported to the local control authority within three days of discovery (for c2 Noxious Weeds). The responsibility for control of noxious weeds on private land rests with the occupier of the land. Failure to control noxious weeds can result in a notice being served; a fine; and/or your local council may enter your land and eradicate the plants, charging the cost to the landholder.

Acknowledgments

The authors acknowledge the following information sources:

Considine, M.L (1984). *Weevils take on the water weeds*. Ecos 42, Summer 1984/85, CSIRO.

Creagh, C. (1991). *A marauding weed in check*. Ecos 70, Summer 1991/92, CSIRO.

Forno, I.W. (1987). *Biological control of the floating fern Salvinia molesta in north-eastern Australia*. Plant-Herbivore Interactions.

Noxious and Environmental Weed Control Handbook. NSW Department of Primary Industries.

Ralph, W. (1982). *A weevil to control salvinia*. Ecos 32, Winter 1982, CSIRO.

Room, P.M. (1990). *Ecology of a simple plant-herbivore system: biological control of salvinia*. Tree 5, No. 3.

Sainty, G.R. and Jacobs S.W.L. (1981). *Water plants of New South Wales*, Water Resources Commission, NSW.

Salvinia Control Manual (2006). NSW Department of Primary Industries.

© State of New South Wales through Department of Trade and Investment, Regional Infrastructure and Services 2012. You may copy, distribute and otherwise freely deal with this publication for any purpose, provided that you attribute the Department of Trade and Investment, Regional Infrastructure and Services as the owner.

ISSN 1832-6668

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (May 2012). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the user's independent adviser.

Always read the label

Users of agricultural or veterinary chemical products must always read the label and any permit, before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication.

Published by the Department of Primary Industries, a part of the Department of Trade and Investment, Regional Infrastructure and Services.

Primefact 210 (second edition)
PUB 12/87
First published September 2009

