

# **WEEDS OF NATIONAL SIGNIFICANCE**

## **Salvinia**

**(*Salvinia molesta* D.S.Mitch.)**

**strategic plan 2012–17**

This publication is produced as part of the Weeds of National Significance initiative, a joint initiative between the Commonwealth of Australia and each of the Australian states and territories.

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An unpublished draft of the revised strategic plan has guided national coordination of this Weed of National Significance for the past two years. Before publishing the revised plan, the Australian Weeds Committee altered it because some actions had been completed, and then agreed to include a uniform monitoring, evaluation, reporting and improvement (MERI) template for all phase-3 Weeds of National Significance.

Supporting information about the Australian Weeds Strategy, Weeds of National Significance and progress to date may be found at [www.weeds.org.au](http://www.weeds.org.au), where links and downloads provide contact details for all species and copies of the strategy. Comments and constructive criticism are welcome as an aid to improving the process and future revisions of this strategy.

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# Summary

Salvinia (*Salvinia molesta*) is a Weed of National Significance (WoNS) because of its severe impacts on freshwater ecosystems. It adversely affects the biodiversity and functioning of wetland and riparian ecosystems, water quality, water storage and distribution infrastructure, recreation and amenity values. It has been described as one of the world's worst weeds (Holm et al. 1977).

Salvinia is a commonly grown, free-floating aquatic fern that wreaks havoc wherever it naturalises. Promoted by various well-meaning groups and individuals, it spread around the world in less than 60 years. Its impacts are many and varied, but it primarily reduces aquatic biodiversity by removing light from the water, killing all submerged plants and eventually their associated fauna. The economic cost to Australia is many millions of dollars when control, fisheries, social and environmental losses are accounted for. The environmental costs will never be known but are likely to be well in excess of the management costs in dollar terms.

Despite being banned throughout Australia, salvinia has remained a popular pond and farm dam plant. From these ponds and dams, it continually reinfests local waterways and is now considered naturalised along most of the east coast of Australia from Cairns to Jervis Bay, and in the Northern Territory from Darwin to Kakadu National Park and Arnhem Land.

In 1999 salvinia was named one of the inaugural 20 WoNS, and a national strategic plan was produced in 2001. The first strategic plan established a national coordinated effort to help prevent further spread and minimise the impacts of salvinia.

In 2009 a review of the national salvinia strategic plan found that considerable progress had been made towards achieving the plan's goals and objectives. As a result, the need for national coordination has significantly reduced. This revised Salvinia Strategic Plan 2012–17 aims to provide guidance to key stakeholders for the ongoing management of salvinia, and to build on the gains made since the release of the first strategic plan.

The three goals of this plan are:

- 1 Prevent new infestations from establishing
  - Monitor waterways to enable early detection of new infestations.
  - Prevent spread from existing sites.
  - Reduce invasion pathways for salvinia.
  - Maintain and monitor outlier eradication and containment programs.
- 2 Strategically manage existing infestations
  - Identify key ecological assets threatened by salvinia and prioritise at national, state and regional levels.
  - Continue to distribute and monitor salvinia biological control agents.
  - Identify improvements to or address threats to salvinia biological control.
  - Minimise the impacts of existing infestations through strategic control.

- 3 Increase the capability and willingness to manage salvinia
  - Collate mapping data and decision support at the national level.
  - Adopt and continuously improve best-practice management.
  - Maintain capacity for coordinated management.

**Vision**

Australia's waterways will be protected from the negative impacts of salvinia.

# 1 The challenge

Salvinia poses a significant threat to waterways across mainland Australia. The first national salvinia strategic plan was developed in 2001 to help direct management efforts towards preventing the spread of salvinia and reducing its impact (ARMCANZ et al. 2001). In the same year, the National Aquatic Weeds Management Group was formed and a National Aquatic Weeds Coordinator was appointed to oversee the implementation of the plan. These efforts have provided a coordinated and national approach, and increased commitment to salvinia management.

Early detection, eradication and control programs are under way across Australia. All infestations of salvinia in Victoria and Western Australia have been the target of eradication programs. Some isolated infestations in New South Wales and Queensland that threaten key ecological assets or pose a further risk of spread have also been targeted for eradication. More than 2500 people across Australia have been trained in salvinia identification and reporting—this forms the basis of a nationwide passive detection network for salvinia. Salvinia biological control (using salvinia weevils) is helping to reduce the impacts of existing infestations across the weed's core range. Salvinia weevil breeding facilities are now established in Queensland, the Northern Territory and New South Wales, which provide weed control authorities with an ongoing, reliable and hygienic supply of weevils.

These initiatives have helped to prevent the spread and reduce the impacts of salvinia since 2003. However, national coordination for the salvinia strategic plan will end in June 2011. To ensure Australia's waterways remain protected from salvinia's adverse impacts, ongoing commitment to its management will be essential. This revised plan outlines the strategic goals and actions required to maintain this commitment in the absence of national coordination. The challenge now lies in encouraging all stakeholders to accept responsibility for implementing these goals and actions, and working together to help ensure that the national effort continues.

## 2 Background

### 2.1 Biology of *Salvinia molesta*

*Salvinia molesta* D.S. Mitchell was referred to as *Salvinia auriculata* Aubl. before it was recognised as a separate species (Mitchell 1972). Its biology was comprehensively reviewed by Room and Julien (1995).

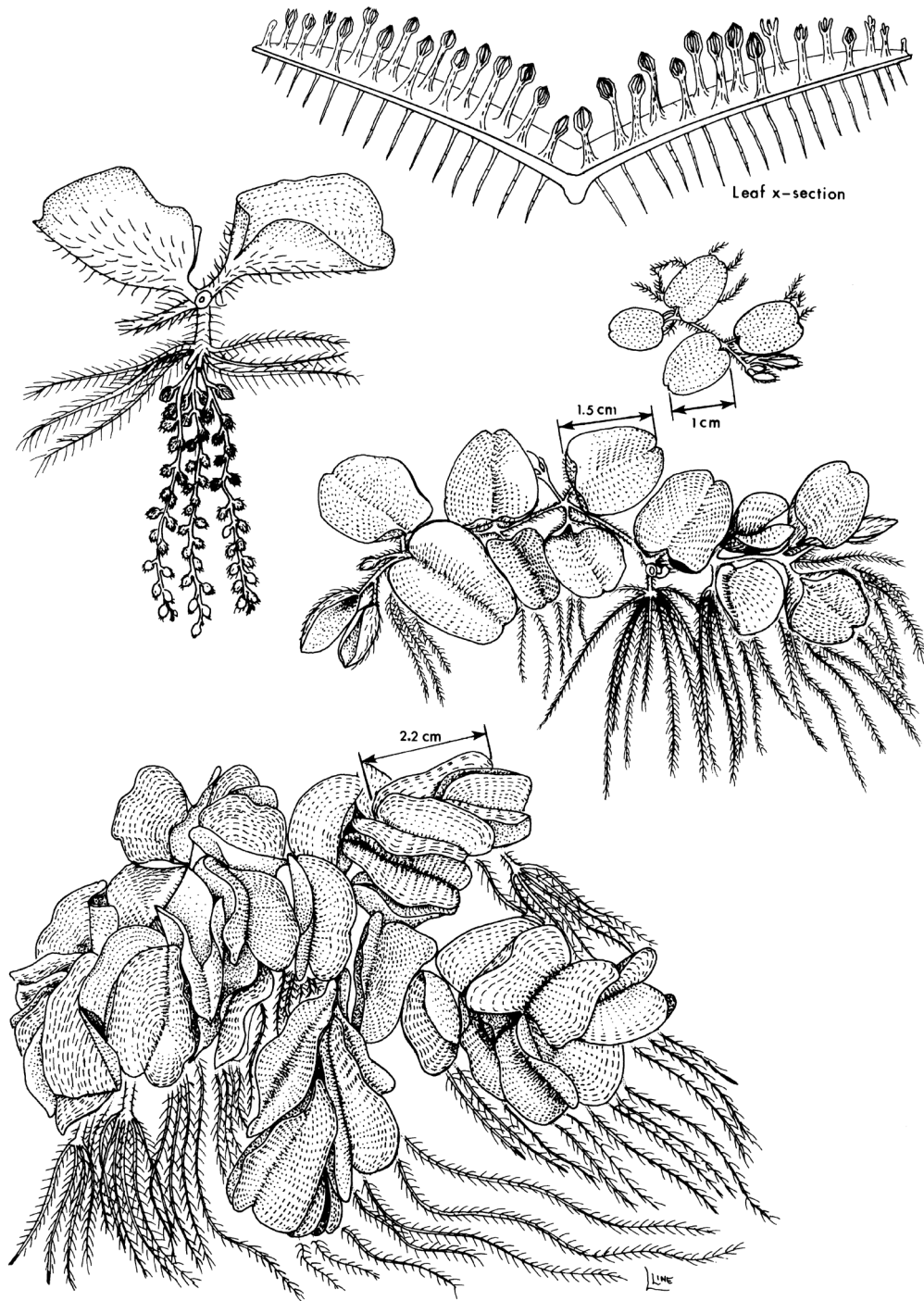
*Salvinia* is a free-floating, sterile aquatic fern that reproduces only through vegetative growth and fragmentation. Under normal conditions, up to three lateral buds may develop on each node. However, with stress, predation and destruction of the apical buds, up to six buds may grow in compensation.

*Salvinia* typically passes through three vegetative growth forms, starting with the primary juvenile or invasive form, followed by the secondary then tertiary forms (Figure 1). As growth progresses, the leaves become larger and begin to fold upwards, and the plants become more compact. In a rapidly expanding population, all three forms may be present. Spore sacs develop among the roots of plants in the tertiary growth form (Figure 1), but fertile spores have not been found (Room & Julien 1995).

*Salvinia* can achieve extraordinary growth rates, doubling its biomass in as little as two days under ideal laboratory conditions (Parsons & Cuthbertson 1992), and in less than a week under field conditions. It can weigh as much as 400 tonnes per hectare in fresh weight (Room & Julien 1995). Growth rates are significantly affected by nutrient availability, especially nitrogen. Even under low-nutrient conditions, densities of 2500 large plants per square metre have been documented. In nutrient-rich waters, densities of small plants can exceed 30 000 per square metre (Room & Julien 1995).

*Salvinia*'s abilities to float and repel water are facilitated by small 'egg-beater' shaped hairs on the upper surface of the leaves. These hairs are very effective air traps and maintain the correct orientation of the plant under most weather conditions. Optimum growth occurs in water temperatures of 20–30 °C. Plants are killed by temperatures that exceed 43 °C or drop below –3 °C for any extended period. However, *salvinia* has survived in Kakadu National Park when leaf temperatures exceeded 45 °C but water temperatures did not exceed 43 °C (Storrs & Julien 1995).

*Salvinia* can tolerate a low level of salinity and will grow in water that has one-tenth the salinity of seawater. This extreme tolerance allows *salvinia* to colonise almost any perennial water body it is introduced to within the temperate, subtropical and tropical regions of the world.



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*Salvinia molesta*  
Giant salvinia

**Figure 1** *Salvinia molesta* (illustration by Line). Top to bottom (L-R): cross-section of a leaf showing the floatation hairs, a single ramet with spore sacs, two connected ramets with long internodes (primary phase), a larger cluster of ramets (secondary phase), a tertiary phase phenet (reproduced with the permission of the University of Florida)

## 2.2 History of spread

*Salvinia molesta* is the only naturalised species of the family Salviniaceae in Australia. It is native to South America, with Forno and Harley (1979) determining its native range as south-eastern Brazil. Introduced to Australia in the early 1950s (most likely via the ornamental plant trade) *salvinia* soon established in dams, rivers and swamps around the country.

The capacity of *salvinia* to invade new catchments is directly linked to human activities, and this is exacerbated by its ongoing popularity as an ornamental plant among fish pond enthusiasts, water gardeners and peri-urban residents. Its floating habit and capacity for rapid growth has led to it escaping from fish ponds and dams during floods, or being discarded and causing new infestations. Naturalised *salvinia* infestations have been found in freshwater ecosystems across much of Australia's east coast and in the Northern Territory. Smaller infestations have also been found in dams and water storage facilities in South Australia, Victoria and Western Australia. Incursions into natural habitats are almost certainly due to the cultivation of *salvinia* in backyard ponds and property dams, and this will continue to be the major source of infestations in urban, periurban and rural areas across Australia.

The potential distribution of *salvinia* has been determined using 'CLIMATE', a predictive model based on the temperature tolerances found in *salvinia*'s native and introduced ranges. This prediction suggests that all states and territories have favourable climatic conditions for *salvinia*, with excellent habitat conditions provided across southern and eastern Australia (Figure 2). The potential distribution of *salvinia* will therefore include any freshwater body within the two highest matching zones ( $\pm 0-30\%$  of the ideal temperature conditions), where *salvinia* would be expected to grow well and cause major problems. Outside these regions, *salvinia* could grow in protected microclimates and potentially reinfest habitats further downstream.

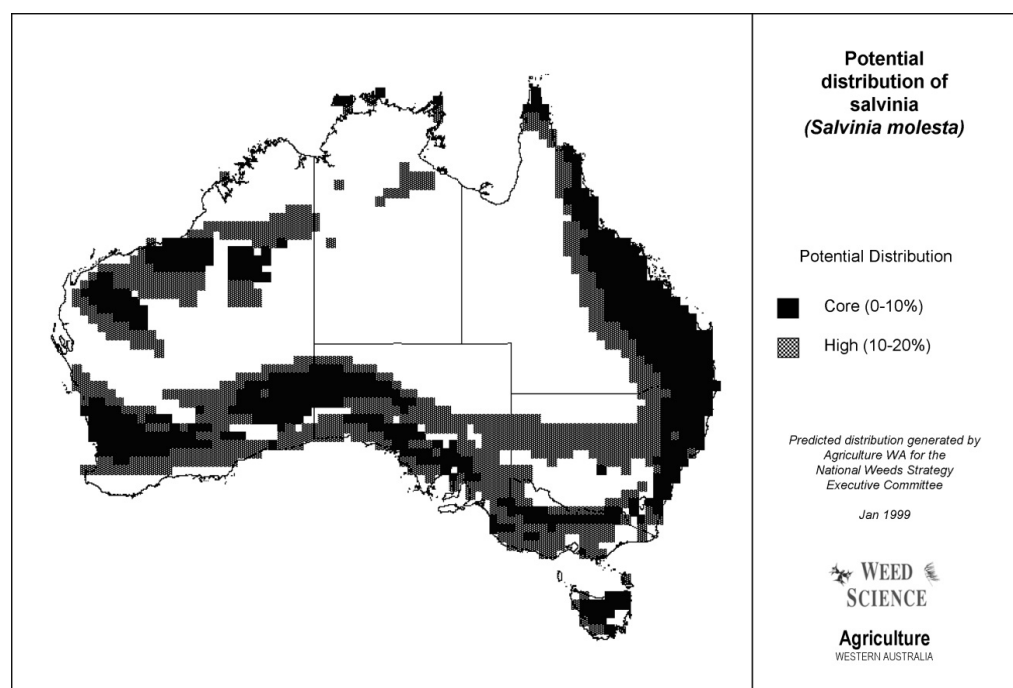


Figure 2 Potential distribution of *Salvinia molesta*

## **2.3 Summary of impacts**

Salvinia is a Weed of National Significance (WoNS) because of its severe impacts in freshwater ecosystems. It adversely affects the biodiversity and functioning of aquatic ecosystems, water quality, water storage and distribution infrastructure, recreation and amenity values. It has been described as one of the world's worst weeds (Holm et al. 1977). *Salvinia natans* and *Salvinia cucullata* are closely related species that also have significant weed potential.

### **2.3.1 Public safety and health**

Salvinia is known to encourage breeding of mosquitoes and other disease-carrying pests by providing a perfect habitat for larval development. Its thick floating mats can provide a dangerous platform for children and animals—animals frequently mistake dense carpets of salvinia for firm ground and fall into the water body underneath.

### **2.3.2 Amenity**

Salvinia reduces the aesthetic value of water bodies by accumulating litter, stagnating the water and developing fetid odours. High numbers of mosquitoes and midges, as well as presenting issues for public health, can severely reduce visitor numbers and length of stay at aquatic venues.

### **2.3.3 Recreation activities**

Salvinia disrupts use of waterways for recreation, including boating, fishing and swimming. Heavy infestations prevent access by boats and recreational fishing is impeded. Swimming is dangerous, if not impossible, in dense infestations. Severe infestations have led to the temporary closure of water bodies for recreation activities. In 2004, the Hawkesbury River in the Sydney Basin experienced a severe outbreak of salvinia, and 88 km of the river and tributaries were heavily infested. This resulted in considerable disruptions to recreational activities and forced the cancellation of some high-profile fishing and water skiing events.

### **2.3.4 Water quality**

Salvinia degrades water quality when it decomposes, reducing dissolved oxygen levels in the water and consequently reducing habitat values for fish.

### **2.3.5 Water storage and distribution infrastructure**

Salvinia can block irrigation channels, dams and pump intakes, which increases pumping times and costs. This can lead to expensive repairs or significantly increase maintenance frequency.

### **2.3.6 Environmental costs**

Salvinia modifies the environment by shading out submerged aquatic plants and removing the air–water interface, both of which reduce dissolved oxygen levels in the water. Dense infestations could eventually kill most vascular plant life that is normally found underwater, and many fish and other aquatic fauna will either die out or move to better conditions if possible. This loss of aquatic biodiversity has been documented in Kakadu National Park where bird species that used open water were excluded from heavily infested billabongs, and small fish and file snake numbers were reduced (Storrs & Julien 1995). Salvinia has negatively affected nine nature reserves in Queensland.

### 2.3.7 Direct costs of control and management activities

Salvinia is a highly expensive weed to manage when conventional mechanical and chemical techniques are required. Management of the salvinia outbreak in the Hawkesbury River in 2004 cost more than \$1.8 million over an 18-month period. Costs for eradication can be much higher due to the need to remove the surrounding vegetation that acts as harbourage areas for salvinia.

## 2.4 Control methods

Very effective control methodologies have been developed for salvinia, including biological control, use of herbicides and manual removal of plants. A salvinia control manual has been developed that contains detailed descriptions of the control methods available (van Oosterhout 2006). This resource also includes background information on planning management strategies and case studies.

### 2.4.1 Biological control

Biological control using the salvinia weevil *Cyrtobagous salviniae* has proved to be the most cost-effective means of controlling salvinia. This weevil was introduced into Australia by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 1980 and has since become highly effective in controlling salvinia across much of its range. Biological control using the salvinia weevil has resulted in considerable cost savings around the world—for example, an economic analysis in Sri Lanka estimated a benefit–cost ratio of up to 53:1 compared with other control methods (Doelman 1989).

To help facilitate further distribution of the weevil, specialised facilities to breed the weevils have been established by state and territory government agencies or local control authorities in New South Wales, the Northern Territory and Queensland. As of March 2011, five regional facilities were operating in Queensland, one statewide facility was operating in New South Wales, and a small-scale facility was operating in the Northern Territory. Both the New South Wales facility at Grafton and the Brisbane City Council facility operate on a user-pays basis.

The breeding facilities provide salvinia managers with a reliable and clean supply of weevils, which has removed the need for ‘wild harvesting’. Wild harvesting involved collecting weevil-infested salvinia from existing sites and transporting it to new locations. This was not a reliable source of weevils and carried the additional risk of transporting other aquatic weeds and pests with the weevil-infested salvinia to new sites.

It was commonly thought that the salvinia weevil only provided effective control in tropical and subtropical environments and, as such, it was not widely used in temperate regions. However, recent studies by Sullivan and Postle (2011) have demonstrated that biological control in cooler climates performs better than was previously thought and, with careful release strategies, can be highly effective in temperate climates as far south as Sydney.

### 2.4.2 Herbicides and mechanical removal

A range of aquatic herbicides are available for use against salvinia. Herbicides can be used either as part of an integrated management strategy for larger areas, or as a stand-alone tool for smaller areas such as farm dams. Careful application of herbicides is required to avoid damage to other aquatic plants. In addition, each state and territory has different legislation regarding the use of herbicides in aquatic environments, and a licence to apply herbicides to water may be required in some jurisdictions.

Mechanical removal using purpose-built machinery is expensive but it can successfully remove infestations when urgent action is required, or where other control methods are unsuitable or undesirable. Mechanical removal can also be used in integrated situations to reduce the bulk of an infestation and leave the remaining salvinia more susceptible to chemical or biological control.

Manual or hand removal of salvinia is highly labour intensive, but it has been successfully used as a follow-up method to other treatments in eradication programs, and to remove small infestations.

## **2.5 Socioeconomic factors affecting management decisions**

Salvinia is highly destructive to waterways and, in most cases, stakeholders agree that it should be managed. Due to its prolific growth and the habitat it invades, salvinia management can be extremely resource intensive, particularly in situations where biological control is unsuitable or will not provide adequate control. In such situations, control programs are usually undertaken by weed specialists and costs are mostly met by local government, state government or the Australian Government.

In some jurisdictions the responsibility for control of salvinia in a waterway belongs to landholders who have property title to the infested waterway. Such legislation can be enforced where the landholder and mechanism for weed spread can clearly be identified. However, aside from small infestations in enclosed water bodies (e.g. farm dams), the costs associated with an intensive salvinia management program are often beyond what the landholder can afford or is prepared to contribute. In addition, some landholders may be reluctant or not permitted by law to use herbicides in waterways to control salvinia.

Where a strategic need arises to manage salvinia beyond normal legislative compliance, a control program often generates considerable public benefits. These benefits can include protection of ecological assets, fisheries or recreational areas from salvinia. Government agencies should therefore provide support and adequate funding where such benefits can be demonstrated.

## **2.6 Legislative controls**

Like most ornamental aquatic plants that have become weeds, the most effective means of preventing spread of salvinia has been by removing it from the ornamental plant trade. The importation of all species of the genus *Salvinia* is prohibited under Commonwealth quarantine legislation on the basis of their weed risk assessments.

The legal status of salvinia is summarised in Table 1.

**Table 1** Legislation related to *Salvinia molesta*

| Jurisdiction                 | Legislation   | Declaration   | Action  |
|------------------------------|---|---|---|
| Australian Capital Territory | <i>Pest Plants and Animals Act 2005</i>                           | Class 1—notifiable pest plant   | Presence must be notified to the Chief Executive  |
| New South Wales              | <i>Noxious Weeds Act 1993</i>                                     | Class 2—regionally prohibited weed;<br>Class 2 weeds are also notifiable weeds<br>Class 3—regionally controlled weed  |   |
| Northern Territory           | <i>Weed Management Act 2001</i>                                   | Class B and C declared weed   | Growth and spread to be controlled, not to be introduced to the Northern Territory  |
| Queensland                   | <i>Land Protection (Pest and Stock Route Management) Act 2002</i> | Class 2 plant—plants are established in the state and have, or could have, an adverse economic, environmental or social impact  | Landowners must take reasonable steps to keep land free of Class 2 plants. It is an offence to keep or sell Class 2 plants without a permit     |
| South Australia              | <i>Natural resources Management Act 2004</i>                      | Class 1   | Generally requiring notification and destruction of the plant throughout the whole state (although sometimes only control in part of the state) |
| Tasmania                     | <i>Weed Management Act 1999</i>                                   | Declared plant  | Details on actual restrictions or measures for each declared weed is contained in the weed management plan for that weed                        |
| Victoria                     | <i>Catchment and Land Protection Act 1994</i>                     | State prohibited weed—does not occur in Victoria, or it is reasonable to expect that they can be eradicated from the state  |   |
| Western Australia            | <i>Agriculture and Related Resources Protection Act 1976</i>      | P1 and P2<br>The legislative arrangements are currently in a transition from the <i>Agriculture and Related Resources Protection Act 1976</i> to the <i>Biosecurity and Agriculture Management Act 2007</i> (BAM Act) | P1—prevention of trade, sale or movement<br>P2—eradicate: serious weeds which are not yet widely established in Western Australia               |

## 2.7 Principles underpinning the plan

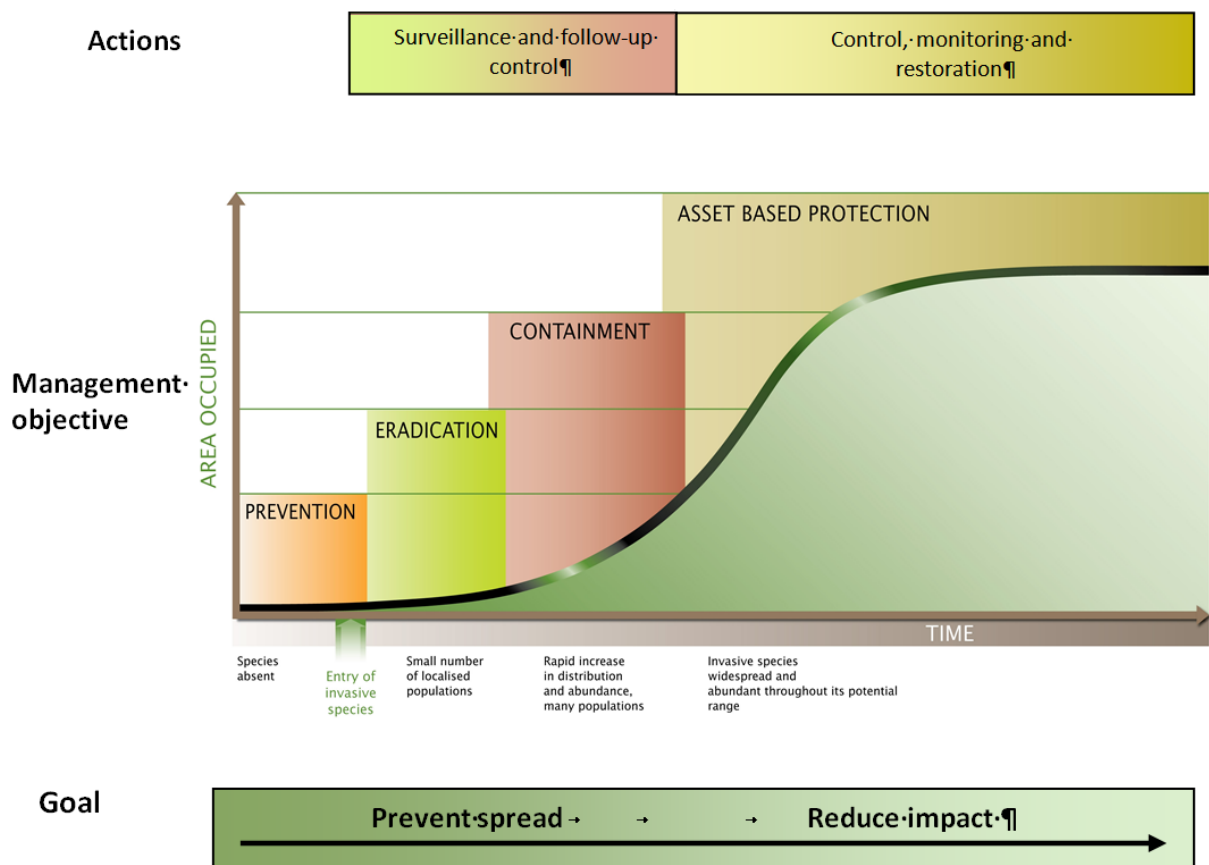
This strategic plan is based on the seven key principles of the Australian Weeds Strategy (NRMMC 2007):

- Weed management is an essential and integral part of the sustainable management of natural resources for the benefit of the economy, environment, human health and amenity.
- Combating weed problems is a shared responsibility that requires all parties to have a clear understanding of their roles.

- Good science underpins the effective development, monitoring and review of weed management strategies.
- Prioritisation of, and investment in, weed management must be informed by a risk management approach.
- Prevention and early detection are the most cost-effective techniques for managing weeds.
- Weed management requires coordination among all levels of government in partnerships with industry, land and water managements and the community, regardless of tenure.
- Building capacity across government, industry, land and water managers, and the community is fundamental to effective weed management.

The WoNS initiative establishes national priorities and facilitates action where there is a significant national or cross-jurisdictional benefit to be gained. These strategic plans do not specifically address resourcing; however, they aim to identify efficiencies and ensure existing resources can be allocated to achieve the most strategic management outcomes.

Effective broadscale management of WoNS and other weeds requires an integrated approach that includes prevention and eradication programs, establishment and implementation of management zones, and the protection of key environmental, social and economic assets in areas where the weeds are already widespread (Figure 3).



Source: Modified from Hobbs & Humphries (1995) and (DPI 2010).

**Figure 3 Stages of weed invasion with corresponding goals, management objectives and actions at each stage**

## 2.8 The national program—progress to date

The first salvinia national strategic plan was developed in 2001 with the aim of delivering four key outcomes: i) prevent and/or reduce the introduction and spread of salvinia, ii) upgrade efforts to prevent the trading of salvinia, iii) minimise the impacts of salvinia and iv) coordinate management. In 2003, a National Aquatic Weeds Coordinator was appointed and a National Aquatic Weeds Management Group (NAWMG) convened for the purpose of implementing the salvinia strategic plan, along with the alligator weed and cabomba strategic plans. Each year since 2003, NAWMG has monitored and reviewed the implementation of the national strategic plan.

In 2009, the Natural Resource Management Ministerial Council (Resolution 15.7, 21 May 2009) endorsed a three-phased approach to national management of WoNS species (Appendix 1). In August 2009, a panel from the Australian Weeds Committee reviewed the implementation of the salvinia strategic plan to:

- assess the progress towards implementation of the goals and actions of the strategic plan
- assess the need for future national coordinated effort
- propose changes to the strategic plan
- make recommendations as to the appropriate level of future support and coordination.

The review found that considerable progress had been made towards the implementation of the strategic plan and the need for national coordination had been significantly reduced. Key achievements include:

- national mapping of occurrence and management actions (Appendix 2)
- implementation of awareness and early detection initiatives
- implementation of management plans for high-priority infestations
- development of an extensive range of communication and awareness materials, including a salvinia best-practice manual and standard operating procedures for biological control–rearing facilities
- establishment of biological control–rearing facilities across the core infestation range of salvinia in Australia, and implementation of a user pays funding model for two of these facilities
- research supported by the WoNS program that demonstrated salvinia biological control agents in temperate regions provided acceptable efficacy and that their performance was limited by cooler temperatures
- development or refinement of improved integration and eradication strategies through the program.

The review also recommended a revision of the strategic plan, which was drafted by NAWMG in February 2011 in conjunction with key stakeholders. This draft was subjected to a public consultation period and due consideration was given to all submissions received during the preparation of the final version.

## 2.9 Relevance to other strategies

The WoNS Salvinia Strategic Plan 2012–17 has been developed to provide a framework for coordinated management of salvinia across the country. Complementary links can be found in a range of existing resource management initiatives at all jurisdictional levels, as shown in Table 2.

**Table 2 Strategies and plans for the management of *Salvinia molesta***

| Scale    | Strategy and plans   |
|----------|--|
| National | Australian Weeds Strategy 2007, National Strategy for the Conservation of Australia's Biodiversity 2010, Draft Basin Plan—Murray–Darling 2012                  |
| State    | State and territory biodiversity conservation strategies, invasive species and biosecurity strategies  |
| Regional | Natural resource and catchment management plans, wetland and water quality management plans, invasive species plans, Mary River Aquatic Weeds Strategy 2010–14 |
| Local    | Weed control plans, creek and catchment plans, local government weed plans   |

### 3 Strategic goals

Revised actions to protect Australia’s waterways from the impact of salvinia are described in Sections 3.1–3.3.

#### 3.1 Goal 1: Prevent new infestations from establishing

Prevention is the most effective way to manage any weed problem. Goal 1 aims to protect salvinia-free areas in Australia by preventing the introduction of salvinia and rapidly responding to new incursions. Monitoring of waterways and invasion pathways helps ensure that new infestations are detected and destroyed early. The strategic actions for each objective under goal 1, and the action level and responsible partners for each action, are shown in Table 3.

A range of early detection tools are available to help build the capabilities of weed managers, waterway managers and the community to monitor waterways for salvinia. These include salvinia identification resources, aquatic weed early detection survey guidelines and aquatic weed identification training. Targeted awareness activities, along with inspection and enforcement activities, should help reduce the ornamental use of salvinia and thus remove a critical invasion pathway.

Response to new salvinia incursions at outlier sites should be rapid, and numerous control techniques have been successfully used to eradicate or contain such incursions in recent years. The salvinia eradication guidelines currently under development will document these approaches to help salvinia managers implement effective eradication and containment programs.

**Table 3 Objectives and strategic actions to achieve goal 1 of the Salvinia Strategic Plan 2012–17**

| Objectives  | Strategic actions  | Action level <sup>a</sup> | Responsibility  |
|---|--|---------------------------|---|
| 1.1 Monitor waterways to enable early detection of new infestations | Continue aquatic WoNS/weeds identification training (or weedspotter) initiatives for weeds staff, community members and waterway managers in priority reconnaissance regions (as determined by national map) | 1                         | State and territory governments, NRM regions  |
|   | Maintain surveillance activities (active and passive) for salvinia in priority reconnaissance regions  | 1                         | State and territory governments, regional weed committees, LCAs, waterway managers, community |
|   | Maintain supply of salvinia identification and awareness information   | 1                         | State and territory governments   |
|   | Review effectiveness of aquatic weed early detection guidelines and revise where necessary   | 2                         | NAWMG   |
|   | Investigate new technologies (e.g. aerial imagery) for their potential as salvinia detection tools or to identify high-risk sites  | 3                         | Research organisations  |

| Objectives  | Strategic actions  | Action level <sup>a</sup> | Responsibility   |
|---|--|---------------------------|--|
| 1.2 Prevent spread from existing sites                                | Ensure legislative compliance of infestations at high risk of further spread   | 2                         | State and territory governments, LCAs  |
|   | Implement salvinia awareness programs for boating and fishing audiences at strategic locations   | 2                         | State and territory governments, regional weed committees, LCAs                      |
|   | Discourage public access to outlier infestations at high risk of further spread  | 3                         | State and territory governments, regional weed committees, LCAs                      |
| 1.3 Reduce invasion pathways for salvinia                             | Undertake inspection and enforcement activities for high-risk invasion pathways, including: <ul style="list-style-type: none"> <li>• permaculture networks</li> <li>• nurseries and aquatic plant retail outlets</li> <li>• fishponds and farm dams on periurban properties</li> </ul> | 2                         | State and territory governments, LCAs  |
|   | Target fishpond owners, periurban landholders and permaculture networks with extension campaigns and materials on salvinia (and aquatic weed) impacts and regulations  | 1                         | NAWMG, state and territory governments, LCAs   |
|   | Continue risk assessments to identify potential high-risk aquatic plants in the ornamental plant trade and remove from sale  | 2                         | APWRA technical group, state and territory governments                               |
|   | Maintain awareness initiatives with aquatic plant wholesalers and retailers  | 2                         | NAWMG, state and territory governments   |
| 1.4 Maintain and monitor outlier eradication and containment programs | Support salvinia eradication programs in key strategic locations, including <ul style="list-style-type: none"> <li>• Cape York</li> <li>• Western Australia</li> <li>• New South Wales South Coast</li> <li>• West Gippsland, Victoria</li> <li>• Murray–Darling Basin</li> </ul>      | 2                         | State and territory governments, regional weed committees, LCAs, regional NRM groups |
|   | Develop management plans for new outlier incursions  | 1                         | State and territory governments, regional weed committees, LCAs, regional NRM groups |

APWRA = aquatic plants weed risk assessment; LCA = local control authority; NAWMG = National Aquatic Weeds Management Group; NRM = natural resource management; WoNS = Weed of National Significance

a The Australian Weeds Committee (AWC) applied three action levels that reflect jurisdictional commitment to implementing actions:

Level 1 = Highly beneficial as a national action that is critical to success of the WoNS revised strategic plan and all relevant AWC jurisdictions have committed resources to implementing this action.

OR

Highly beneficial to a particular jurisdiction and the responsible party/ies have committed resources to implement this action.

Level 2 = Highly beneficial at national and/or jurisdictional level, but implementation will be subject to resource availability and investment priorities.

Level 3 = Desirable and still beneficial to improving uptake and efficiency of on-ground action, but not critical to success.

## 3.2 Goal 2: Strategically manage existing infestations

Goal 2 aims to reduce the impact of salvinia within its core infestation range. This includes an asset-protection approach where control programs protect aquatic habitats of national, state or regional significance from salvinia. This approach will require a better understanding of the impacts of current control technologies on aquatic ecosystems. The strategic actions for each objective under goal 2, and the action level and responsible partners for each action, are shown in Table 4.

Biological control will continue to provide a highly cost-effective measure for reducing the impact of salvinia across much of its core range. Salvinia weevil breeding facilities are located across the core infestation area and it is critical for the ongoing management of salvinia that local and regional investment is sought to ensure these facilities remain operational. Both asset protection and ongoing biological control programs should be incorporated into regional weeds or natural resource management planning to ensure ongoing investment.

**Table 4 Objectives and strategic actions to achieve goal 2 of the Salvinia Strategic Plan 2012–17**

| Objectives  | Strategic actions  | Action level <sup>a</sup> | Responsibility  |
|---|--|---------------------------|---|
| 2.1 Identify key ecological assets threatened by salvinia and prioritise at national, state and regional levels | Compile database of key national, state and regional ecological assets threatened or impacted by salvinia and other WoNS and develop management actions and strategies to protect assets | 3                         | State and territory governments, regional NRM groups, regional weed committees, LCAs                  |
|   | Further quantify the impacts of floating aquatic weeds and best-practice control methods on water quality and ecology  | 2                         | Research organisations  |
| 2.2 Continue to distribute and monitor salvinia biological control agents                                       | Maintain existing salvinia biological control ( <i>Cyrtobagous salviniae</i> weevil) rearing facilities  | 2                         | State and territory governments, regional weed committees, LCAs, rearing facility managers            |
|   | Continue state and regional <i>C. salviniae</i> release programs on established and non-eradicable infestations  | 2                         | State and territory governments, regional weed committees, LCAs, biological control facility managers |
| 2.3 Identify improvements to or address threats to salvinia biological control                                  | Quantify the benefits of herbicide 'strip treatments' to salvinia biological control performance   | 2                         | Research organisations  |
|   | Determine the effects of climate change (temperature and carbon) on potential salvinia distribution and biological control performance   | 3                         | Research organisations  |
| 2.4 Minimise the impacts of existing infestations through strategic control                                     | Develop and implement best-practice management plans for priority infestations (in addition to 2A) that protect key assets and values  | 2                         | State and territory governments, regional weed committees, LCAs                                       |

LCA = local control authority; NRM = natural resource management; WoNS = Weeds of National Significance

a The Australian Weeds Committee (AWC) applied three action levels that reflect jurisdictional commitment to implementing actions:

Level 1 = Highly beneficial as a national action that is critical to success of the WoNS revised strategic plan and all relevant AWC jurisdictions have committed resources to implementing this action.

OR

Highly beneficial to a particular jurisdiction and the responsible party/ies have committed resources to implement this action.

Level 2 = Highly beneficial at national and/or jurisdictional level, but implementation will be subject to resource availability and investment priorities.

Level 3 = Desirable and still beneficial to improving uptake and efficiency of on-ground action, but not critical to success.

### 3.3 Goal 3: Increase capability and willingness to manage salvinia

Goal 3 aims to ensure the capacity and willingness to manage salvinia continues to increase in the absence of national coordination. Maintenance of the national salvinia map and strategic actions will help ensure the ongoing communication of national priorities. Ongoing provision of best-practice materials will be critical for maintaining the skills base required for effective salvinia management. In addition, a range of improvements to best practice should be pursued, including registration of a glyphosate-based herbicide and training to help weed control authorities use biological control agents more effectively. Integration of the key priorities from the Salvinia Strategic Plan 2012–17 into state and regional weeds and natural resource management plans will help ensure that commitment to salvinia management continues.

The strategic actions for each objective under goal 3, and the action level and responsible partners for each action, are shown in Table 5.

**Table 5 Objectives and strategic actions to achieve goal 3 of the Salvinia Strategic Plan 2012–17**

| Objectives  | Strategic actions   | Action level <sup>a</sup> | Responsibility  |
|---|---|---------------------------|---|
| 3.1 Collate mapping data and decision support at the national level | Use national online data storage and mapping tool for ongoing reporting and access to salvinia dataset        | 2                         | State and territory governments   |
|   | Collate and use national data to revise national map and strategic actions                                    | 1                         | State and territory governments   |
| 3.2 Adopt and continuously improve best-practice management         | Pursue label registration of glyphosate-based formulations for use against salvinia                           | 2                         | Herbicide companies   |
|   | Ensure ongoing availability of salvinia best-practice information, including best-practice management manuals | 1                         | State and territory governments   |
|   | Continue to train LCAs to develop effective biological control release and monitoring strategies              | 2                         | State and territory governments, regional weed committees, LCAs, biological control facility managers |
|   | Update management information and state-based fact sheets to reflect new developments in best practice        | 2                         | State and territory governments   |
| 3.3 Maintain capacity for coordinated management                    | Integrate national strategic plan objectives throughout regional and state policy and planning approaches     | 1                         | State and territory governments, regional weed committees LCAs, regional NRM groups                   |
|   | Encourage weed management networks to include aquatic weed issues from the local to the national level        | 1                         | State and territory governments, regional weed committees, LCAs, regional NRM groups                  |

LCA = local control authority, NRM = natural resource management

a The Australian Weeds Committee (AWC) applied three action levels that reflect jurisdictional commitment to implementing actions:

Level 1 = Highly beneficial as a national action that is critical to success of the WoNS revised strategic plan and all relevant AWC jurisdictions have committed resources to implementing this action.

OR

Highly beneficial to a particular jurisdiction and the responsible party/ies have committed resources to implement this action.  
Level 2 = Highly beneficial at national and/or jurisdictional level, but implementation will be subject to resource availability and investment priorities.

Level 3 = Desirable and still beneficial to improving uptake and efficiency of on-ground action, but not critical to success.

## 4 Monitoring, evaluation, reporting and improvement framework

The Australian Weeds Strategy (NRMMC 2007) gives the Australian Weeds Committee (AWC) responsibility for monitoring and evaluating the management of national priority weeds, including WoNS. The AWC is therefore responsible for monitoring and reporting on progress under this strategic plan.

This strategic plan is subject to a five-year review; however, mechanisms must also be put in place to allow the goals and actions to be evaluated throughout this period. This enables ongoing assessment of progress towards intermediate and long-term outcomes, and, ultimately, helps to determine the effectiveness of individual actions. It also helps to identify program improvements, and provides evidence to stakeholders and funding bodies that they are getting value from their investment.

Individual jurisdictions and/or organisations responsible for weed management and conservation will need to develop their own monitoring strategies. They should, where possible, coordinate actions to implement this plan, and monitor and evaluate progress towards its goals in conjunction with existing state, regional or local plans. While individual actions should be monitored at the jurisdictional level, data or evidence collected as a part of state, regional and local activities or plans should be provided to the AWC and collated so that it can be assessed each year within the national context. This will help to build a comprehensive overview of the plan's delivery. Table 6 lists key evaluation questions that should be assessed by the AWC each year at the national level to ensure progress against strategy goals, and which should be used to provide the basis for an annual report to the AWC.

This monitoring, evaluation, reporting and improvement (MERI) framework lists the basic reporting information that should be collected for the life of the strategic plan—including during phase 3 delivery (see Appendix 1). This will ensure that sufficient data are collected to identify successes and failures, and provide the opportunity for improvement where outcomes are not being achieved. Annual MERI plans may be developed to follow activities in more detail.

Although performance indicators or other ways of measuring progress are not provided in this strategic plan, a scoring system could be appropriate.

A generic program logic model (Appendix 3) was developed by WoNS coordinators in 2010. This shows the relationship between strategic actions and the objectives and goals they achieve. The program logic is one way to communicate the links between activities, their intermediate and long-term outcomes, and the vision of the strategic plan.

**Table 6 Suggested monitoring and evaluation questions to measure progress under the phase 3 WoNS Salvinia Strategic Plan 2012–17**

| WoNS:  |  | Jurisdiction:  | Date:  |
|--|--|--|--|
| Goal   | Key evaluation questions   | Data or evidence required  | Consider   |
| 1 Prevent new infestations from establishing | To what extent have new infestations been prevented from establishing? | 1.1 National distribution data:<br>Has the national distribution map been reviewed and/or updated?<br>Has the Priority Management Action spreadsheet been updated? | <ul style="list-style-type: none"> <li>• Are these documents publicly available?</li> <li>• Have stakeholders been advised of any changes?</li> <li>• Where is this data or information stored?</li> <li>• Does this information capture national priorities?</li> </ul>   |
|  |  | 1.2 New infestations:<br>Number of new infestations recorded<br>Percentage of known infestations actively controlled   | <ul style="list-style-type: none"> <li>• Are any new infestations occurring in areas identified as a high priority in the national strategy?</li> <li>• How were infestations detected (passive or active surveillance, community reporting etc.)?</li> <li>• Have high-risk pathways been adequately identified?</li> <li>• Have threats been minimised?</li> </ul> |
|  |  | 1.3 Eradication and containment programs:<br>Percentage of eradication and/or containment programs being maintained  | <ul style="list-style-type: none"> <li>• What percentage of programs identified in the national strategy are being actively managed?</li> <li>• Is there a plan in place for ongoing management?</li> <li>• How is progress being monitored and reported to stakeholders?</li> </ul> <p>(Examples using case studies can be included)</p>                            |
|  |  | 1.4 Legislation:<br>Legislation or policy changes for this species<br>Legislative change has been identified by stakeholders                                       | <ul style="list-style-type: none"> <li>• What legislative changes have been made?</li> <li>• Are minimum requirements being maintained (e.g. ban on sale, trade, movement)?</li> <li>• Is control required throughout or in part of the jurisdiction?</li> <li>• Is compliance actively enforced?</li> </ul>   |
|  |  |  | Score:   |

Table 6 *continued*

| WoNS: |   | Jurisdiction:  |   | Date:  |
|-------|---|--|---|--|
| Goal  | Key evaluation questions                          | Data or evidence required  | Consider  |  |
| 2     | Strategically manage existing infestations        | To what extent is integrated weed management effectively managing core infestations? | 2.1 Integrated weed management: Effectiveness of integrated weed management programs  | <ul style="list-style-type: none"> <li>• Are existing tools providing adequate control of WoNS?</li> <li>• Have new advances or technologies been developed and are they incorporated into best-practice management information?</li> <li>• Are there barriers to adoption of best-practice management?</li> <li>• Are research programs addressing any observed gaps (e.g. herbicide trials, biocontrol, restoration requirements post-control)?</li> </ul>                             |
|       |   | To what extent are assets being protected through strategic management?              | 2.2 Asset protection: Number of priority assets identified as 'at risk' from WoNS<br>Percentage of priority assets being protected (e.g. assessed against relevant threat abatement plans)<br>Percentage of state and regional invasive species plans that identify priority assets at risk from WoNS | <ul style="list-style-type: none"> <li>• Methods by which assets are being protected (e.g. targeted annual spray programs, high-risk pathway surveillance, strategic plans)</li> <li>• Are long-term monitoring programs in place to detect change?</li> <li>• To what extent is management leading to an improvement in asset condition?</li> </ul> <p>(Response should include status report on progress towards asset-protection programs)</p>  |
|       |   |  |   | Score:   |
| 3     | Increase capability and commitment to manage WoNS | To what extent has the capability and commitment to manage WoNS increased?           | 3.1 Community engagement and awareness:<br>What is the status of best-practice information?<br>Are partnerships being maintained to ensure collaboration on WoNS?<br>Number and type of media activities  | <ul style="list-style-type: none"> <li>• Is best-practice information up to date and readily available?</li> <li>• Is this information and/or advice being targeted to priority regions?</li> <li>• Is training being delivered to meet the needs of weed managers (including the community)?</li> <li>• Are networks and groups being supported (e.g. through dissemination of research outcomes, funding opportunities, control options etc.)?</li> <li>• Has awareness and</li> </ul> |

Table 6 *continued*

| WoNS:                  | Jurisdiction:   | Date:   |  |
|------------------------|---|---|--|
| Goal                   | Key evaluation questions  | Data or evidence required   | Consider   |
|                        |   |   | engagement in WoNS management been raised effectively?   |
|                        |   | 3.2 Resourcing:<br>From what sources are programs being funded?   | <ul style="list-style-type: none"> <li>Number of projects funded by Australian Government, jurisdictions, industry, etc.</li> </ul>  |
|                        |   | 3.3 Policy and planning:<br>Are the objectives of the strategy being integrated into Australian Government/state/regional plans, policies and programs?<br>Has cross-border collaboration occurred? | <ul style="list-style-type: none"> <li>How are priorities reflected in planning and policy approaches (e.g. weed risk assessments, invasive species plans, asset-protection plans, district plans, weed spread prevention activities, management programs, incentive programs, state working groups)?</li> <li>How are national priorities being maintained (e.g. containment lines, eradication targets, training and awareness raising, research projects)?</li> </ul> |
|                        |   |   | Score:   |
| Continuous improvement | Are there any unexpected outcomes that have been identified through implementation of strategy? | Barriers: <ul style="list-style-type: none"> <li>Have any other management issues or impediments been identified?</li> </ul>  |  |

WoNS = Weeds of National Significance

Scoring:

1: Insufficient evidence to score

2: No progress has been made against this goal

3: Limited progress is being made against this goal

4: Reasonable progress is being made against this goal

5: Excellent progress is being made against this goal

## 5 Stakeholder responsibilities

Although landowners and managers have primary responsibility for the control of salvinia on their land, relevant agencies share responsibility for the actions listed in Sections 3 and 4. The effective implementation of this strategy requires the involvement of a range of stakeholders. Stakeholders' responsibilities may vary between jurisdictions: some actions may be optional while others are prescribed by legislation. The successful achievement of strategic actions relies on the development and maintenance of partnerships between community, industry and government, and recognition of the roles of each stakeholder. In particular, while the National Aquatic Weeds Management Group provided oversight for the original strategy, future coordination arrangements will evolve to maintain and build on past achievements. The Australian Weeds Committee, at a national level, and various agencies at the state and territory level will continue to provide a leadership role.

# Appendix 1 The Weeds of National Significance initiative and its phases<sup>1</sup>

In 2007, an independent review of the WoNS initiative concluded that the nationally strategic approach of WoNS was highly successful in leveraging consistent multijurisdictional activity on high-priority weed species. This initial review was followed by a detailed review of the inaugural WoNS species by the Australian Weeds Committee (AWC) in 2009–10. The AWC reviewed the implementation of the 20 WoNS national strategies and, in light of achievements for these 20 species, considered the capacity for national coordination of additional WoNS species.

Following the reviews, the Natural Resource Management Ministerial Council (Resolution 15.7, 21 May 2009) endorsed a three-phased approach to national management of WoNS species (Figure 4). This ‘phased approach’ aims to provide the most cost-effective use of limited ‘national coordination’ resources.

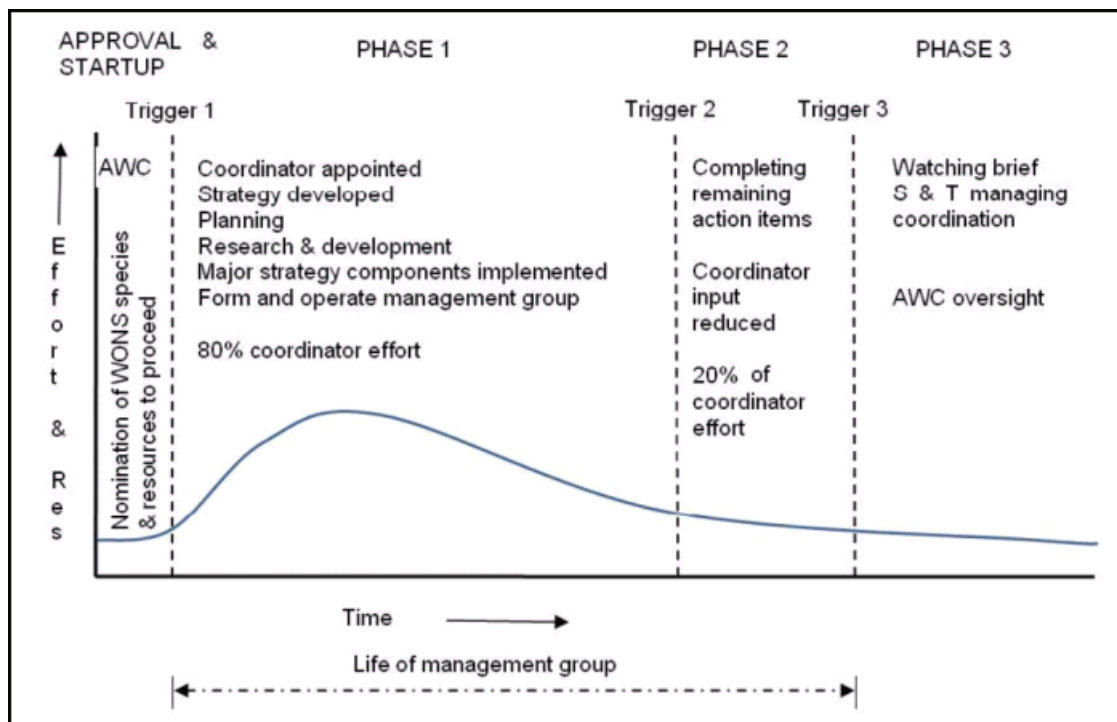


Figure 4 Australian Weed Committee diagrammatic representation of coordinator effort and resource use when implementing a Weeds of National Significance strategy

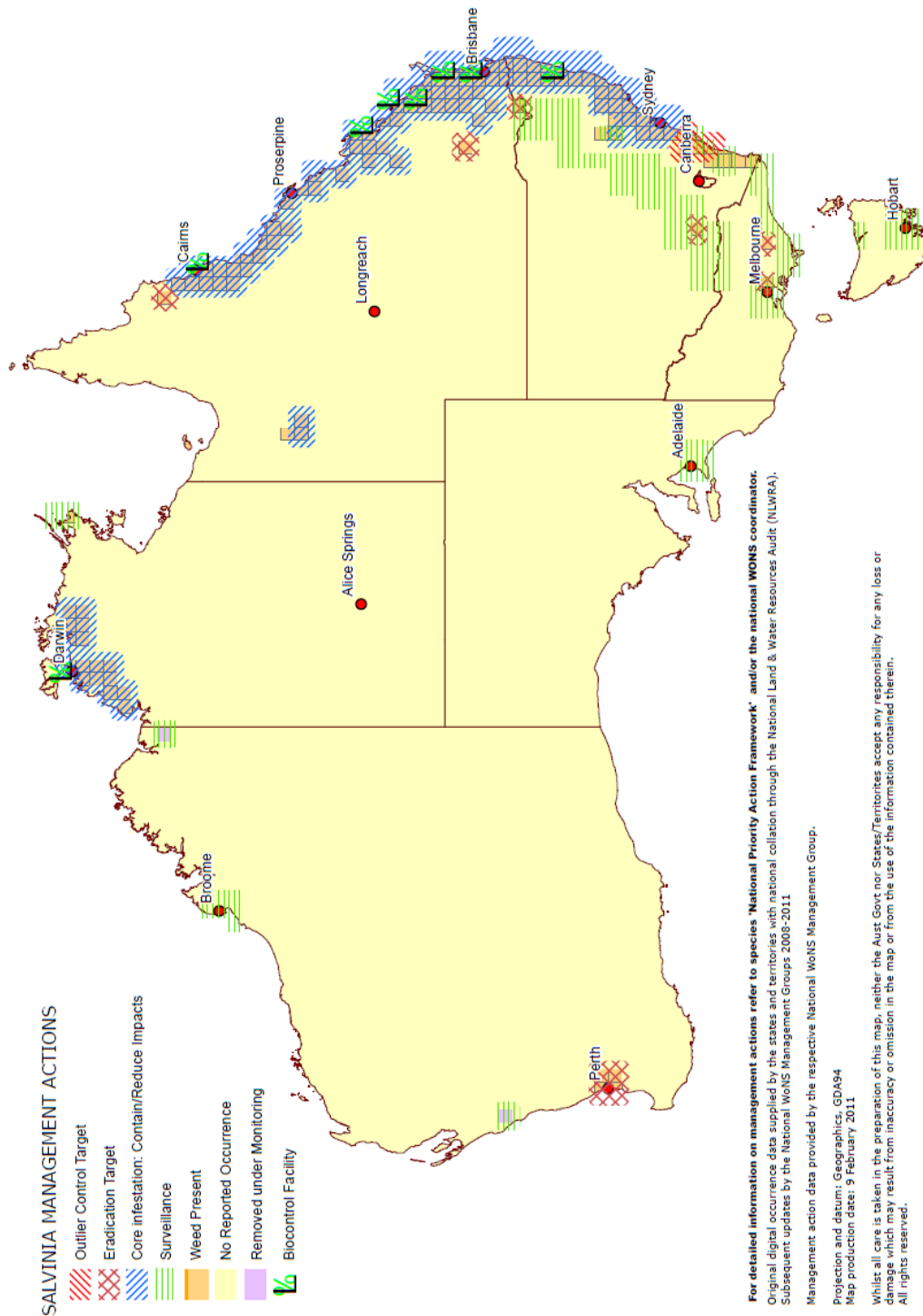
The phased approach recognises the need for reduced national coordination (‘phasing down’) of WoNS species that are under effective national management, and allows for further weed species to be nominated for consideration as additional WoNS. The AWC is implementing these reforms, and national coordination of the inaugural 20 WoNS species has already transitioned to phase 2 or 3, depending on the species. No species have yet been removed from the WoNS list. The AWC is developing a protocol to guide future decisions about when this should occur on a case-by-case basis.

<sup>1</sup> Adapted from Thorp 2012, Additional list of Weeds of National Significance, <[www.org.au/WoNS](http://www.org.au/WoNS)>.

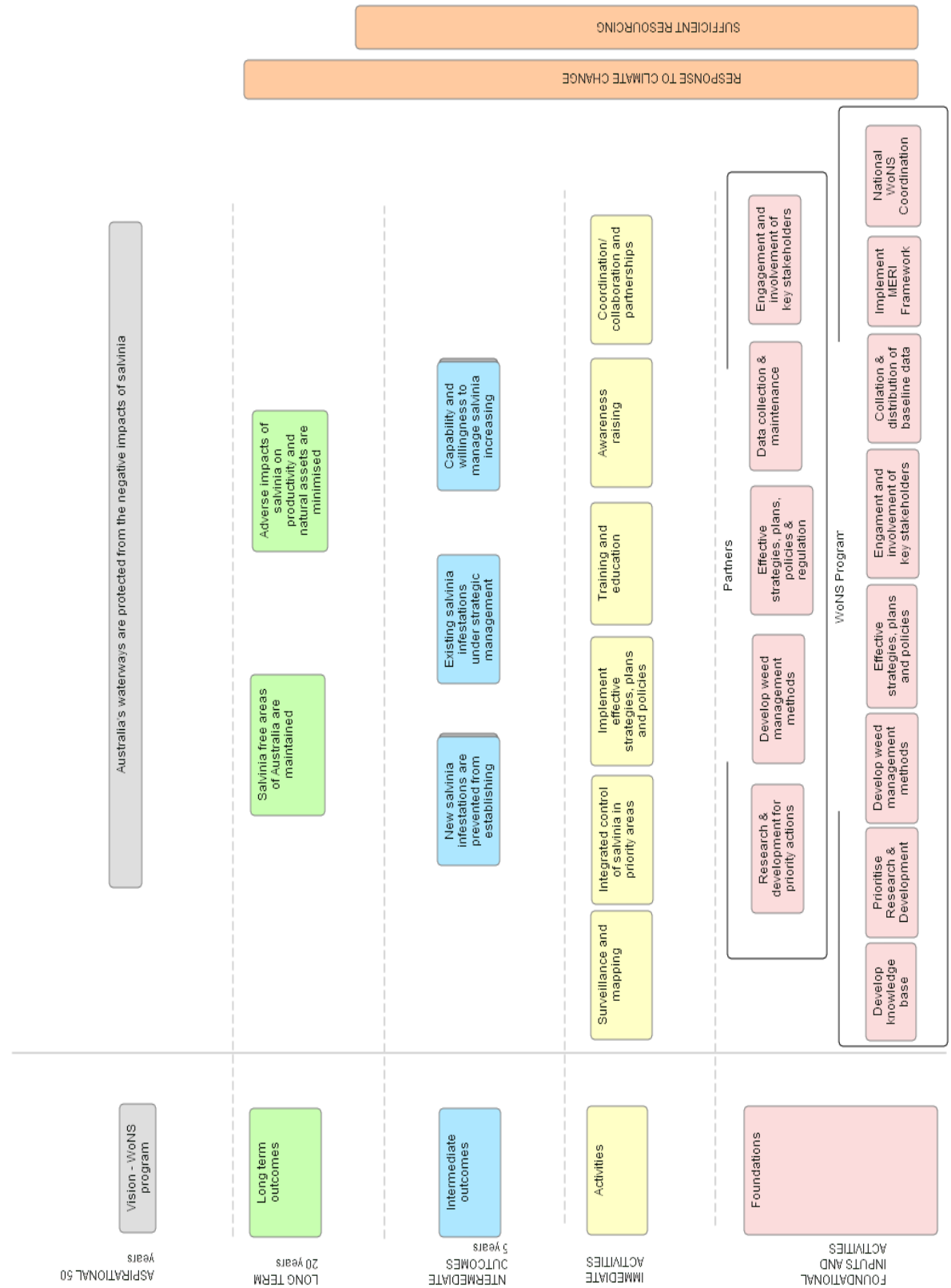
In 2010, jurisdictions nominated additional candidate WoNS species. These species were independently assessed, and the AWC endorsed 12 additional 'species' to be listed as WoNS. The AWC Chairman, Dr Jim Thompson, announced these additional plant species as WoNS on 20 April 2012. Additional information on the selection of these species and the phased approach is available on [www.weeds.org.au/WONS](http://www.weeds.org.au/WONS).

# Appendix 2 National salvinia distribution and management zone map, February 2011

The priority management actions for salvinia outlined in goals 1–3 of the strategic plan are reflected in the national weed spread and management map below.



# Appendix 3 Program logic for the salvinia strategic plan



## References and further reading

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