WEEDS OF NATIONAL SIGNIFICANCE

Pond apple

(*Annona glabra* L.)
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An unpublished draft of the revised strategic plan has guided national coordination of this Weed of National Significance for the past two years.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, 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

Pond apple (*Annona glabra*) is an invasive tree, with the potential to cause significant problems in Australia's tropical and subtropical coastal wetlands and riparian habitats. Habitats at risk include coastal creek and riverbanks, paperbark and pandanus wetlands, sedge lands, mangrove communities and high-tide zones on beaches. Under favourable conditions, pond apple can form pure stands, replacing native vegetation and causing dramatic changes to natural ecosystems.

The fruits and seeds are readily dispersed by water, as well as by animals, thereby allowing pond apple to spread within and between catchments.

Introduced to Australia as grafting stock for custard apple, pond apple currently infests at least 2200 hectares in coastal north Queensland. If left unchecked, pond apple will spread throughout the northern Australia mainland and islands, potentially extending from the Kimberley region of Western Australia to Casino in northern New South Wales. Implementation of the Pond Apple Strategic Plan 2012–17 will reduce the current extent of pond apple, minimise adverse impacts of any remaining infestations and ultimately result in the eradication of the species from Australia.

This strategic plan has two goals and associated objectives:

1 Reduce the extent of pond apple and reverse its impacts

- Provide strategic coordination of pond apple control programs.
- Maintain spatial information on current and potential distribution.
- Maintain a 'tool box' of effective control options.
- Deliver targeted education programs.
- Maintain the shared responsibility and commitment to manage pond apple across Australia

2 Implement the National Pond Apple Strategic Plan and evaluate its effectiveness

- Encourage community involvement in and ownership of pond apple management.
- Improve knowledge of the ecology and impacts of pond apple.

Vision

Pond apple is eradicated from Australia.

1 The challenge

Pond apple is potentially one of Australia's most environmentally damaging weeds because it has the ability to colonise disturbed and undisturbed sites in fresh, brackish and salt water. It has invaded remote, nationally significant sites, including endangered ecosystems in World Heritage–listed areas of the Wet Tropics and Cape York Peninsula bioregions of north Queensland.

Unlike many weeds, pond apple can invade and dominate undisturbed ecosystems, forming dense thickets. Dispersal occurs when its fruit are carried by flowing water, ocean currents or fruit-eating animals. Many sites are extremely remote, and when access is possible control is often dangerous due to problems associated with getting people and equipment on site and the fact that pond apple and the saltwater crocodile often share the same habitat. Thorough planning and implementation is required to overcome these challenges.

Pond apple competes strongly in native wetlands and other natural ecosystems, reducing biodiversity, ecosystem function and conservation values. Management of pond apple in natural ecosystems can be extremely difficult. The mechanics of eradication illustrate that significantly more labour is often needed to treat environmental weeds (i.e. those that invade native ecosystems and adversely affect the survival of indigenous flora and fauna) than other weeds. Workers must be careful that the treatment does not create disturbance that will allow pond apple or other exotic species to reoccupy the site.

Management effort over the life of the first national strategy has reduced many upper catchment infestations to a monitoring and follow-up phase. The next challenge is to control lower catchment infestations safely and effectively. To do this, new control practices will be required.

Pond apple often occurs in remote areas that are difficult to access and, as a result, tends to go unnoticed by most landowners. Awareness and identification products have raised the profile of this species; however, greater ownership by managers of affected lands is required. The whole community will benefit from the reduction and eventual eradication of pond apple.

2 Background

Pond apple poses a particularly serious threat to high-value, biologically diverse wetland ecosystems. It also has the potential to have negative impacts on ecotourism and agriculture. For these reasons, pond apple was included as a Weed of National Significance (WoNS) in 1999. A collaborative, national approach is required to mitigate its impacts.

Since being listed as a WoNS, several important steps have been taken to reduce the spread and impacts of pond apple. Some of the key outcomes are:

- formation of the National Pond Apple Management Group to oversee implementation of a national strategic plan
- formation of the Pond Apple Working Group, led by the Far North Queensland Regional Organisation of Councils
- identification and registration of effective herbicide controls
- implementation of local eradication projects for small, outlier infestations
- initiation of local control programs
- consistency of legislative controls across jurisdictions
- prohibition of sale and new plantings, including the use of rootstock for the custard apple industry
- integration of pond apple management into pest and natural resource management planning frameworks
- improved understanding of the ecology of pond apple
- improved public awareness of the impacts of pond apple and best-practice control methods.

In 2010, the Australian Weeds Committee (AWC) reviewed the progress and effectiveness of the implementation of the previous national Pond Apple Strategic Plan. The review culminated in a series of recommendations to improve national, strategic management of pond apple. The AWC recognised the achievements of the Pond Apple Working Group, led by the Far North Queensland Regional Organisation of Councils (FNQROC), and the National Pond Apple Management Group in meeting targets set in the previous strategic plan. The recommendations focused on setting new measurable goals, and are addressed in the strategic actions in Section 3.

2.1 The biology of pond apple

Pond apple is a member of the family Annonaceae. It has no close native relatives in Australia although 30 native rainforest species are in the same family. Pond apple may be confused with some native mangrove species because of its occurrence in mangrove communities and the presence of lenticels on the stems. Lenticels are small, raised, cork-like structures that are involved in gas exchange, enabling plants to survive periods of inundation. Three congeners are grown commercially in Australia: *A. cherimola* (cherimoya or custard apple), *A. reticulata* (bullock's heart) and *A. squamosa* (sweet apple or sweet sop).

Pond apple is a semi-deciduous, woody tree, usually 3–6 m tall, but sometimes up to 15 m tall. Specimens are usually single-trunked but multi-stemmed plants are relatively common because several seedlings often germinate together. Mature specimens tend to develop gnarled, buttressed roots. The soft-wooded stems have thin, grey bark with prominent lenticels. The leaves are alternate, oval, 70–120 mm long with a prominent midrib, and are aromatic when crushed (smelling similar to a green apple). There is a distinctive small fold where the leaf blade joins the leaf stalk—a feature that helps to differentiate pond apple from other plants of similar appearance. The upper leaf surface is light to dark green depending on age, and the lower leaf surface is paler. Dull green leaves of mature trees turn yellow and fall in the dry season, a feature that aids detection from the air.

Ongoing studies suggest the species reaches reproductive maturity at 3–4 years of age. The main flowering period is from December to February, although sporadic flowering can occur at other times of the year. Flowers are pale yellow to cream, 2–6 cm in diameter, and consist of three leathery outer petals and three smaller inner petals. The inner base of the flower is red. Fruit-set is limited by floral biology; the flowers are hermaphroditic but do not self-pollinate and are probably pollinated by beetles.

Flower of pond apple

Fruit of pond apple

Green fruit, 5–15 m in diameter, form from January to March and contain about 140 pumpkin-like seeds. The fruit resembles a smooth-skinned custard apple. The ripe fruit has yellow or orange skin and orange flesh. It falls from the tree when ripe (February to April) and turns black on the ground.

Preliminary research into seed production found that plants produce between 440 000 and more than 8 million seeds per hectare each year. Seed longevity trials found that an average of 38% of seeds germinate after being placed in salt water for 12 days. Seeds placed in fresh water remained viable for up to two years and eight months, and had all either germinated or expired after three years (Setter et al. 2008).

Studies have shown pond apple fruits are spread considerable distances by ocean currents. Infestations are often found on the northern peripheries of bays and inlets, suggesting that fruit have been transported northward along the coast from river mouths.

Animals including cassowaries, wallabies and feral pigs consume the fruits and readily disperse viable seeds within and between catchments. Research found that cassowary droppings contained as many as 842 seeds and feral pig droppings contained up to 288 seeds (Setter et al 2008). While most ingested seeds are passed by the animals in the vicinity of the infested area, feral pigs can disperse seeds up to 10 km away and cassowaries up to 1.2 km away. These animals influence the abundance and distribution of pond apple

and probably disperse the plant's fruits into areas where water cannot, such as upstream of infested areas and into adjacent catchments.

Pond apple tolerates some mutilation or damage. Cut stems can produce adventitious roots if they come into contact with wet soil. Figure 1 summarises key parts of the plant's biology and identifies critical control points.

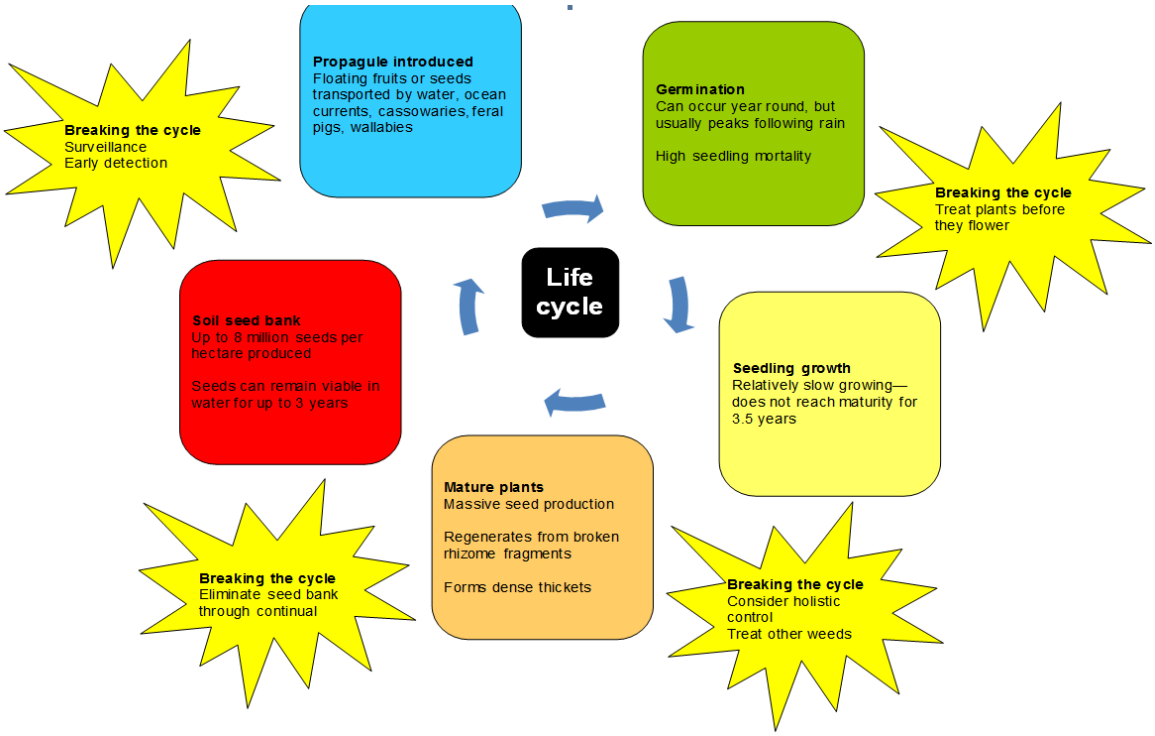


Figure 1 Life cycle of pond apple

Seedlings require moist to wet, generally well-lit conditions. Pond apple can replace the understorey of wetland and riparian communities with dense seedling thickets and become the sole canopy tree over time. Pond apple is versatile; it grows in fresh, brackish and even saline waters, where it acts very much like the mangroves it replaces. The plant will not survive, however, in areas that are permanently inundated or too shady. Pond apple is adapted to a wide range of soils including moist sand depressions, steep hillsides on metamorphic soils and the high tide mark on rocky coastal shores.

Natural and human disturbance can both play an important part in encouraging infestations of pond apple. For example, cyclones can create canopy gaps that allow light to penetrate rainforest environments allowing the growth of pond apple. A reduction in canopy cover after disturbance results in higher light intensity and soil temperature, factors that stimulate germination and growth. In a different scenario, excessive drainage of coastal land through land reclamation raises saline watertables, killing paperbark trees but allowing the growth of the more salt tolerant pond apple. Storm surges or high tides that result in increased salinity may also favour pond apple. The infestation in Mutchero Inlet (between Cairns and Innisfail) may have developed following such an event.

Pond apple fruit is edible and has reportedly been sold in north Queensland as 'caramel custard apple' (Low 1999). Sale of the species is now prohibited in all states and territories,

as is its commercial use as a salt and water-tolerant rootstock for custard apple. New infestations continue to be identified in historical orchard sites.

2.2 History of spread

Pond apple is native to Costa Rica, Nicaragua, Honduras, Puerto Rico, Columbia, Ecuador, the Leeward islands, Mexico and Florida, and has spread naturally to coastal West Africa. It is naturalised in Sri Lanka, Thailand, Vietnam, mangrove communities in the Malay Peninsula and, possibly, China.

Pond apple was first recorded in Australia in 1886 at the Cooktown Botanic Gardens. It was subsequently imported as grafting stock for commercial custard apple production and has since invaded waterways and wetlands, mostly between Ingham and Cooktown, but also south to Mackay and north to some inhabited islands in Torres Strait. Major infestations occur in the Murray, Tully, Johnstone, Russell and Mulgrave catchments, and in the Daintree and Cooktown lowlands. Pond apple has been found in home gardens near Humpty Doo in the Northern Territory, but no untreated infestations exist there or in New South Wales (which also offers suitable habitat and climatic conditions for pond apple). Several trees have been detected and removed at the Brisbane Botanic Gardens, and a small infestation is currently being eradicated at the Maroochy Research Station at Nambour in south-east Queensland.

The Russell River, south of Cairns, is central to the naturalised distribution of pond apple. More than 600 hectares are infested, including most waterbodies in the catchment.

The plant has been found growing in a wide range of climates and ecosystems, from rainforest creeks such as Jumrum Creek near Kuranda with 2000–2500 mm rainfall per year to open forest at Paddy's Creek near Mareeba with 750 mm per year.

Although areas such as Murray Upper between Tully and Cardwell have been infested for more than 80 years, the pond apple problem has developed quite quickly in some areas, with infestations near Kuranda thought to be about 25 years old prior to their removal.

Estuaries and floodplains in north-eastern Cape York are at immediate risk from pond apple due to the northward movement of ocean currents from infested creeks. Plants have already been found north of Cooktown by Cape York Weeds and Feral Animals Project staff and are believed to have been dispersed by tidal flow from the Cooktown infestation. The Torres Strait islands and southern, coastal Papua New Guinea are also at risk of invasion.

The species could spread throughout northern Australia, across the Northern Territory into Arnhem Land and the Daly and Victoria rivers, and along the coastline to the Mitchell Plateau in the Kimberley region of Western Australia (Figure 2). Coastal areas of Queensland are at risk, south to about Casino in New South Wales.

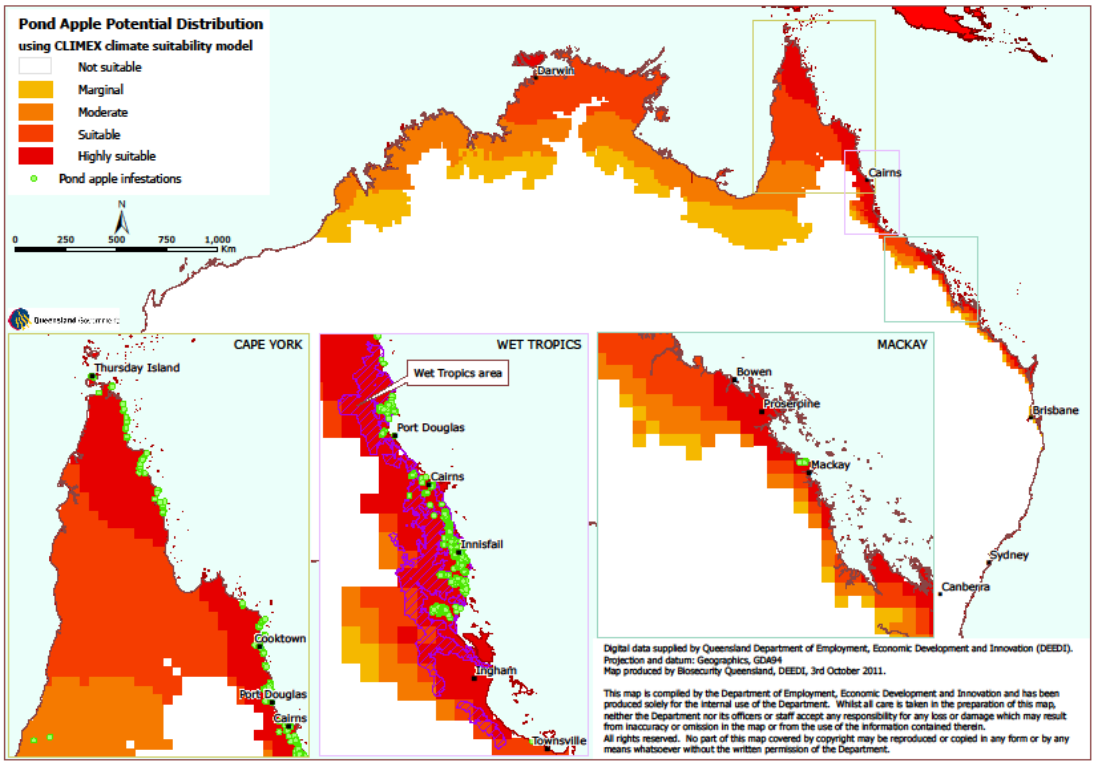


Figure 2 Potential distribution of pond apple

2.3 Summary of impacts

The major impacts and issues caused by pond apply are summarised below.

2.3.1 Environmental impacts

- In the Wet Tropics and Cape York Peninsula bioregions of far north Queensland, a wide range of habitats have been invaded including stream and riverbanks, paperbark and pandanus wetlands, sedge lands, mangrove communities and high-tide zones on mainland and island beaches.
- The tropical wetlands affected are of national and international importance and include World Heritage–listed areas representing endangered bioregional ecosystems.
- Pond apple forms a dense understorey or subcanopy, replacing ferns, grasses, shrubs and sedges, and preventing their regeneration.
- Seasonally inundated coastal habitats supporting paperbarks (*Melaleuca viridiflora*, *M. leucadendra*, *M. quinquenervia* and *M. cajuputi*) and mangroves are at risk.
- Fire frequency and intensity can be modified due to changes in plant species composition and abundance.
- Many infested ecosystems are habitat for rare and threatened flora and fauna: paperbark swamps in the Tablelands Regional Council, the vulnerable ant plants (*Myrmecodia beccarii*) that host the larval symbionts of the endangered apollo jewel

butterfly (*Hypochrysops apollo*) and endangered orchids (*Dendrobium nindii*, *D. mirbelianum* and *Phaius tancarvilleae*).

- The fruit provide a food source for fruit-eating animals including the endangered southern cassowary (*Casuarius casuarius johnsonii*). In Innisfail, however, pond apple infestations growing along a main road significantly increase the risk of vehicular fatalities of these birds.
- Unlike many weeds, pond apple can invade and destroy relatively undisturbed ecosystems—for example, the infestation in the Graham Range National Park between Cairns and Innisfail.
- Seed dispersal by animals makes locating new infestations difficult, particularly as pond apple can establish in areas where little or no disturbance has occurred.
- Pond apple has invaded 15 protected areas and 10 Wetlands of National Significance.

It is worth noting that pond apple is threatened in the United States. In Florida, vast pond apple forests have been drained for farming and removed for other human activities.

2.3.2 Tourism, recreation and amenity impacts

- Thickets of pond apple restrict access for boating, fishing, bird watching and bushwalking.
- Pond apple can spoil visual amenity by creating muddy monocultures in creeks and intertidal areas.

2.3.3 Primary production issues

- Current impacts to primary industries are minimal although, if left unchecked, they may become significant.
- Pond apple can affect the cattle and sugar cane industries by growing in and along creeks, fence lines and farm drains, increasing management costs.
- Thickets restrict access and movement of animals, humans and vehicles.
- Low-lying sugar cane land and associated drainage ditches may be invaded, particularly following floods.

2.4 History of research and management including regulation

Since its listing as a Weed of National Significance, there has been research on pond apple ecology, seed production, dispersal, longevity and viability (Section 2.1). Dispersal of pond apple fruit by ocean currents has been modelled and various mechanical control methods have been trialled.

2.5 Control methods

The two most cost-effective forms of management are prevention (exclusion) and early detection/control. Restrictions on sale and cultivation help exclude pond apple from areas where it is currently absent. New infestations need to be detected and controlled quickly

before they become widespread and more difficult to manage. Large, established infestations pose a major challenge, particularly in remote areas. Difficulties associated with site access, combined with safety issues (e.g. operating in saltwater crocodile habitat), mean that pond apple control requires careful planning.

2.5.1 Biological control

Biological control of pond apple has not been investigated. The requirement to only release host-specific agents that do not affect commercial or native species within the same family of plants as pond apple means that biological control may be difficult.

2.5.2 Physical control

Chain-pulling and bulldozing have been used successfully to control pond apple in drains near Babinda, south of Cairns. Two machines—the Positrack and Tracksaw—are being trialled to determine their effectiveness. Although mechanical control is not a viable option in many situations, preliminary results are promising.

Posi-track

Tracksaw

Fire can be a cost-effective control method, although it is not appropriate in many situations. Its use is limited by a lack of fuel load and concern about non-target environmental effects, particularly in rainforest and mangrove habitats. Fire has been used successfully in areas with sufficient understorey to sustain it, such as the sedge–grass community in Eubenangee Swamp National Park, near Innisfail.

Several herbicides are available and may be used via a variety of application methods. Stem injection using triclopyr plus picloram or glyphosate is effective on actively growing plants, as is triclopyr plus picloram, or fluroxypyr for basal-bark spraying and treatment of seedlings. The cut-stump method (i.e. cutting the tree off close to the ground and applying herbicide to the cut surface) is effective, but stumps must be treated immediately after cutting. Foliar spraying may also be used with imazapyr-based herbicides.

2.5.3 Routine management

A number of control measures have been used and refined for pond apple. The method used and its success depends on local conditions. Methods should be chosen that do not adversely affect non-target plants or the surrounding environment. Minimising disturbance will help restore the natural environment. Control work should be approached holistically, in combination with restoration works where possible.

As with all control methods, sites must be monitored to ensure pond apple seedlings are removed over a number of years until the soil seed-bank is exhausted. Sites prone to erosion or weed establishment after pond apple removal should be revegetated using local native plant stock. The requirements of native fauna, such as cassowaries, is important in revegetation, and naturally occurring cassowary food plants can be used where appropriate to replace pond apple.

2.6 Socioeconomic factors affecting management decisions

The profile of pond apple has risen significantly following its listing as a Weed of National Significance. However, like many other environmental weeds, investment in control by private landholders is often poor because pond apple is not considered a threat to agriculture. Its tendency to persist in remote and inaccessible areas also hampers effective control.

The substantial environmental impacts posed by pond apple have been recognised by government conservation agencies and significant control programs are under way in protected areas. Similarly, local governments, particularly in far north Queensland, are committed to reducing the species' impacts and contribute significant resources to its control.

2.7 Quarantine and legislative controls

In Queensland, pond apple is declared a Class 2 pest, in recognition of its potentially serious impacts. Current legislative controls are summarised in Table 1.

Table 1 Legislation related to pond apple

Jurisdiction	Legislation	Declaration	Action
Australian Capital Territory		Prohibited plant	
New South Wales		Class 1 weed	The plant must be eradicated from the land and the land must be kept free of the plant
Northern Territory	*Weeds Management Act 2001*	Class A and Class C	Class A—to be eradicated Class C— not to be introduced
Queensland	*Land Protection (Pest and Stock Route Management) Act 2002*	Class 2 pest—illegal to sell pond apple or keep it without a permit	Landowners must take reasonable steps to keep their land free of this weed
South Australia		Not declared	
Tasmania		Not declared	
Victoria		Not declared	
Western Australia	*Agriculture and Related Resources Protection Act 1976* *Biosecurity and Agriculture Management Act 2007* The legislative arrangements are currently in a transition from the *Agriculture and Related Resources Protection Act 1976* to the *Biosecurity and Agriculture Management Act 2007* (BAM Act)	P1 and P2 weed	P1— introduction of the plant into, or movement of the plant within, the state is prohibited P2—to be eradicated

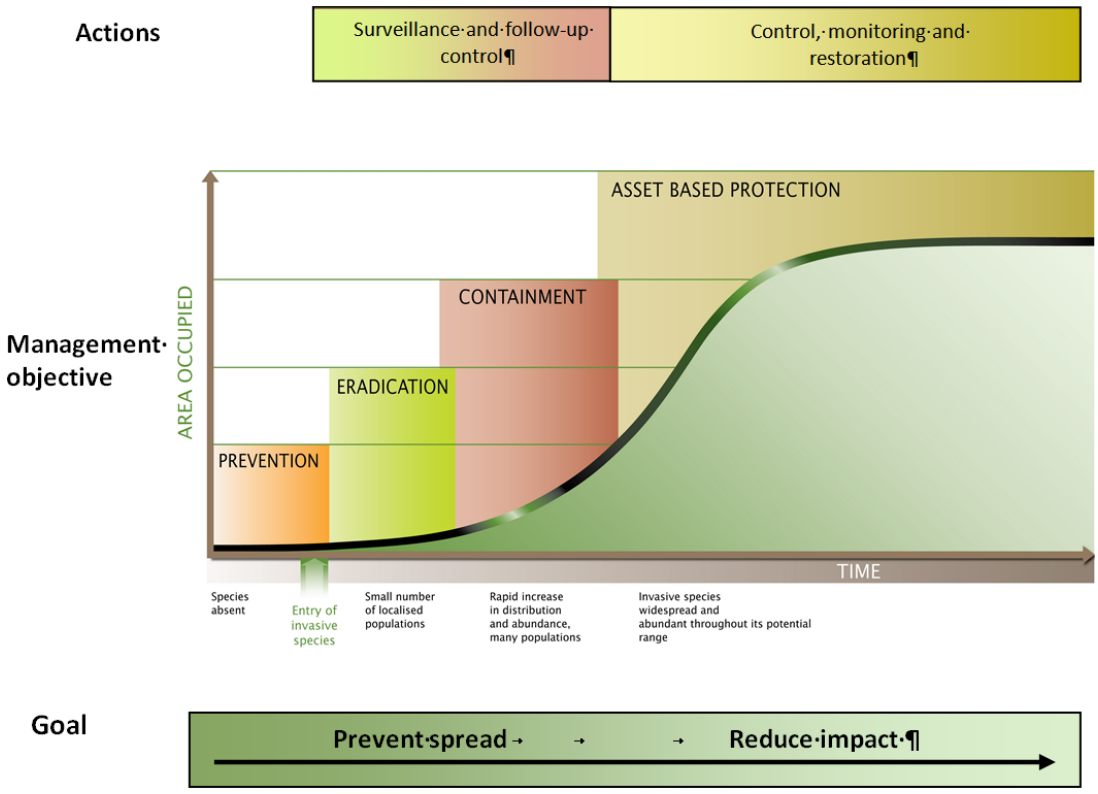
2.8 Principles underpinning the plan

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

2.8.1 Process followed

The previous strategy was revised by the National Pond Apple Management Group, whose membership comprises representatives from agriculture, conservation agencies, research institutions, the community, and state, territory and local governments. The draft strategy was available for public comment during February and March 2011. Eight submissions were received and amendments were incorporated in this document as a result.

It should be noted that, 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).

2.9 Relevance to other strategies

The Pond Apple Strategic Plan 2012–17 has been developed to provide a framework for coordinated management of pond apple 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 pond apple

Scale	Natural resource management	Pest management	Weed species management
National	*Environment Protection and Biodiversity Conservation Act 1999* National Strategy for the Conservation of Australia's Biological Diversity 2010	Australian Weeds Strategy Caring for our Country Business Plan	WoNS Pond Apple Strategic Plan Weeds of National Significance Strategy
State	State biodiversity and natural resource management strategies	State agency pest management plans	Guideline for the management of pond apple (Queensland)
Regional	Regional NRM plans	Regional pest management strategies	*Adaptive management; the next steps* *Pond apple management in North Queensland 2010–15* (Far North Queensland Regional Organisation of Councils)
Catchment	Strategy for the Conservation and Management of Queensland Wetlands	ICM pest management strategies	North Queensland afforestation catchment rehabilitation plans—Russell-Mulgrave, Tully-Murray, Barron
Local	Landcare plans	Local government pest management plans	Pond apple plans in far north Queensland Local government pest management plans
Property	Property management plans	Property pest management plans National parks pest strategies	Property weed management plans National parks pest management activity plans

3 Strategic goals

Revised goals and actions for the management of pond apple are described in Sections 3.1 and 3.2.

Priority management actions for pond apple outlined in Sections 3.1 and 3.2 are reflected in a national management map (Appendix 2).

3.1 Goal 1: Reduce the extent of pond apple and reverse its impacts

The objectives and strategic actions to achieve goal 1 of the strategic plan, and the action level and responsible partners for each action, are shown in Table 3.

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

Objective	Strategic actions	Action level[a]	Responsibility[b]
1.1 Provide strategic coordination of pond apple control programs	Develop an eradication plan for all known pond apple infestations in Australia, including timelines	1	**State and territory agencies, local governments**, landholders
	Commence control or continue progress towards eradication of infestations	1	Pond Apple Working Group, state and territory agencies, **local governments, landholders**
1.2 Maintain spatial information on current and potential distribution	Maintain and update national distribution and density maps	1	State and territory agencies, NRM groups, local governments, landholders
	Determine and document surveillance priorities	1	State and territory agencies, **NRM groups,** local governments, landholders
	Encourage surveillance in at-risk areas	1	State and territory agencies, **local governments**, landholders
	Collect voucher specimens from outlier infestations	1	**State and territory agencies, Northern Australia Quarantine Strategy**
	Encourage the continued use of aerial coastal surveys to supplement ground mapping	1	Working Group, **state and territory agencies, NRM groups, local governments**
	Collate the outcomes of distribution modelling for use in pest management plans	1	**Working Group,** state and territory agencies, local governments
1.3 Maintain a 'tool box' of effective control options	Investigate research opportunities to fill identified information gaps	2	**Pond Apple Working Group**, state and territory agencies, local governments, landholders, **research**
	Seek solutions to access infested sites and other operational barriers to	2	

Objective	Strategic actions	Action level[a]	Responsibility[b]
	pond apple control		**bodies**
	Develop best-practice management for operating in protected areas	2	
	Seek policy and/or legislative provision to undertake best-management practice control options in protected areas	2	
	Ensure currency of best-practice control resources	2	State and territory agencies, local governments, landholders, **research bodies**
	Ensure pond apple control is integrated as a component of whole-of-landscape management	2	State and territory agencies, **NRM groups,** local governments, landholders
	Facilitate the development of incentives (and disincentives) and other initiatives, including consideration of environmental levying, to control pond apple	2	State and territory agencies, NRM groups, **local governments**, landholders
1.4 Deliver targeted education programs	Undertake extension activities in conjunction with local and regional opportunities	2	**State and territory agencies, NRM groups, local governments**
	Maintain best-practice demonstration sites and conduct training in control techniques	3	State and territory agencies, NRM groups, **local governments**, landholders, **research bodies**
	Identify and increase the awareness of relevant field officers that may assist in identifying new infestations of pond apple	2	State and territory agencies, NRM groups, local governments
	Target identification and awareness materials at identified at-risk areas ncluding through Indigenous communities, fishing groups, etc.	2	State and territory agencies, NRM groups, local governments
	Increase awareness of assistance available to control pond apple	2	State and territory agencies, NRM groups, local governments

NRM = natural resource management

a To help set priorities, the Australian Weeds Committee (AWC) described three action levels that reflect jurisdictional commitment to implementing action:
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.

b Bolding denotes the lead agency.

3.2 Goal 2: Maintain the shared responsibility and commitment to manage pond apple across Australia

The objectives and strategic actions to achieve goal 2 of the strategic plan, and the action level and responsible partners for each action, are shown in Table 4.

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

Objective	Strategic actions	Action level[a]	Responsibilityb
2.1 Implement the National Pond Apple Strategic Plan and evaluate its effectiveness	Support and maintain national implementation through jurisdictional pest plant management planning at state/territory, regional and local scales as appropriate	1	**State and territory agencies**, NRM groups, **local governments**
	Evaluate implementation progress against plan targets	1	State and territory agencies, AWC
	Maximise the efficient use of available resources to support on-ground pond apple control	1	State and territory agencies, regional NRM bodies, local governments, **Pond Apple Working Group,** landholders
2.2 Encourage community involvement in and ownership of pond apple management	Build new partnerships and strengthen existing partnerships with key stakeholders	2	State and territory agencies, regional NRM bodies, local governments, community groups
	Promote the status of pond apple as a Weed of National Significance	2	State and territory agencies, regional NRM bodies, local governments, community groups
	Encourage vigilance within the community to report new infestations	2	**State and territory agencies, NRM groups, local governments**
	Empower traditional owners to deliver control programs and undertake monitoring in remote areas	2	State and territory agencies, regional NRM bodies, local governments, community groups
	Promote pond apple control success stories to reward and encourage effort	2	State and territory agencies, regional NRM bodies, local governments, community groups

Objective		Strategic actions	Action level[a]	Responsibilityb
2.3	Improve knowledge of the ecology and impacts of pond apple	Collate available information on environmental impacts of pond apple and investigate opportunities to gather new information	2	Research bodies
		Identify critical information gaps and investigate research opportunities to fill identified information gaps	2	**Pond Apple Working Group**, state and territory agencies, local governments, landholders, **research bodies**
		Maintain a suite of extension products to assist with identification and general awareness of pond apple and its impacts	2	**State and territory agencies**
		Update and maintain a national communication plan	2	Pond Apple Working Group

NRM = natural resource management

a To help set priorities the Australian Weeds Committee (AWC) described 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.

b Bolding denotes the lead agency.

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 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 build a comprehensive overview of the plan's delivery. Table 5 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 5 Suggested monitoring and evaluation questions to measure progress under the phase 3 WoNS Pond Apple 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: Has the national distribution map been reviewed and/or updated? Has the Priority Management Action spreadsheet been updated?	• Are these documents publicly available? • Have stakeholders been advised of any changes? • Where is this data or information stored? • Does this information capture national priorities?
		1.2 New infestations: Number of new infestations recorded Percentage of known infestations actively controlled	• Are any new infestations occurring in areas identified as a high priority in the national strategy? • How were infestations detected (passive or active surveillance, community reporting etc.)? • Have high-risk pathways been adequately identified? • Have threats been minimised?
		1.3 Eradication and containment programs: Percentage of eradication and/or containment programs being maintained	• What percentage of programs identified in the national strategy are being actively managed? • Is there a plan in place for ongoing management? • How is progress being monitored and reported to stakeholders? (Examples using case studies can be included)
		1.4 Legislation: Legislation or policy changes for this species Legislative change has been identified by stakeholders	• What legislative changes have been made? • Are minimum requirements being maintained (e.g. ban on sale, trade, movement? • Is control required throughout or in part of the jurisdiction? • Is compliance actively enforced?
			Score:

Table 5 ***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	• Are existing tools providing adequate control of WoNS? • Have new advances or technologies been developed and are they incorporated into best-practice management information? • Are there barriers to adoption of best-practice management? • Are research programs addressing any observed gaps (e.g. herbicide trials, biocontrol, restoration requirements post-control)?
	To what extent are assets being protected through strategic management?	2.2 Asset protection: Number of priority assets identified as 'at risk' from WoNS Percentage of priority assets being protected (e.g. assessed against relevant threat abatement plans) Percentage of state and regional invasive species plans that identify priority assets at risk from WoNS	• Methods by which assets are being protected (e.g. targeted annual spray programs, high-risk pathway surveillance, strategic plans) • Are long-term monitoring programs in place to detect change? • To what extent is management leading to an improvement in asset condition? (Response should include status report on progress towards asset-protection programs)
			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: What is the status of best-practice information? Are partnerships being maintained to ensure collaboration on WoNS? Number and type of media activities	• Is best-practice information up to date and readily available? • Is this information and/or advice being targeted to priority regions? • Is training being delivered to meet the needs of weed managers (including the community)? • Are networks and groups being supported (e.g. through dissemination of research outcomes,

Table 5 ***continued***

WoNS:	Jurisdiction:		Date:
Goal	**Key evaluation questions**	**Data or evidence required**	**Consider**
			funding opportunities, control options etc.)? • Has awareness and engagement in WoNS management been raised effectively?
		3.2 Resourcing: From what sources are programs being funded?	• Number of projects funded by Australian Government, jurisdictions, industry, etc.
		3.3 Policy and planning: Are the objectives of the strategy being integrated into Australian Government/state/regional plans, policies and programs? Has cross-border collaboration occurred?	• 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)? • How are national priorities being maintained (e.g. containment lines, eradication targets, training and awareness raising, research projects)?
			Score:
Continuous improvement	Are there any unexpected outcomes that have been identified through implementation of strategy?	Barriers: • Have any other management issues or impediments been identified?	

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 have primary responsibility for control of pond apple 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 Pond Apple 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. Suggested responsibilities for each group are listed below.

Australian Government

- Provide resourcing to agreed levels to ensure the effective coordination and monitoring of the WoNS Pond Apple Strategic Plan.
- Promote the status of pond apple as a WoNS, its impacts and the importance of management.
- Ensure strategic pond apple control occurs on all federally managed lands.
- Prevent further import of pond apple through AQIS (now Biosecurity Australia).
- Provide research support through CSIRO and the Commonwealth Weeds Research Group.

Australian Weeds Committee

- Monitor, evaluate and report on the implementation of this strategy.
- Promote the status of pond apple as a WoNS, its impacts and the importance of management.
- Promote the importance and benefits of the WoNS initiative to all levels of government.

National Pond Apple Management Group

- Promote, seek consistency with and oversee implementation of this strategic plan.
- Maintain and build partnerships with key stakeholders to improve national pond apple management.
- Identify and fill critical information gaps, including best-management practice.

State and territory agencies

- Contribute to the delivery of the WoNS initiative.

- Ensure pest management plans for state lands are consistent with this strategic plan.
- Promote consistency with this strategic plan in jurisdictional pest management plans.
- Source funding for strategic management programs.
- Refine and enforce (or support enforcement by local government) legislation to support implementation of this strategic plan.
- Contribute to priority research initiatives.
- Develop and implement communications strategies that include pond apple impacts and management.
- Maintain spatial data on pond apple distribution.
- Provide representation to the National Pond Apple Management Group.

Local governments

- Continue to undertake a regional approach to on-ground works planning through the Pond Apple Working Group.
- Ensure consistency of jurisdictional pest management plans with this strategic plan.
- Implement jurisdictional pest management plans to ensure the prevention, eradication and containment of pond apple.
- Improve community awareness of impacts and identification and promote early detection.
- Collaborate with stakeholders to maintain project momentum.
- Collect spatial data on pond apple distribution.
- Enforce legislation and develop consistent local policies relevant to pond apple management.
- Seek funding for strategic control projects that are consistent with this strategic plan.
- Provide representation to the National Pond Apple Management Group.

Industry

- Improve awareness of impacts and identification among members, particularly in the grazing and sugar industries.

Natural resource management bodies and community groups

- Ensure consistency of regional pest and natural resource management plans with this strategic plan.
- Promote consistency of jurisdictional pest management plans with this strategic plan.
- Seek funding for strategic management projects that are consistent with this strategic plan.
- Include pond apple impacts, prevention and control in regional communications activities.

- Collect and share spatial data on strategic pond apple infestations.

Private landholders

- Control pond apple on private lands in accordance with state, territory and local government legislation and policy.
- Improve knowledge of impacts of pond apple.
- Improve ability to identify pond apple.
- Undertake surveillance of private lands for pond apple outbreaks.
- Report new infestations to weeds officers.

Appendix 1 The Weeds of National Significance initiative and its phases[1]

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.

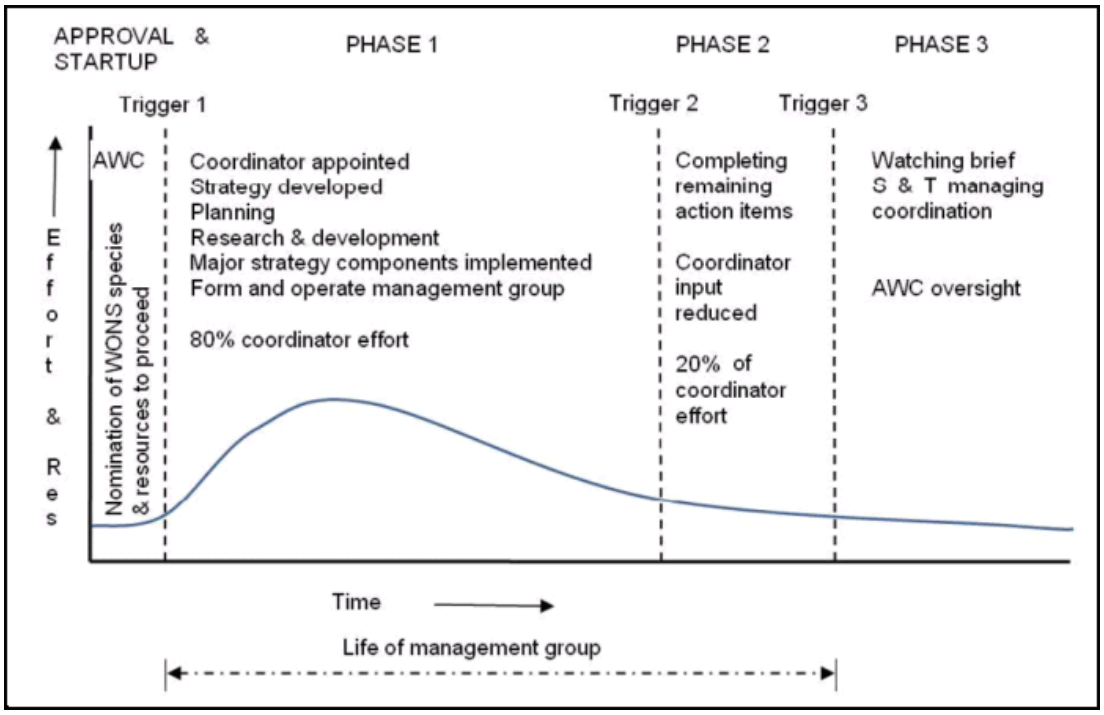


Figure 4 Australian Weed Committee diagrammatic representation of coordinator effort and resource use when implementing a Weeds of National Significance strategy

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

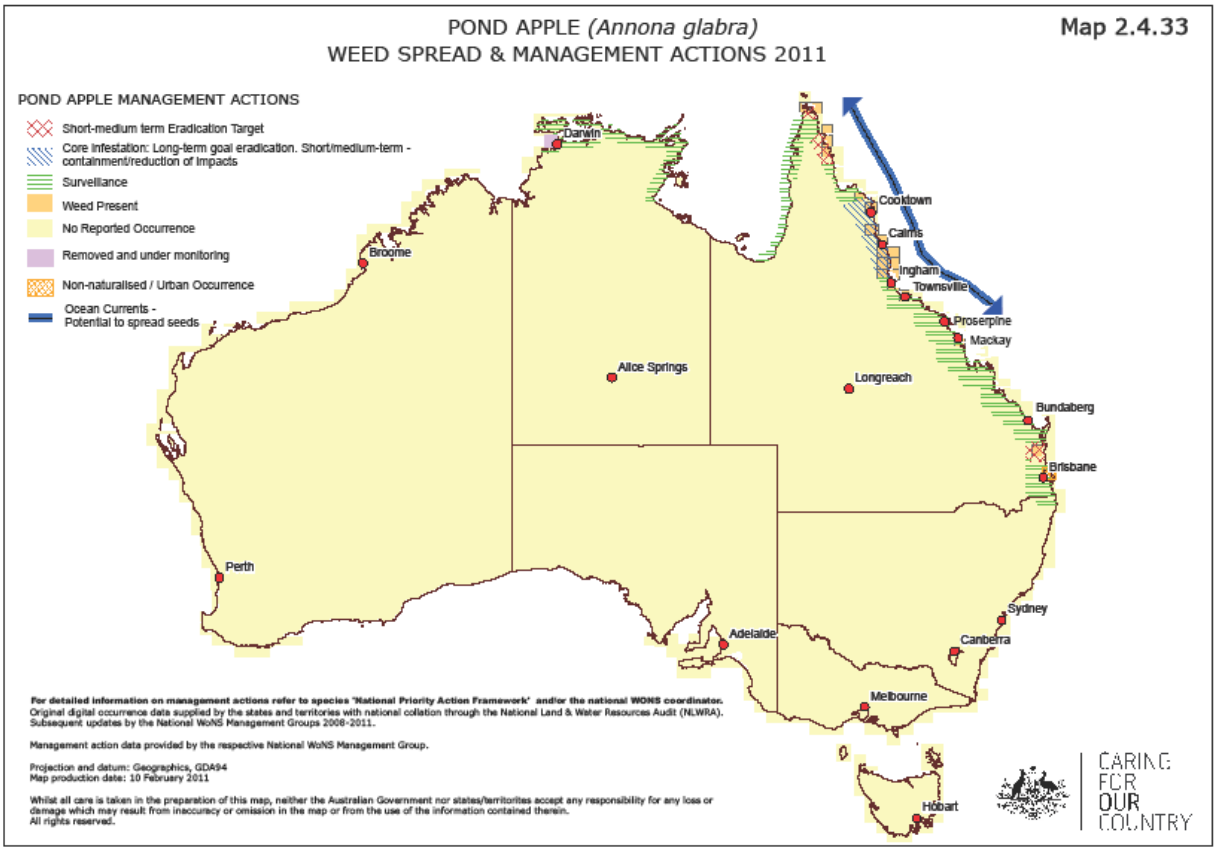
[1] Adapted from Thorp 2012, *Additional list of Weeds of National Significance*, <www.org.au/WoNS>.

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.

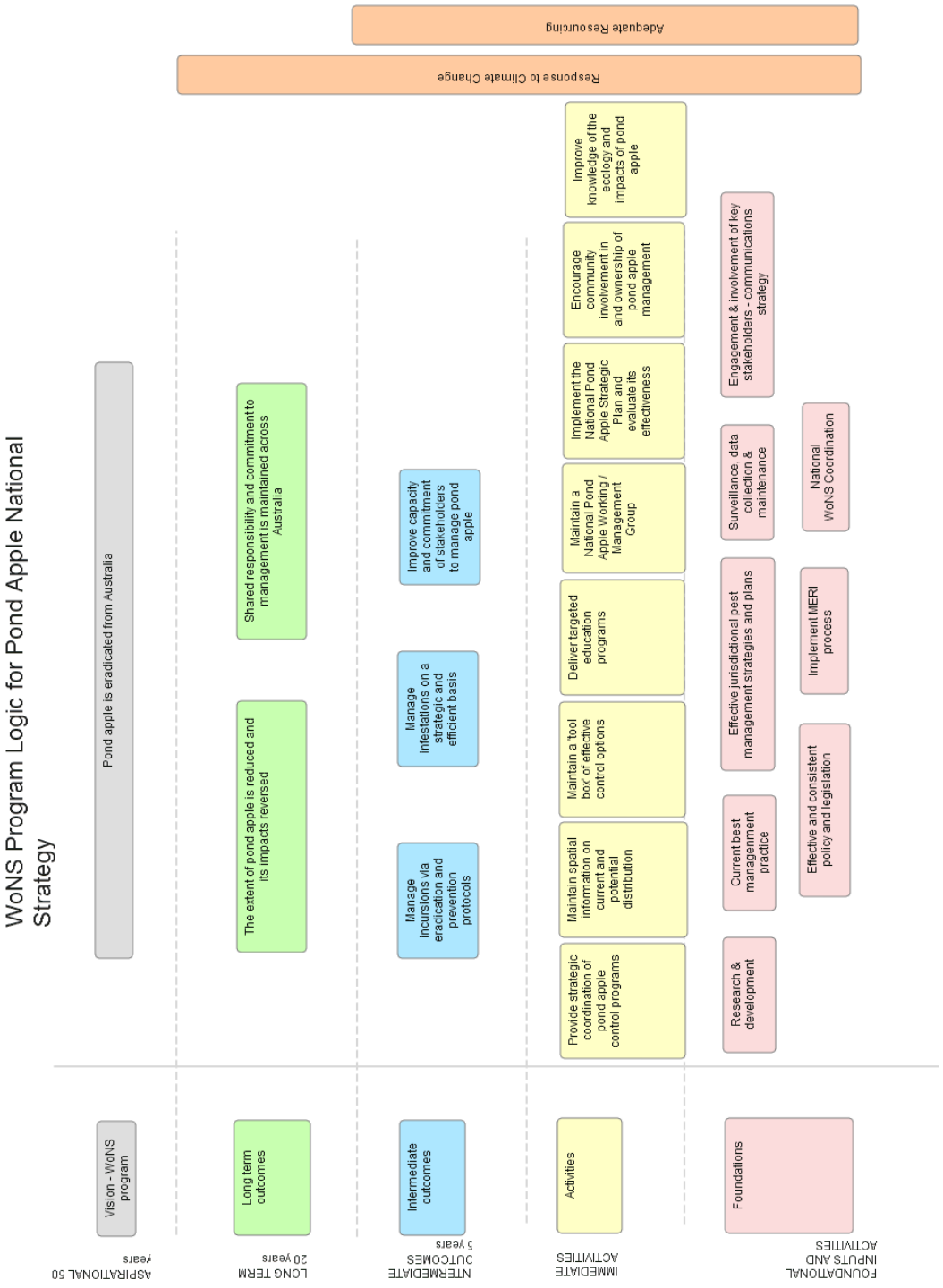
In 2010, jurisdictions nominated additional candidate WoNS species. These species were independently assessed, and the AWC endorsed 12 additional 'species' to be listed as WoNS. The AWC Chairman, Dr Jim Thompson, announced these additional plant species as WoNS on 20 April 2012. Additional information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

Appendix 2 National pond apple distribution and management zone map

The priority management actions for pond apple outlined in goals 1–2 of the strategic plan are reflected in the national weed spread and management map below.



Appendix 3 Program logic model for the pond apple strategic plan



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