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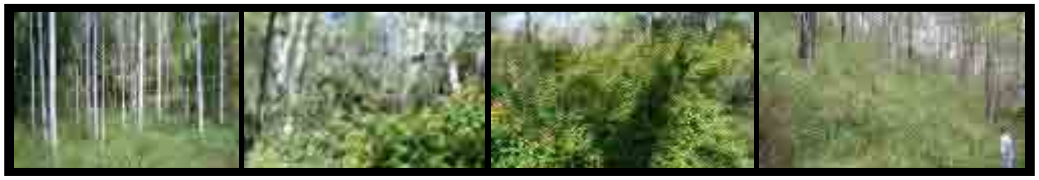
Plan to Protect Environmental Assets from Lantana



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Executive summary

Lantana (*Lantana camara* L.) has invaded more than five per cent of the Australian continent, and is a Weed of National Significance that impacts greatly on biodiversity. Lantana management strategies are needed to conserve biodiversity, but, as lantana cannot be controlled across its full distribution due to the large area invaded, these strategies need to ensure efficient use of the available resources, while still focusing on biodiversity asset protection.

This *Plan to Protect Environmental Assets from Lantana* fulfils the requirements for environmental asset protection under the Weeds of National Significance Lantana (*Lantana camara*) Strategic Plan. It establishes a national strategic framework to guide and coordinate Australia's response to lantana invasions in native ecosystems, ensuring management is targeted to sites where the biodiversity benefit will be maximised. It identifies the research, management and other actions needed to ensure the long-term survival of native biodiversity affected by lantana invasions. The principle aim of the Plan is to abate, ameliorate or eliminate lantana's adverse effects on threatened biodiversity, and to prevent other native biodiversity from becoming threatened. It also addresses the monitoring that is required to assess the response of native biodiversity to lantana management, and the benefits of lantana to native animals. This Plan is to be implemented over five years and will require subsequent review.

Throughout lantana's distribution within Australia, this Plan has identified 303 native species and 154 ecological communities (including regional ecosystems) as high-priority environmental assets that are under immediate threat from lantana. This includes 113 plant species, nine animal species and ten ecological communities that are already listed as nationally threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A triage approach to managing lantana to conserve biodiversity has been adopted by assessing and prioritising assets and sites for control. This process allows management to be directed towards sites that contain the highest priority environmental assets. Sites for lantana management identified in this Plan have been prioritised based on the ability to achieve control and the likelihood of protecting the assets most at risk, irrespective of land tenure. Using this approach, sites containing high-priority environmental assets have been separated into three categories:

1. sites that require urgent and long-term management to allow high-priority assets to persist and recover
2. sites that require prompt, long-term management but where only a medium probability of protecting high-priority assets through management alone exists
3. sites where high-priority assets will remain threatened even if active lantana management occurs; for example, where broader integrated management is required to address other major threats to native species at these sites.

Lantana management at the high-priority control sites identified within this Plan will help reduce the threat of lantana on native species and ecological communities and increase their resilience to future threats, such as climate change. In addition, management will help meet a major goal of the Australian Weeds Strategy: to reduce the impacts of existing priority weeds and to protect environmental assets. To achieve this, the Plan requires the support of all stakeholders. Land managers and other stakeholders should use this Plan when developing lantana control programs to protect biodiversity. Maintaining areas that are presently free of lantana or removing isolated infestations, including those within other states, will also be beneficial, as biodiversity in these areas will be protected from lantana invasions.

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Many staff and students at various universities also helped develop the Plan. Ben Gooden and Kris French, at the University of Wollongong, investigated the impacts of lantana on native plant richness and abundance. Heidi Case, Andrew Le Brocque and John Dearnaley, at the University of Southern Queensland, investigated the impact of lantana on mycorrhizal fungi; and Diana Virkki with Cuong Tran and Guy Castley at Griffith University studied the effects of lantana and lantana control on reptile composition and abundance. Alice Yeates, at the University of Queensland, investigated the effect of lantana management on the composition and structure of lantana-invaded communities.

Many people from across Queensland (QLD) and New South Wales (NSW) assisted with workshops to determine biodiversity threatened by lantana. The authors wish to thank all of the 199 participants who took part in these workshops. Thank you also to those organisations that provided venues for the workshops. Many others also commented on the interim list of biodiversity that was compiled following the workshops; others nominated sites for control. This Plan would not have been possible without the assistance of these people.

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Acronyms and abbreviations

Agvet Act: *Agricultural and Veterinary Chemicals Code Act 1994* (Commonwealth)

APVMA: Australian Pesticides and Veterinary Medicines Authority

ARMCANZ: Agriculture and Resource Management Council of Australia and New Zealand

BMAD: Bell Miner Associated Dieback

CMA: Catchment Management Authorities (NRM regions in NSW)

CCP: Commonwealth Coastal Policy

DEED&I: Department of Employment, Economic Development and Innovation (QLD), which includes Biosecurity Queensland formally part of Department of Primary Industries and Fisheries.

DECCW: Department of Environment, Climate Change and Water (NSW), formerly the Department of Environment and Climate Change and the Department of Environment and Conservation

DERM: Department of Environment and Resource Management (QLD), formally the Environmental Protection Agency, which includes Queensland Parks and Wildlife

DII: Department of Industry and Investment NSW formerly Department of Primary Industries

EEC: Endangered Ecological Community under the TSC Act (NSW)

Environmental assets: Native species, populations, regional ecosystems and ecological communities

EPBC Act: *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

High-priority control sites: Sites where lantana control is urgent and where control is likely to lead to the protection of high-priority environmental assets, with no other restoration beyond control needed

High-priority environmental asset: Environmental assets that are under immediate threat from lantana and are highly likely to increase in threatened status unless lantana management occurs within their distribution

KTP: Key Threatening Process listed under either the EPBC Act or TSC Act

Lantana: *Lantana camara* L.

MER Strategy: Monitoring, Evaluation and Reporting Strategy

NC Act: *Nature Conservation Act 1992* (QLD)

NPWS: NSW National Parks and Wildlife Service, now part of DECCW

NRM regions: Natural Resource Management regions. In New South Wales, they are known as CMAs. The core infestations of lantana can be found across 12 NRM regions, seven in Queensland and five in New South Wales.

NSW: New South Wales

PAS: Priorities Action Statement under the TSC Act (NSW)

QLD: Queensland

RE: Regional Ecosystem (QLD) (see Sattler and Williams 1999)

SoE: State of the Environment Report (NSW)

TAP: Threat Abatement Plan

TSC Act: *Threatened Species Conservation Act 1995* (NSW)

VM Act: *Vegetation Management Act 1999* (QLD)

WINS: Weed Impact to Native Species (see Downey 2006)

WoNS: Weed of National Significance (see Thorp and Lynch 2000)

1 Introduction

This Plan establishes a national framework to guide and coordinate Australia's response to *Lantana camara* (lantana) invasion in native ecosystems. It identifies the research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by lantana invasions. This Plan sits within, and should be read in conjunction with, the publication *Weeds of National Significance Lantana* (Lantana camara) *Strategic Plan* (ARMCANZ et al. 2001). This overarching strategy provides information on lantana biology, distribution and current management practices.

Given that lantana is widely established within Australia, especially in Queensland (QLD) and New South Wales (NSW), the focus of management outlined in this Plan is on abating impacts caused by established lantana populations, rather than prevention. Complete eradication and widespread control are no longer feasible. In addition, mitigating the threat of lantana at some sites may not be simply a matter of providing better technical solutions, such as improved herbicides and techniques. Therefore, control programs that aim to protect biodiversity need to be directed to areas where control is achievable and where they will provide the greatest benefits for biodiversity; this will ensure that maximum benefit is gained from resources, as well as limiting non-target biodiversity impacts. To achieve such conservation measures, information on the biodiversity impacted and specific site information has been collected. This information allows control techniques and recovery actions to be tailored to the known species at risk.

1.1 Asset-led approach

The *Plan to Protect Environmental Assets* has been prepared to:

- abate, ameliorate or eliminate lantana's adverse effects on threatened species, populations or ecological communities
- prevent more species, populations or ecological communities becoming threatened under threatened species legislation.

For widespread weeds, such as lantana, the management emphasis should be on protecting important environmental assets via an asset-led approach (Platt et al. 2008, Williams et al. 2009), as there is little to be gained from attempting eradication or control across the entire range. Therefore, management needs to focus on reducing the impacts of the weed species (Weeds CRC and Standards Australia 2006). This Plan outlines a method for identifying high-conservation areas invaded by lantana, and determining other barriers to restoring these areas. Management is then undertaken for the purpose of reducing the impact of lantana on environmental assets (native species, populations and ecological communities), not solely as a means to reduce lantana's density.

1.2 The Australian Weeds Strategy

This Plan will operate within the Australian Weeds Strategy framework and is consistent with many Actions under the Strategy, including issues relating to environmental assets such as:

2.3.1 'Identify the threats posed by weeds to key cultural, environmental and production assets and values'

2.3.2 'Develop and implement site-based approaches to managing weed threats that protect key assets and values' (NRMMC 2007).

1.3 Weeds of National Significance Lantana (*Lantana camara*) Strategic Plan

Lantana is ranked as one of the 20 worst weeds in Australia and has been identified as a Weed of National Significance (WoNS) (see Thorp and Lynch 2000). The National Lantana WoNS Strategy has established a suite of actions to combat the threat of lantana (ARMCANZ

et al. 2001). This *Plan to Protect Environmental Assets from Lantana* has been developed as part of the implementation of the WoNS Lantana (*Lantana camara*) Strategic Plan (ARMCANZ et al. 2001). It sits within Strategy 2.1.4 of the abovementioned Strategic Plan—to 'identify strategic management areas'—and the Actions within to review and evaluate areas where control programs have already been undertaken, and to identify high-priority areas, including those for conservation, and take appropriate action (see Figure 1.1).

A Plan to protect environmental assets was seen as a priority under the WoNS Strategy and by the National Lantana Management Group, because:

- the invasion, establishment and spread of lantana poses a significant impact on biodiversity and lantana is the main threat to many native species
- lantana's impacts vary depending on location
- management of lantana requires coordination and commitment from a range of stakeholders
- cost-effective management is available for lantana at a site level.

1.4 Other conservation and management plans

Aspects of this Plan should be integrated into state, regional and local resource protection and management plans (see Figure 1.1). For example, in NSW the invasion, establishment and spread of lantana has been listed as a Key Threatening Process (KTP) under the NSW *Threatened Species Conservation Act 1995* (TSC Act) (NSW SC 2006). Therefore, the actions identified within this Plan will be incorporated into the Priorities Action Statement (PAS), which outlines the threats to native species, populations and communities listed under the TSC Act as well as the recovery and threat abatement actions for those assets. In addition, this Plan has already been integrated into the Draft Biodiversity Action Plan for Fitzroy Basin Region (EPA 2008) where it refers to this Plan as the National Lantana Plan for Biodiversity Conservation.

1.5 Involvement of stakeholders

Effective and efficient weed management requires a coordinated national strategic approach, which involves all levels of government in establishing and coordinating frameworks in partnership with industry, landholders and the community (Parker et al. 1999, ARMCANZ et al. 2001). The success of this Plan will depend on a high level of cooperation between these groups. Importantly, all participants must allocate adequate resources to achieving effective on-ground control of lantana at priority sites (in accordance with this Plan), improving the effectiveness of control programs, and measuring and assessing outcomes. No impacts on Aboriginal or cultural heritage are expected that cannot be addressed during the development of site-specific management plans for lantana control (see Section 5.2 and Appendix 1).

Lantana is viewed as an agricultural weed, an environmental weed, an ornamental plant, and a food resource or habitat for a number of native animals. While the depth of concern and the range of groups with an interest will vary, lantana management is unlikely to be successful unless all of these interests and concerns are identified and the relevant groups and individuals are fully consulted. This Plan acknowledges the benefits native animals receive from lantana and the significant agricultural impacts of lantana. For example, it has been estimated that graziers spend $17.1 million a year on lantana control and lose in excess of $104 million in production (QLD NRW 2007). While the actions in the Plan will indirectly contribute to addressing agricultural impacts, it does not set out to be comprehensive in that regard as the reason for the Plan is primarily to abate impacts on environmental assets.

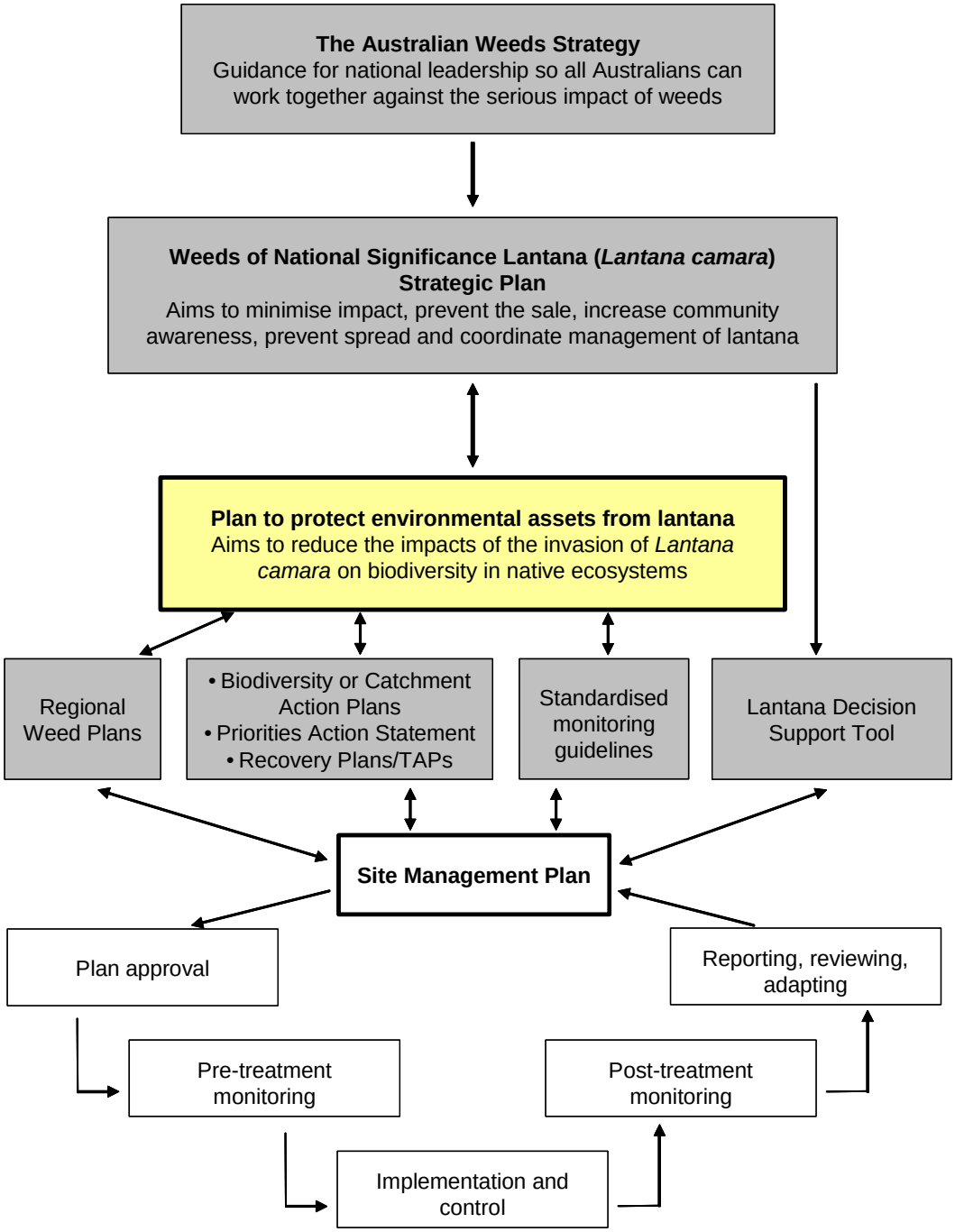

Figure 1.1. Weed management framework in Australia in relation to lantana and biodiversity protection (modified from the Environmental Weeds Working Group 2007).

1.6 The threat

Lantana is considered a weed of international significance (Sharma et al. 2005) because of its widespread distribution in temperate, subtropical and tropical climates (Swarbrick 1986, QLD NRM & E 2004) and impacts on primary production and biodiversity (Sharma et al. 2005). It is a scrambling or thicket-forming shrub from tropical South and Central America (Swarbrick et al. 1998) and was introduced to Europe as an ornamental plant during the 17th Century. Lantana was then moved to other parts of the world as various European colonies developed (Parsons and Cuthbertson 1992). Lantana has now been classed as one of the 100 worst invasive species (Lowe et al. 2000) and among the ten worst weeds worldwide (Sharma et al. 2005). In South Africa, this weed was ranked as the top weed of concern by Robertson et al.

(2003). In Australia it occupies 5.1 per cent of the continent (Sinden et al. 2004) and since its introduction in the 1840s (Swarbrick et al. 1998), lantana has become highly invasive in both agricultural and natural ecosystems, to the point that it is now ranked as one of the 20 worst weeds in Australia (see Thorp and Lynch 2000).

Lantana has spread extensively along the east coast of Australia, with whole ecosystems and many species now threatened (Turner et al. 2008a, Turner and Downey in press). Despite extensive efforts at control, lantana remains a major weed (ARMCANZ et al. 2001). Lantana thrives in warm, high-rainfall environments, where it grows along forest edges, penetrates disturbed rainforest and invades open eucalypt woodlands, tree plantations and pastures (ARMCANZ et al. 2001). In NSW in 1919, 18 municipalities and 22 shires had proclaimed lantana as noxious (Swarbrick 1986). Lantana now covers more than 4 million hectares of Australia, from Eden in southern NSW to north of Cooktown on Cape York, QLD. Outlying infestations also occur on the Torres Strait Islands, Lord Howe Island, Norfolk Island, and Cape York, and in central western QLD, in the Northern Territory, in Western Australia and (until recent removal) near Orbost in Victoria and near Adelaide in South Australia (Swarbrick 1986, QLD NRM & E 2004, Kym Johnson pers comm.). The ecology and biology of lantana has recently been reviewed by Stock et al. (2009) and Johnson (2007) and the full distribution of lantana is currently being mapped using remote sensing (Stewart et al. 2008).

1.7 Managing the threat

There are insufficient resources to fully implement lantana control measures at all sites across lantana's range. Therefore, sites within this Plan have been ranked on a nationally consistent basis to ensure that decisions about funding for control activities maximise the conservation benefits. This methodology allows for the protection and expansion of existing populations of threatened species and ecological communities, and has been guided by:

- the degree of threat that lantana poses to environmental assets (native species and ecological communities)
- the number of high-priority environmental assets likely to benefit from control in a locality
- the potential of the environmental asset to recover at the site
- the importance of the site to the environmental asset's existence
- the effectiveness of lantana control in each particular area.

Maintaining areas that are presently free of lantana or removing isolated infestations, including those within other states, will also be beneficial, as biodiversity in these areas will be protected from lantana invasions. Given this, this Plan is supported by the Lantana Weeds of National Significance (WoNS) Program, which coordinates management of isolated infestations outside core infestations, including containment zones.

This document outlines the:

- threats lantana poses to environmental assets and their conservation priority (Chapter 2), especially those plant and animal species and ecological communities identified to be at risk from invasion, as well as the native species that benefit from such invasions
- site selection process of high-priority sites for the control of lantana, which will offer the greatest benefit to high-priority assets (Chapter 3)
- objectives and actions to abate, ameliorate or eliminate the threat of lantana to high-priority assets across Australia, along with performance indicators for each (Chapter 4)

- implementation process for the Plan (Chapter 5), including Indigenous consultation; plans for site-specific management (see Figure 1.1); maintaining other areas that are presently free of lantana; and the economic and social implications of this Plan,
- monitoring required to assess the effectiveness of control programs at high-priority control sites, especially with respect to protecting assets (Chapter 6)
- a proforma for developing site-specific management plans (Appendix 1)
- legislation, programs and strategies relevant to lantana management with respect to the development of this Plan across the main infestations in NSW and QLD, and containment in other states (Appendix 2)
- high-priority environmental assets at risk from the invasion of lantana (Appendix 3).

1.8 Implementation

This Plan provides a framework for lantana control that will generate positive outcomes for the conservation of environmental assets within lantana infestations in NSW and QLD. The principal aim is to minimise the impact of lantana on threatened environmental assets and to prevent further assets from becoming threatened. This is to be achieved by:

1. developing a strategic framework for targeting lantana control to areas where the biodiversity benefits will be greatest
2. promoting best practice management
3. monitoring the effectiveness of control programs, in terms of the recovery of threatened biodiversity
4. fostering community education, involvement and awareness
5. identifying and filling knowledge gaps where possible.

A number of actions outlined in this Plan have already been implemented, partly with funding received from the Australian Government as well as with support from individual Natural Resource Management Regions (NRMs) or Catchment Management Authorities (CMAs). The main economic benefit of this Plan is that it provides a consistent framework for lantana management at high-priority control sites. Sites have been ranked based on the likelihood of success; therefore funds are allocated to areas where biodiversity outcomes are greatest.

By implementing this plan, a critical threat to biodiversity can be reduced and the condition and resilience of habitats enhanced. This is a key outcome in the Caring for our Country initiative (DEWHA and DAFF 2008).

1.9 Timeframe

It is recommended that the Plan be implemented over a five-year period from its adoption. At the end of the five-year period the Plan should be reviewed. Monitoring the effectiveness of the control programs at high-priority control sites is a core component of the Plan (see Figure 1.1), not just in terms of lantana control, but also in gauging the response of high-priority environmental assets to control. Data collected from these monitoring programs is critical in determining the success of this Plan, and in refining future control methods and priorities (Chapter 6).

2 Environmental assets at risk from lantana

2.1 Lantana as an environmental weed

Across NSW and QLD lantana is a serious environmental weed. For example, in NSW, Downey et al. (in press-a) ranked lantana second out of 341 weeds based on its current threat and level of impact to biodiversity. Coutts-Smith and Downey (2006) also identified lantana as the most commonly recorded weed threat for all rare and threatened species, with ten per cent of all listed threatened species in NSW at risk from the invasion of lantana. In addition, Batianoff and Butler (2003) ranked lantana as having the highest impact of all 66 priority invasive weeds of south-east QLD. This QLD study assessed the effects of weeds on wildlife recruitment; fire regimes; nutrient cycling; water oxygenation; poisoning or movement of wildlife, water or people; aesthetics; community structure; and social well-being.

Lantana invades both disturbed and undisturbed ecological communities (DECC 2007d) and is a transformer species (see Richardson et al. 2000 for the description of transformer weeds). For example, lantana can form dense stands that exclude native seedlings (Swarbrick et al. 1998), and can inhibit or reduce the germination, seedling growth and survival of native plants (Fensham et al. 1994, Gentle and Duggin 1997a, 1998, Sharma et al. 2005). Kooyman (1996) reported that lantana in rainforests could prevent the regeneration of native plants and halt succession following disturbance. In a woodland near Brisbane, Alcova (1987) reported a decreased density of plants in lower size classes in lantana-infested areas when compared to lantana-free areas, which suggests that lantana can affect the recruitment of species. Allelopathy is often considered the mechanism behind these impacts (Gentle and Duggin 1997a); however, competition for light and nutrients may also be important (Lamb 1988).

Each mature lantana plant can produce up to 12,000 seeds per year, which are readily dispersed long distances (up to 1 km or more) by birds and mammals (Swarbrick et al. 1998). Lantana can also spread vegetatively by layering, where horizontal stems take root if they are in contact with moist soil. Plants are long-lived and can survive prolonged dry conditions by becoming deciduous and then re-shooting after rain. Frost-affected plants can also re-shoot, and plants regrow quickly from basal dormant buds after fire (Swarbrick et al. 1998, QLD NRM & E 2004).

2.2 Review of current impacts and threats

A number of studies have been undertaken to determine the impacts of lantana. Some involved lantana removal experiments (see Adair and Groves 1998). For example, Thomas and Shaw (2007) reported the recovery of many native plants, including at least five rare and threatened species, following the removal of lantana in a national park in south-east QLD. Observations undertaken by land managers have also reported the recovery of native plants, such as Macleay (2004), who reported an increase in native plants following the removal of lantana at a site in northern NSW. Correlative studies have also been undertaken, such as the study by Fensham et al. (1994) within Forty Mile Scrub National Park in northern QLD, which established a reduction in plant species richness with increasing density of lantana. In a woodland near Brisbane, Alcova (1987) also found that numbers of native shrubs, saplings and trees were lower in lantana-infested areas compared to lantana-free areas. In addition, Lamb (1982) reported that native species richness declined following the invasion of lantana into eucalypt woodlands near Sydney. A recent report found that 96 species listed under the TSC Act in NSW were at risk from lantana invasion—significantly higher than previous estimates (Coutts-Smith and Downey 2006).

The abovementioned studies have defined the impact and threat of lantana at particular sites or areas, and within certain ecosystems, but to date there have been no broadscale studies undertaken across the full distribution of lantana; this is due to lantana being widespread and having invaded more than five per cent of the Australian continent (Sinden et al. 2004).

However, understanding the threats and impacts widespread weeds have on environmental assets across a weed's full distribution is necessary if strategic management of infestations within natural ecosystems is to occur (Turner et al. 2007). Therefore, given the extent of lantana across NSW and QLD, a full assessment on a national scale was warranted to identify, and hence protect, the (at-the-time unknown) assets at risk.

2.3 Identifying plants and animals at risk from invasion

The Weed Impact to Native Species (WINS) assessment process (Downey 2006) was used to select and prioritise environmental assets (native species and ecological communities) at risk from lantana. This process consists of four stages:

- a review of the literature
- collation and assessment of the knowledge from land managers, ecologists and botanists with specific involvement, either in managing lantana or the native species in lantana-infested areas
- evaluation and examination of an interim list of species potentially at risk
- ranking the revised list to determine what native species required urgent protection from lantana (see Downey 2006 for description of the WINS assessment).

Using this WINS procedure, the impacts and threats of widespread alien plant species can be efficiently assessed across their full distribution, to identify those native species at greatest risk (Turner and Downey in press). The results from this process can then be used to direct management to where the conservation need is the greatest (Downey et al. in press-b).

Stage 1 of the WINS process involved a literature review, which is summarised in Section 2.2, as well as a review of recovery plans and other threatened species information. This literature review revealed that 126 native plant species had previously been identified as threatened from lantana invasions in Australia (Turner and Downey in press)—83 of which were derived from one study (Coutts-Smith and Downey 2006). Previously, only five native animal species had been identified as threatened from lantana invasions in Australia (Alcova 1987, Coutts-Smith and Downey 2006, DECC 2007a and see PAS).

Stage 2 involved accumulating knowledge from local experts, which is extremely useful for obtaining species information, particularly in the absence of published information (Weeds CRC and Standards Australia 2006). Twenty workshops were held in NSW and QLD to determine the biodiversity at risk from lantana. A total of 199 participants attended these workshops. Participants included bush regenerators, landholders, council pest and environmental officers, threatened species and biodiversity officers, volunteers, QLD Parks and Wildlife and NSW DECCW staff, botanists and ecologists (Table 2.1).

During the workshops, participants were asked to identify and justify why they thought a particular species (plant or animal) was affected by lantana, using the impact codes listed in Table 2.2. Following a round-table discussion, if it was agreed that the species was at risk from lantana, it was then added to an interim list. During the discussions, one or more codes (Table 2.2) were assigned for each species identified.

As part of Stage 3 of the WINS procedure, each of the 20 interim lists of species were combined and circulated to a wider group of land managers and experts, who were then asked to comment on the inclusion of each species. To increase the total audience, this combined list was also placed on the DECCW website with instructions on how to comment and amend the list (see DECC 2007c). Before the combined list was circulated, additional information for each species identified was sourced, and included:

- the distribution of each species

- the NRM region in which each species occurred
- the functional group (or form) for each plant species or the class (or group) of each animal species
- the threatened status of the asset, as listed in state and Commonwealth threatened species legislation.

Table 2.1. Breakdown of the participants from 20 workshops.

Workshop participants	Number of people
Local government	45
QLD Environmental Protection Agency (now DERM)	41
Department of Environment and Climate Change (now DECCW)	39
Other state government agencies	16
Natural Resource Management (NRM)/Catchment Management Authorities (CMA)	12
Landcare	11
Non-government conservation organisations	11
Non-government bush regenerators	10
Individuals	9
University academics and CSIRO	5
Total	**199**

Table 2.2. Criteria used to support inclusion of species as being potentially impacted by lantana (modified from Downey 2006).

Impact	Code	Description
Negative	**NP**	The native species is **not present** in infested areas of that species' typical vegetation community or range. This can be determined by comparing infested and un-infested sites, as well as anecdotal or observational data about declines following invasion.
	D	There is clear evidence that lantana **displaces** the native species. For example, the native species occurs at lower than 'normal' densities in invaded sites, but is not totally out-competed or excluded. Displacement may also occur through indirect effects, such as changes in fire intensity.
	OCS	**Suppresses** the native species by reducing individual's vigour or reproductive output.
	RP	**Recruitment is prevented**—the adult population is at 'normal' or 'near-normal' density, but few or no juveniles are present.
	CAR	The native species is **considered at risk**, but more information is needed to determine the level of risk.
Positive	**AH+**	There is clear evidence that the weed provides an **additional habitat** for the native species. For example, the native species occurs at higher than 'normal' densities in invaded sites.
	P+	The weed **promotes** the native species by increasing individuals' vigour or reproductive output through such things as increased resources, providing food for animals or changes to soil characteristics.
Neutral	**N**	Animals have switched to utilising the weed as a result of native vegetation being replaced by lantana, but there has been **no change** in their overall density or condition.

The interim list of species was further verified by Gooden (2007) and Gooden et al. (2009b), who assessed the relationship between native plant diversity and lantana abundance in wet sclerophyll forests. Species richness and abundance declined with increasing lantana abundance. Gooden (2007) was able to verify the species identified to be at risk in wet sclerophyll forests with those identified in the WINS, and concluded that the WINS process is likely to be an efficient and accurate method to identify species impacted by lantana.

Using the first three stages of the WINS process, 1322 native plant species and 158 native animal species were identified as being threatened by lantana in Australia. The full list of species found to be threatened by lantana infestations can be found on the website www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm

Many of the plant species identified as being at risk (38%) were threatened due to their recruitment being prevented (see Table 2.2). Given that lantana can prevent the regeneration of native plants and halt succession following disturbance, while lantana is present at a site it will reduce or remove the resilience of these species and ecological communities. This will increase the level of threat of other processes, such as climate change, as the ability of the native vegetation to respond to, or recover from, these other threats will be reduced (for example see Alps to Atherton Initiative in Appendix 2).

2.4 Ranking plant and animal species

Determining the level of threat lantana posed for each asset was an important step in the development of this Plan. Stage 4 of the WINS process identified those native species most likely to increase in threatened status in the next five years (high priority), those that are under significant threat (medium priority) and those that are likely to persist with limited action in the next five years (low priority) (Turner et al. 2008a, Turner and Downey in press).

As mentioned above, this Plan aims to minimise the impact of lantana by:

- protecting native species and ecological communities listed under the threatened species legislation
- preventing further species and ecological communities from becoming listed under such legislation.

Therefore, species were prioritised according to the extent that their distribution overlapped with that of lantana, and also to the species' threatened status under threatened species legislation (Commonwealth EPBC Act, NSW TSC Act, or QLD *Nature Conservation Act 1992*—NC Act —see Appendix 2). Species with a high degree of distributional overlap with lantana were deemed less likely to survive the impacts of lantana than species with a lower degree of distributional overlap with lantana. Additionally, if the species was threatened (under the EPBC Act, NSW TSC Act or QLD NC Act), the likelihood of serious decline was high and species were classed accordingly (Turner and Downey in press).

2.4.1 High-priority species

High-priority species were estimated to be those most at risk and most likely to change to a higher threatened status in the near future (for instance, change from vulnerable to endangered or become eligible for listing). Species were identified as high priority according to the following criteria:

1. the distribution of the native species at risk had a high degree of overlap with lantana (that is, ≥ 90% overlap) and
2. the native species was listed under the TSC Act, the NC Act, and/or the EPBC Act; or the native species had the potential to be listed, through being documented in the

workshops as having experienced a decline in numbers due to lantana invasion (code NP or D—Table 2.2), and had a limited distribution.

There was one exception to this process. Animal species that were classed as a high priority, but also received a benefit from lantana (see Section 2.6), were placed into the lower medium category. As these species received both a positive and negative impact, it was thought that they were unlikely to change to a higher threatened status solely due to lantana in the near future. However, the Richmond birdwing butterfly (*Ornithoptera richmondia*) receives a benefit from lantana only as an adult, by sipping the nectar of lantana flowers, while juveniles are solely dependant on the native birdwing vine (*Pararistolochia praevenosa*) as a food source and cannot progress to metamorphosis without this plant. This native vine is a high-priority plant species, being at high risk from the invasion of lantana. Thus *O. richmondia* is considered a high priority, even though it receives a benefit from lantana as an adult.

This process revealed 277 of the 1322 native plant species identified and 24 of the 158 native animal species identified that required immediate protection from lantana invasions within Australia. In addition, one isolated population of the yellow-bellied glider (*Petaurus australis*) was also classed as high priority in Terrain NRM (although this species was given a medium ranking overall); and the endangered Nambucca Glycine (*Glycine clandestine*) population in Northern Rivers CMA was also listed as high priority (although this species was given a low ranking overall). The full list of high-priority species is listed in Appendix 3. The number of these high-priority species, across the 12 main NRM regions within Australia that have significant lantana infestations, is also presented in Table 2.3.

Table 2.3. Breakdown of the distribution of the high-priority species threatened by lantana within Natural Resource Management (NRM) regions.[1]

NRM region	No. of plant species	No. of animal species	Total no. of high-priority species
SEQ Catchments NRM	126	17	**143**
Northern Rivers CMA	121	15	**136**
Burnett Mary Regional NRM	84	10	**94**
Terrain NRM	66	7	**73**
Fitzroy Basin Association NRM	59	8	**67**
Condamine Alliance NRM	47	10	**57**
Reef Catchments NRM	48	7	**55**
Hunter/Central Rivers CMA	37	6	**43**
Burdekin Dry Tropics NRM	31	6	**37**
Hawkesbury Nepean CMA	29	5	**34**
Sydney Metro CMA	19	4	**23**
Southern Rivers CMA	15	4	**19**

[1]Note many species occur in more than one NRM region.

2.4.2 Medium-priority species

Medium-priority species were those considered to be under significant threat and were identified based on either of the following two criteria:

1. the native species at risk had a medium degree of overlap with lantana (between 40% to 89% overlap), and the native species was listed under threatened species legislation or had the potential to be listed, or
2. the native species at risk had a high degree of overlap with lantana (≥ 90% overlap), but was not currently listed under threatened species legislation and did not have the current potential to be listed (see Turner and Downey in press).

A total of 474 native species were classed as medium priority, being 413 native plant species and 61 animal species.

2.4.3 Low-priority species

The remaining species threatened by lantana were placed into the low-priority group. This accounted for 623 plant and 62 animal species. Ten additional plant species and 11 animal species could not be ranked as insufficient details were available. Examples of three native grass species for which lantana is either a high, medium or low threat are presented in Table 3.2.

2.5 Selecting and prioritising ecological communities at risk

In addition to identifying plants and animals threatened by lantana, ecological communities and Regional Ecosystems at risk were also determined. As with species at risk, ecological communities and Regional Ecosystems at risk were determined using the first three stages of the WINS process (Turner and Downey in press). Ecological communities are defined under the TSC Act as an assemblage of species occupying a particular area. The Regional Ecosystem approach is a classification system used in QLD and is defined by Sattler and Williams (1999) as vegetation communities within a bioregion that are consistently associated with a particular geology, landform or soil type.

Generally, riparian zones and wet sclerophyll forests in eastern NSW and QLD were identified as being most at risk from lantana invasion. Thirty-nine endangered ecological communities in NSW, listed under the TSC Act, and ten communities under the EPBC Act, were identified as being threatened by lantana invasions. In QLD, 407 Regional Ecosystems were identified as being at risk from lantana. The full list of ecological communities at risk from lantana infestations across these two states can be found on the website www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm

2.5.1 High-priority ecological communities

High-priority communities were determined by investigating the overlap of distributions of the community at risk with lantana (≥ 90% overlap), in the same manner as for high-priority species at risk. Unlisted communities, occurring only in a few isolated patches and identified in the workshops as being sensitive and highly susceptible to lantana invasion or able to be transformed by lantana (reduction in community integrity), were also classed as high priority.

Twenty-nine ecological communities in NSW are considered high priority, as well as 125 Regional Ecosystems in QLD (see Appendix 3).

2.5.2 Medium-priority ecological communities

A list of medium-priority ecological communities was compiled in the same manner as for medium-priority species at risk. Many of the listed threatened communities had lantana invasion only around their edges, as opposed to throughout the community. Other medium-priority communities were unlisted communities, occurring across large areas that had been identified in the workshops as being sensitive and highly susceptible to lantana invasion.

2.5.3 Low-priority ecological communities

The remaining communities not classified as high or medium were placed into the low-priority group.

2.6 Native animals that benefit from lantana

Information on species that benefit from lantana must also be taken into account so that they are not adversely affected during lantana control programs. Lantana is a food or habitat resource for a number of native animals. For example, lantana provides superb fairy-wrens (*Malurus cyaneus*) with a dense, protective understorey (Parsons et al. 2008); therefore, it is important that when control of lantana is undertaken, lantana is replaced by native plant

species to limit any detrimental effects. The criteria used to determine weed impacts were modified from those presented in the WINS system within Downey (2006) to determine the biodiversity that may benefit from the presence of lantana (see Table 2.2).

A total of 142 native animal species were found to benefit from the presence of lantana within Australia (Turner and Downey 2008). The major group of animals that was positively impacted upon, or switched to using lantana as habitat in the absence of native species, was birds (63%), followed by mammals (19%) (Table 2.4). A list of native species that benefit from lantana can be found at www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm These animals should be considered in site management plans (see Appendix 1) if they are present at a site where lantana is to be managed (see also Section 5.2).

Table 2.4. Number of native animal species benefiting from lantana.

Class (or group) of animals	No. of species positively affected
Mammal	27
Bird	90
Reptile	12
Amphibian	3
Invertebrate	10
Total	**142**

2.6.1 Bell Miner Associated Dieback

The bell miner (*Manoria melanophrys*) is a native honeyeater that was identified as a bird species that benefited from the presence of lantana. Bell Miner Associated Dieback (BMAD) is a significant threat to the sustainability of the moist eucalypt forests of NSW and south-eastern QLD (Wardell-Johnson et al. 2006). BMAD refers to eucalypt forest dieback that is associated with the occurrence of outbreaks of mainly psyllid species and colonies of the bell miner. Forests affected by BMAD are severely degraded with the loss of a significant proportion of overstorey species and subsequent invasion of the understorey by weeds, particularly lantana (DECC 2007d). Forest eucalypt dieback associated with over-abundant bell miners and psyllids has recently had a final determination as a Key Threatening Process under the TSC Act.

A key action in the BMAD Strategy is to implement lantana removal trial plots within areas affected by dieback (Bell Miner Associated Dieback Working Group 2004). This should promote a more complex native flora, and therefore links in with the objectives of this Plan for biodiversity conservation. Many species and ecological communities associated with BMAD are also high priority assets listed in this plan, including White Gum Moist Forest in the NSW North Coast Bioregion and the Blue Gum High Forest Ecological Community (see Appendix 3 - Table A3.3). Therefore sites containing both lantana and BMAD have been prioritised within this plan (see Table 3.3).

2.7 Interactions between lantana and invertebrates

Thirteen invertebrates, including three high-priority species, have been identified as being threatened by lantana through the WINS process. However, some species, such as the native reed bee (*Exoneura* sp.), benefit from lantana as they can nest in the stems. The adults of the Richmond birdwing butterfly also receive a benefit, as discussed in 2.4.1. However, litter invertebrates do not appear to be impacted, with lantana infestations maintaining litter invertebrate communities with similar composition to those found in surrounding lantana-free communities (Rees 1998). No differences in the composition or overall abundance of litter invertebrates have been reported between lantana-infested and un-infested areas of wet

sclerophyll forests or rainforest near Wollongong (Rees 1998). However, higher numbers of springtails (collembola) and mites were observed in ground litter at lantana-free sites in tall open woodland and forest in Brisbane compared with infested sites (Traby 1986 cited in Swarbrick et al. 1995). In addition, more than 50 species of mites can be found on lantana in QLD, including three species that are exotic pests (Walter 1999).

2.8 Other exotic species present at lantana sites

As many exotic species can co-occur (Simberloff and Von Holle 1999), details of exotic plants and animals associated with lantana were also recorded during the WINS workshops (see Section 2.3). Given that weed substitution can occur if a single weed is targeted for control (Turner and Virtue 2006, Thomas and Shaw 2007, Reid et al. 2008, Turner et al. 2008c), participants were asked to identify other weed species that co-occurred with lantana, or weeds that replaced lantana following control (Turner and Downey in press). Not all weeds were recorded, only those that the participants thought would be equally or more difficult to control, or those that could form a barrier to the recovery of environmental assets following the control of lantana. In this group, participants nominated 144 weed species (Turner and Downey in press). The full list of weed species can be found on the DECCW website: www.environment.nsw.gov.au/lantanaplan/OtherExotics.htm. The most frequently cited species are listed below (Table 2.5). These other weed species will need to be considered if present in or near a site where lantana is to be managed, and documented within the site management plan (see Appendix 1).

Lantana was also identified in the workshops as providing shelter for pest animals, including foxes, rabbits and cats (Table 2.6). For this reason, it was suggested that lantana hindered the control or removal of these pest species from native areas. The exotic honey bee (*Apis mellifera*) also utilises lantana and may benefit lantana through increased pollination of its flowers; this may have assisted lantana in invading native areas (Goulsen and Derwent 2004). In total, 21 pest animals were identified as benefiting from lantana (Turner and Downey in press).

Many native animals also use lantana for protection from exotic predators (see Section 2.6). Therefore control of lantana may also place these native species at further risk. If foxes or cats are present at the site, they will need to be considered and possibly managed at the same time as lantana, and documented in the site management plan (see Appendix 1).

Table 2.5. The most frequently cited weed species that would be equally or more difficult to control or could hinder the recovery of environmental assets if weed management is targeted solely at lantana.

Scientific Name	Common Name	No. of workshops cited
Anredera cordifolia	madeira vine	10
Ageratina adenophora	crofton weed	9
Ipomoea indica	morning glory	9
Macfadyena unguis-cati	cat's claw creeper	8
Ligustrum sinense	small-leaved privet	7
Panicum maximum var. *maximum*	Guinea grass	7
Solanum mauritianum	wild tobacco	7
Araujia sericifera	moth vine	6
Ipomoea cairica	five-leafed morning glory	6
Ochna serrulata	mickey mouse plant	6

Table 2.6. The most frequently cited pest animals that utilise lantana, or where control of pest animals is hindered by the presence of lantana.

Pest Animal	No. of workshops cited
Fox	13
Rabbit	12
Cat	11
Pig	10

3 Prioritising sites for lantana control

It has been suggested that targeting those environmental assets with the highest probability of extinction is not the most efficient way of promoting recovery, given that some assets may require a large amount of recovery effort with limited chance of success (Possingham et al. 2002). Therefore, alongside the list of ranked environmental assets, as detailed in Chapter 2, a second step in the development of this Plan involved ranking sites based on the likelihood of successful lantana control and the potential of high-priority environmental assets to recover (Downey et al. in press-b). This process allows for an efficient use of resources by prioritising sites where control is achievable and where there is a high likelihood of protecting the assets most at risk.

3.1 Selecting sites

Site information was collected from land managers, who attended workshops, and numerous others who responded to calls for nominations. A site is defined here as a natural area that is the focus of a program to protect native species and communities. It may be an entire reserve, or a defined subset of a larger area that is too big to manage as a whole, (or management unit as defined by Owen 1998).

The list of environmental assets at risk from lantana (see Chapter 2) provided the basis for this step of selecting sites. Site nominations usually contained at least one high-priority species or ecological community and were nominated irrespective of land tenure. Nominations were via a template located on the DECCW website: www.environment.nsw.gov.au/lantanaplan/sites.htm

Additional site nominations were collected from land manager's offices throughout QLD and NSW. Although 442 sites had been nominated and assessed as at 31 March 2009, it is acknowledged that the list of sites presented on the website is not definitive (see www.environment.nsw.gov.au/lantanaplan/sites.htm), as some locations may have been inadvertently overlooked, especially if not nominated by specific land managers. Therefore, sites can still be nominated after the publication of this document via the website, and ranked using the method below.

3.2 Site ranking process

The full site ranking process is detailed in Figure 3.3 (these methods have been modified from DEC 2006a, Downey et al. in press-b). This process aimed to ensure that control will be undertaken in areas where the outcomes will have the greatest benefit for biodiversity while ensuring efficient use of resources. Firstly, sites were ranked based on the following five criteria (relating to assets at the site):

- the ability to achieve **effective** lantana control at the site
- the degree of **impact** of lantana on assets at each site
- the **condition** of the asset present
- the **site importance** to the asset's overall survival
- the presence of **other threats** to the asset at the site.

By assessing sites using these criteria, this strategic plan will deliver on-ground benefits by targeting areas where lantana control will best protect environmental assets.

When nominating a site, land managers were asked to assign a high, medium or low rating to each of the five criteria listed above, with respect to each priority environmental asset found at their site. For consistency, ratings such as high, medium and low were accompanied by clear definitions and examples to reduce subjective variation between land managers (Weeds CRC and Standards Australia 2006). These definitions were placed on the website next to the site nomination template and have been reproduced below.

3.2.1 Effective control

The ability to achieve **effective** lantana control at a given location was based on the feasibility of removing lantana at the site while minimising off-target impacts, particularly with respect to protecting the environmental assets at risk. The assessment range included:

High: site easily accessible, lantana infestations easily controllable, with no adverse impacts to the assets at risk.

Medium: (i) site access difficult or expensive but lantana infestations easily controllable with no adverse impacts to the environmental assets at risk; or,
(ii) site easily accessible but lantana infestations difficult or expensive to control, especially with respect to the environmental assets at risk.

Low: site access difficult, lantana infestations difficult or expensive to control, especially with respect to the environmental assets at risk.

3.2.2 Impact

As the impact of lantana on the environmental assets at risk will vary from site to site, the degree of **impact** at each site also needed to be considered. Two different criteria were used to account for variation in impacts between native plants and animals. The level of the lantana infestation present at the site, and its proximity to the environmental assets at risk, form the basis for this attribute. At some sites, lantana may pose a threat to the species at risk in the future, so is considered a 'potential impact'. A potential impact is where lantana currently poses a threat to species, but has no current impacts, although it could affect those species in the future (see Downey et al. in press-b for further information on differences between threats and impacts).

Native plant species at risk

The assessment range for native plant species included:

High: lantana poses a direct impact to the plant species at risk and is growing within/over the species at risk.

Medium: lantana poses a reduced impact to the species at risk or threatens the native species in that it is within close proximity to lantana (growing next to the species at risk).

Low: lantana poses only a low threat to the plant species at risk (lantana is a distance away from the species at risk so that there is no immediate threat, but could still pose a threat in the short-term).

Native animal species at risk

The assessment range for native animal species included:

High: lantana poses a direct impact to the animal species at risk (displacing animals by restricting their movements); or indirectly through lantana out-competing native plants that provide a source of food, or by lantana negatively altering the native habitat that these animals utilise.

Medium: lantana poses a reduced impact to the species at risk or threatens the native species when in close proximity to lantana (growing next to the species at risk), with lantana invading the species' habitat or altering the structure of the habitat.

Low: lantana poses only a low threat to the animal species at risk (lantana is a distance away from the species at risk so that there is no immediate threat, but could still pose a threat in the short-term).

3.2.3 Condition

The **condition** of the environmental assets at risk was determined based on the population health of the individuals at each site. Again, to account for variation between plants and animals at risk, two different criteria were used. Where adult and juveniles do not co-occur within a species, the health of the individuals present was assessed.

Native plant species at risk

The assessment range for native plant species included:

High: majority of individuals within the population are healthy. There is a mix of age classes (seedlings through to adults).

Medium: mixture of sick/dying and healthy individuals and/or a poor age structure (few seedlings and mostly adults).

Low: majority of individuals sick/unhealthy. There is a limited age structure (no seedlings).

Native animal species at risk

The assessment range for native animal species included:

High: majority of individuals within the population are healthy. There is a mix of age classes (juveniles through to adults).

Medium: mixture of individuals in poor condition through to healthy individuals. There is a poor age structure (few juveniles).

Low: majority of individuals are in poor condition. There is a limited age structure (only adults present with no offspring).

3.2.4 Site importance

The value of the site to the environmental assets' overall survival was also considered. Factors taken into account included the size of the population (for example, few or many individuals) in relation to its natural occurrence (some species only occur in small populations). To account for climate change, whether the environmental asset occurs at a site at the edge of its range or whether the site is an important corridor for the native animals at risk were also considered. To account for the variation between plants and animals at risk, different criteria were again used.

Native plant species at risk

The assessment range for native plant species included:

High: the site has one of the largest known populations or is important for the species (for example is an outliner population or an important corridor).

Medium: smaller or larger populations known elsewhere; important but not critical for the species survival.

Low: few individual plants only at the site, with larger populations elsewhere; site not important for the species survival.

Native animal species at risk

The assessment range for native animal species included:

High: the site has one of the largest known populations or is important for the species (for example an important corridor or breeding site).

Medium: smaller or larger populations known elsewhere; habitat important but not critical for the species survival.

Low: few individuals only at the site, with larger populations elsewhere; site not important for the species survival.

3.2.5 Other threats

The presence of **other threats** to the environmental assets, which may affect the success of the lantana control program in the recovery of these assets, was also considered. Reduction of all other threats is outside the scope of this Plan, with the exception of other weeds that pose a similar threat. This criterion also indicated the level of resilience of a site, and ranked sites that had a high level of resilience highly, given that these sites would have a greater ability to respond to, and recover from, future disturbances. The assessment range included:

High: lantana poses the main or only threat. Other weeds present are easily controlled or are at low densities.

Medium: some minor threats present, which will still be active after lantana control. Other weeds present are as difficult as lantana to control.

Low: significant threats and impacts other than lantana present (for example, land clearing), which will still be active after, or irrespective of, lantana control. Other weeds present more difficult to control than lantana.

3.3 Probability of protecting assets through lantana management

To determine the probability of protecting individual environmental assets at specific sites through lantana management, a simple additive model was used. This model was modified from the NSW Bitou Bush TAP (DEC 2006a) and involved using the assessment scores for the above five criteria (see Section 3.2). Land managers were asked to assign a high, medium or low rating to each of the five criteria, although some managers provided intermediate scores such as high/medium or could not answer all of the five criteria. Each criterion was scored, based on this subjective assessment, for each environmental asset at each site (see Sections 3.2.1 to 3.2.5), by converting the responses to a numerical value (Table 3.1).

Table 3.1. Numerical values assigned to assessment scores for each criterion.

Subjective assessment for each attribute	Numerical value
Low or unknown	1
Low/Medium	2
Medium	3
Medium/High	4
High	5

The numerical value for each of the five criteria was then used to rank the individual assets at a site.

Site score = (effective control x 3) + (impact + condition + site importance) + (other threats x 3)

The site score pertains to the probability/likelihood of protecting an individual asset (a species, population or community) at a specific site through weed management. Additional weighting was applied to the criteria relating to ability to achieve control and the presence of other threats. As this Plan involves protecting environmental assets through lantana control, the ability to achieve effective control (which includes minimal off-target damage to the asset in question) was considered of high importance and was weighted by a factor of three. In addition, if other threats to the asset in question were at the site (and would remain after control), little would be gained through solely managing lantana, as other threats would remain; therefore, this criterion was also weighted by a factor of three.

The above additive model allows for a maximum ‘score’ of 45 and a minimum of nine. A site score divided by the maximum of 45 was then considered the probability of protecting an individual asset at the specific site through lantana management.

Each site score was assigned an overall value of low, medium or high based on the following division:

- **low—**if an asset scored between 9 to 26 (<60% probability of successful protection through weed control alone)
- **medium—**if an asset scored between 27 to 38 (60 to 85% probability of successful protection)
- **high—**if an asset scored between 39 to 45 (>85% probability of successful protection).

Examples of high, medium and low priority sites are provided in Table 3.3.

3.4 Categorising sites for control

To ensure efficient use of resources, management needs to focus on areas where the outcomes from lantana control offer the greatest benefit to high-priority assets, based on the:

- likelihood of achieving control
- recovery of high-priority assets.

Therefore, the abovementioned two steps of determining the level of threat to environment assets (see Section 2.4 for native species and 2.5 for ecological communities) and determining the probability of successful protection of an asset through weed control alone at specific sites (see Section 3.3) were combined into a two-way matrix to categorise sites for control.

As discussed above, each asset was assigned a high, medium or low priority. A high, medium or low category was also determined based on the probability of protecting a species or community through lantana management at specific sites. Combining ranked assets and a site score in the below matrix provided nine categories for control or a triage number (see Figure 3.1, where category one is the highest priority for lantana control).

Individual asset[#]	Site score[*] High	Site score[*] Medium	Site score[*] Low
High	1	2	5
Medium	3	4	6
Low	7	8	9

Figure 3.1. Nine possible control categories or triage numbers for each asset at a nominated site.
*see Section 3.3 for determining a site score.
[#]see Section 2.4 for ranking of species at risk and 2.5 for ranking of communities

Category one is the highest priority for lantana control, based on a single high-priority asset being at a site where there is a high likelihood lantana control will result in the recovery of the asset. At these sites, control is urgent and is most likely to result in significant biodiversity conservation outcomes. In addition, control of lantana at these sites is expected to have biodiversity benefits beyond reducing, abating or ameliorating the threat to the high-priority environmental asset identified here, by protecting lower priority assets or those not identified in this Plan.

A total of 414 nominated sites were assessed through this process. There were another 28 nominated sites that could not be assessed, as further information from the sites was required.

3.4.1 Multiple assets at a site

Each priority environmental asset nominated for a site was assigned a high, medium or low category for the five site criteria (see Section 3.2). This meant that all assets nominated by a site manager for a particular site were dealt with individually in the above matrix, thus multiple matrix values were possible for a site. Therefore, each site was placed into one of the nine control categories based on the highest ranked asset (Figure 3.3).

This two-way matrix, which combines environmental assets and site priorities, yields an overall management priority and management approach. The triage matrix utilised here (see Figure 3.2) ensures efficient use of funds and that the limited resources available for lantana management will result in real benefits to the most at-risk assets (Turner et al. 2008a). Figure 3.2 details the nine management categories, with each of the nine cells describing the management context and priority represented in the triage system (Downey et al. in press-b).

Probability of protecting the asset at a specific site

Current level of threat to asset	High	Medium	Low
High	**1—**Lantana management is critical, immediate, targeted, and if long-term is likely to result in biodiversity recovery.	**2**—Targeted management action needs to occur promptly and over the long-term.	**5**—Broader management with other restoration (specific to assets) or reduce lantana spread.
	e.g. species A at site 1a	e.g. species A at site 2	e.g. species A at site 3a
Medium	**3**—Targeted management to minimise the threat over the long-term.	**4**—General management to reduce the impact of lantana.	**6**—General low-level management to reduce the threat.
	e.g. species B at site 1a	e.g. species B at site 2	e.g. species B at site 3a
Low	**7—**Actions to minimise the threat and prevent further elevation of the problem.	**8**—Low level of management only.	**9—**No immediate action, management action required; only after completion of higher priorities.
	e.g. species C at site 1a	e.g. species C at site 2	e.g. species C at site 3a

Figure 3.2. Triage matrix for the strategic management of widespread weeds for the protection of biodiversity. Examples of the species (Table 3.2) and sites (Table 3.3) as determined from the two-step assessment process (modified from Downey et al. (in press-b); Hobbs and Kristjanson (2003); Parker et al. (1999)).

3.4.2 High-priority control sites

'High-priority control sites' were selected if they fell within control category one or two (see Figures 3.1 and 3.2). A total of 325 nominated sites fell within this group (see full list of sites at www.environment.nsw.gov.au/lantanaplan/sites.htm). Sites in this group were then sub-ranked by the number of category one matrix values (Figure 3.1) for each asset at the site. Sites with the highest number of environmental assets in category one were ranked highest (based on the premise that lantana control would benefit a greater number of high-priority assets) (Figure 3.3).

Table 3.2. Examples of native species for which lantana is either a high, medium or low threat (see Section 2.4), and the justification for each threat ranking (see Figure 3.2).

High	**Species A**—*Arthraxon hispidus*: (i) >90% overlap of its distribution with that of lantana; and (ii) listed as vulnerable under the EPBC, NC and TSC Acts.
Medium	**Species B**—*Panicum pygmaeum*: (i) >90% overlap of its distribution with that of lantana, despite being widespread in all NRM regions heavily invaded by lantana; and (ii) not listed as threatened.
Low	**Species C**—*Themeda australis*: (i) widespread with at least 90% of its distribution outside of lantana's; and (ii) not listed as threatened.

Table 3.3. Examples of high-, medium- and low-priority sites that have been invaded by lantana (as determined from methods in Section 3.3).

High	**Site 1a**: Easily accessible, lantana is controllable, and control results in no adverse impacts to the species at risk. Lantana is the main threat and is currently impacting on the species at risk. The population at risk is in good condition and is one of the largest known populations. **Site 1b** (BMAD example): A site where BMAD occurs in combination with lantana, which still has the resilience to rebound following lantana control. Easily accessible, lantana is controllable, and control results in no adverse impacts to the species at risk. These are BMAD areas that would most benefit from lantana control in the short-term and lantana control alone would significantly improve biodiversity values (see Section 2.6.1 for specific details on BMAD).
Medium	**Site 2**: Site is very steep and difficult to access. Lantana is the main threat and is currently impacting on the species at risk, but the population size of the species at risk is small and healthier populations occur elsewhere.
Low	**Site 3a**: Site is difficult to access and control of lantana could adversely affect the species at risk. There are feral pigs at the site and lantana is only currently at the margins of the population at risk. The population at risk has poor age structure and there are larger populations of the species elsewhere. **Site 3b** (BMAD example): A site where BMAD is in such an advanced state that substantial regeneration work would be required to rehabilitate these areas (so lantana control alone would not significantly improve biodiversity values).

3.4.3 Ensuring the greatest number of high-priority assets are protected

Although control of lantana at any of the 325 high-priority control sites is likely to result in recovery of threatened assets and the abatement of the lantana threat, the high-priority control sites were further sorted by the variety of the high-priority assets present at a site (Figure 3.3). This within-group ranking takes into account the high-priority environmental assets found at higher ranked sites and aims to ensure that the greatest number of assets is conserved at the minimum number of sites. This is achieved by ranking sites on the basis of the greatest number of *new* (unique) high-priority assets present at the site—that is, an asset not previously captured in a higher site (a method described in DECC et al. 2009). This was done so that the highest ranked sites contained the greatest variety of high-priority assets. This should ensure that management is directed to sites with different assets, as opposed to managing multiple sites that have the same assets.

Not all high-priority environmental assets identified in this Plan were found at control category one sites. Sites with high-priority assets not present in category one, but present in category two, were also placed within the 'high-priority control group'. At the category two sites, there is only a medium probability of protecting these assets through lantana management alone; however, these sites still represent the best-known location. Therefore, once all the available high-priority assets were accounted for twice in category one sites, sites with *other* high-

priority species, or communities from category two, were ranked immediately after this subset of category one sites. The first round identified 149 high-priority control sites. Once all the high-priority assets at sites in category one and two were captured at least twice (twice to account for stochastic events), the whole process was repeated for the remaining sites in category one and two.

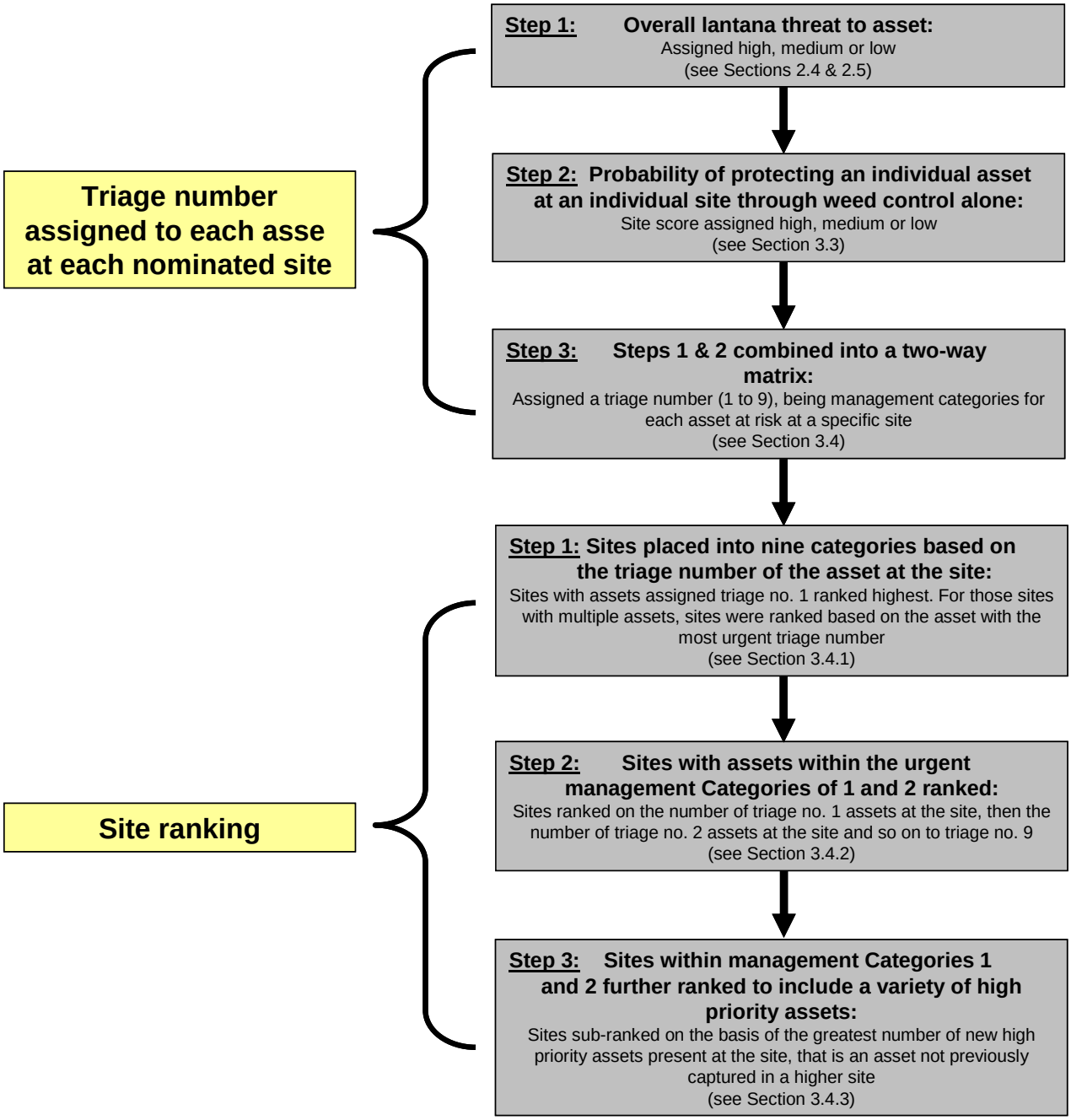

Figure 3.3. The site ranking process. These steps were developed so that the highest ranked sites contained the greatest variety of high-priority assets. This way, management can be directed to sites with different assets, as opposed to managing multiple sites that have the same assets.

This method increased the maximum number of high-priority assets that could be conserved within a small number of sites, as well as representing the high-priority assets at a minimum of two sites (as long as two or more sites were nominated that contained the high-priority asset). The rationale behind this ranking procedure stems from systematic reserve selection procedures (Wessels et al. 1999), which aimed to identify priority areas that complement one

another in terms of their contribution towards protecting regional biodiversity, while ensuring that minimal land allocation was required. That is, the largest number of environmental assets are conserved within the smallest number of sites (see DECC et al. 2009 for further explanation). If control is undertaken across the top group of 149 high-priority control sites, it should help in the protection of 237 of the high-priority assets identified in this plan (see www.environment.nsw.gov.au/lantanaplan/sites.htm). These sites urgently require control measures to be implemented; failure to implement control is likely to lead to a negative change in the conservation status of the high-priority species and communities.

As there was a group of high-priority assets that had not been recorded at any of the previously nominated sites, additional sites that contain these assets should be nominated. So that these additional sites can be assessed, nominations can be made via a template on the DECCW website (www.environment.nsw.gov.au/lantanaplan/sites.htm). New sites nominated will be forwarded to members of the National Lantana Management Group for ranking in the future.

3.4.4 Other sites for control

To meet the objectives of this Plan, control should not be initially directed at sites that fall within control categories three to nine (see Figure 3.1 and 3.2 and the list of sites in each category at www.environment.nsw.gov.au/lantanaplan/sites.htm). However, it is anticipated that individual landholders/managers will undertake control at category three to nine sites that are significant at a regional or local level. Any control programs at these sites will have broader biodiversity benefits for a wide range of species, populations and ecological communities, although there will be fewer benefits at sites that have a low probability of protecting biodiversity (that is, sites that fall within the far right-hand column of Figure 3.2).

Category five sites (see Figure 3.2) also contain high-priority assets. However, at these sites, lantana control on its own would probably not be sufficient to protect the high-priority assets. Broader actions to protect high-priority assets at these sites may be needed beyond lantana management, and sites within categories one and two should take precedence over control category five. For example, a category five site may be a remnant of a high-priority, endangered ecological community situated near a residential area that may be threatened by lantana, trampling, pollution and rubbish dumping. Carrying out lantana and other weed control alone would not prevent this remnant from being further degraded (DECC 2007b). An integrated approach would need to be adopted at this site, including control of stormwater, restriction of access, and education of surrounding residents (DECC 2007b).

4 A strategy to protect environmental assets

4.1 Background

Currently, resources are insufficient to control lantana effectively in all areas in which it occurs. In order to utilise resources effectively, control and management efforts need to be focused on areas where the benefits will be maximised. This Plan concentrates on identifying those environmental assets (species or ecological communities) that are at the greatest risk from lantana. The identification of such assets is then used to establish priority sites for control. It is also important to remember that control is needed for reasons other than biodiversity conservation. For example, control may also be necessary for the protection of primary production areas, and access to roads and fire trails; however, these issues are not directly addressed in this Plan.

The main objective of this Plan is to prioritise lantana control to areas where the outcomes of such control will be most beneficial to native biodiversity, particularly, but not exclusively, for threatened environmental assets. The effectiveness of control programs will be measured through comprehensive monitoring programs.

A core component of this Plan is the coordination of control programs across different land tenures and land management organisations throughout NSW and QLD. This Plan does not aim to replace or reduce existing priority control programs identified in national, state and regional strategies. For example, carrying out lantana control in lightly infested areas, where further spread and/or an increase in density is prevented, is very cost-effective and should continue. In addition, it must be noted that this Plan is not a recovery plan. The aim of this Plan is to reduce one specific threat that is acting on many threatened entities, whereas a recovery plan aims to reduce the major threat/s to one species/entity.

4.2 Objectives and actions

This Plan has seven objectives, listed in Table 4.1, and the following Sections outline the strategies to be used to achieve these objectives. A summarised list of actions for each of the objectives is also given in Table 4.2.

Table 4.1. Lantana Plan objectives

No.	Objective
1	Ensure that lantana control is undertaken in areas where the benefits to high-priority environmental assets are greatest.
2	Ensure that lantana control is undertaken at, and outside of, containment lines.
3	Evaluate the effectiveness of control programs at high-priority control sites with respect to the response of environmental assets.
4	Ensure that stakeholders and the general public are involved/participate at high-priority control sites, by raising awareness of this Plan and the threat lantana poses to environmental assets.
5	Ensure implementation and administration of this Plan is undertaken.
6	Evaluate the ways in which lantana causes the decline of environmental assets and determine the effects of lantana control on these assets.
7	Establish guidelines for future control programs and research projects based on the outcomes of this Plan

4.3 Objective 1: Priority lantana control programs

Objective 1	**Ensure that lantana control is undertaken in areas where the benefits to high-priority environmental assets are greatest.**

4.3.1 Action 1.1

Action 1.1	Key stakeholders will liaise with and encourage landholders and land managers to undertake lantana control programs at high-priority control sites across all land tenures. In addition, key stakeholders will undertake lantana control programs at high-priority control sites on their estate and will seek agreement from other landholders to ensure lantana control programs are undertaken at other high-priority control sites.

The list of high-priority control sites and the biodiversity at risk within these sites are presented on the DECCW lantana website: www.environment.nsw.gov.au/lantanaplan/sites.htm.

Although control is already occurring at some high-priority control sites, the objectives of many of these programs are different from those outlined in this Plan. For example, many programs simply aim to control lantana over the entire site rather than focusing on alleviating the lantana threat from around the environmental assets at risk. Thus, site-specific management plans will be used to help re-align the objectives of such control programs with the objectives of this Plan (see Action 1.2 below).

Performance indicator for Action 1.1

- Control programs will be established at 50 high-priority control sites within two years.

4.3.2 Actions 1.2 and 1.3

Action 1.2	At high-priority control sites, key stakeholders will help to develop and implement site-specific management plans for lantana control programs, based on currently available best practice guidelines. Key stakeholders will work with landholders that agree to Action 1.1 to develop site-specific management plans.
Action 1.3	Indigenous communities will be encouraged to assist with the development of site-specific management plans.

Site-specific management plans are required for all high-priority control sites. Each plan will follow the framework established in Chapter 5, and should be completed using the proforma presented in Appendix 1.

Indigenous people/communities are encouraged to participate in the development and implementation of the Site Management Plans. In the first instance, Indigenous people's/communities' views should be considered during the development of site-specific management plans, especially relating to cultural values of sites, species, populations and ecological communities, as well as potential impacts that may arise from control.

Performance indicators for Actions 1.2 and 1.3

- Site-specific management plans to control lantana will be developed for 50 high-priority control sites within two years.
- Indigenous people are involved in the development and implementation of site-specific management plans.

4.4 Objective 2: Containment lines

Objective 2	**Ensure that lantana control is undertaken at and outside of containment lines.**

4.4.1 Actions 2.1 and 2.2

Action 2.1	Key stakeholders will continue to promote the control of lantana at and beyond the containment lines in northern Queensland and southern New South Wales, and to promote lantana removal in other states.
Action 2.2	National Lantana Management Group to investigate the possibility of establishing new containment lines in strategic areas on the western distribution of lantana in northern New South Wales and Queensland to prevent further spread westward.

Commitment to containment lines is crucial in limiting future impacts to biodiversity. Lantana control north of the northern containment line and south of the southern containment line is a priority. It will also be important to maintain controlled areas and prevent recruiting plants from seeding, and to determine the success of the program by assessing the level of recruitment within these areas.

Performance indicator for Actions 2.1 and 2.2

- ► The presence of lantana beyond the containment lines and in other states is kept to a minimum throughout the duration of the five-year period of this Plan.

4.5 Objective 3: Monitor the effectiveness of lantana control programs

Objective 3	**Evaluate the effectiveness of control programs at high-priority control sites with respect to the response of environmental assets.**

4.5.1 Action 3.1

Action 3.1	Key stakeholders will encourage and coordinate the monitoring of lantana control programs at high-priority control sites.

The primary objective of this Plan is to reduce the impacts of lantana on high-priority environmental assets. To achieve this objective, the threat of lantana will need to be reduced. Although control programs may result in visible or obvious reductions in the density of lantana, this may not necessarily correlate with a reduction in threat or a positive response from the assets at risk. Therefore, it is important to undertake an evaluation of the control program(s) to ensure success in achieving biodiversity conservation outcomes. Such evaluations must consider:

- the effectiveness of the control programs on lantana infestations (including re-infestation rates of lantana)
- the response of the priority assets to the control of lantana
- the response of other environmental factors, including weeds to the removal and/or the control of lantana.

Information on the monitoring process is outlined in Chapter 6 (also see Commonwealth of Australia 2009) and specific monitoring protocols for native fauna will be developed in the future.

Performance indicators for Action 3.1

- ► Initiate monitoring programs at 50 sites to measure the response of priority assets and non-target species (including other weed species) to lantana control, using the tiered approach to monitoring (discussed in Section 6.1), within two years of the publication date of this Plan.
- ► Establish monitoring protocols for native fauna within five years of the publication date of this Plan.
- ► Maintain commitment to undertaking the monitoring programs established over the course of this Plan.
- ► Collate, analyse and report on monitoring programs.

4.6 Objective 4: Public involvement and awareness

Objective 4	**Ensure that stakeholders and the general public are involved/participate at high-priority control sites, by raising awareness of this Plan and the threat lantana poses to environmental assets.**

4.6.1 Actions 4.1, 4.2 and 4.3

Action 4.1	Key stakeholders and other agencies will encourage public involvement and ownership of programs at priority sites.
Action 4.2	Key stakeholders and other agencies will undertake public awareness programs on the impacts of lantana, especially to biodiversity, and the importance of its control.
Action 4.3	Key stakeholders will continue to provide and seek further information for this Plan (for example further site nominations).

In line with the Australian and State Governments' commitment to community involvement in natural resource management, this Lantana Plan encourages community involvement at all sites, not just those in the high-priority group. Public understanding of the issues involved with environmental weeds has increased in recent years through initiatives like *Weed Busters* and Australia's *Weeds of National Significance*. It is extremely important that public awareness of weeds, and their impact on biodiversity, is maintained, especially for environmental weeds like lantana. It is also important to know which groups are undertaking lantana control to:

- provide training and guidance, where needed, to achieve wider implementation of the Plan
- identify those high-priority control sites that require the support of additional volunteers and/or other resources.

Performance indicators for Action 4.1, 4.2 and 4.3

- ► Establish a database of those who are working/volunteering at high-priority control sites, and monitor their progress at regular intervals during the life of this Plan.
- ► Produce a poster, fact-sheet and web page for this Plan, and place signage at selected high-priority control sites.
- ► Further sites are nominated and prioritised (see Section 3.1), and land managers, at sites deemed to be high-priority control sites adopt this Plan.
- ► Publicise significant events in lantana management to the general public and provide regular updates, especially at sites considered to be high-priority to the National Lantana Management Group.

4.7 Objective 5: Lantana Plan Coordinator

Objective 5	**Ensure implementation and administration of this Plan is undertaken.**

4.7.1 Action 5.1

Action 5.1	Key stakeholders will seek support for a position to coordinate the implementation of the Lantana Plan.

Full implementation of this Plan will require the establishment of lantana control programs at high-priority control sites across a range of land tenures and environments throughout NSW and QLD. Once established, coordination of these sites will be needed for five years in order to achieve the Plan's objectives and to ensure that biodiversity outcomes are achieved through national coordination and implementation.

Links to TAPs, recovery plans and the PAS should also be established, and the design, implementation and analysis of experiments to measure the responses of priority environmental assets to lantana control at the high-priority control sites will need to be undertaken. Given the scale of these actions, it is essential that a coordinator be appointed to effectively implement this Plan. The specific role of the Lantana Plan Coordinator would be to:

- coordinate the implementation of lantana control at high-priority control sites (including guidance, where needed, for private landholders and other stakeholders, and the development of site-specific management plans)
- liaise with landholders to ensure commitment is maintained at high-priority control sites for the five-year Plan duration
- collect and rank future site nominations
- establish and implement a protocol for monitoring the effectiveness of control programs at high-priority control sites
- liaise with research organisations to establish the effect of various herbicides on non-target plant species, and the impact and control of lantana on fauna (including supervision of postgraduate students and development of experimental protocols)
- liaise with training providers and/or regional stakeholders to maintain community support and to increase the capacity of volunteers
- collate and analyse monitoring and expenditure data collected through the implementation of the Plan, especially with regard to improving best practice methods, and report results
- prepare a revised plan after five years of the date of commencement of this Plan
- perform day-to-day administration of the Plan, including maintaining the project website and providing regular program reports to the National Lantana Management Group, DECCW (including licensing requirements relating to work undertaken near threatened species), Biosecurity Queensland, and other stakeholders.

Performance indicators for Action 5.1

- ► A position is established, following the endorsement of this Plan, to coordinate its implementation.
- ► The Plan is reviewed and revised after five years of the date of its adoption.

4.8 Objective 6: Impact of lantana invasions on environmental assets

Objective 6	**Evaluate the ways in which lantana causes the decline of environmental assets and determine the effects of lantana control on these assets.**

4.8.1 Action 6.1

Action 6.1	Key stakeholders will foster research into the decline in native plant species as a result of lantana invasions.

The mechanisms whereby weed invasions cause declines in native plants are not clearly understood (Levine et al. 2003). Native species respond in a range of ways to plant invasions, including rapid extinction, slow decline, persisting at lower densities, or surviving only in the seed bank. It is also not clear at which life stages lantana causes the most impact, and such information would inform better management decisions, both strategic and local.

The patterns observed at particular sites are also dependent on the length of time the weed species has occupied the site. The issue of ecosystem repair after weed control should also be considered, given that many ecosystems that have been invaded for a relatively long period cannot recover following weed control without additional restoration (Richardson and van Wilgen 2004). For example, in two eucalypt woodlands near Sydney, soil organic carbon and nitrogen increased following the invasion of lantana (Lamb 1982, 1988, Buchanan 1989). Therefore, knowing which species to protect is by no means a substitute for understanding the ecological context in which they can persist (Lamb 1988). Weed invasions have the ability to modify ecosystem properties and processes once they have invaded. For example, invasive weeds can alter fire regimes (Mack and D'Antonio 1998), biogeochemistry and hydrology (Vitousek 1990, Gordon 1998). While some information is available on how lantana impacts native species (see Chapter 2), it is imperative that we obtain a greater understanding of the processes involved and the magnitude of any impacts.

Performance indicators for Action 6.1

- ► Establish and support research to determine the ways in which lantana causes a decline in native plant species.
- ► Collect data where possible during monitoring programs.

4.8.2 Action 6.2

Action 6.2	Key stakeholders will foster research into the decline in native animal species as a result of lantana invasions.

Although the impact of weed invasion on plant species is not well understood, the impact on native animals has generally been neglected (Adair and Groves 1998). The processes by which weed invasions contribute to native animal species decline are difficult to determine, especially given that the invasion may both benefit and negatively impact on native animal species simultaneously. For example, lantana may provide protection from predators but also reduce access to nesting sites. In addition, to study the impacts on animals, sample sizes of animal populations need to be relatively large. For example, Alcova (1987) investigated the impact of lantana on birds, while Dowsett (2006) investigated the impact of lantana on mammals. In both instances, sample sizes of individual species were often too small to draw any significant conclusions.

Performance indicators for Action 6.2

- ► Support research to determine the ways in which lantana causes a decline in native animal species.
- ► Collect data where possible during monitoring programs.

4.8.3 Action 6.3

Action 6.3	Key stakeholders will foster research into the effects of lantana control on native fauna.

There have been few studies on how removing a weed from an ecosystem affects fauna (see review in Gosper 2004), especially when the weed has become dominant and may have been so for many years or decades. The disturbance involved in removing weeds may affect many fauna species long after the actual control event has taken place (for example, from increased light, soil disturbance, trampling of the ground, removal of a food source and/or the direct effects of management techniques like fire). Also, some native plant species that these animals use for habitat may take many years to recover following control (for example see Turner and Virtue 2006).

Performance indicator for Action 6.3

- ► Support the establishment of sites where studies can be undertaken to determine the effects of lantana control on fauna.
- ► Develop research projects on the effects of lantana control on fauna.

4.8.4 Action 6.4

Action 6.4	Key stakeholders will foster research into the effects of herbicides on priority assets.

Herbicides have been used successfully to control lantana in Australia for many years. However, there is little data available about the impact of herbicides on native flora and fauna. This needs to be investigated so that high-priority assets are not threatened by the application of herbicides.

Performance indicators for Action 7.2

- ► Establish experiments to determine the non-target effects of herbicides used in lantana control.
- ► Collect data where possible during monitoring programs.

4.9 Objective 7: Review data and set future priorities

Objective 7	**Establish guidelines for future control programs and research projects based on the outcomes of this Plan.**

4.9.1 Actions 7.1 and 7.2

Action 7.1	Key stakeholders will examine new data and integrate it into future control/management strategies.
Action 7.2	National Lantana Management Group and other stakeholders will examine new data and establish future priorities for lantana management.

After five years of implementation, the outcomes of this Plan should be used to determine future management and research objectives to reduce lantana's impact on native biodiversity.

Performance indicator for Action 7.1

- Re-evaluated management plans and control strategies based on data collected in Actions 3.1 (monitoring of control programs), 6.1 (decline of native plants), 6.2 (fauna and lantana), 6.3 (fauna and control) and 6.4 (herbicide impacts), as well as any other data available, during the final year of this Plan.

Performance indicator for Action 7.2

- Determine future priorities for lantana management and research objectives based on data collected from the above.

Table 4.2. Summary of the Lantana Plan objectives and actions

Objective 1	**Ensure that lantana control is undertaken in areas where the benefits to high-priority environmental assets are greatest.**	**Priority and timeframe**
Action 1.1	Key stakeholders will liaise with and encourage landholders and land managers to undertake lantana control programs at high-priority control sites across all land tenures. In addition, key stakeholders will undertake lantana control programs at high-priority control sites on their estate and will seek agreement from other landholders to ensure lantana control programs are undertaken at other high-priority control sites.	High priority, immediate and long-term
Action 1.2	At high-priority control sites, key stakeholders will help develop and implement site-specific management plans for lantana control programs, based on currently available best practice guidelines. Key stakeholders will work with landholders that agree to Action 1.1, to develop site-specific management plans.	High priority, immediate and long-term
Action 1.3	Indigenous communities will be encouraged to assist with the development of site-specific management plans.	High priority, immediate and long-term

Objective 2	**Ensure that lantana control is undertaken at and outside of containment lines.**	**Priority and timeframe**
Action 2.1	Key stakeholders will continue to promote the control of lantana at and beyond the containment lines in northern Queensland and southern New South Wales and to promote lantana removal in other states.	High priority, immediate and long-term
Action 2.2	National Lantana Management Group to investigate the possibility of establishing new containment lines in strategic areas on the western distribution of lantana in northern New South Wales and Queensland to prevent further spread westward.	Medium priority, medium-term

Objective 3	**Evaluate the effectiveness of control programs at high-priority control sites with respect to the response of environmental assets.**	**Priority and timeframe**
Action 3.1	Key stakeholders will encourage and coordinate the monitoring of lantana control programs at high-priority control sites.	High priority, immediate and long-term

Objective 4	**Ensure that stakeholders and the general public are involved/participate at high-priority control sites, by raising awareness of this Plan and the threat lantana poses to environmental assets.**	**Priority and timeframe**
Action 4.1	Key stakeholders and other agencies will encourage public involvement and ownership of programs at priority sites.	Medium priority, medium-term
Action 4.2		Low priority, medium-term
Action 4.3	Key stakeholders will continue to provide and seek further information for this Plan (for example further site nominations).	Low priority, long-term

Objective 5	**Ensure implementation and administration of this Plan is undertaken.**	**Priority and timeframe**
Action 5.1	Key stakeholders will seek support for a position to coordinate the implementation of the Lantana Plan.	High priority, immediate and long-term

Objective 6	**Evaluate the ways in which lantana causes the decline of environmental assets and determine the effects of lantana control on these assets.**	**Priority and timeframe**
	Key stakeholders will foster research into the decline in native plant species as a result of lantana invasions.	Low priority, long-term
Action 6.2		Low priority, long-term
Action 6.3	Key stakeholders will foster research into the effects of lantana control on fauna.	Medium priority, long-term
Action 6.4	Key stakeholders will foster research into the effects of herbicides on priority assets.	High priority, long-term

Objective 7	**Establish guidelines for future control programs and research projects based on the outcomes of this Plan.**	**Priority and timeframe**
Action 7.1		Low priority, long-term
Action 7.2	National Lantana Management Group and other stakeholders will examine new data and establish future priorities for lantana management.	Low priority, long-term

5 Implementing the Plan

This Plan provides a framework for lantana control that will provide positive outcomes for the conservation of environmental assets within lantana infestations in NSW and QLD. This is to be achieved by:

1. developing a strategic framework for targeting lantana control in areas where the biodiversity benefits will be greatest
2. promoting best practice management
3. monitoring the effectiveness of control programs in terms of the recovery of threatened biodiversity
4. fostering community education, involvement and awareness
5. identifying and filling knowledge gaps where possible.

In addition, a Site Management Plan proforma has been prepared (Appendix 1) and is to be developed and implemented at all identified high-priority control sites. Actions in each Site Management Plan must address, or aim to protect, the high-priority environmental assets listed in Appendix 3. It must be noted that this Plan is solely directed at reducing the threat to biodiversity, rather than control *per se,* therefore a staged approach to lantana management at high-priority control sites is recommended. Site-specific management plans are imperative to ensuring control is effective and is targeted towards protecting the high-priority assets and minimising any non-target impacts to high-priority assets and other threatened biodiversity. To date, there has been limited consultation with Indigenous communities. It is expected that input from Indigenous communities will increase as site plans are developed in consultation with Indigenous people.

5.1 A staged approach to lantana control

At many sites, the density and area infested by lantana is such that it cannot be controlled in a single control operation. Even if lantana could be controlled in a single operation at a site, long-term follow-up will still be needed (for example, see Section 2.8). Thus, the control of lantana at sites needs to occur in a staged manner with planned follow-up of previously treated stages.

The **first stage** is the removal of lantana and other weed species from the immediate vicinity of the environmental assets most at risk. This will reduce the direct threat in the short-term.

The **second stage** is the expansion of stage one to cover a larger area of the lantana infestation at the site. In this stage, the removal of lantana should be prioritised in areas that contain suitable habitat for the priority assets to expand in the future, thus decreasing the threat by providing a bigger buffer zone between lantana and the threatened entity. Stage two also involves the follow-up control of lantana seedlings that germinate within all previously controlled areas.

The **third and subsequent stages** involve the further expansion of earlier stages, with the aim of removing all lantana from the site and surrounding areas to prevent re-invasion. This stage also includes the continual follow-up control of lantana seedlings in all previously controlled stages/areas of the site (that is, stage one and two areas). An illustration of this mapped, staged approach can be found in an example Site Management Plan at: www.environment.nsw.gov.au/lantanaplan/implementation.htm

A staged approach can be beneficial for a number of reasons:

- control is focused on an area for which there are sufficient resources available
- thought is given to follow-up control constraints
- control can be focused initially on areas where the highest priority assets occur
- habitat or resources that might be provided by lantana will be removed gradually to reduce any impact this might cause on dependant species.

The staged approach must be planned before any control is undertaken, with all stage boundaries clearly defined on a map, and the timing of each stage determined and incorporated into a site-specific management plan (Appendix 1). Control should not be undertaken in areas where there are insufficient resources to undertake the subsequent follow-up treatment of seedlings and regrowth. Irrespective of the initial control measure implemented, follow-up treatments are required to control recruitment. For assistance in developing a sequence of initial control and follow-up actions refer to the *Decision Support Tool* in the *Lantana Best Practice Manual* (Stock et al. 2009).

5.2 Site-specific management

In developing the actions and setting priorities for site management, the key assumptions underlying effective control programs for lantana include:

- No single management technique is recommended. Therefore, site-specific management plans need to be developed and implemented for each high-priority control site.
- Follow-up control is needed to prevent re-infestation and/or re-invasion. Therefore, all control programs must be long-term and account for more than initial control in one year. Sources for re-infestation should also be identified where possible.
- Other threats to biodiversity may be present at many of the lower-priority sites. Managing these additional threats is essential if lantana control is desired, but this is beyond the scope of this Plan. The exception is where the threat comes from another weed species that may replace lantana following control. At such sites, control programs must address these weed species as well.
- Resources are limited and must be directed towards protecting the highest priority assets at sites where the benefits will be greatest.
- Commitment to the high-priority control sites outlined in this Plan is to be maintained for a minimum of five years, as effective control can only be achieved over the medium to long-term.
- The effect of control measures on target and non-target species needs to be considered at all sites.

For the purpose of achieving the outcomes of this Plan, a proforma has been developed to help land managers prepare site-specific management plans (Appendix 1). At all high-priority control sites, a site-specific management plan should be prepared using this proforma. To ensure consistency with the objectives of this Plan, site plans should be approved by the Lantana Plan Coordinator (see Figure 1.1 and Action 5.1). Managers of lower-ranked sites should also complete this site plan if their objective of lantana management is for biodiversity conservation.

Monitoring is a key aspect of the Site Management Plan process and all site managers must implement some form of monitoring in conjunction with their control program to demonstrate the effectiveness of their program (see Chapter 6).

5.2.1 A framework for site-specific management plans

Using the site-specific management plan proforma in Appendix 1, each plan should:

- be developed in consultation with relevant stakeholders
- clearly identify and determine the roles and responsibilities of all stakeholders for each stage of the plan
- involve consultation with Indigenous people, with respect to any special knowledge or interest at the site (for example, any Aboriginal or Torres Strait Islander cultural heritage sites present) or the species, population or ecological community (for example, traditional foods) and control programs at that site, including the likely social, cultural and economic consequences
- specify the high-priority assets present that are listed in Appendix 3, as well as any TAPs, recovery plans, biodiversity management plans or PAS Actions relating to the site (or for any other legislative requirements under the EPBC, NC or TSC Acts)
- refer to the *Decision Support Tool* in the *Lantana Best Practice Manual* (Stock et al. 2009) to identify the most appropriate management techniques for the level of lantana present, as well as for other aspects of the site, including the native fauna positively impacted by lantana, non-target effects, the terrain, access, and other local conditions
- ensure all pesticide applications comply with the relevant legislation (see Appendix 2) and APVMA regulations
- identify the milestones and measures to be achieved during the life of the Plan (including the staged approach to management as described above)
- provide a site map that outlines the location of lantana infestations (or different patches as described in the *Lantana Best Practice Manual*), high-priority assets and other threatened species, the stages of control and other important weed species
- provide an estimate of the cost of control stages, as well as outline a follow-up control program to prevent re-invasion/re-infestation of the site after the initial control (in line with the staged approach)
- outline any monitoring programs being undertaken to measure the effectiveness of lantana control programs
- identify other weed species that are likely to invade following the removal of lantana, and outline a control program to address the problem
- identify the training qualifications of all stakeholders and/or persons who will undertake the management actions, including volunteers (for example, the application of herbicides)
- outline the previous long-term management of the site and any other site history.

5.2.2 Interactions between lantana and birds

While lantana is considered a lower quality habitat than uninvaded native communities (see Crome et al. 1994, Smith et al. 1998, Parsons et al. 2008), the native birds (and other animals) that utilise lantana must also be identified before management of lantana commences (see Crome et al. 1994, Gosper and Vivian-Smith 2006). For species such as rainforest pigeons, lantana has become an important part of their diets (Recher et al. 1995). Lantana fruits are similar in many ways to native fruits (Gosper and Vivian-Smith 2006), thus they provide a viable replacement food for birds, which results in the dispersal of viable lantana seeds (Liddy 1985) into native communities.

Twenty-eight native bird species have been reported to consume lantana fruits and also consume the fruits and seeds of a range of native plants, some of which are also threatened by lantana (Turner and Downey 2008). For example, 202 fruit- or seed-producing native plant species used as a food source by these 28 bird species are also threatened by lantana (as determined in Section 2.3). These 28 bird species also consume the fruits/seeds of another 36 weed species, which can invade following lantana control (see Section 2.8).

Unfortunately, the dispersal of lantana by birds that also forage on native species may have indirectly contributed to native plant declines, as some of these native plant species are affected by the invasion of lantana. Compounding the problem is that, as native plant species decline following lantana invasion, native birds may in turn consume more lantana fruits—thus increasing dispersal and invasion and decreasing the dispersal of native plants. This bird–weed positive feedback loop will impact on revegetation programs and the long-term restoration of managed sites, as it will be difficult to stop further dispersal of weeds into these managed sites (Turner and Downey 2008). A gradual, staggered approach to lantana removal is suggested (see Section 5.1) as a way to minimise the impact on native animals following lantana control (for example see Recher et al. 1995). Lantana seeds are readily dispersed long distances (up to 1 km or more) by birds and mammals (Swarbrick et al. 1998) and recent research suggests that this distance may be even greater (David Westcott, pers. comm.) Therefore, buffer zones will need to be created around managed sites over time. In addition, weed management, especially in native communities, should always be a long-term and gradual process (Lawrie 2002). As native animals will play a role in dispersing both native plants and weeds, it will be important to encourage native plant recovery while controlling weeds that will continue to invade over the long-term and preventing recruitment to maturity (Turner and Downey 2008).

5.2.3 Control techniques

This Plan is supported by other programs that are managed under the Lantana WoNS Strategy. This includes integrated lantana management research, which was undertaken to develop a best practice control manual and decision support tools to assist in lantana control.

The *Lantana Best Practice Manual and Decision Support Tool* (Stock et al. 2009) was developed following a series of lantana management trials. The aims of the project were to:

- develop a management decision tree—a simple guide to comparing control options in terms of cost versus effectiveness
- improve the knowledge of adaptive management options faced by landholders and site managers to allow them to make informed decisions about control options
- implement eleven integrated trials for various climatic zones and land-use sites
- develop trial sites into demonstration sites suitable for public access
- develop a lantana best practice control manual.

A guide to best management practices, *Using Herbicides on Lantana* (Clark et al. 2006) can be downloaded at www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Lantana-Herb-Bro.pdf This guide, in conjunction with the *Lantana Best Practice Manual and Decision Support Tool* (Stock et al. 2009) provides guidance on the use of herbicides for the control of lantana. In addition, the Weeds Cooperative Research Centre has produced guidelines for lantana management (Weeds CRC 2003) that can be downloaded from www.weedscrc.org.au/documents/wmg_lantana.pdf Given the above, the information on control is only briefly discussed below and is focused on control for the protection of environmental assets detailed in this Plan.

Site mangers and landholders will need to consider management techniques to limit off-target damage to environmental assets. Each management technique must be tailored to the environmental asset at each site, and, as such, landscape scale control measures, such as fire, may not be appropriate for the protection of assets. This is especially the case for Stage 1 of control (see Section 5.1). Stage 1 is the removal of lantana and other weed species from the immediate vicinity of the threatened species. For example, although fire can be used to control lantana, especially if integrated with other methods, it must be remembered that some

ecosystems and species are not fire-tolerant and most are not tolerant to frequent fire regimes. In most cases, fire events cannot be repeated with high frequency and/or intensity without adversely affecting native species diversity (J. Hodgon pers. comm.). Fire has been identified as a significant disturbance that allows the successful invasion of lantana (Gentle and Duggin 1997b). Lantana recovers quickly after fire by shooting from basal dormant buds (Swarbrick et al. 1998); therefore, follow-up control with other methods will be necessary after fire. Under varying conditions lantana may either increase or decrease the fuel load along a rainforest margin (Swarbrick et al. 1998). Fire is not appropriate in such areas because lantana provides a fuel load that changes the intensity of fire (Day et al. 2003). As a means to reduce the invasion hazard of lantana, Duggin and Gentle (1998) suggested that fire should be completely removed from the ecotones between dry rainforest and open forest in northern NSW, except for low-intensity fires to manage fuel loads.

5.3 Areas presently free of lantana

The control of lantana for biodiversity conservation can also be directed to new lantana infestations in order to address potential or future impacts. However, the current impacts to threatened biodiversity are so great and immediate that they require our urgent attention in the first instance. For widespread weeds, such as lantana, treatment needs to focus on strategically reducing the impacts of these weeds where they are significantly affecting key assets, as this outweighs any gains from preventing its further spread (Weeds CRC and Standards Australia 2006). However, any potential or future impacts of lantana on un-infested areas within the core distribution of lantana in QLD and NSW must also be considered and addressed as a high priority. Maintaining areas that are presently free of lantana will be beneficial to biodiversity, as native species, populations and ecological communities in these areas will remain protected from lantana invasions.

The removal of outlying infestations will prevent further spread of this invasive plant into new areas, and ensure further economic and environmental impacts are avoided. Infestations requiring control have been identified in northern QLD, western QLD, the Northern Territory, Western Australia and South Australia (Rogers and Johnson 2008), where removal or containment is regarded as an important outcome of the national Lantana Strategic Plan (ARMCANZ et al. 2001). Northern QLD has also been identified as a containment zone. The containment line extends north from Pormpuraaw, Laura and Cooktown. The national Lantana Strategy (ARMCANZ et al. 2001) is also supported in southern NSW by the Southern Tablelands and South Coast Lantana Weed Management Plan (ST & SCNPC 2005). This Plan established the Southern Containment Zone, which commences south of Shoalhaven City Council's boundary.

5.4 Control at locations not addressed or identified in this Plan

The sites outlined in this Plan represent just a small proportion of the area invaded by lantana. Control of lantana currently occurs at many locations for various reasons, including:

- for biodiversity conservation
- to reduce impacts on primary production
- to prevent further spread of lantana
- for neighbour relations (including community relations)
- for cultural heritage asset management, infrastructure management and control in prominent public recreation areas (such as control at picnic areas, walking tracks, camping grounds and roads), as well as for amenity purposes
- to maintain or extend containment zones and to eradicate isolated infestations
- to meet noxious weed obligations
- to foster research aimed at improved management.

While this Plan specifically targets the control of lantana for biodiversity conservation, it is important that control for these other reasons continues at locations not addressed in this Plan, as it delivers broader outcomes as well as reducing the lantana problem. However, if management is to occur for biodiversity conservation, as a starting point control at sites within control categories three to nine (see Figure 3.2) should only be resourced when control category one and two sites have already been resourced.

5.5 Social and economic impacts of the Plan

The implementation of this Plan will have positive social benefits. As lantana is a major environmental weed infesting more than five per cent of the Australian continent (Sinden et al. 2004) and threatening many plant communities, any reduction in the distribution of lantana should result in enhanced protection and aesthetic appeal of natural areas and parks; reduced impacts on biodiversity; reduced lantana spread; and fewer impacts on primary production. Raising public awareness of lantana will help to maintain and augment the historically strong community support for lantana control across NSW and QLD. Improved understanding of lantana's threat to biodiversity will help to ensure that support for lantana control programs continues into the future.

There is widespread public appreciation that lantana is a threat to native flora and fauna and that it impacts upon native environments. The prioritisation of lantana control to specific sites within this Plan may be unpopular where such priorities do not match existing programs (for example control undertaken in more conspicuous areas, such as in urban reserves, along roadsides, and recreation areas). However, it must be noted that this Plan is solely directed at reducing the threat to biodiversity and not control *per se*. This Plan does not seek reallocation of funds between organisations, but there may be a reallocation of funds within organisations as priorities may have changed due to the above ranking process. This Plan also does not aim to replace or reduce existing priority control programs identified in national, state and regional strategies.

An economic analysis of the cost of lantana to the grazing industry has been undertaken, but not on the environmental costs or on other primary production. Graziers currently spend $17.1 million a year on lantana control and lose in excess of $104 million from lost production (QLD NRW 2007). The economic benefits of implementing this Plan are difficult to quantify, especially given the problem of developing an accurate estimate of the cost of environmental weeds, let alone the economic benefit of reducing threats to specific native species, populations or ecological communities. This is currently being attempted for the NSW Bitou Bush TAP (Sinden et al. 2008), which follows a similar approach to this Plan and shows an average return of $2.56 for every dollar spent on control.

The main economic benefit of this Lantana Plan is that it provides a consistent framework for control measures to be undertaken at high-priority control sites (Action 1.1). Sites have been ranked based on the likelihood of success and therefore funds are allocated preferentially to areas where biodiversity outcomes are likely to be met. For example, sites that are difficult to access, have other threats present, or where a native species or community is in a degraded condition, will not rank highly given the large investment necessary to achieve a biodiversity outcome. As with this Plan, previous control programs have also been dependant on the continuity of funding. Where funding has ceased prior to the completion of a control program, any initial benefits may be quickly lost as lantana can re-invade rapidly. Where funds cease and re-invasion occurs, there are also likely to be negative social impacts; for example, the disillusionment of those involved in control, including volunteer groups. This Plan seeks to ensure that funding is maintained at high-priority control sites for the duration of the Plan, and thus prevent such failures. It is also anticipated that by identifying sites in other control categories, regional and local priorities will be developed that should help to maintain control programs currently in place at these locations.

There are no public health issues related to the implementation of the Plan. This Plan will not have a significant negative impact on public access or recreational use of public lands, although some existing control programs to protect threatened species and ecological communities may limit the use of some areas. There are significant adverse social and economic impacts that could arise from not implementing this Plan. Lantana is a major threat to a large range of biodiversity. These assets may continue to be threatened in the absence of this Plan. The continued threat posed by lantana will add to the cost of recovering these environmental assets, which will increase with time. The longer the threat is in place the greater the risk of additional assets becoming threatened and those assets that are threatened becoming extinct. Any such extinction is likely to have major social implications, especially if a plan to prevent such extinctions were prepared but not adopted.

5.6 Indigenous involvement

To date there has been limited consultation with Indigenous communities in the development of this Plan. It is expected that Indigenous involvement will increase as site plans will be developed in consultation with Indigenous people. Site Management Plans will involve consultation with respect to any special knowledge or interest at the site (for example, any Aboriginal or Torres Strait Islander cultural heritage sites present) or the affect on particular species, populations or ecological communities (with respect to traditional foods and medicines) and including likely social, cultural and economic consequences.

There may be social impacts on Indigenous people and/or on Aboriginal/Indigenous heritage that arise from lantana invasion and management; for example, the effect of lantana invasion on availability and access to traditional foods, and the degradation of, and access to, culturally significant sites. Indigenous consultation should be undertaken during the development of the site-specific management plans, and any site-specific impacts addressed (Action 1.2). If lantana is growing within a culturally significant site then the control actions should be tailored to the site. It is anticipated that Indigenous people will make likely impacts known during the development of site-specific management plans, so these can be taken into account.

5.7 Current expenditure on management for conservation

Managers of nominated sites in control categories one and two (see Section 3.4) were asked to provide details of their expenditure on lantana control for the 2006/07 financial year. Details from 147 of these sites were obtained. No control was undertaken at 21 sites, the remaining sites spent on average $18,500 on lantana control in the 2006/07 year (Table 5.1). In 2006/07, total expenditure on lantana control at these 126 sites was $2.34 million. Of the 126 sites that did spend money on control, 93 did so specifically for biodiversity conservation and $1.86 million or $20,000 per site was spent. Many stakeholders have already begun to re-align their lantana control programs around this Plan and many site managers have started to implement it across a variety of land tenures in QLD and NSW. To assist with the initial implementation of this Plan, an Australian Government grant provided $360,000 for 20 high-priority control sites over 18 months to 30 June 2009. This equated to $12,000 per site per annum.

Table 5.1. Expenditure on lantana at 126 control sites (within control categories 1 and 2) in 2006/07 across Queensland and New South Wales.

	Cash ($,000)	**In-kind** ($,000)	**External Grants** ($,000)	**Total expenditure** ($,000)
Total	**1,301**	**758**	**279**	**2,339**
Site average	**10.3**	**6.0**	**2.2**	**18.5**

5.8 Summary of the expenditure associated with proposed actions

As stated previously, the main economic benefit of this Plan is that it provides a consistent prioritisation framework for control measures, based on the likelihood of successful biodiversity outcomes. There is already a significant commitment to lantana management at the high-priority control sites. Lantana-control expenditure of $2.34 million, detailed on the previous page, was only calculated at 126 sites; the amount of expenditure on lantana management in conservation areas in Australia would be significantly higher than this figure. Given this, this Plan has no additional financial implications. However, there may be a re-alignment of existing priorities and the commencement of control at high-priority control sites. Where control is not currently being undertaken, any new programs will be subject to future funding opportunities. Where possible, the respective site managers, researchers, the National Lantana Management Group, NRM regions/CMAs, and the community should seek additional funds from new sources to implement unfunded actions or parts thereof.

Achieving the objectives of this Plan will be subject to budgetary and other constraints. Also, with changes in knowledge, proposed Actions may be modified over the life of the Plan. It should also be noted that the production of this Plan does not necessarily indicate individual stakeholders' commitment to undertaking any specific actions, and the effective control of lantana will require significant ongoing attention and resources.

This Plan aims to guide the responsible use of public resources to achieve the best outcomes for biodiversity threatened by lantana. These outcomes will be enhanced by recognising existing opportunities and limitations, and ensuring that field experience and research are used to further improve lantana management. The activities and priorities identified in this Plan will need to evolve with, and adapt to, developments as they occur.

5.9 The 'no change to current management' option

An alternative approach to this Plan is the 'no change to current management' approach. At present a range of lantana control programs are in place at various sites to conserve native species and limit lantana spread. These control programs involve many agencies (for example, Parks and Wildlife Group of DECCW, Parks and Wildlife within QLD DERM and local councils), the community (through community groups) and private landholders. There is, however, a need for an overall, coordinated strategy for lantana control for biodiversity and organisations should consider the reallocation of resources to their high-priority control sites, because:

- Limited resources must be used efficiently.
- Some control programs do not have strategic conservation objectives (apart from the assumption that control alone will result in biodiversity outcomes).
- Some programs do not identify assets that are expected to benefit from lantana control, nor is control targeted at specific assets. Control also may not involve comprehensive follow-up programs, or does not occur over a sufficiently large area or for sufficient duration.
- There is no consistent plan for all land tenures, yet greater collaboration between landholders is fundamental to the success of control programs.
- In most cases, there is no monitoring to measure the response of the priority assets to lantana control, or different variables are monitored, preventing comparisons across sites.
- Many years of lantana control (> than 90 years) have not provided information on which native species are impacted by lantana invasions, let alone shown a reduction in these impacts.

6 Measuring the success of lantana management

Monitoring is the key to evaluating the success of lantana control programs and the recovery of the environmental assets at risk. The Bitou Bush TAP monitoring guidelines (Hughes et al. in press) will be adopted for this Plan. These monitoring guidelines provide standard methods, across a range of differing resource and skill levels, to measure the response of the weed to control and the response of the native plant species at risk (King and Downey 2008). Unfortunately, these guidelines do not provide methods for monitoring fauna. Although the first level of monitoring within the Bitou Bush TAP guidelines can accommodate some fauna observations, a detailed monitoring technique for fauna is still required.

6.1 Monitoring the response of biodiversity

Monitoring is perhaps the most neglected aspect of weed control programs (Burley et al. 2008). For example, in Australia a review by Reid et al. (2008) established that, following the management of WoNS, monitoring the response of plant communities was often not undertaken. Where monitoring information has been collected, it is generally restricted to the level of weed removal achieved, rather than the associated ecosystem response. However, to determine the effectiveness of any weed control program, a monitoring program must be developed and implemented. This is particularly important in natural areas to demonstrate that public funds are being used efficiently.

Given that this Plan is focused on biodiversity at risk, monitoring must be tailored to those assets identified and form part of the Australian Government Natural Resource Management Monitoring, Evaluation, Reporting and Improvement Framework (see Commonwealth of Australia 2009). Many variables can be measured and a number of monitoring techniques can be used. The following measures should be considered at high-priority control sites:

- the response of **lantana** (mature plants and seedlings) to the control program, measured by consistent assessments of plant abundance and vigour, as well as through regular observations from photo points, both before and after control
- the response of the **high-priority environmental assets** to the control program, measured by presence/absence of target species or similar measures (as described for lantana above)
- the response of **other weed species** to the control program
- cost of control and monitoring.

Additional measures can help determine the effectiveness of control programs, with respect to the broader invaded community, and should be collected, where resources are available, to measure:

- the response of a **broader suite of native species** (both plants and animals), populations and ecological communities to the control program
- the response of **biological control agents**, measured by the rate of attack and density of the agents taken at regular intervals following control.

More comprehensive monitoring may occur in both managed and unmanaged areas (for instance, in experimental control areas) in order to detect changes in lantana and native species that can be attributed to the management program. A target for restoring invaded areas can also be set. A target could be a historic condition of the plant community, before lantana invasion; however, Chapman and Underwood (2000) suggested that, as ecological systems do not stay constant, reference areas as well as experimental control areas may be needed. Experimental control areas are sites that are similar to the area where weed control is being undertaken, but that are not subjected to the weed management. Reference areas are

uninvaded natural areas that represent the native species restoration target following weed management (Chapman 1999, Blossey 2004, Turner and Virtue 2006).

6.2 Survey of current monitoring programs

In early 2007, land managers involved with lantana management were surveyed. Forty of the 57 respondents (70%) indicated that the aim of their lantana management was for biodiversity conservation. However, only half (20 out of 40) reported that they monitored the response of native species following their control program. Further to this, only three respondents used graphs or charts to illustrate their results, and only two (5%) of the respondents managing lantana for conservation used statistical analyses to demonstrate the response of native biodiversity. However, to assist with monitoring, 75 per cent indicated they would use standard monitoring guidelines if they were available. Only 5 per cent (2 out of 40) indicated they would not use standard monitoring guidelines, with the remainder unsure.

6.3 Standard monitoring guidelines

As part of the implementation of the Bitou Bush TAP (DEC 2006a), monitoring guidelines have been developed (Hughes et al. in press). These guidelines have been tested for lantana and will be adopted for this Plan. The guidelines are split into three tiers. The first level of monitoring involves simple mapping, photo points and observational measurements, with the aim of identifying the reduced threat to native flora resulting from control of the weed bitou bush. This level is aimed at most land managers and has been prepared for a general audience. The second level builds on the first level, but requires a more rigorous monitoring program. For example, using permanent quadrats or transects to monitor weed invasion and native flora diversity and abundance before and after control. The third level involves a more rigorous approach, with an experimental design that aims to scientifically demonstrate that weed control has led to a beneficial biodiversity response.

6.3.1 Measuring the effect of control on lantana infestations

Many factors may confound the response of biodiversity to lantana control. These include lantana recruitment levels from the seed bank; re-invasion rates of lantana post-control; the condition of the assets at risk; the age of the lantana infestation, and the percentage of plants that persist after control actions.

Most control methods do not result in 100 per cent mortality of the weed, so it is important to monitor the number of lantana plants that survive control treatments, both as an indicator of the success of a control program and to determine when follow-up control should occur. Plants that survive control treatments can produce seed in a shorter timeframe than plants that germinate following the same control treatment. Hence, plants that survive initial treatments will require earlier follow-up treatment if the amount of fresh seed is to be limited. In order to control weed seed banks, a measure of lantana plants that survive control treatments (for example, missed totally, treated but re-sprouting, or unaffected) needs to be determined for each method used.

Recruitment from the seed bank will have important implications for the long-term success of any lantana control program, as the time taken to exhaust lantana seed banks is currently unknown (Day et al. 2003) with different studies placing viability between two and five years. A recent QLD study established that mean lantana seed persistence ranged from 4 to 20 per cent after three years (DPI & F 2008). However, in one replicate, 52 per cent of the seed was still viable, indicating that management programs will need to run for more than three years to exhaust the seed bank. Seed viability is likely to depend on many factors, including biotype, soil type and soil moisture (QLD NRM & E 2004, Vivian-Smith et al. 2006). Therefore, a measure of recruitment may also be undertaken.

6.3.2 Measuring the response of high-priority assets to lantana control

As the ultimate aim of lantana control conducted under this Plan is to protect biodiversity—particularly those species or ecological communities that are high-priority assets—the assets' response to control must be measured to accurately gauge the efficacy of lantana control programs. For example, the recruitment levels of native plant species present at the site will have important implications for the long-term success of any lantana control program. The number of seedlings of high-priority taxa can indicate their ability to recover/regenerate following lantana control programs. A lack of seedlings could suggest that additional restoration techniques, such as revegetation, fire or soil disturbance, may be needed (Turner and Virtue 2006, Turner et al. 2008b, Turner and Virtue 2009).

Monitoring the response of the environmental assets can be conducted in a similar fashion to monitoring the response of lantana. The main issue is choosing which assets to monitor and finding a suitable monitoring technique for those selected. With respect to this Plan, native biodiversity at risk has been identified (as listed on the website: www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm) and this Plan will adopt the monitoring guidelines from the Bitou Bush TAP (Hughes et al. in press). Hence, monitoring for this component of the Plan will be determined in consultation with stakeholders and based on the high-priority assets present at each site and the skill level of land managers and workers. Alternatively, if resources are available, all native species at a site can be monitored (by presence/absence or cover abundance), which will show the response of the broader community.

6.3.3 Measuring the response of other weed species to lantana control

The control of one weed species, in this case lantana, can lead to the invasion of a site by another weed species (see Reid et al. 2008, Turner and Downey 2008). Sometimes this secondary invader can be more difficult to control than the original weed species. Therefore, a list of 144 weeds likely to invade after lantana control has been developed (see Section 2.8). There is a need to also monitor these weed species during and after the control of lantana if they are present at a site. The number of other weed seedlings will indicate the need for other control programs; thus, monitoring programs should measure the recruitment of lantana as well as other weed species present.

6.3.4 Monitoring the response of animals to control

Wherever possible, monitoring the impacts of both lantana invasion and lantana control on fauna should be considered during a lantana control program. In addition to focusing on high-priority animal species, such monitoring could also focus on generic groups of fauna (such as birds), depending on the resources available, the skill or knowledge level of the observer, and the level of understanding required. As outlined in Section 4.5.1, more detailed information on monitoring techniques for fauna will need to be developed, or sourced from elsewhere.

6.3.5 Additional research

As discussed previously, data on the impact of lantana and its control on fauna and flora are limited. Such information is necessary to manage and better protect threatened biodiversity. Data on the impact of herbicides on threatened species is also limited, and most is anecdotal. Rigorous examination into the affect of herbicides on threatened species needs to be undertaken. The above areas of research had already commenced during the development of this Plan, with research students receiving funding to investigate:

- the post-germination growth of native seedlings in the presence of lantana, and to determine if thresholds exist in relation to impacts of lantana on native plant richness and abundance (University of Wollongong) (see Gooden 2007, Gooden et al. 2009a, Gooden et al. 2009b)
- the impact of lantana on mycorrhizal and other soil fungi (University of Southern Queensland)

- the effect of lantana management on the composition and structure of lantana-invaded communities (University of Queensland) (Yeates 2008)
- the effects of lantana and lantana control on reptile composition and abundance (Griffith University) (Virkki 2009).

6.4 The review process

Data collected from the monitoring and research programs described in this Plan is critical to demonstrating the success of this Plan and to refining future control methods and guiding future priorities. It is recommended that the Plan be implemented over a five-year period. At the end of the five-year period the Plan should be reviewed, based on field monitoring and other research undertaken. This review should report on the objectives and performance indicators.

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Appendices

1. Site-specific management plan

This proforma is to be used at all high-priority control sites identified as part of the *Plan to Protect Environmental Assets from Lantana*. Actions in this site plan must address, or aim to protect, all high-priority species or ecological communities listed below. This proforma can also be used for lower priority biodiversity and sites. Each site-specific management plan should be developed in consultation with relevant stakeholders and in accordance with the details of this Plan, as outlined on the website (see www.environment.nsw.gov.au/LantanaPlan). Copies of this proforma and an example site plan are also available in electronic format from the above website.

Site number (as listed on the website)	
Site name	
Site owner (or contact)	
Contact name for site	
Phone number	
Mobile	
Email	

Site location details	**GPS coordinates** (i.e. one of these three)	Where GPS reading was taken from? (e.g. centre point of site)
latitude / longitude		
AMG (Australian Map Grid)		
GDA (Geodetic Datum of Australia)		

LGA or National Park name	
CMA / NRM region	

List all priority species, populations or ecological communities at risk from lantana at the site, along with their priority (The main aim of this site plan is to abate the threat of lantana to all high-priority environmental assets listed in this table— see Appendix 3)	**Scientific name / s**	**Common name / s**	**Priority**	**Impact –ve or +ve**

Prepared by (name / organisation)			
Address			
Phone number		**Date prepared**	
Mobile		**Review date of plan**	
Email		**Plan duration**	**5 years**

Section 1— site map

1. Map the priority site. Site map should include the following features:

- scale, legend and north orientation
- locations of *Lantana camara*— referred to as patches in the *Lantana Best Practice Manual* (Stock et al. 2009)
- the location of all high-priority environmental assets listed on page 1. Also include any other rare or threatened species at your site. If your control program is to conserve an animal species, please include their distribution (or likely distribution) on the map, as well as the habitat type.
- locations of the stages of control and any distinct control areas within the site (see Section 4 below and www.environment.nsw.gov.au/lantanaplan/implementation.htm). Please note that each stage of control may take several years to complete
- other major weed species present.

Use cross-hatching to illustrate the general area for those species and ecological communities where the exact location is unknown, and for widely dispersed species and ecological communities. If using a computer package for mapping, please retain your shape files so that new maps can be created at the end of the plan. Alternately, files can be sent to the Lantana Plan Coordinator (lantana.plan@environment.nsw.gov.au) for storage. Please also refer to the Bitou Bush TAP monitoring guidelines (www.environment.nsw.gov.au/bitouTAP/monitoring.htm) that will be adopted for this Lantana Plan, as they contain procedures for completing the below maps.

Section 2—site history

2. Outline the long-term management of the site. Include a site history over the last five years, if possible. Include all lantana control and work on priority species. Include the year each activity took place and the stakeholders and costs involved. Also include information on any other weed control undertaken at the site.

Year*	**Control measure undertaken**	**List all priority species, populations or ecological communities present**	**Stakeholders** (community group and contractor)	**Cost**		**Other control measures and the target weed species**
				Cash ($)	**In- kind**	

*Please insert extra lines if needed

3. Identify all programs or actions undertaken for threatened species or high-conservation-value vegetation or cultural heritage values present on site. In New South Wales, refer to the Priorities Action Statement, threat abatement or recovery plans, park or reserve-specific pest management plans, or other legislative requirements. In Queensland, refer to park or reserve-specific pest strategies, property plans under the QLD *Vegetation Management Act 1999* or recovery plans and/or other legislative requirements.

List all important species, populations or ecological communities present	**Program or action undertaken**	**Reference** (e.g. recovery plan)

4. **List all threat abatement and recovery plan actions relevant to the site, and state how the actions are addressed in this Plan.** List all threatened species, populations or ecological communities present. This includes the threatened entities listed on page 1 and any others that may not be at risk from lantana. This is to ensure that actions outlined in this Plan do not contravene other conservation outcomes intended for other biodiversity at the site. Also, if in New South Wales, check with the Priorities Action Statement to ensure all actions have been accounted for.

List all threatened species, populations or ecological communities present	**Source**	**Action required**	**How is this action addressed in this Plan?**

Section 3—site attributes

5. **Identify the attributes of the site that may affect control, and thus the cost**, such as steep terrain, difficult access, and remediation works or fencing that may be needed. Attributes may also include visitation rates; for example, in high visitation areas the use of fire as a control measure may not be feasible because of the need for park closures.

Attributes that may affect control at the site	**How they affect control and how this will be managed**

6. **Identify the important native biodiversity present OTHER THAN the priority environmental assets listed on page 1, including those species that are positively impacted.** See www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm (e.g. herbicide sensitive species, locally/regionally significant species, animals that use lantana for protection).

Other priority biodiversity present	**+ve or –ve impact**	**Significance** (e.g. southern limit)	**Linkage with your control program and other plans**

Section 4—control

In some instances you may be required to provide a more detailed breakdown for this section; if so, please also fill out Appendix A.

7a. **Identify the stages of lantana control required** and the proposed timetable for each stage over a five-year period (see www.environment.nsw.gov.au/lantanaplan/implementation.htm).

Identify the most appropriate management technique required for the level of lantana present, the stage of control and follow-up. Refer to the Decision Support Tool in the *Lantana Best Practice Manual* (Stock et al. 2009) for sequences of initial control and follow-up. In addition, for species that benefit from lantana (that is, those being positively impacted), indicate what measures will be put in place to reduce the impact of lantana removal (e.g. replanting of native food trees). Also list other methods that will be used to protect the high-priority assets.

Outline the follow-up control required in each stage to prevent re-invasion/re-infestation of the site after the initial control.

Year	**Stages of control**	**Area/location to be treated** (please also mark on map in Section 1)	**Initial control technique to be used** (e.g. cut and paint, ground spraying, etc.)	**Follow-up control technique to be used** (e.g. for recruitment and resprouting plants)	**Other restoration activities** (other methods beyond weed control)
1					
2					
3					
4					
5					

7b. Outline the source of funding for each stage of control.

Year	Stages of control	**Your funds ($)** (also include and advise if this is in-kind)		**Other sources ($)** (e.g. from this national Plan or a pest initiative and advise any in-kind amounts if volunteers are contributing)		**Source of other funds** (insert likely sources of funding or where funds will be sought e.g. CMA, CfoC, this Plan, other external grants, in-kind etc)
		Initial	**Follow-up**	**Initial**	**Follow-up**	**Details**
1						
2						
3						
4						
5						

8. Identify any likely non-target effects of the control program outlined above and how this will be accounted for (see www.environment.nsw.gov.au/lantanaplan/implementation.htm).

Non-target effects of control (include biodiversity affected, which may include that listed above in Point 6)	**How this will be avoided or mitigated**

Section 5—other weeds

9. Identify all other significant weed species present and highlight those likely to invade following removal of lantana. A list of other significant weeds associated with lantana is available from the website www.environment.nsw.gov.au/lantanaplan/OtherExotics.htm

Other significant weed species present (common/scientific name); note if plant is a weedy native	**Density of weed species** (i.e. scattered, common, dominant)	**How these weed species influence your lantana control program** (e.g. much harder to control and require other techniques)	**Likely change following lantana control** (i.e. increase, stay same, decrease, don't know. For those likely to increase, please complete Point 10 below)

10. Outline a control program that addresses the weed species identified above (e.g. do not move onto stage 2 until other major weeds are controlled as well). Ensure that this information is also provided in Section 4. Refer to the *Lantana Best Practice Manual* (Stock et al. 2009) for a list of other weeds that can be treated with the same lantana management technique.

Stages of control	**Other weed species present**	**Control measure to be implemented that differs from that used for lantana**
Stage 1		
Stage 2		
Stage 3		

Section 6—legislative requirements

11a. Ensure all pesticide applications comply with the Australian Pesticides and Veterinary Medicines Authority (APVMA) regulations.

11b. Ensure that all herbicides are used in accordance with the label recommendations.

11c. Ensure all regulations of the NSW *Pesticides Act 1999* or the QLD *Agricultural Chemicals Distribution Control Act 1966* and *Agricultural Chemicals Distribution Control Regulation 1998* and the QLD *Chemical Usage (Agricultural and Veterinary) Control Act 1988* and *Chemical Usage (Agricultural and Veterinary) Control Regulation 1999* are upheld, depending on which state your site is located in (e.g. training, record keeping and notification).

12. Where required in NSW, a Section 132C Licence can be applied for individually (through DECCW, see www.environment.nsw.gov.au/wildlifelicences/sciedconlicences.htm) or by completing this proforma and submitting it to the Plan Coordinator, who holds a generic licence, and agreeing to any conditions placed upon such a licence. In QLD, when undertaking management on private property, Vegetation Management Permits may be required.

13. Assess the potential environmental impacts of the management strategies outlined and if needed undertake a risk assessment.

14. Ensure all activities comply with OH&S standards/guidelines and that a Job Safety Analysis (or similar) has been prepared where required.

Section 7—monitoring

15. Outline any monitoring programs being undertaken to evaluate the effectiveness of lantana control or the response of the environmental assets to lantana control.

Monitoring method undertaken (e.g. photo points, quadrats)	**Measures collected** (i.e. what is being measured or recorded—seedling counts)	**Interval of collection** (frequency at which data is collected)	**Where the data is stored and the collector of the data**

Section 8—stakeholder involvement

16. Identify and determine the roles and responsibilities of all stakeholders, especially for each stage of the plan (see Section 4 above).

Stakeholder's details	**Responsibility of stakeholder**	**Stage**

Section 9—Indigenous involvement

17. Where possible identify any Aboriginal cultural heritage sites present. Check the sensitivity of any disclosure of this information before listing below.

Cultural heritage site name (if known officially)	**Description of the site** (e.g. midden)	**Location** (coordinates—if location details are sensitive ensure that knowledge of the site is passed on to personnel implementing the control)	**Site number** (e.g. NPWS Aboriginal Heritage Information Management System)	**Protection works required**

18. Identify and consult with Indigenous people with respect to any special knowledge or interest at the site or the species, population or ecological community and control programs at that site, including the likely social, cultural and economic consequences. Any consultation should be consistent with the requirements of the Commonwealth *Native Title Act 1993* and the respective state legislations.

Name of person contacted	**Details of interest**	**Date contacted**	**Outcomes of consultation**

Section 10—community involvement

19. Identify the community groups that presently work in the area or any other groups that may wish to work in the area (either now or in the future), and the skills and qualifications of those volunteers.

Name of community group or individual/s working at the site	**Frequency of work undertaken at the site**	**Number of people involved**	**Training/qualifications**

Section 11—other information

20. Outline any other aspect of your site and lantana control program that may influence the delivery of the Lantana Plan objectives (www.environment.nsw.gov.au/LantanaPlan). Please also include here any general observations of the site and the vegetation community (e.g. time since last fire).

Other aspects of the site which may influence delivery of the Plan	Effect

Appendix A—additional budget information

In some instances you may need to provide a more detailed break up of your proposed expenditure. Such details may also require identification of capital costs.

21. Outline a detailed budget for the period of funds being sought with respect to specific management activities (also refer to section 4 for more information)

Expenditure Item	A. Total Project Funding ($) (operating under the Lantana Plan)					B. Your Contribution ($)					C. Other funding sources e.g. CfoC ($)				
Year	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Management activity (i.e. weed control)															
Labour															
Contractors															
Travel															
Materials															
Vehicle costs															
Equipment															
Other[#]															
Non-management activities															
Labour															
Travel															
Materials															
Vehicle costs															
Equipment															
Other[#]															
Grand Total															

[#] Please provide details in the box below

Budget explanation notes

2. Relevant legislation, policies, strategies and programs

The main Commonwealth and state legislation, policies, strategies and programs that influence lantana management are presented below. In addition, refer to Makinson (2008) for a guide to the national and state listing processes and legislative provisions for threatened plant species and ecological communities.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
National	*Agricultural and Veterinary Chemicals Code Act 1994* (Agvet Act)	All pesticides, including herbicides, insecticides and fungicides, used, supplied or distributed in Australia must be registered under the Agvet Act by the Australian Pesticides and Veterinary Medicines Authority [APVMA: formerly the National Registration Authority for Agricultural and Veterinary Chemicals (NRA)].	Before any chemical or product (for example commercially formulated pesticide) is registered for use, supply or distribution, the APVMA is required under the Agvet Act to conduct a rigorous assessment of potential impacts on the environment, human health and trade.	All APVMA approved chemicals (or products) have affixed product labels that contain specific usage requirements and application rates. Label breaches can result in prosecutions under the Agvet Act. The APVMA also grants permits for minor use of specific unregistered chemicals in certain circumstances as well as off-label use of registered chemicals. Refer to the guide, *Using Herbicides on Lantana* (Clark et al. 2006) and the *Lantana Best Practice Manual* (Stock et al. 2009) for a list of registered rates of herbicides depending on the application used. Please also refer to the appropriate legislation in your state concerning the use of pesticides.
	Alps to Atherton Initiative (Great Eastern Ranges Initiative in NSW)	The Alps to Atherton Initiative is a long-term strategy to strengthen the resilience of Australia's native plants and animals along the eastern seaboard in the face of climate change and other threats.	It involves communities, agencies and governments in NSW, Victoria, QLD and the Australian Capital Territory using the best available science, practical community knowledge and environmental stewardship to conserve, restore and connect landscapes and ecosystems for more than 2800 km along Australia's great eastern ranges.	Unfortunately, lantana's main distribution starts south of Sydney, to north of Atherton. There is a major overlap of lantana's distribution with that of the ecosystems identified in this Initiative. Because of the threat lantana poses to biodiversity, and the reduction in resilience of vegetation following lantana invasion, lantana may become a major challenge to this strategy and lantana management will likely be required to meet the project's objectives. As lantana can prevent the regeneration of native plants and halt succession following disturbance, when lantana is present at a site it will reduce or remove the resilience of many species.
Australian	Weeds Strategy	The Australian Weeds Strategy provides a framework to establish consistent guidance for all parties, and identifies priorities for weed management across the nation with the aim of minimising the impact of weeds on Australia's environmental, economic and social assets.	The goals of the Australian Weeds Strategy are to: • prevent new weed problems • reduce the impact of existing priority weed problems • enhance Australia's capacity and commitment to solve weed problems.	This Lantana Plan is consistent with many Actions under the Australian Weeds Strategy, including issues relating to environmental assets such as: • 2.3.1 'Identify the threats posed by weeds to key cultural, environmental and production assets and values' • 2.3.2 'Develop and implement site-based approaches to managing weed threats that protect key assets and values' (NRMMC 2007).
	Biological Control Act 1984	The use of non-native biological organisms (the agent) to control a specific pest or weed species (the target) is governed by the *Biological Control Act 1984*. This Act establishes a detailed set of procedures and a framework for the selection of agents (through host-specificity testing), the importation of agents into Australian quarantine, and the intentional release of agents from quarantine.	Prior to allowing importation and intentional release from quarantine, the impacts of the agent on the target as well as non-target species are assessed. In addition, the importation of biological control agents requires approval from Biosecurity Australia (part of the Department of Agricultural Forestry and Fisheries Australia), the Australian Quarantine and Inspection Service, and the Department of Environment, Water, Heritage and Arts. The Australian Weeds Committee, in conjunction with the Natural Resource Management Standing Committee (formerly the Standing Committee on Agriculture and Resource Management), must also approve all biological control proposals before any control is attempted. Approval includes wide consultation with all stakeholders.	For over 90 years, biological control agents have been released against lantana (Walton 2005) with 30 different species released (Zalucki et al. 2007). In Australia, 17 of these agents have established (Zalucki et al. 2007) and five are causing seasonal damage (Taylor et al. 2008). To date these agents have not provided effective control (Walton 2005, Zalucki et al. 2007). Landscape control measures, such as biocontrol, may not be appropriate for the protection of the biodiversity identified in this Plan unless used in conjunction with other techniques.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
National (Cont'd)	Caring for our Country	The Australian Government has committed $2.25 billion in funding over five years for a new environmental programs funding initiative, Caring for our Country (CfoC). It commenced July 2008.	Caring for our Country has one clear goal: 'An environment that is healthy, better protected, well managed, resilient and provides essential ecosystem services in a changing climate'.	Caring for our Country focuses on six national priorities: 1) national reserve system; 2) biodiversity and natural icons, including weed and feral animal control, threatened species; 3) coastal environments and critical aquatic habitats; 4) sustainable farm practices, including Landcare; 5) natural resource management in remote and northern Australia; and 6) community skills, knowledge and engagement. This national Lantana Plan will complement this program across these six priorities.
	Commonwealth Coastal Policy (CCP)	The CCP addresses the nature and complexity of coastal management. The CCP acknowledges that coastal management cannot be achieved by any one jurisdiction and that the management of Australia's coastal zone needs to be shared across all levels of government and the community. The CCP is a blueprint for the management and use of Australia's coastal zone with the aim to 'promote ecologically sustainable use of Australia's coastal zone' (DEWHA 2007).	The CCP acknowledges that Indigenous Australians manage a significant proportion of the Australian coastal zone and as such need to be included in the development and implementation of the CCP. The relevant public participation objectives are: • to ensure that there is informed public participation in open, consultative processes dealing with planning and management of coastal resources • to recognise the interests in the coastal zone of Australia's Indigenous peoples and incorporate these interests in management arrangements.	Several objectives of the CCP are of direct relevance/importance to the management of lantana. The relevant resource conservation objectives are: • to conserve and manage areas and features of significant ecological, physical, cultural, historic, landscape and scientific importance, so that their values are maintained • to maintain the biological diversity and productivity of marine and terrestrial ecosystems and natural processes within the coastal zone for present and future generations. Where environmental qualities have been degraded remedial action should be taken to restore them.
Containment	Zones Project - Lantana	This project, as part of the Lantana WoNS Program, coordinated management of isolated infestations outside of core infestations (Rogers and Johnson 2008). It was a federally supported project with the aim of identifying and coordinating the control of lantana infestations established outside of the core eastern seaboard area.	Infestations requiring control have been identified in northern QLD, western QLD, the Northern Territory, Western Australia and South Australia, where removal or containment is an important outcome of the *Lantana camara* Strategic Plan (ARMCANZ et al. 2001). Northern QLD was placed in a containment zone. The zone extends north from Pormpuraaw, Laura and Cooktown. The Lantana WoNS Program is also supported in southern NSW by the Southern Tablelands and South Coast Lantana Weed Management Plan. This plan established the Southern Containment Zone. This zone commences south of Shoalhaven City Council's boundary.	Lantana's ability to establish in a wide range of environments, such as sensitive riparian areas, and to displace highly specialised native flora means lantana infestations in any state or territory of Australia should be considered a serious threat. Maintaining areas that are presently free of lantana will be beneficial to biodiversity, as native species, populations and ecological communities in these areas will remain unaffected by lantana invasions. Given this, this project is supported by this Lantana Plan and embodied in Actions 2.1 and 2.2.
	Defeating the Weed Menace Program	In 2004, the Australian Government committed $44.4 million over four years for national action on Australia's most threatening weeds through the Defeating the Weed Menace Program.	One of the aims of this program is to fund programs relating to the WoNS, especially where this leads to on-ground management.	In 2006, the QLD Department of Natural Resources, Mines and Water (now Biosecurity Queensland) received funding for three years, from this program, to develop and implement this Lantana Plan. DECCW was subcontracted to develop this Plan and coordinate its initial implementation to June 2009.
	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides a national framework for environmental management (including the recognition of nationally threatened species and ecological communities) directing resources towards the delivery of improved environmental protection.	With respect to threatened species and ecological communities, the EPBC Act provides for: • identification and listing of threatened species and threatened ecological communities • development of recovery plans for such species and ecological communities • recognition of key threatening processes • reducing these processes through threat abatement plans.	Lantana currently poses serious threats to several species/ecological communities listed on schedules of the EPBC Act. Lantana invasion is not currently listed as a threatening process under the EPBC Act. The EPBC Act therefore currently applies where lantana threatens any listed species or ecological community under the EPBC Act or where its control may have adverse effects on matters of national environmental significance.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
National (Cont'd)	National NRM Monitoring and Evaluation Framework	The Natural Resource Management Ministerial Council has established the National Natural Resource Management Monitoring and Evaluation Framework to assess progress towards an improvement in the condition of natural resources. Based on a set of principles for monitoring, evaluation and reporting on natural resource condition, the Framework also provides a set of indicators for assessing change in resource condition and program performance.	This progress is to be attained through the development of accurate, cost-effective and timely information on: • the health of the nation's land, water, vegetation and biological resources • the performance of programs, strategies and policies that provide national approaches to the conservation, management and sustainable use of these resources. The roles and responsibilities for meeting national, state and territory, and regional reporting requirements are also outlined.	Monitoring guidelines will be adopted for this Plan. The overall aim of the monitoring guidelines is to address the issues of monitoring and reporting deficiencies. The monitoring guidelines provide a standardised methodology across a range of differing resource and skill levels to measure the response of the weed to control and the response of the native plant species at risk (see Chapter 6). In addition, given that this Plan is focused on biodiversity at risk, monitoring must be tailored to those assets identified and form part of the Australian Government Natural Resource Management Monitoring, Evaluation, Reporting and Improvement Framework (see Commonwealth of Australia 2009).
Natural	Resource Management	In order to facilitate the integrated delivery of Natural Resource Management (NRM) priority issues, the Australian Government, in association with state and territory governments, identified 56 regions covering all of Australia.	The NRM regions are responsible for managing natural resources at the catchment scale, through strategic investment.	The core infestations of lantana can be found across 12 NRM regions, seven in QLD and five in NSW. In NSW, they are called Catchment Management Authorities (CMAs). Each NRM in QLD is currently developing a Biodiversity Action Plan for their region and each CMA in NSW has a Catchment Action Plan that details their actions for achieving statewide targets established by the Natural Resource Commission. This Plan will assist with meeting these targets.
	Weeds of National Significance (WoNS)	The WoNS were determined from a list of 71 major weed species derived using set criteria (see Thorp and Lynch 2000 for further information). A species was included if it: • threatened the profitability or sustainability of Australia's principal primary industries • threatened conservation areas or environmental resources of national significance • required remedial action across several states and territories • constituted a major threat to Australia's biodiversity.	*Lantana camara* was listed as one of the 20 WoNS in 2000 (see Thorp and Lynch 2000), after which a national strategy was produced (see ARMCANZ et al. 2001). The national strategy for lantana has five goals, to: • minimise impact • prevent the sale • increase community awareness • prevent spread • coordinate management.	This Lantana Plan sits within, and meets actions detailed within, the Lantana WoNS Strategy. The Plan aims to protect biodiversity by strategically identifying management areas where the chances of biodiversity protection will be maximised through lantana management. Therefore, implementation of the Lantana Plan will assist the Lantana WoNS Strategy, within Strategy 2.1.4—to 'identify strategic management areas'—and the Actions within to review and evaluate areas where control programs have already been undertaken and to identify high-priority areas and take appropriate action including that for conservation (ARMCANZ et al. 2001).

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
NSW	Bell Miner Associated Dieback Strategy (BMAD)	The bell miner is a native honeyeater that was identified as a bird species that benefited from the presence of lantana. BMAD is a significant threat to the sustainability of the moist eucalypt forests of north-eastern NSW and south-eastern QLD (Wardell-Johnson et al. 2006). BMAD refers to eucalypt forest dieback, which is associated with the occurrence of outbreaks of mainly psyllid species and colonies of the bell miner. Forests affected by BMAD are severely degraded with the loss of a significant proportion of overstorey species and subsequent invasion of the understorey by weeds, particularly lantana (DECC 2007d). Forest eucalypt dieback associated with over-abundant bell miners and psyllids has recently had a final determination as a key threatening process under the TSC Act.	Bell miners create negative feedback mechanisms that maintain elevated and damaging populations of psyllids, as bell miners can exclude a wide range of smaller insectivorous birds from the areas they occupy. A more diverse bird community usually has a much greater impact on (and reduction of) psyllid infestations than communities dominated by bell miners. While lantana may not be a primary factor in initiating BMAD, its presence provides increased canopy openings, which may be a primary cause for increases in psyllids (Wardell-Johnson et al. 2006). The management of lantana has therefore been promoted to discourage bell miners and to promote native plant recovery.	A key action in the BMAD Strategy is to implement lantana removal trial plots within areas affected by dieback (Bell Miner Associated Dieback Working Group 2004). This should promote a more complex native flora, and therefore links in with the objectives of this Plan for biodiversity conservation. Many species and ecological communities associated with BMAD are also high priority assets listed in this Plan, including White Gum Moist Forest in the NSW North Coast Bioregion and the Blue Gum High Forest Ecological Community. The group of high priority control sites in this Plan also include sites that contain BMAD (see Table 3.3). However, many other native species and ecological communities are also threatened by lantana outside of BMAD's distribution.
	Invasive Species Plan	The NSW Invasive Species Plan aims to prevent and effectively manage the introduction and spread of invasive species so that significant threats are minimised. It proposes to prevent, contain and manage invasive species, including weeds, vertebrate and invertebrate animal pests.	To achieve the NSW Government's target of reducing the impact of invasive species in the state by 2015, the Invasive Species Plan identifies four goals: • exclude—prevent the establishment of new invasive species • eradicate or contain—eliminate or prevent the spread of new invasive species • effectively manage—reduce the impacts of widespread invasive species • capacity building—ensure NSW has the ability and commitment to manage invasive species.	Goal 3—reducing the impacts of widespread invasive species has direct links to this Plan, as the Plan has identified and prioritised lantana management at sites where benefits are greatest for biodiversity conservation.
Monitoring,	Evaluation and Reporting (MER) Strategy	During preparation of the 2006 NSW State of the Environment (SoE) Report, the NSW Government adopted a set of 13 statewide targets for natural resource management, based on recommendations by the Natural Resources Commission. The next SoE Report in 2009 will report on the progress in meeting these targets through the integrated NSW MER Strategy for natural resources.	The purpose of the MER Strategy is to refocus the resources of NSW natural resource and environment agencies and coordinate their efforts with CMAs, local governments, landholders and other natural resource managers to establish a system of monitoring, evaluation and reporting on natural resource condition.	The strategy will make the best use of existing resource condition information to inform policy and investment decisions and best practice management by all natural resource managers across NSW. Monitoring guidelines will be adopted for this Plan. The overall aim of the monitoring guidelines is to address the issues of monitoring and reporting deficiencies. The monitoring guidelines provide a standardised methodology across a range of differing resource and skill levels to measure the response of the weed to control and the response of the native plant species at risk, including threatened species.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
NSW (Cont'd)	*Noxious Weeds Act 1993*	This Act provides for the identification, classification and control of noxious weeds in NSW. The lead agency for this Act is Industry and Investment NSW (formerly Department of Primary Industries and NSW Agriculture), with the Act administered by Local Control Authorities (usually local councils, but can be a combination of council areas).	The Act defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The Act sets up categorisation and control actions for the various noxious weeds: • The control objective for weed control class 1 is to prevent the introduction and establishment of those plants in NSW. • The control objective for weed control class 2 is to prevent the introduction and establishment of those plants in parts of NSW. • The control objective for weed control class 3 is to reduce the area and the negative impact of those plants in parts of NSW. • The control objective for weed control class 4 is to minimise the negative impact of those plants on the economy, community or environment of NSW. • The control objective for weed control class 5 is to prevent the introduction of those plants into NSW, the spread of those plants within the state or from the state to another jurisdiction.	Lantana [all species] are Class 5 Restricted Plants. Among other actions. lantana must not be sold, purchased, or moved in NSW. Lantana is a Class 3 Regionally Controlled Weed in the Local Control Authorities: Bega Valley, Eurobodalla, Lord Howe Island. Lantana is a Class 4 Locally Controlled Weed in the following Local Control Authorities: Ashfield, Auburn, Bankstown, Bellingen, Botany, Burwood, Campbelltown, Canada Bay, Canterbury, Cessnock, Clarence Valley, Coffs Harbour, Fairfield, Far North Coast County Council for the Ballina, Byron, Kyogle, Lismore City, Richmond Valley and Tweed Shire Councils, Gloucester, Great Lakes, Greater Taree, Holroyd, Hornsby, Hunters Hill, Hurstville, Illawarra District Weeds Authority, Kempsey, Kiama, Kogarah, Ku-ring-gai, Lane Cove, Leichhardt, Liverpool, Manly, Marrickville, Mosman, Nambucca, North Sydney, Parramatta, Pittwater, Port Macquarie-Hastings, Randwick, Rockdale, Ryde, Shellharbour, Shoalhaven, Strathfield, Sutherland, Sydney, Warringah, Waverley, Willoughby, Wollongong, Woollahra. The growth and spread of Class 4 weeds must be controlled according to the measures specified in a management plan published by the local control authority (Johnson 2007).
	NSW National Parks and Wildlife Act 1974	This Act established the National Parks and Wildlife Service (NPWS), now part of DECCW. The Parks and Wildlife Division of DECCW is responsible for the care, control and management of all national parks, historic sites, nature reserves, Aboriginal areas, state conservation areas, karst conservation reserves, marine parks and regional parks within NSW.	The aims of weed management undertaken by the NPWS are: • to conserve biodiversity and cultural heritage on-park • to minimise the spread of weeds to and from neighbouring properties • to raise community awareness of the impacts of weeds • to encourage community involvement • to conform to legislative requirements for the control of noxious weeds (DEC 2006b).	Many of the NSW high-priority control sites within this Plan are found on NPWS estate, and implementation of this Plan fulfils the aims of weed management conducted by the NPWS. In addition, any action that is likely to harm or damage threatened species, populations or ecological communities listed under the TSC Act (see below) requires one of the following: • a Section 91 licence under the TSC Act; or, for lands managed by the DECCW, a Section–171 authority issued under the *National Parks and Wildlife Act 1974* • a certificate of exemption under Section 95 of the TSC Act • a licence under Section 132C of the *National Parks and Wildlife Act 1974*.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
NSW (Cont'd)	*Pesticides Act 1999*	The *Pesticides Act 1999* regulates the use of all pesticides in NSW after the point of sale. This includes pesticides used in agriculture, on public lands and on domestic and commercial premises.	Additional amendments have been added to the Act, including: • Pesticide Record Keeping: Records must be kept by all people who use pesticides for commercial or occupational purposes such as on a farm, on produce, or as part of their occupation or business. • Pesticide Training: People who use pesticides in their business or as part of their occupation must be trained in how to use those pesticides. Any person employed or engaged to use pesticides must also be trained. • Pesticide Notification: From 1 February 2007, new notification requirements apply to pesticides applications by public authorities in outdoor public places and to pesticide applications by licensed pest management technicians in common areas of multi-occupancy residential complexes.	Under the provisions of the *Pesticides Act 1999* all pesticide users in NSW, including those implementing this Plan, are required to ensure that they: • use only pesticides registered by the APVMA • read the pesticide registration label on pesticide containers (or have them read to them) and strictly follow the label directions • not risk injury to persons, property and non-target plants and animals through the use of a pesticide • obtain an APVMA permit if they wish to vary the label directions or use pattern • follow the instructions on any Pesticide Control Order relevant to the pesticide being used • make a record of all pesticide applications • become trained or licensed where required under the *Pesticides Act 1999* and the *Pesticides Regulation 1995* • in some circumstances provide notice of their pesticide use.
	Regional Weed Management Priorities for Biodiversity Conservation	In 2007, DECCW and the DII started to develop regional weed control priorities so that widespread weed management programs could target those areas where control will result in the best outcome for biodiversity. This project will complement those weed strategies already established or being planned within each CMA.	The project has prioritised sites for control of widespread weeds for biodiversity conservation within each of the 13 CMAs in NSW (DECC et al. 2009). Widespread weed species have been prioritised according to their impact on biodiversity, from which sites have been identified where weed control is likely to have the greatest benefit to the biodiversity at risk (see Williams et al. 2008). This list can be used by each CMA region to direct weed control funding.	This program complements that of the Lantana Plan as both programs follow similar methodologies, except that this CMA project focuses on multiple weed species at a regional scale.
	Threatened Species Conservation Act 1995 (TSC Act)	In 1996, the NSW *Threatened Species Conservation Act 1995* (TSC Act) commenced, with the purpose of conserving threatened species, populations and ecological communities in NSW. Contained within the TSC Act are three schedules: Schedule 1 contains lists of critically endangered species and communities, endangered species, populations and communities, and extinct species; Schedule 2 contains lists of vulnerable species and communities; and Schedule 3 contains a list of Key Threatening Processes (KTPs). In 2004, amendments were made to the TSC Act. The amendments relevant to this Plan are: (i) the preparation of a TAP is no longer mandatory; and (ii) the development of a Priorities Action Statement (PAS). The PAS outlines recovery and threat abatement actions for the biodiversity listed under the Act (see DECC 2007b).	The objectives of the TSC Act are to: • conserve biological diversity and promote ecologically sustainable development • prevent the extinction of, and promote the recovery of, threatened species, populations and ecological communities • protect the critical habitat of those threatened species, populations and ecological communities that are endangered • eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities • ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed • encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving cooperative management.	The invasion, establishment and spread of lantana has been listed as a Key Threatening Process under the TSC Act (NSW SC (Scientific Committee) 2006). The actions identified within this Lantana Plan will be incorporated into the Priorities Action Statement (PAS). Any action that is likely to harm or damage threatened species, populations or ecological communities listed under the TSC Act requires one of the following: • a Section 91 licence under the TSC Act; or, for lands managed by the DECCW, a Section–171 authority issued under the *National Parks and Wildlife Act 1974* • a certificate of exemption under Section 95 of the TSC Act • a licence under Section 132C of the *National Parks and Wildlife Act 1974*. Therefore, the control of lantana in some areas may require such a licence or certificate to be issued by the DECCW.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
QLD	*Agricultural Chemicals Distribution Control Act 1966*	The QLD Department of Employment, Economic Development and Innovation (DEED&I) administers the *Agricultural Chemicals Distribution Control Act 1966*. This Act controls aerial distribution (spraying, spreading or dispersing) of agricultural chemicals from aircraft to which aerial equipment is installed or attached. The Act also controls ground distribution of herbicides from ground equipment.	A key control mechanism for aerial distribution of agricultural chemicals is the dual licensing of both the pilots, who are in command of aircraft from which aerial distribution is carried out. Aerial agricultural businesses and individual contractors who carry on the business of aerial distribution, or direct or authorise an aircraft to be used to carry out aerial distribution of agricultural chemicals in QLD must also be licensed.	Site managers and landholders will need to consider the use of aerial spraying due to the off-target damage it may cause to native biodiversity. Landscape control measures such as this may not be appropriate for the protection of the environmental assets identified in this Plan. This is especially the case for Stage 1 of control (see Section 5.1 of the Plan). Stage 1 is the removal of lantana and other weed species from the immediate vicinity of the high-priority assets.
	Biological Control Act 1987	The *Biological Control Act 1987* provides for biological control of agricultural pests for the protection of the environment. This Act is jointly administered by the DEED&I and the DERM. The Act provides for the case of biological control agents to control agricultural pests through the declaration of target organisms and the declaration and release of agent organisms to combat them. The Act also establishes the QLD Biological Control Authority and prescribes its powers and functions. The Queensland Biological Control Authority may establish a Commission of Inquiry to inquire into matters relating to target organisms or agent organisms.	The Act aims to provide a link with complementary legislation in the other states and the Northern Territory to ensure a uniform approach to biological control throughout Australia.	For over 90 years, biological control agents have been released against lantana (Walton 2005) with 30 different species released (Zalucki et al. 2007). In Australia, 17 of these agents have become established (Zalucki et al. 2007) and five are causing seasonal damage (Taylor et al. 2008). To date these agents have not provided effective control (Walton 2005, Zalucki et al. 2007).
	Chemical Usage (Agricultural and Veterinary) Control Act 1988 and *Chemical Usage (Agricultural and Veterinary) Control Regulation 1999*	This legislation, administered also by the QLD DEED&I, provides for controls over the use of agricultural and veterinary chemical products by all chemical users.	In general terms, agricultural chemical products are pesticides (including insecticides, fungicides and herbicides) that are used to control pests in food and fibre crops, aquatic situations and non-agricultural situations (for example, commercial land or buildings). It should be noted that any substance used to control pests in these situations would be considered to be an agricultural chemical product. *The Chemical Usage* Act *1988* allows all persons to use registered agricultural chemical products in certain ways (for example lower rate of use) that are not in accordance with the instructions on the label approved by APVMA (that is, off-label), without these uses being considered offences under the legislation. These off-label use allowances are limited. Refer to s. 13B of the *Chemical Usage Act 1988* (Compliance with instructions). All other off-label use is not permitted unless a permit for the use has been issued by APVMA. Agricultural chemical products that have not been registered by APVMA must not be used, unless a permit has been issued for use.	Users of agricultural and veterinary chemical products implementing this Plan are required, under the legislation, to: • only use registered chemical products that have been approved for the proposed use • use the registered chemical product in accordance with the instructions on the label approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA). (The label approved by APVMA is generally the label appearing on the container of the product.) • Other chemical products can only be used if allowed by legislation or if a permit is issued by APVMA.

National/ State	Strategy/Act	Background/Purpose	Goals/Actions	Links to the Lantana Plan
QLD (Cont'd)	*Land Protection (Pest and Stock Route Management) Act 2002*	This Act provides a framework and powers for improved management of weeds and pest animals. It governs the actions with respect to the control and management of declared plants and animals in QLD. It also provides local governments with the legal instrument they need to enforce the management of high-priority weeds and pest animals.	This legislation is administered by Biosecurity Queensland to ensure the fight against invasive pests in QLD is coordinated, consistent, and does not waste precious resources. An important function of the Act is the ability to declare plants and animals that are considered serious or potentially serious pests in QLD. Biosecurity Queensland imposes a range of restrictions on declared plants and animals in QLD (including introduction, possession and sale) but allows certain activities under declared pest permits.	The supporting subordinate legislation, which includes establishing the purposes for keeping declared species and which species can be kept under permit and declares the pest plants and pest animals for control and management in the state, is the *Land Protection (Pest and Stock Route Management) Regulation 2003*. Lantana (all species) is a Class 3 pest, and cannot be bought or sold in QLD. Landholders are not required to control Class 3 plants unless their land is adjacent to an environmentally significant area.
	Nature Conservation Act 1992 (NC Act)	In QLD, legislation about conserving and managing native animals and plants and declaring and managing protected areas, such as national parks, is under the NC Act. This replaced the *Fauna Conservation Act 1974*, *National Parks and Wildlife Act 1975*, *Native Plants Protection Act 1930* and provisions of the *Land Act* relating to environmental parks. The NC Act is based on principles to conserve biological diversity, ecologically sustainable use of wildlife, ecologically sustainable development and international criteria developed by the World Conservation Union (International Union for the Conservation of Nature and Natural Resources) for establishing and managing protected areas.	The NC Act's objective is the conservation of nature. This is to be achieved by an integrated and comprehensive conservation strategy involving: • gathering, researching and disseminating information on nature, identifying critical habitats and areas of major interest, and encouraging the conservation of nature by education and cooperative involvement of the community • dedication and declaration of areas representative of the biological diversity, natural features and wilderness of QLD as protected areas • managing protected areas • protecting native wildlife and its habitat • ecologically sustainable use of protected wildlife and areas • recognition of the interest of Aborigines and Torres Strait Islanders in nature and their cooperative involvement in its conservation • cooperative involvement of landholders.	Lantana currently poses serious threats to many species listed under the NC Act. Under this Act is the Nature Conservation (Protected Plants) Conservation Plan 2000. Part of the purpose of this plan is to control threatening processes. Many of the high-priority control sites in QLD within this Lantana Plan are found in protected areas.
	Vegetation Management Act 1999	This Act is in place to regulate the clearing of vegetation in QLD. The regional ecosystems classification scheme and the associated Biodiversity Planning Assessments are part of the biodiversity planning framework that has been developed to assist the QLD DERM to plan for biodiversity. The framework has been incorporated into planning initiatives, including the development of guidelines for clearing on leasehold lands under the *Lands Act 1994* and the *Vegetation Management Act 1999*; the assessment of the comprehensiveness, adequacy and representativeness of the conservation reserve network; and as a guide for proactive conservation.	Regional ecosystems were defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The framework is dynamic and is regularly reviewed as new information becomes available. The Regional Ecosystem Description Database lists the status of Regional Ecosystems as gazetted under the *Vegetation Management Act 1999* (their Vegetation Management Status) and their Biodiversity Status as recognised by DERM (formerly the Environmental Protection Agency). The *Vegetation Management Act 1999* status is based on an assessment of the pre-clearing and remnant extent of a Regional Ecosystem. The Biodiversity Status is defined by DERM and is based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of a Regional Ecosystem. The current biodiversity status is given on the Regional Ecosystem Description Database.	In QLD, 407 Regional Ecosystems were identified as at risk from lantana during the development of this Lantana Plan. This includes 105 Endangered and 187 Of-concern Regional Ecosystems.

National/ State	Strategy/Act	Links to the Lantana Plan
Australian Capital Territory	*Pest Plant and Animal Act 2005*	Lantana is on the declared pest plant list under the ACT *Pest Plant and Animal Act 2005*.
Northern Territory	*Weeds Management Act 2001*	The Northern Territory has declared *L. camara* under the *Weeds Management Act 2001*. It is declared at two levels: • Class B Noxious Weed (regional declaration): growth and spread to be controlled outside town areas. • Class C Noxious Weed: not to be introduced to the Northern Territory. Declared weeds are restricted from sale in the Northern Territory (QLD NRM & E 2004). See above under the National Containment Zones Project for lantana.
South Australia	*Natural Resources Management Act 2004*	*Lantana camara* is a declared plant in South Australia. See above under the National Containment Zones Project for lantana.
Tasmania	*Weed Management Act 1999*	*Lantana camara* is declared under the *Weed Management Act 1999*. Lantana may not be imported into Tasmania, and its sale or other supply is not permitted. Landholders may be required to take steps to control lantana on their property (QLD NRM & E 2004).
Victoria	*Catchment & Land Protection Act 1994*	*Lantana camara* is declared under the *Catchment and Land Protection Act 1994*. Trade and distribution in lantana and materials containing it are prohibited. See above under the National Containment Zones Project for lantana.
Western Australia	*Agricultural & Related Resources Protection Act 1976*	*Lantana camara* is declared in Western Australia under the *Agricultural and Related Resources Protection Act 1976*. The movement of plants or their seeds is prohibited within the state. This Act is currently being combined into the *Biosecurity and Agricultural Management Act 2007.* See above under the National Containment Zones Project for lantana.

3. High-priority biodiversity at risk from the invasion of lantana

The environmental assets listed in the below tables are considered those that will be adversely affected by lantana, if lantana management is not undertaken within their distribution within the next five years (see Chapter 2 for the process used to determine biodiversity at risk and their priority). For further information, or lower priority biodiversity at risk from lantana, see www.environment.nsw.gov.au/lantanaplan/biodiversityatrisk.htm

Table A3.1. High-priority plant species at risk from lantana

Scientific name	Listed under legislation*
Acacia bakeri	N
Acacia chrysotricha	N
Acacia pubescens	C, N
Acalypha eremorum	N
Acianthus amplexicaulis	Q
Acianthus exiguus	O
Acomis acoma	Q
Acronychia littoralis	C, N, Q
Actephila sessilifolia	Q
Adiantum hispidulum var. *minus*	O
Agathis microstachya	Q
Alectryon ramiflorus	C, Q
Alectryon semicinereus	Q
Allocasuarina portuensis	C, N
Alloxylon flammeum	C, Q
Alpinia hylandii	Q
Alpinia modesta	O
Alyxia magnifolia (*Alyxia ilicifolia* subsp. *magnifolia*)	Q
Alyxia sharpei	Q
Ancistrachne maidenii	N
Angophora crassifolia	O
Angophora inopina	C, N
Archidendron hendersonii	N
Archidendron lovelliae	C, Q
Archidendron muellerianum	O
Arthraxon hispidus	C, N, Q
Arthrochilus prolixus	O
Arytera dictyoneura	Q
Asperula asthenes	C, N
Asterolasia elegans	C, N
Atalaya calcicola	Q
Atalaya collina	C, Q
Atalaya rigida	Q
Auranticarpa edentata	O
Austrobuxus swainii	Q
Austromyrtus pubiflora	O
Backhousia oligantha	O
Baloghia marmorata	C, N, Q
Belvisia mucronata var. *mucronata*	N
Berrya rotundifolia	Q
Bertya polystigma	O
Boronia umbellate	C, N
Bosistoa transversa (*Bosistoa selwynii*)	C, N
Bothriochloa bunyensis	C, Q
Bunochilus majus	O
Callerya australis	Q
Callistemon linearifolius	N
Callistemon shiressii	O
Capparis velutina	O
Cassia brewsteri var. *marksiana* (*Cassia marksiana*)	N, Q
Cassia sp. Paluma Range	Q
Chiloglottis truncata	O
Choricarpia subargentea	N, Q
Clematis fawcettii	C, N, Q
Corchorus cunninghamii	C, N, Q
Corchorus hygrophilus	Q
Corchorus thozetii	Q
Cordyline congesta	O
Corokia whiteana	C, N
Corybas dowlingii	N
Corymbia abergiana	O
Corynocarpus rupestris subsp. *arborescens*	Q
Corynocarpus rupestris subsp. *rupestris*	C, N
Cossinia australiana	C, Q
Croton magneticus	C, Q
Cryptocarya bellendenkerana	O
Cryptocarya floydii	O
Cryptocarya foetida	C, N, Q
Cryptocarya mackinnoniana	O
Cryptocarya williwilliana	O
Cupaniopsis newmanii	Q
Cupaniopsis serrata	N
Cupaniopsis shirleyana	C, Q

Scientific name	Listed under legislation*
Cycas candida	O
Cycas megacarpa	C, Q
Cycas ophiolitica	C, Q
Cynanchum elegans	C, N
Cyperus semifertilis	C, N, Q
Dansiea elliptica	Q
Daphnandra sp. McPherson Range (W.D.Francis AQ217480) (*Daphnandra micrantha*)	O
Daphnandra sp. Illawarra (Schodde 3475) (*Daphnandra johnsonii*)	C, N
Davidsonia jerseyana	N
Davidsonia johnsonii (*Davidsonia* sp. Mullumbimby-Currumbin Ck (Floyd 1595))	C, N, Q
Decaspermum struckoilicum (*Decaspermum* sp. Mt Morgan (D.Hoy 71))	C, Q
Dendrocnide moroides	N
Desmodium acanthocladum	C, N
Digitaria abyssinica	O
Diospyros mabacea	C, N
Diospyros major var. *ebenus*	N
Diploglottis campbellii	C, N, Q
Dipodium ensifolium	O
Dissiliaria muelleri	O
Diteilis simmondsii (*Liparis simmondsii*)	O
Diuris disposita	N
Diuris flavescens	N
Diuris oporina	O
Diurus praecox	C, N
Drynaria rigidula	N
Ehretia grahamii	O
Elaeocarpus sp. Rocky Creek (G. Read AQ 562114)	C, N
Elaeocarpus williamsianus	C, N
Endiandra floydii	C, N, Q
Endiandra globosa	Q
Endiandra hayesii	C, N, Q
Endiandra muelleri subsp. *bracteata*	N
Epacris purpurascens var. *purpurascens*	N
Erythrina sp. Croftby (P.I.Forster PIF6209)	O
Eucalyptus benthamii	C, N
Eucalyptus dunnii	Q
Eucalyptus fergusonii subsp. *fergusonii*	O
Eucalyptus largeana	O
Eucalyptus parramattensis subsp. *decadens*	C, N
Eucalyptus pellita	O
Eucalyptus raveretiana	C, Q
Eucalyptus reducta	O
Eucalyptus rummeryi	O
Eucalyptus sp. Cattai (Gregson s.n., 28 Aug 1954)	N
Eucalyptus taurina	Q
Eucalyptus tetrapleura	C, N
Floydia praealta	C, N, Q
Fontainea australis	C, N, Q
Fontainea fugax	Q
Fontainea oraria	C, N
Fontainea rostrata	C, Q
Fontainea venosa	C, Q
Geijera paniculata (*Coatesia paniculata*)	N
Genoplesium insigne (*Genoplesium insignis, Corunastylis insignis*)	N
Glochidion hylandii	O
Glochidion pungens	Q
Glycine clandestine (Nambucca *Glycine* population only)	N
Gossia fragrantissima (*Austromyrtus fragrantissima*)	C, N, Q
Gossia gonoclada	Q
Gossia inophloia	Q
Grammitis stenophylla	N
Graptophyllum excelsum	Q
Graptophyllum ilicifolium	C, Q
Graptophyllum reticulatum	C, Q
Grevillea caleyi	C, N
Grevillea guthrieana	C, N
Grevillea hilliana	N
Grevillea juniperina subsp. *juniperina*	N
Grevillea parviflora subsp. *parviflora*	C, N
Grevillea quadricauda	C, N, Q
Grevillea rivularis	C, N
Grewia australis	O
Hakea archaeoides	C, N

Scientific name	Listed under legislation*
Haloragis exalata sub. *velutina*	C, N, Q
Harnieria hygrophiloides (*Calophanoides hygrophiloides*)	N
Helicia ferruginea	Q
Hernandia bivalvis	Q
Hicksbeachia pinnatifolia	C, N, Q
Ipomoea saintronanensis	Q
Irenepharsus trypherus	C, N
Isoglossa eranthemoides	C, N
Jasminum jenniae	Q
Lasiopetalum sp. Proston (J.A.Baker 17)	Q
Lenwebbia prominens	Q
Lepiderema pulchella	N, Q
Livistona drudei	Q
Lomandra fluviatilis	O
Macadamia integrifolia	C
Macadamia jansenii (*Macadamia* sp. Pine Creek)	C, Q
Macadamia ternifolia	C, Q
Macadamia tetraphylla	C, N, Q
Macropteranthes fitzalanii	Q
Macropteranthes leiocaulis	Q
Macrozamia flexuosa	O
Macrozamia lomandroides	C
Macrozamia lucida	O
Macrozamia pauli-guilielmi	C, Q
Macrozamia serpentina (*Macrozamia* sp. Marlborough (P.I. Forster))	O
Marsdenia coronata	C, Q
Marsdenia liisae	O
Marsdenia longiloba	C, N, Q
Marsdenia straminea	Q
Melaleuca biconvexa	C, N
Melicope vitiflora	N
Myrsine richmondensis (*Rapanea* sp. A Richmond River (J.H. Maiden & J.L. Boorman NSW 26751))	N
Niemeyera chartacea	N
Niemeyera whitei (*Amorphospermum whitei*)	O
Notelaea ipsviciensis	O
Notelaea lloydii	C, Q
Ochrosia moorei	C, N, Q
Oldenlandia gibsonii	Q
Olearia cordata	C, N
Olearia heterocarpa	Q
Owenia cepiodora	C, N, Q
Pandorea baileyana	Q
Pararistolochia praevenosa	Q
Parsonsia dorrigoensis	C, N
Parsonsia largiflorens	Q
Parsonsia lenticellata	Q
Parsonsia sankowskyana	Q
Parsonsia wildensis	Q
Paspalidium grandispiculatum	C, Q
Peristeranthus hillii	N
Persoonia amaliae	Q
Persoonia mollis subsp. *maxima*	C, N
Persoonia nutans	C, N
Persoonia pauciflora	C, N
Persoonia pinifolia	O
Persoonia tropica	O
Persoonia volcanica	Q
Phaius australis	C, N
Phaius tancarvilleae	C, N, Q
Phebalium longifolium	O
Phyllanthus microcladus (*Phyllanthus* (*Sauropus*) *albiflorus, Phyllanthus pusillifolius*)	N
Phyllanthus sauropodoides	Q
Phyllanthus sp. Bulburin (P.I.Forster+ PIF16034)	Q
Pilidiostigma rhytispermum	O
Pimelea curviflora var. *curviflora*	C, N
Pimelea spicata	C, N
Plectranthus alloplectus	N
Plectranthus amoenus	Q
Plectranthus graniticola	Q
Plectranthus nitidus	C, N, Q
Plectranthus omissus	C, Q
Plectranthus torrenticola	C, Q
Pomaderris clivicola	C, Q
Pomaderris coomingalensis	Q
Pouteria eerwah (*Planchonella eerwah*)	C, Q
Prostanthera askania	C, N
Prostanthera densa	C, N
Psilotum complanatum	N
Psychotria simmondsiana	O
Pultenaea maritime	N
Pultenaea parviflora	N
Quassia bidwillii	C, Q
Quassia sp. Moonee Creek'(King s.n., Nov 1949)	C, N
Quassia sp. Mt Nardi	O
Randia moorei	C, N, Q
Rhizanthella slateri	N
Rhodamnia angustifolia	Q
Rhodamnia glabrescens	Q
Rhodamnia longisepala	O
Rhodamnia maideniana	O
Rhodamnia pauciovulata	Q
Rhynchosia acuminatissima	N
Ricinocarpos speciosus	Q
Romnalda strobilacea	C, Q
Ryssopterys timorensis	O
Sarcochilus fitzgeraldii	C, N
Sarcochilus hartmannii	C, N
Sarcopteryx montana	Q
Sauropus macranthus	C, Q
Schizomeria whitei	Q
Senna acclinis (*Cassia retusa, Senna gaudichaudiana*)	N, Q
Senna sophera var. 40 Mile Scrub (J.R.Clarkson+ 6908)	O
Solanum celatum	N
Solanum limitare	N
Solanum sporadotrichum	Q
Sophora fraseri	C, N, Q
Symplocos harroldii	Q
Syzygium hodgkinsoniae	C, N, Q
Syzygium moorei	C, N, Q
Syzygium paniculatum	C, N
Tarenna cameronii	N
Tectaria devexa var. *devexa*	C
Tephrosia sp. Magnetic Island	O
Tinospora tinosporoides	C, N, Q
Trichosanthes subvelutina	O
Triunia robusta	C, Q
Tylophora rupicola	C, Q
Tylophora woollsii	C, N
Typhonium sp. aff. *brownii* (A.G. Floyd 11/3/1958)	N
Xanthostemon oppositifolius	C, Q
Xylosma ovatum	Q
Xylosma terrae-reginae	N
Zieria baeuerlenii	C, N
Zieria collina	C, Q
Zieria furfuracea subsp. *gymnocarpa*	Q
Zieria granulata	C, N
Zieria involucrata	C, N
Zieria obovata	C, Q
Zieria sp. Binjour (P.I.Forster 14134)	Q
Zieria sp. Brolga Park (A.R.Bean 1002)	C, Q
Zieria tuberculata	C, N
Zieria verrucosa	Q

*This biodiversity is either listed under the Commonwealth (C) EPBC Act, the QLD (Q) NC Act and/or the NSW (N) TSC Act. Other (O) species which are high priority under this Plan but not currently listed under any of the above legislation are also included.

Table A3.2. High-priority animal species at risk from lantana

Scientific name	Listed under legislation*
Adelotus brevis	Q
Cacophis harriettae	N
Cacophis krefftii	O
Coeranoscincus reticulates	C, N, Q
Cyclopsitta diophthalma coxeni	C, N, Q
Dasyornis brachypterus	C, N, Q
Delma torquata	C, Q
Eroticoscincus graciloides	Q
Hoplocephalus stephensii	N, Q
Kerivoula papuensis	N, Q
Lichenostomus hindwoodi	Q
Menura alberti	N, Q
Meridolum corneovirens	N
Miniopterus australis	N
Nangura spinosa	Q
Nyctimene robinsoni	N
Onychogalea fraenata	C, Q
Ornithoptera richmondia	Q
Petaurus australis (high priority in Terrain NRM only)	N
Petaurus gracilis	C, Q
Phyllodes imperialis (southern ssp.)	C, N
Pseudophryne australis	N
Pseudophryne covacevichae	C
Thersites mitchellae	C, N
Tyto capensis	N

*This biodiversity is either listed under the Commonwealth (C) EPBC Act, the QLD (Q) NC Act and/or the NSW (N) TSC Act. Other (O) species which are high priority under this Plan but not currently listed under any of the above legislation are also included.

Table A3.3. High-priority ecological communities in New South Wales at risk from lantana

Threatened ecological community	Listed under legislation*
Bangalay Sand forest	N
Blue Gum High Forest	C, N
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	N
Cumberland Plain Woodland	C, N
Eastern Suburbs Banksia Scrub in the Sydney Basin Bioregion	C, N
Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion	N
Illawarra Subtropical Rainforest in the Sydney	N
Kurnell Dune Forest in the Sutherland Shire and City of Rockdale	N
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	C, N
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	N
Lowland Rainforest in NSW North Coast and Sydney Basin Bioregion	N
Lowland Rainforest on Floodplain in the NNSW North Coast Bioregion	N
Milton Ulladulla Subtropical Rainforest in the Sydney Basin Bioregion	N
Moist Shale Woodland in the Sydney Basin Bioregion	N
O'Hares Creek Shale Forest	N
Pittwater Spotted Gum Forest	N
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	N
Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion	N
Shale/Sandstone Transition Forest	C, N
Southern Highlands Shale Woodlands in the Sydney Basin Bioregion	N
Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion	N
Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion	N
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	N
Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	N
Sydney Turpentine–Ironbark forest	C, N
Themeda Grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions	N
Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion	N
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	N
White Gum Moist Forest in the NSW North Coast Bioregion	N

*These communities are either listed under the Commonwealth (C) EPBC Act and/or the NSW (N) TSC Act.

Table A3.4. High-priority Regional Ecosystems in Queensland at risk from lantana

Regional ecosystem	Listed under legislation*
7.2.3 *Corymbia tessellaris* +/- *Acacia crassicarpa* +/- *C. intermedia* +/- *C. clarksoniana* woodland to closed forest	Q
7.3.1 *Hemarthria uncinata* +/- *Ischaemum australe* and/or **Cynodon dactylon* grassland	Q
7.3.9 *Corymbia tessellaris*, *Acacia* spp., *Melaleuca* spp. open forest	Q
7.3.10 Simple–complex mesophyll to notophyll vine forest	Q
7.3.16 -*Eucalyptus platyphylla* woodland to open forest	Q
7.3.19 *Corymbia intermedia* or *C. tessellaris* +/- *Eucalyptus tereticornis* open forest (or vine forest with these species as emergents)	Q
7.3.20 *Corymbia intermedia* and *Syncarpia glomulifera*, or *C. intermedia* and *Eucalyptus pellita* or *Syncarpia glomulifera* and *Allocasuarina* spp., or *E. cloeziana*, or *C. torelliana* open forests (or vine forests with these species as emergents)	Q
7.3.26 *Casuarina cunninghamiana* woodland to open forest	Q
7.3.28 Rivers and streams including riparian herbfield and shrubland on river and stream bed alluvium	Q
7.3.37 Complex semi-evergreen notophyll vine forest	C, Q
7.3.39 *Eucalyptus tereticornis* +/- *E. platyphylla* +/- *Corymbia intermedia* +/- *Lophostemon suaveolens* open woodland to open forest	Q
7.3.40 *Eucalyptus tereticornis* open forest	Q
7.3.42 *Eucalyptus grandis* open forest to woodland (or vine forest with emergent *E. grandis*)	Q
7.3.43 *Eucalyptus tereticornis* open forest to woodland	Q
7.3.46 *Lophostemon suaveolens* open forest to woodland	Q
7.3.50 *Melaleuca fluviatilis* +/- vine forest species, open to closed forest	Q
7.8.3 Complex semi-evergreen notophyll vine forest	C, Q
7.8.7 *Eucalyptus tereticornis* open forest to tall open forest, and associated grasslands	Q
7.8.8 *Eucalyptus tereticornis*, *E. reducta* +/- *Angophora floribunda* open forest to woodland	Q
7.8.10 *Eucalyptus tereticornis*, *E. drepanophylla* (or *E. granitica*), *E. portuensis*, *Corymbia intermedia* woodland to open forest, or *E. moluccana* woodland to open forest	Q

Regional ecosystem	Listed under legislation*
7.8.15 *Eucalyptus grandis* open forest to woodland (or vine forest with *E. grandis* emergents)	Q
7.8.16 *Eucalyptus resinifera* open forest to woodland	Q
7.8.18 *Corymbia intermedia* and/or *Lophostemon suaveolens* +/- *Allocasuarina torulosa* open forest to woodland	Q
7.8.19 *Corymbia clarksoniana* open forest to woodland	Q
7.11.3 Semi-deciduous mesophyll vine forest on metamorphics	C, Q
7.11.13 *Corymbia torelliana* open forest, usually with a vine forest element	Q
7.11.14 *Eucalyptus grandis* open forest to woodland, or *Corymbia intermedia*, *E. pellita*, and *E. grandis*, open forest to woodland (or vine forest with these species as emergents)	Q
7.11.16 *Eucalyptus portuensis* and *Corymbia intermedia* open forest to woodland	Q
7.11.31 *Eucalyptus resinifera* +/- *Eucalyptus portuensis* +/- *Syncarpia glomulifera* open forest to woodland (or vine forest with these species as emergents)	Q
7.11.32 *Syncarpia glomulifera* and/or *Allocasuarina* spp. +/- heathy understorey, woodland to tall woodland to open forest (or vine forest with these species as emergents)	Q
7.11.33 *Eucalyptus reducta* open forest to woodland	Q
7.11.39 *Themeda triandra*, or *Imperata cylindrica*, *Sorghum nitidum* and *Mnesithea rottboellioides* closed tussock grassland	Q
7.11.44 *Eucalyptus tereticornis* open forest to woodland	Q
7.11.49 *Eucalyptus leptophleba*, *Corymbia clarksoniana* and *E. platyphylla* open forest to woodland	Q
7.12.4 *Syncarpia glomulifera* +/-*Eucalyptus pellita* open forest	Q
7.12.5 *Eucalyptus pellita* +/- *Corymbia intermedia* open forest, or *Acacia mangium* and *Lophostemon suaveolens* open forest, (or vine forest with these species as emergents)	Q
7.12.6 Semi-deciduous mesophyll vine forest	Q
7.12.10 Notophyll vine forest with emergent *Araucaria cunninghamii*	Q
7.12.13 *Acacia melanoxylon* and *A. celsa* closed forest	Q
7.12.17 *Corymbia torelliana* open forest usually with a well developed simple notophyll vine forest element	Q
7.12.21 *Eucalyptus grandis* open forest to woodland, or *Corymbia intermedia*, *E. pellita*, and *E. grandis*, open forest to woodland, (or vine forest with these species as emergents)	Q
7.12.22 *Eucalyptus resinifera* +/- *Eucalyptus portuensis* +/- *Syncarpia glomulifera* tall open forest to tall woodland (or vine forest with these species as emergents)	Q
7.12.23 *Corymbia intermedia* and/or *C. tessellaris* +/- *Eucalyptus tereticornis*, open forest to tall open forest to woodland (or vine forest with these species as emergents)	Q
7.12.24 *Eucalyptus portuensis* and *Corymbia intermedia* open forest to woodland (or vine forest with *E. portuensis* and *C. intermedia* emergents)	O
7.12.25 *Eucalyptus cloeziana* woodland to open forest	Q
7.12.26 *Syncarpia glomulifera* +/- *Corymbia intermedia* +/- *Allocasuarina* spp. closed forest to woodland, or *Lophostemon suaveolens*, *Allocasuarina littoralis*, *C. intermedia* shrubland, (or vine forest with these species as emergents)	O
7.12.27 *Eucalyptus reducta* open forest to woodland	O
7.12.28 *Eucalyptus platyphylla* +/- *E. drepanophylla* +/- *Corymbia* spp. open woodland to open forest	O
7.12.29 *Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland +/- areas of *Allocasuarina littoralis* and *A. torulosa*	O
7.12.34 *Eucalyptus portuensis* and/or *E. drepanophylla*, +/- *C. intermedia* +/- *C. citriodora*, +/- *E. granitica* open woodland to open forest	O
7.12.35 *Eucalyptus portuensis*, *E. tereticornis*, *Corymbia intermedia* woodland	Q
7.12.40 Closed vineland of wind-disturbed vine forest	Q

Regional ecosystem	Listed under legislation*
7.12.46 Microphyll vine forest with *Gossia bidwillii* +/- *Araucaria cunninghamii*	Q
7.12.51 *Eucalyptus resinifera*, *Syncarpia glomulifera*, *E. portuensis*, *Corymbia abergiana*, +/- *C. leptoloma* woodland	Q
7.12.52 *Eucalyptus resinifera*, *Corymbia intermedia*, *Allocasuarina littoralis*, *Syncarpia glomulifera*, *E. drepanophylla* +/- *E. reducta* woodland	Q
7.12.61 *Eucalyptus tereticornis* +/- *E. granitica* woodland to open forest	Q
7.12.66 *Lophostemon confertus* low shrubland or low to medium closed forest	Q
8.1.5 *Melaleuca* spp. and/or *Eucalyptus tereticornis* and/or *Corymbia tessellaris* woodland to open forest	Q
8.2.2 Microphyll vine forest (beach scrub)	C, Q
8.2.5 Notophyll feather palm vine forest dominated by *Archontophoenix cunninghamiana*	Q
8.2.6 - *Corymbia tessellaris* open-forest	Q
8.3.3 *Casuarina cunninghamiana* and/or *Melaleuca leucadendra* (or *M. fluviatilis*) open-forest to woodland, sometimes with a rainforest understorey	Q
8.3.13 Variable community, usually adjacent to estuarine communities, ranges from open-woodland to closed forest to wetlands	Q
8.5.3 *Eucalyptus drepanophylla* woodland, often with *Corymbia dallachiana*, and sometimes *C. clarksoniana* and *E. platyphylla*	Q
8.5.5 *Eucalyptus exserta* and/or *Corymbia clarksoniana* woodland	Q
8.8.1 Complex notophyll (feather palm) vine forest	Q
8.11.3 Woodland to open-forest with a variable species dominance	Q
8.11.4 *Eucalyptus platyphylla*, *Corymbia clarksoniana*, and *Eucalyptus drepanophylla* woodland, often with *Lophostemon suaveolens*	Q
8.11.5 *Corymbia tessellaris* and *Eucalyptus tereticornis* woodland to open-forest, sometimes with *E. drepanophylla*	Q
8.11.6 *Eucalyptus latisinensis* and/or *Eucalyptus crebra* and/or *Corymbia intermedia* and/or *Eucalyptus portuensis* woodland	Q
8.12.7 *Corymbia citriodora*, *Eucalyptus portuensis*, and *C. trachyphloia* open-forest to woodland	O
8.12.12 Variable mixed woodland to open-forest	O
8.12.20 *Eucalyptus drepanophylla* and/or *E. platyphylla* woodland	Q
8.12.23 *Eucalyptus moluccana* woodland	Q
8.12.25 *Eucalyptus tereticornis* woodland	Q
8.12.26 *Corymbia tessellaris* and *Eucalyptus tereticornis* open-forest	Q
8.12.27 *Eucalyptus tereticornis*, *Corymbia tessellaris* and *Livistona decipiens* open-forest	Q
9.3.1 *Eucalyptus camaldulensis* and/or *E. tereticornis* ± *Casuarina cunninghamiana* ± *Melaleuca fluviatilis* and /or *M. leucadendra* fringing woodland to open forest	Q
9.3.2 *Eucalyptus leptophleba* ± *Corymbia confertiflora* ± *C. clarksoniana* ± *C. tessellaris* woodland	O
9.3.7 Wetlands and seasonally inundated grasslands with a fringing open woodland of mixed *Eucalyptus* spp.	O
9.3.8 *Eucalyptus moluccana* ± *E. tereticornis* ± *E. platyphylla* ± *Corymbia clarksoniana* ± *E. crebra* (*sens. lat*.) woodland to open woodland	Q
9.3.10 *Melaleuca bracteata* low open forest to dense shrubland	O
9.3.14 *Melaleuca fluviatilis* and/or *M. leucadendra* and/or *M. argentea* ± *Eucalyptus tereticornis* ± *Nauclea orientalis* ± *E. camaldulensis* ± *Barringtonia acutangula* ± *Acacia auriculiformis* ± *Syzygium forte* ± *Leptospermum parvifolium* fringing woodland to open-forest	Q
9.3.15 *Eucalyptus tereticornis* ± *Casuarina cunninghamiana* ± *C. tessellaris* ± *C. clarksoniana* ± *E. platyphylla* ± *Ficus* spp. ± *E. camaldulensis* fringing woodland to open forest	Q

Regional ecosystem	Listed under legislation*
9.3.16 *Eucalyptus tereticornis* ± *E. platyphylla* ± *E. leptophleba* ± *Corymbia tessellaris* ± *C. clarksoniana* and other *Corymbia* spp. woodland to open forest	Q
9.5.2 Semi-evergreen vine thicket	Q
9.5.5 Mixed open forest to woodland	Q
9.5.6 *Eucalyptus leptophleba* ± *Corymbia clarksoniana* ± *C. dallachiana* ± *E. platyphylla* ± *E. tereticornis* ± *E. crebra* (sens. lat.) woodland	O
9.8.1 *Eucalyptus crebra* (sens. lat.) and *Corymbia erythrophloia* ± *C. dallachiana* ± *C. confertiflora* ± *E. orgadophila* ± *E. microneura* woodland or *E. leptophleba* ± *C. dallachiana* ± *C. erythrophloia* woodland	O
9.8.2 *Eucalyptus leptophleba* and *Corymbia clarksoniana* ± *C. dallachiana* ± *E. cullenii* ± *C. erythrophloia* woodland or *Corymbia erythrophloia* ± *Eucalyptus leptophleba* ± *C. dallachiana* woodland	Q
9.8.3 - Semi-evergreen vine thicket	Q
9.8.4 *Eucalyptus crebra* ± *Corymbia intermedia* ± *E. tereticornis* ± *C. clarksoniana* ± *C. dallachiana* woodland	O
9.8.7 Semi-evergreen vine thicket	Q
9.11.4 *Eucalyptus portuensis*, *E crebra* (sens. lat.), *Corymbia clarksoniana* and *C. citriodora* mixed open forest or *Eucalyptus crebra* (sens. lat.) and *E. shirleyi*, *E. exserta*, *C. peltata*, *E. acmenoides* and *C. citriodora* woodland	O
9.12.1 *Eucalyptus crebra* (sens. lat.) and/or *E. xanthoclada* and/or *E. drepanophylla* and/or *E. paedoglauca* ± *Corymbia erythrophloia* ± *C. dallachiana* ± *Eucalyptus* spp. ± *Corymbia* spp. open woodland or woodland	O
9.12.2 Mixed open forest	O
9.12.21 *Eucalyptus drepanophylla*, *Corymbia dallachiana*, *E. platyphylla*, *C. clarksoniana* ± *C. tessellaris* woodland	Q
9.12.34 Semi-evergreen vine thicket with *Araucaria cunninghamii* emergents	O
9.12.36 *Cochlospermum gregorii* or *C. gillivraei* ±*Terminalia* spp. ± *Erythrophleum chlorostachys* ± *Brachychiton chillagoensis* low woodland to low open woodland or *Acacia leptostachya* and *C. gillivraei* low woodland to woodland	O
11.2.1 Open woodland of *Corymbia tessellaris*, *C. clarksoniana* and *Melaleuca viridiflora* (which may be locally dominant)	Q
11.2.3 - Microphyll/notophyll vineforest to semi-deciduous vine thicket	C, Q
11.2.5 Beach ridge woodland	O
11.3.4 *Eucalyptus tereticornis* woodland to open-forest	Q
11.3.9 *Eucalyptus platyphylla* ± *Corymbia clarksoniana* ± *C. intermedia* ± *E. tereticornis* ± *Lophostemon suaveolens* woodland	O
11.3.13 *Grevillea striata* +/- *Corymbia tessellaris* open-woodland	Q
11.3.35 *Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland	O
11.11.3 *Corymbia citriodora*, *Eucalyptus crebra* and *E. acmenoides* open-forest	O
11.11.4 *Eucalyptus crebra* tall woodland	O
11.11.5 Microphyll rainforest (with or without *Araucaria cunninghamii* emergents) and semi-evergreen vine thicket	O
11.12.4 Semi-evergreen vine thicket and microphyll vine forest	O
11.12.9 *Eucalyptus platyphylla*, *Corymbia dallachiana*, *C. tessellaris* and *E. drepanophylla* woodland	O
11.12.12 *Araucaria cunninghamii* woodland or open-forest	Q
11.12.13 *Eucalyptus crebra*, *Corymbia erythrophloia*, *C. dallachiana* and *C. tessellaris* ± *C. intermedia* ± *E. acmenoides* ± *Canarium australianum* mixed open-forest or woodland	O
11.12.14 *Lophostemon* spp. shrubby woodland	Q
12.2.2 Microphyll/notophyll vine forest	C, Q
12.2.7 *Melaleuca quinquenervia* open-forest to woodland	Q
12.3.3 *Eucalyptus tereticornis* open-forest to woodland	C, Q
12.3.7 Narrow fringing community of *Eucalyptus tereticornis, Callistemon viminalis*, *Casuarina cunninghamiana* ± *Waterhousea floribunda*	O
12.3.11 Open-forest to woodland of *Eucalyptus tereticornis*, *E. siderophloia* and *Corymbia intermedia*	Q
12.5.1 Open-forest complex	O
12.5.6 *Eucalyptus siderophloia*, *E. propinqua*, *E. microcorys* and/or *E. pilularis* open forest	Q
12.8.1 *Eucalyptus campanulata* tall open-forest with shrubby to grassy understorey	O
12.8.22 -ow microphyll vine forest and semi-evergreen vine thicket	Q
12.11.14 *Eucalyptus crebra*, *E. tereticornis* grassy woodland	Q
12.12.13 Microphyll and microphyll/notophyll vine forest ± *Araucaria cunninghamii*	O

*This biodiversity is either listed under the Commonwealth (C) EPBC Act or the QLD (Q) VM Act. Please refer to the website www.epa.QLD.gov.au/nature_conservation/biodiversity/regional_ecosystems/ for further details on Regional Ecosystems. Other (O) Regional Ecosystems that are high priority under this Plan but not currently listed as Endangered or Of Concern under the VM Act are also included.