



Lord Howe Island Weed Management Strategy 2016 – 2025



Lord Howe Island Board

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Lord Howe Island Board

PO Box 5 / Bowker Avenue
Lord Howe Island NSW 2898

Phone: +61 2 6563 2066

Fax: +61 2 6563 2127

Email: administration@lhib.nsw.gov.au

Website: <http://www.lhib.nsw.gov.au/>

For additional information or any enquiries regarding the Lord Howe Island Weed Management Strategy please contact the Lord Howe Island Board Administration Office at the above address.

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Disclaimer

The 'Lord Howe Island Weed Management Strategy 2016 – 2025' has been adopted by the Lord Howe Island Board. The wording of the strategy is being reviewed for alignment to the 'North Coast Regional Strategic Weed Management Plan 2017 – 2022' and 'Biosecurity Act 2015' [refer to <http://northcoast.lis.nsw.gov.au/biosecurity/weed-control>].

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This report was prepared and written by Sue Bower (Lord Howe Island Board) with assistance from Megan Bennett (Lord Howe Island Board).

Photographs

Unless noted, photos have been sourced from the Lord Howe Island Board (LHIB).

Helicopter with forward mounted lance-spray apparatus. Trialled in 2015, this method has provided a breakthrough in treating Ground Asparagus on cliffs.



The LHIB team at elevation on Mt Gower, completing the follow-up of a former Cherry Guava outbreak (see page 10). Photo: S. Wilson, LHIB.

Foreword



Forest dominated by the native plant Fitzgerald (*Dracophyllum fitzgeraldii*) on Mt Lidgbird. Lord Howe Island is a haven for endemic species. The Lord Howe Island Weed Management Strategy aims to protect these unique values for the long term.

Oceanic islands globally are threatened by the impacts of introduced invasive species. Lord Howe Island's environment is at risk from invasive weeds despite having 80% cover of native vegetation and being reasonably undisturbed. Invasive weeds not only compromise the integrity of the island's terrestrial ecosystems and World Heritage values (DECC 2007) but also pose a threat to agricultural productivity (which is a limited resource) and to human health.

This strategy aims to adopt a framework to prevent the introduction of new weed incursions, detect and contain newly emerging weed risks and to continue to address weed risks at the island scale.

The impacts of widespread, highly invasive weeds are being managed through a multi-species weed-eradication program that has been in effect since 2004. This 10-year program has proven effective in reducing the extent and threat of target weeds (LHIB 2016). With a 90% reduction in mature weed plants achieved across the island, the opportunity to eradicate many weeds has improved.

The implementation of this strategy will benefit the island ecosystems but also the local community and economy by protecting the integrity of the island's nature-based tourism assets and World Heritage values. Weeds are everyone's problem and a cooperative approach ensuring the community, relevant stakeholders and government remain alert, committed and capable will help to address current and future weed risks to the island.

The Vision of the Weed Management Strategy

The long-term vision of the Weed Management Strategy is to protect Lord Howe Island's unique ecosystems and World Heritage values from current and future threats posed by invasive weeds, so as to improve the island's resilience to inevitable future disturbances.

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Executive Summary

This strategy outlines the requirements for effective weed management on Lord Howe Island for the next decade 2016–2026. It is based on the experience gained from, and the on-ground results of, controlling and eradicating invasive weeds on Lord Howe Island over 12 years (for example see LHIB 2016). The 2006 Weed Management Strategy advised the eradication of 25 weed species over a forecast 30-year program. The results of weed management undertaken since late 2004 show an 80% reduction in target weeds of all life-stages and a 90% reduction in numbers of mature weeds across the island. This has greatly improved the feasibility of eventual eradication of these weed species. Without taking the bold step to eradicate these target weeds, the ecosystems and biota of Lord Howe Island will remain at risk. This Weed Management Strategy advises the continuation of the weed eradication program for at least the next two decades.

The significant reduction in the distribution and density of target weeds achieved over the past 10 years has improved the opportunity and the capacity of the Lord Howe Island Board to drive an eradication program given adequate funding, dedicated teams on the ground and development of technical applications. The program has incorporated adaptive management through experience and improvements in technique and expertise, thus increasing the ability to achieve eradication.

Protection of the island's World Heritage values from invasive weeds is a primary focus, as is reducing the impact of weeds on agricultural productivity and human health. Nearly all of the introduced and invasive plants were intentionally brought to Lord Howe Island. The local community plays a vital role in the future stewardship of the island, in replacing plants of sentimental or cultural value with species that are sustainable and safe for the island environment.

The following goals and strategies will deliver best practice weed management outcomes on LHI:

Goal 1 – Exclude: Prevent the establishment of new invasive weeds;

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds;

Goal 3 – Manage effectively: Reduce the impact of widespread, non-eradicable invasive weeds; and

Goal 4 – Build capacity: Ensure the Lord Howe Island Board and Lord Howe Island community have the ability and commitment to manage invasive weeds, promote awareness of invasive weeds within the community and inform visitors to the island of the threat posed by weeds to the ecosystems of Lord Howe Island.

As many as 1000 introduced plant species are estimated to occur on Lord Howe Island, with 670 introduced species recorded to date (LHIB 2006). Of the introduced species that occur on the island, 68 are declared under the NSW *Noxious Weeds Act 1993* and have been targeted for **eradication**, including 40 species with limited distribution on the island.

The following categories, based on the risk they pose and the feasibility of management, will allow effective and coordinated on-ground weed management:

Category 1: Eradicate (immediate eradication, or suppression leading to eradication);

Category 2: Alert (sleeper weeds – watch and act as necessary);

Category 3: Control (effectively manage).

Preventing the introduction of invasive weeds as well as early detection and rapid removal provide the greatest cost–benefit in invasive species management (DPI 2013). Continuing the eradication of widespread invasive weeds is also an effective weed-management strategy. Eradication is an optimal investment because it can provide permanent protection for the island’s unique environment and World Heritage values.

Weeds pose a significant threat to the integrity of the environment of Lord Howe Island



Working on an outbreak of Cherry Guava on Mt Gower, at 550 m above sea level (2011).

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Some definitions

Active phase	The period of removal of all life-stages (including mature plants) of weeds targeted for eradication while search effort (delimitation) continues.
Containment	A weed-management strategy that aims to prevent the spread of a weed.
Control	A weed management strategy that reduces the extent of a weed in a specific locality.
Delimitation	Identification of the extent of a weed incursion or infestation.
Endemic	An organism that is native to a particular place or region.
Eradication	A weed management strategy that aims to completely remove a target weed and all of its propagules. There should be limited or no risk of re-invasion of the species. The eradication of a weed species is declared when the target weed species remains undetected beyond the period of seed viability and the species continues to remain undetected following consecutive visitations.
Invasive weed	A weed that can establish in undisturbed vegetation communities and compete with native plant species for resources (light, water and nutrients, and space) and, over time, can form dense populations resulting in the decline and eventual replacement of native species, or affect valued assets, such as human health or agricultural productivity.
Monitoring phase	The continuation of search effort to monitor the absence of weeds, beyond the limit of seed-bank persistence, in the lead up to eradication.
Outliers	Isolated infestations of weeds, mostly in remote and rugged terrain. Outliers pose a significant threat to the success of weed control or eradication programs if left undetected and unchecked, as they can act as sources for the establishment of new infestations. Outliers are also referred to as <i>nascent foci</i> .
Seed persistence	The length of time that seeds remain viable to germinate in the environment where they are subject to ecological factors and decay (generally referring to seeds on or in soil).
Seed viability	The length of time that seeds remain viable in laboratory conditions; seeds viability is often greater in laboratory conditions than in the environment (see Seed persistence).
Zero density	Weeds are not evident in the landscape but are not necessarily absent.

Abbreviations

APVMA	Australian Pesticides and Veterinary Medicines Authority
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI	NSW Department of Primary Industries
<i>EPBC Act</i>	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
FMO	Flora Management Officer
FTE	full-time equivalent
HBT	Herbicide Ballistic Technology
KTP	Key Threatening Process
LCA	Local Control Authority
<i>LHI Act</i>	<i>Lord Howe Island Act 1953</i> (NSW)
LHI	Lord Howe Island
LHIB	Lord Howe Island Board
LHI BMP	Lord Howe Island Biodiversity Management Plan
LHIG	Lord Howe Island Group
LHI WMS 2006	<i>Weed Management Strategy for Lord Howe Island</i> (LHIB 2006)
LLS	Local Land Service
MEWH	Manager Environment World Heritage
Mt	Mount
NCLLS	North Coast Local Land Service
NSW	New South Wales
NZDOC	New Zealand Department of Conservation
OEH	NSW Office of Environment and Heritage (Department of Premier and Cabinet)
PPP	Permanent Park Preserve
<i>TSC Act</i>	<i>Threatened Species Conservation Act 1995</i> (NSW)
UAV	unmanned automated vehicles (drones or aero robotics)
WAP	NSW Weeds Action Program 2015–2020 (DPI 2015)
WoNS	Australian Weeds of National Significance
WRA	Weed Risk Assessment
WRM	Weed Risk Management

Standard units and their abbreviations are used, including: ha, hectares; km, kilometres.

1 Introduction

The Lord Howe Island Group (LHIG) is an isolated oceanic island group located in the Tasman Sea, lying 783 km north-east of Sydney and 585 km east of Port Macquarie and is politically treated as part of New South Wales (NSW), Australia (31°33'29"S, 159°05'12"E). The island group consists of Lord Howe Island (LHI) and its smaller associated islands, including the remote Balls Pyramid. The main island is 11 km long and from 0.6 to 2.8 km wide, with a total land area of 1455 hectares (ha). The topography of the main island rises from beaches to low hills and sheer mountain slopes and cliffs in the north and south, with the distinctive peaks of Mt Lidgbird and Mt Gower reaching an elevation of 875 m above sea level (Figure 1). About 75% of the terrestrial part of the property is managed as a Permanent Park Preserve (PPP), consisting of the northern and southern mountains of the main island, plus the Admiralty Islands, Mutton Bird Islands, Balls Pyramid and surrounding islets.

LHI is a unique oceanic island with a high number of endemic and threatened species and as such plays an important global role in biodiversity conservation. Collectively, islands worldwide cover only 5% of the Earth's land area but support an estimated 20% of all known bird, reptile and plant species and almost half of all endangered species. Between 70 and 95% of the world's extinctions of terrestrial species have occurred on islands, and most of these (55–67%) were directly caused or facilitated by invasive alien species (see <http://www.islandconservation.org/>).

1.1 Lord Howe Island — World Heritage

The LHIG was inscribed on the World Heritage List in 1982 in recognition of the Group's outstanding natural landscapes and scenery and its rich terrestrial and marine biodiversity (UNESCO; see <http://whc.unesco.org/en/list/186>). It was one of only five Australian World Heritage properties at that time (there are now 19 properties listed for Australia; see <http://whc.unesco.org/en/statesparties/au>).

The LHIG meets two criteria for World Heritage listing:

- *Criterion (vii) — contain superlative natural phenomena, formations or features, for instance, outstanding examples of the most important ecosystems, areas of exceptional natural beauty or exceptional combinations of natural and cultural elements; and*
- *Criterion (x) — contain the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value from the point of view of science or conservation still survive.*

The LHIG was deemed by UNESCO to have Outstanding Universal Value as 'an outstanding example of an oceanic island of volcanic origin, having a unique biota with a high level of endemism and the world's most southerly true coral reef. It is an area of exceptional natural beauty and provides important breeding grounds for colonies of seabirds as well as habitat for rare and endangered species'. The World Heritage property covers the terrestrial and marine areas, including the coral reefs, and covers 146,300 ha, with the terrestrial area covering approximately 1540 ha (see <http://www.environment.gov.au/system/files/pages/a7088999-c54e-4e80-9891-fba5de5acd77/files/lord-howe-map.pdf>).

Specific attributes of the World Heritage listing include:

- the exceptional diversity of spectacular and scenic landscapes, including sheer mountain slopes and cliffs, and the hills enclosing the lagoon, as well as Balls Pyramid rising abruptly from the ocean to the south-east;

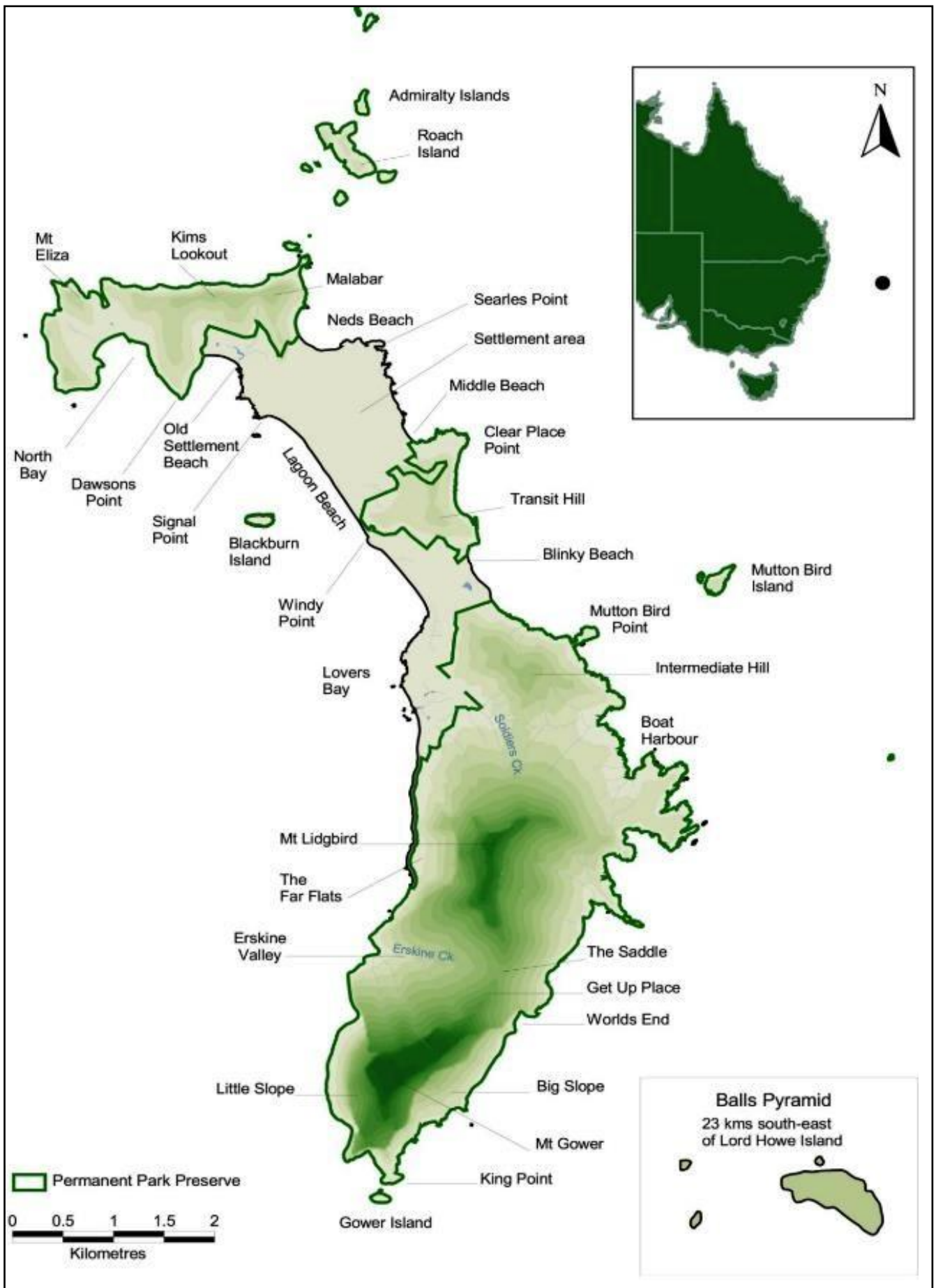


Figure 1 The Lord Howe Island Group (from DECC 2007).

- as an outstanding example of an island ecosystem developed from submarine volcanic activity;
- the most southerly coral reef in the world, with unique assemblages of temperate and tropical forms;
- large colonies of nesting seabirds, and the only major breeding locality for the Providence Petrel (*Pterodroma solandri*), and one of the world's largest breeding concentrations of Red-tailed Tropicbird (*Phaethon rubricauda*);
- an outstanding example of independent evolutionary processes and an insular biota that has adapted to the island environment through speciation, with a significant number of endemic species or subspecies of plants and animals in a very limited area;
- the high number of threatened and endemic species and subspecies of plants and animals, for example the Lord Howe Woodhen (*Gallirallus sylvestris*);
- an outstanding example of an oceanic island group with a diverse range of ecosystems and species that have been subject to human influences for a relatively limited period; and
- as containing important and significant habitats for *in situ* conservation of biological diversity.

The LHIG was also included on the Australian National Heritage List (in 2007) and in the NSW State Heritage Register.

1.2 Local and global conservation values

The vegetation of LHI is broadly classified as Oceanic Rainforest and, at higher elevations, Oceanic Cloud Forest; the latter, with an area of only 300 ha, is the most restricted vegetation class in NSW (Keith 2004). The island's vegetation has affinities with the flora of eastern Australia, New Zealand, Norfolk Island and New Caledonia. The LHIG supports at least 239 native vascular plant species (DECC 2010) and a recent systematic flora survey recorded a total of 222 plant taxa, including 47 exotic species, in floristic sites (Sheringham *et al.* 2016).

The recent systematic flora survey and vegetation classification for LHI recognised 33 vegetation communities for the LHIG (excluding Balls Pyramid). A saltmarsh and two rainforest communities that had not been recognised in previous studies were identified and mapped in the study (Sheringham *et al.* 2016). At least 18 vegetation communities have been considered of high conservation significance, owing to threatening processes or restricted distributions, or both (e.g. Gnarled Mossy Cloud Forest, mangrove communities) (DECC 2007; Sheringham *et al.* 2016).

The LHIG exhibits a high level of endemism, with 113 species (47%) of the island's flora endemic to the LHIG. The high degree of endemism is illustrated not only at the species level, but also at the generic level, with five endemic genera of vascular plants, including three endemic genera of palms. Further, at least six vertebrate animals are also endemic to the LHIG, and the diversity of terrestrial invertebrates is very high, with more than 1600 species recorded, also with high levels of endemism. The southern mountains have the highest species richness of endemic flora and endemic invertebrates on the island (DECC 2007).

Since human settlement, nine species of land bird, one species of bat and two species of plant have become extinct or are presumed extinct on LHI (DECC 2007; Sheringham *et al.* 2016). Legislation protecting threatened species is applied at both the State and Federal level in Australia, and the NSW *Threatened Species Conservation Act 1995 (TSC Act)* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (DECC 2007) list 41 species of threatened flora and fauna, including resident and migratory

species on the LHIG (this excludes threatened bird species that occur in the LHIG only as occasional vagrants) and two Endangered Ecological Communities (Table 1).

Table 1 A summary of the threatened flora, fauna and ecological communities of the LHIG identified under the *TSC Act* or *EPBC Act*. Status: CE = Critically endangered; E = Endangered; CEEC = Critically Endangered Ecological Community; M = Migratory; V = Vulnerable.

Group	Number	Species or ecological community	TSC Act	EPBC Act
Endangered Ecological Communities	2	Gnarled Mossy Cloud Forest on Lord Howe Island	CEEC	
		Lagunaria Swamp Forest on Lord Howe Island	CEEC	
Plants	13	Phillip Island Wheat Grass (<i>Anthosachne kingiana</i> subsp. <i>kingiana</i> [listed as <i>Elymus multiflorus</i> subsp. <i>kingianus</i>])	CE	CE
		Knicker Nut (<i>Caesalpinia bonduc</i>)	E	
		Lord Howe Island Morning Glory (<i>Calystegia affinis</i>)	CE	CE
		Lord Howe Island Broom (<i>Carmichaelia exsul</i>)	E	
		Sand Spurge (<i>Chamaesyce psammogeton</i>)	E	
		Small-leaved Currant Bush (<i>Coprosma inopinata</i>)	E	
		Hutton's Geniostoma (<i>Geniostoma huttonii</i>)	E	E
		<i>Hypolepis elegans</i>	Ex	
		Little Mountain Palm (<i>Lepidorrhachis mooreana</i>)	CE	CE
		Coast Euodia (<i>Melicope vitiflora</i>)	E	
		Rock Shield Fern (<i>Polystichum moorei</i>)	E	E
		<i>Solanum bauerianum</i>	Ex	
		Mountain Xylosma (<i>Xylosma parvifolia</i>)	E	E
Invertebrates	8	Lord Howe Island Phasmid (<i>Dryococelus australis</i>)	E	CE
		Lord Howe Island Earthworm (<i>Pericryptodrilus nanus</i>)	E	
		Lord Howe Island Wood-eating Cockroach (<i>Panesthis lata</i>)	E	
		Lord Howe Island Placostylus (<i>Placostylus bivaricosus</i>)	E	CE
		Master's Charopid Land Snail (<i>Mystivagor masteri</i>)		CE
		Whitelegge's Land Snail (<i>Pseudocharopa whiteleggei</i>)		CE
		Mount Lidgbird Charopid Snail (<i>Pseudocharopa lidgbirdii</i>)		CE
		<i>Gudeoconcha sophiae magnifica</i> (a snail)		CE
Reptiles	2	Lord Howe Island Gecko (<i>Christinus guentheri</i>)	V	V
		Lord Howe Island Skink (<i>Cyclodina lichenigera</i>)	V	V
Resident landbirds	4	Lord Howe Silvereye (<i>Zosterops lateralis tephroleurus</i>)		
		Lord Howe Golden Whistler (<i>Pachycephala pectoralis contempta</i>)		
		Lord Howe Pied Currawong (<i>Strepera graculina</i>)	V	

		<i>crissalis</i>)		
		Lord Howe Woodhen (<i>Gallirallus sylvestris</i>)	E	
Breeding seabirds	12	Red-tailed Tropicbird (<i>Phaethon rubricauda</i>)	V	
		White-bellied Storm-Petrel (<i>Fregetta grallaria</i>)	V	V
		Flesh-footed Shearwater (<i>Ardenna carneipes</i>)	V	M
		Little Shearwater (<i>Puffinus assimilis</i>)	V	
		Kermadec Petrel (<i>Pterodroma neglecta</i>)	V	V
		Providence Petrel (<i>Pterodroma solandri</i>)	V	
		Gould's Petrel (<i>Pterodroma leucoptera leucoptera</i>)	V	E
		Black-winged Petrel (<i>Pterodroma nigripennis</i>)	V	M
		Masked Booby (<i>Sula dactylatra</i>)	V	M
		White Tern (<i>Gygis alba</i>)	V	
		Grey Ternlet (<i>Procelsterna cerulea</i>)	V	
		Sooty Tern (<i>Onychoprion fuscata</i>)	V	
Total	41			

1.3 The Weed Management Strategy

This Weed Management Strategy for the decade 2016–25 aims to further protect the unique ecosystems of the LHIG by providing a strategic framework for the continued reduction and elimination of the threats posed by invasive weeds over the next 10 years. It is important that a consistent and coordinated approach to weed management continues, to ensure resources and effort are allocated according to the highest priorities to achieve best weed threat-abatement outcomes on LHI.

This Strategy for the 10 years 2016–25 is based on a sound and well-informed knowledge of the biology of the weed species that pose a risk to the environment of LHI, of the effective measures required to control them and the experience in the control, containment and eradication of target weeds gained over the past 10 years.

The effective management of weeds on LHI requires an all-tenure approach with public and private land managers and owners having a shared responsibility to manage weeds. The Strategy will be reviewed and adapted to reflect the outcomes of monitoring and evaluation, new weed risks, improved knowledge and new technologies.

2 The impact of weeds on Lord Howe Island

2.1 What is a weed?

A weed is a non-native or native plant species that colonises and persists in an ecosystem in which it did not previously exist, and which may have been introduced either intentionally or incidentally. A weed is also recognised as a plant that requires some form of action to reduce its effect on the economy, the environment, human health, amenity or cultural practices (see <http://www.environ/invasive/weeds/.html>).

Typically, invasive weeds have high reproductive rates, broad environmental tolerances that allow them to persist and thrive in a range of habitats, and the ability to spread widely. Invasive weeds can out-compete native plant species, change the composition of native habitats, facilitate the invasion of other weeds, and alter ecosystem processes (Radosevich *et al.* 2007). The impact of introduced plants may not be immediately perceived or understood: invasive species may establish rapidly or it may take decades for introduced species to spread invasively. The gardening practices of today, as well as those of yesterday, can affect ecosystems in years to come (Basset *et al.* 2016).

Invasive weeds are a major concern throughout Australia, adversely affecting natural environments and agricultural productivity. More than 27,000 non-native plant species have been introduced into Australia and, of these, 94% were introduced through the gardening and horticultural industry (Groves *et al.* 2005).

Invasive plants pose a significant threat to the conservation values of islands (Timmins and Braithwaite 2002). Islands are particularly fragile ecosystems and highly vulnerable to invasion by introduced species owing to their isolation and finely adapted ecologies (Macarthur and Wilson 1967; Simberloff 1995). Islands in general have high levels of endemism resulting from their long-term isolation and separation from mainland environments, and have limited resilience to the long-term impacts of invasive weeds. Extinctions of native species on islands have rapidly accelerated following the advent of global trade and human settlement, which has allowed both the deliberate and inadvertent movement of species, often resulting in unexpected and sometimes disastrous consequences (Steiner 2010).

Islands, however, by the very nature of their often limited size and isolation, provide opportunities to achieve biodiversity conservation and management outcomes, such as eradications, that would otherwise not be feasible in mainland environments (see <http://www.islandconservation.org/invasive-species-council-of-australia/>).

2.2 Weeds on Lord Howe Island

Non-native, invasive plant species have been present on LHI, and affecting the ecology of the island, since settlement in 1834. As early as the 1930s, the local island authority raised concerns about the indiscriminate introduction of seed of exotic plants and sought restrictions on the importation of introduced plant species, other than common vegetables and flowers (Lord Howe Island Board of Control 1933). The threat of Climbing Asparagus fern (*Asparagus plumosus*) was recognised in the 1940s; an island circular issued 13 February 1940 advised the removal of the weed from a lease at the leaseholder's expense. However, by the 1960s, the weed must have remained uncontrolled, as large clumps of the plant were evident on the property and adjacent road verge (C. Murray, personal communication). Concerns about the threat posed by other invasive weeds on LHI, particularly of Cherry Guava (*Psidium cattleianum* var. *cattleianum*), were first formally reported as part of the biological surveys of

the island conducted by the Australian Museum and Royal Botanic Gardens, Sydney, in 1970 (Recher & Clark 1974; Pickard 1983). These surveys noted that 120 introduced species had naturalised, and recommended that the import of introduced species be prohibited. Hunter (2002) identified weeds as one of the most serious threats to the natural values of the island.

In the 1990s, the LHIB targeted weed management on 13 invasive weed species, including Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), African Boxthorn (*Lycium ferocissimum*), Cherry Guava, Climbing Asparagus, Ground Asparagus (*Asparagus aethiopicus*) and Ochna (*Ochna serrulata*) in priority areas in the PPP, and on leasehold lands.

Baseline mapping of the density and distribution of weeds was undertaken in 2002–03 across 460 ha of the island’s landscapes to quantify the extent and effects of weeds on LHI (Le Cussan 2002a, 2002b, 2003a, 2003b). This mapping confirmed the significant threat that was posed by weeds and that an island-scale and time-bound eradication approach was needed to deal with this threat.

An inventory of garden plants in 2002 identified more than 670 introduced species on the island and, of these, at least 270 had invasive characteristics (DECC 2007). It is estimated that at least 1000 introduced plants are likely to occur on the island (LHIB 2006). Based on these figures, the number of species of native vascular flora of LHI is far smaller than the numbers of introduced species, in a ratio of 1 : 4 (239 native species compared with >1000 introduced species; Figure 2).

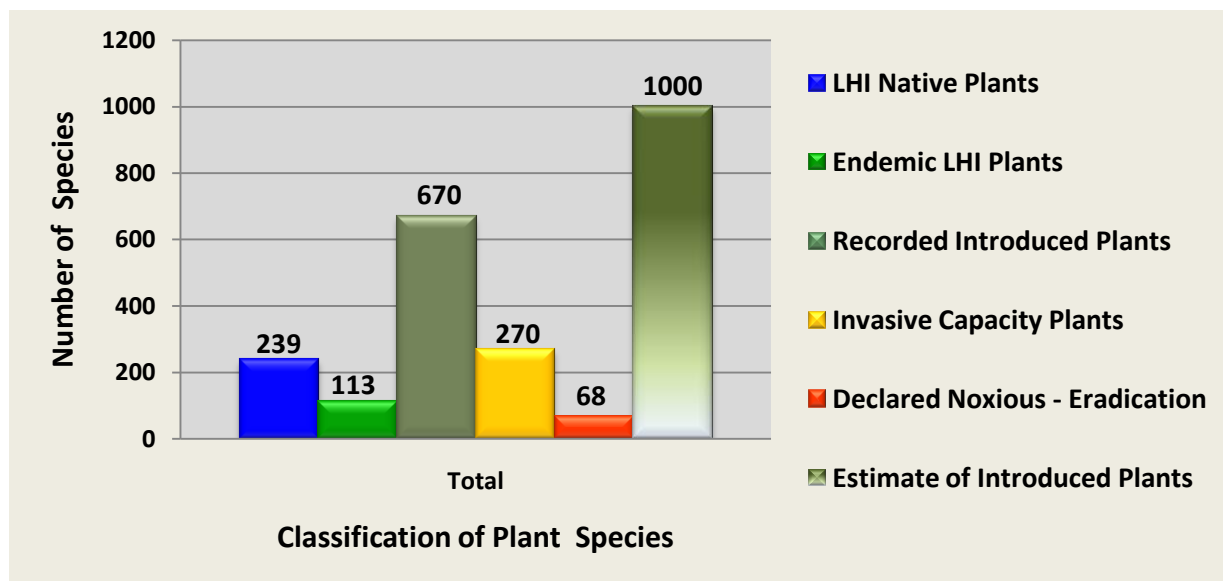


Figure 2 The vascular plant species of LHI, highlighting numbers of introduced and native and endemic species and introduced species. Endemic LHI Plants ($n = 113$) are a subset of LHI Native Plants and are included within that total ($n = 239$). Invasive Capacity Plants ($n = 270$) and plants Declared Noxious – Eradication ($n = 68$) are subsets of, and recorded within, the total number of Recorded Introduced Plants ($n = 670$).

It is likely that additional introduced species that exhibit weedy characteristics will be recorded on LHI in the future. Since the publication of the initial *Weed Management Strategy for Lord Howe Island* (LHI WMS 2006) in 2006 (LHIB 2006), a number of invasive weeds species have been newly detected in gardens on LHI, including Bathurst Burr (*Xanthium spinosum*), Cat’s Claw Creeper (*Dolichandra unguis-cati*), Climbing Nightshade (*Solanum seaforthianum*), Ming Fern (*Asparagus macowanii* var. *zuluensis*), Leaf Cactus (*Pereskia aculeata*), French Broom (*Genista monspessulana*) and Tree of Heaven (*Alnus altissima*). Other species thought to

have been removed have been detected again, including Dutchman's Pipe (*Aristolochia elegans*).

A more detailed summary of the history of weed management on LHI is provided in Appendix 2.

2.3 Legislative and policy settings

The LHIB has the responsibility for the care, control and management of the LHIG under the NSW *Lord Howe Island Act 1953 (LHI Act)*. The Commonwealth and NSW State governments, with the LHIB, have specific statutory obligations for the management of weeds in the LHIG. The implementation of this Weed Management Strategy addresses objectives in the Lord Howe Island Biodiversity Management Plan (LHI BMP; DECC 2007), which is a Federal and State multi-species threatened species recovery plan. This Strategy also addresses targets in the *New South Wales Biosecurity Strategy 2013–2021* (DPI 2013), the *New South Wales Weeds Action Program 2015–2020* (WAP; DPI 2015), *New South Wales Invasive Species Plan 2008–2015* (DPI 2008) and the *Australian Weeds Strategy* (NRMCC 2007). The LHI Weed Management Strategy will need to align to changes in weed management legislation when the *Biosecurity Act 2015* enacted (due to commence in 2017; NSW Government 2015). The legislation, strategies and plans relevant to weed management on LHI are summarised in Table 2 (with further details provided in Appendix 3).

Land tenure and responsibility for weed management on LHI

LHI is Crown Land, with tenure consisting of Public Land (including the PPP), Perpetual Lease, Special Lease and Permissive Occupancy. The LHIB is responsible for the PPP, which covers approximately 75% of the main island. The PPP has a similar status to a national park but is managed by the LHIB. Under the NSW *Noxious Weeds Act 1993*, leaseholders are obliged to manage declared weeds on their leases, which collectively cover 160 ha of the island.

2.4 Weeds as a Key Threatening Process

Weeds are a key threatening process (KTP) for a number of threatened species. The implementation of the current Weed Management Strategy addresses nine KTPs listed under the NSW *TSC Act* or the Commonwealth *EPBC Act* that affect threatened species and their habitats, either directly or indirectly. A preliminary summary of the risks posed by weeds to threatened species of the LHIG and their habitats is summarised in Table 3. The strategy will help to address a number of KTPs, thus improving ecosystem resilience by removing the competitive advantage of invasive weeds.

Table 2 International, Commonwealth, NSW and other legislation, strategies and plans relevant to management of weeds on LHI.

Global conservation initiatives

International Union for Conservation of Nature (IUCN)
World Heritage Program (<https://www.iucn.org/theme/world-heritage>)
Species Survival Commission (IUCN SSC; www.iucn.org/theme/species/about/species-survival-commission)
IUCN SSC Invasive Species Specialist Group (www.issg.org/)
International Convention for Biological Diversity (Australia is a signatory)

Commonwealth Government legislation, plans and strategies

Environment Protection and Biodiversity Conservation Act 1999
Biological Control Act 1984
Australian Weeds Strategy (NRMMC 2007)
Weeds of National Significance Strategic Plan (see www.enviro/WONS/weeds/publications)

NSW State Government legislation, plans and strategies

(Acts with an asterisk are due to be repealed by the *Biosecurity Act 2015*, which is yet to be enacted)

Biosecurity Act 2015 (to be enacted in 2017)
Local Land Service Act 2013
Pesticides Act 1999
**Threatened Species Conservation Act 1995*
**Noxious Weeds Act 1993*
NSW National Parks and Wildlife Act 1976
Lord Howe Island Act 1953
**Plant Diseases Act 1924*
NSW Weeds Action Program 2015–2020 (DPI 2015)
NSW Biosecurity Strategy 2013–2021 (DPI 2013)
NSW Invasive Species Plan 2008–2015¹ (DPI 2008)

Lord Howe Island Board regulations, plans and strategies

Lord Howe Island Regulation 2014 (www.legislation.nsw.gov.au/regulations/2014-497.pdf)
Lord Howe Island Board Pesticide Use Notification Plan (LHIB 2015a)
Lord Howe Island Lagoon Foreshore Management Plan (LHIB 2015b)
Lord Howe Island Biosecurity Strategy (AECOM 2016)
Lord Howe Island Vegetation Rehabilitation Plan (2002)
Lord Howe Island Plant Importation Policy (LHIB 2014)
Lord Howe Island Permanent Park Preserve Plan of Management (DECCW 2010)
Strategic Plan for the Lord Howe Island Group World Heritage Property (LHIB 2010)
Lord Howe Island Biodiversity Management Plan (DECC 2007)

¹ This plan is being updated, with a draft having been available for public consultation (NSW Government 2015).

Table 3 Identified Key Threatening Processes relating to weed invasion on LHI.

Primary KTPs (TSC Act)

Invasion and establishment of exotic vines and scramblers
Invasion, establishment and spread of Lantana (*Lantana camara*)
Invasion of native plant communities by *Chrysanthemoides monilifera* (Bitou Bush and Boneseed)
Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*)
Invasion of native plant communities by exotic perennial grasses
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Secondary KTPs (TSC Act and EPBC Act)

Infection of native plants by *Phytophthora cinnamomi*
Introduction and establishment of exotic rust fungi of the order Pucciniales that are pathogenic (Myrtle Rust) on plants of the family Myrtaceae
Predation by the Ship Rat (Black Rat *Rattus rattus*) on LHI (TSC Act) and exotic rats on Australian offshore islands of less than 1000 km² (EPBC Act)

2.5 The effects of weeds on endemic and uncommon native plant species of LHI

As already stated, the LHIG shows high levels of endemism. At least half of the vascular plants and six vertebrate animals are endemic to the LHIG, and terrestrial invertebrate diversity is also very high with high levels of endemism (DECC 2007). The southern mountains have the highest species richness of endemic flora and endemic invertebrates on the island but the area continues to be at risk from infestations of Cherry Guava (with thickets detected and removed from up to 600 m above sea level and outliers on cliffs which remain untreated) and Ground Asparagus (with mature plants detected and removed at elevation from Mt Lidgbird). The LHI BMP (DECC 2007) recommends that rapid responses are adopted to control outbreaks of significant weeds in remote areas.

Many native or endemic plant species on LHI have restricted distributions or occupy specialist niches that are at risk from invasive weeds, such as Lord Howe Island Passionfruit (*Passiflora herbertiana* subsp. *insulae-howei*) and native ground orchids like the Helmet Orchid (*Corybas barbara*), which are threatened by competition from asparagus weeds.

The weed species targeted for eradication on LHI are species that show typical invasive characteristics: broad environmental tolerances, ability to spread widely, are known to affect and alter ecosystems, and may affect human health. They are capable of wide dispersal and establishing in all habitats across the island, from cliff edges to undisturbed forest, and many are dispersed by wind or birds (and, formerly, Pigs, which were eradicated in 1979). The main vectors of fleshy fruited plants on LHI currently are the endemic Lord Howe Silvereye (*Zosterops lateralis tephroleurus*) and Lord Howe Pied Currawong (*Strepera graculina crissalis*) and the introduced Common Blackbird (*Turdus merula*).

Table 4 provides a preliminary summary of the actual and potential of impacts of weeds on threatened species of LHI.

Table 4 Preliminary listing of the threatened species of LHI and the weeds that pose a risk to their status. The scientific names and status of species are given in Table 1.

Threatened species	Weed risk
Flesh-footed Shearwater Black-winged Petrel Little Shearwater Red-tailed Tropicbird	Bitou Bush, Bridal Creeper (<i>Asparagus asparagoides</i>) and Ground Asparagus smothering burrows; Entrapment of birds by African Boxthorn and Climbing Asparagus
Lord Howe Woodhen	Breeding and foraging habitat at risk from ground-covering weeds, including Ground Asparagus and Climbing Asparagus; entrapment by Leaf Cactus
Lord Howe Island Morning Glory (southern mountains and Old Settlement)	Crofton Weed (<i>Ageratina adenophora</i>) in the southern mountains and Kikuyu (<i>Pennisetum clandestinum</i>) in Old Settlement
Lord Howe Island Broom Mountain Xylosma Hutton's Geniostoma <i>Coprosma</i> sp. nov. [rare]	Competition from dense thickets of Cherry Guava, Crofton Weed and Ground Asparagus (Figure 23)
Knicker Nut	Competition from Buffalo Grass (<i>Stenotaphrum secundatum</i>) and invasion from asparagus weeds
Sand Spurge	Smothering from Bitou Bush and <i>Scaevola calandulacea</i> (an introduced Australian native)
Small-leaved Currant Bush Rock Shield Fern	Ground Asparagus invasion of rock outcrops and cliff-lines
Phillip Island Wheat Grass	Ground Asparagus, with lesser threat from annual grasses and broad-leaved weeds
Lord Howe Silveryeye Lord Howe Pied Currawong Lord Howe Golden Whistler	All weeds, resulting in simplification of plant community composition resulting in loss of biotic interactions and seasonality of food resources
Lord Howe Island Phasmid on Balls Pyramid	Coastal Morning Glory (<i>Ipomoea cairica</i>), smothering the main food tree of the Phasmid (Tea Tree <i>Melaleuca howeana</i>) and preventing its
Gnarled Mossy Cloud Forest EEC	Cherry Guava and Ground Asparagus found in proximity and at elevation in the southern mountains (Figure 23)
Sallywood (<i>Lagunaria Patersonia</i>) Closed Swamp Forest EEC	Coastal Morning Glory and all other weeds

Most of the weeds targeted for management on LHI can form dense thickets or monocultures and would eventually out-compete and exclude native plant species if left unchecked. The diversity of the life-forms of introduced weeds on LHI (vines, herbaceous and ground layering plants, shrubs, trees and epiphytes) increases the impact on the island's ecology as they can occupy and overwhelm all strata of a native plant community. Further, the invasion of multiple weed species can also have a compound impact on habitats and, over time, may eventually dominate and replace native vegetation.

Some vegetation communities, such as *Howea* forest (DECC 2007), show a degree of resilience to weed invasion, but all habitats are known to be at risk. The two most abundant

weed species – Cherry Guava and Ground Asparagus – are recorded from 165 and 192 weed blocks respectively, the area of the blocks covering an area of 1064 ha (73% of the island area) and 1018 ha (70% of island), demonstrating their island-scale invasive range.

2.6 Weeds targeted for management on Lord Howe Island

The invasive weed species targeted for active management or eradication on LHI are species recognised under a range of international, national, state or other listings of invasive species. These invasive species listings are summarised in Table 5, and discussed in more detail below.

Table 5 Classification of weed species targeted for eradication or control on LHI under broader categories of weeds at federal, state or other levels. Details of each category are provided below.

Invasive weed recognition group or listing	Number of plant species
Australian Weeds of National Significance (WoNS)	11
National Environmental Weeds Alert List	3
World's 100 Worst Invasive Alien Species	4
Declared weeds under the NSW <i>Noxious Weeds Act 1993</i>	68
NSW Regional and State High-Priority weeds	14
Native Australian plants not indigenous to LHI (i.e. introduced to LHI) that have spread or which are showing invasive characteristics	23
Recognised Sleeper Weeds or introduced ornamental plants with invasive characteristics	>20

Weeds of National Significance (WoNS) are regarded as among the worst weeds in Australia and require national effort owing to their degree of invasiveness, potential for spread, and their social, economic or environmental impacts in at least two Australian states or territories. Management of these weeds must also benefit from national coordination (see www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html). Of the 32 listed WoNS, 11 occur, or formerly occurred, on LHI. All WoNS that occur on LHI are identified for eradication.

The **National Environmental Weeds Alert List** outlines non-native plant species in the early stages of establishment that have the potential to become a significant threat to biodiversity if not managed. The National Environmental Weeds Alert List currently identifies 28 species that have established naturalised populations in Australia and have the potential to become a significant threat to biodiversity (see <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/alert.html>). Three species are, or were, recorded on LHI: Glory Lily (*Gloriosa superba*), Leaf Cactus and Tipuana (*Tipuana tipu*; now eradicated).

The list of the **World's 100 Worst Invasive Alien Species** (Lowe *et al.* 2004; ISSG 2013; see <http://www.issg.org/database/welcome/>) lists invasive pest animals and weeds considered among the worst on the planet. Four species from this list occur on LHI: Cherry Guava, Ginger Lily (*Hedychium gardnerianum*), Singapore Daisy (*Sphagneticola trilobata*) and Giant Reed (*Arundo donax*).

NSW Noxious Weeds Act 1993. Currently, 68 invasive weed species declared under this Act occur on LHI and are targeted for eradication (see section 2.7, following).

Regional and State High-Priority Weeds. The NSW Natural Resource Commission undertook a review of weed management in NSW (Natural Resource Commission 2014) and identified 22 extreme- to high-priority invasive weed species that posed a threat to biodiversity in NSW, most of which are declared noxious weeds. Of these 22, 14 occur on LHI and are listed for eradication.

Native Australian plants. A number of plants native to the Australian mainland but not indigenous to LHI have been introduced and have spread across the island. In order of numbers of individuals removed on LHI they are: Sweet Pittosporum (*Pittosporum undulatum*), Silky Oak (*Grevillia robusta*), Umbrella Tree (*Schefflera actinophylla*), Flame Tree (*Brachychiton acerifolius*), White Cedar (*Melia azedarach* var. *australasica*) and Purple Cherry (*Syzygium paniculatum*). Other Australian plant species targeted for removal include some that occur in small numbers, including Bower Vine (*Pandorea jasminoides*) and Red Cedar (*Toona ciliata*), or that may hybridise with endemic species, for example the King Orchid (*Dendrobium speciosum*).

Sleeper weeds are introduced plants that have naturalised and have the potential to form large and widespread populations, but have not yet done so (Groves *et al.* 2005). Such plants can appear benign for many years, but may suddenly spread rapidly and widely, and can include ornamental plants that have long been grown in gardens and that may suddenly become environmental weeds. Such a transformation can result from changing climatic conditions, introduction of new non-sterile material, the appearance, development or introduction of a dispersal vector (spread mechanism) or pollinator, or changes in horticultural or agricultural practices. Sleeper weeds are often not recognised as significant problems until their impact becomes evident (see <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/sleeper.html>).

2.7 Declared weeds on Lord Howe Island

The *NSW Biosecurity Act 2015* is due to subsume the *NSW Noxious Weeds Act 1993* and the associated Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014) (as well as the *TSC Act* and *Plant Diseases Act 1924*; see Table 2). Under the new legislation, management of declared species will be referred to as a General Biosecurity Duty (GBD). LHI is a proposed biosecurity zone under the new Act (NSW Government 2015). However, until the undertakings and responsibilities of the new legislation and their application to LHI are known fully, the *NSW Noxious Weeds Act 1993* continues to apply (as does other legislation, plans and strategies outlined in Table 2).

Under the *Noxious Weeds Act 1993*, declared weeds are those plants that have the potential to cause harm to the economy, environment, community and individuals, can be controlled by reasonable means and have the potential to spread within an area and to other areas. The Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014) lists all weeds declared noxious in NSW, their class (five classes of noxious weeds are defined) and the area to which the order applies. Noxious weeds are declared for a Local Control Authority (LCA) area or state-wide. A LCA has a responsibility for inspections and enforcement on private lands as well as control of noxious weeds on their own lands; the LCA for LHI is the LHIB. Declared noxious weeds require all-tenure management in accordance with the Act.

The NSW Weed Risk Management (WRM) system is used to evaluate noxious weed declarations and to guide weed management practise. The NSW WRM system uses a series

of questions to arrive at a score for weed risk (invasiveness, impacts, potential distribution) and feasibility of coordinated control (control costs, persistence, current distribution) (refer to dpi.nsw.gov.au/__data/assets/pdf_file/0004/279958/INT09-54079-revised-Weed-Risk).

Currently, 68 weed species declared under the Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014) occur on LHI and all are targeted for eradication (Table 6, Appendix 1). Although management of these species may seem an onerous task, 40 of these species have, or had, only small populations (<1000 individuals on the island) or restricted distributions at a limited number of sites, mainly close to the Settlement. Weed management since 2004 has reduced the density and distribution of all of these species (LHIB 2016). Continued management with early intervention for these species will further reduce their impacts and the costs of management.

NSW legislation relating to weeds provides a regulatory basis to enable the management of high-risk species. However, before legislative action, it is preferable to firstly raise awareness with leaseholders to undertake the removal of potentially harmful plants before they spread.

Table 6 Summary of declared noxious weeds on LHI and eradication targets. Note that weed populations have been significantly reduced during the 10 years of the Weed Eradication Program and populations are lower than indicated for targeted weeds below; the residual populations are being determined.

Declared noxious weeds on LHI	Number of species
Declared noxious weeds specified for LHI LCA area	68
NSW state-declared weeds, not recorded on LHI	87
Distribution of declared weeds targeted for <i>eradication</i> on LHI	
Species targeted for eradication with 13,000–700,000 plants removed to 2014 (classified as Common and Widespread to Localised) – Settlement and PPP	10
Species targeted for eradication with >1000 to <2000 plants removed to 2014 (classified as Occasional to Uncommon) – Settlement and PPP	18
Species targeted for eradication with <1000 individuals removed to 2014 (classified as Uncommon) – Settlement only	40
Total	68



The team involved in the Cherry Guava chain-sawing days (2005). The team here includes staff of the LHIB and New Zealand Department of Conservation (NZDOC) and volunteers.

3 The 2006 Lord Howe Island Weed Management Strategy

Since 2004 the LHIB has been implementing the Weed Eradication Program, applying a systematic repeated grid-search and treatment effort across the island, aiming to treat priority weed blocks every 24 months to remove ecosystem-transforming invasive weed species (LHIB 2006). This program also applied a time driven approach to weed grid-search effort and strict data collection and data management systems. A multispecies approach was adopted to avoid only removing one serious weed to be replaced by another serious weed.

The LHI WMS 2006 (LHIB 2006) forecast a 30-year time-frame to achieve the eradication of 25 target invasive weed species across the island. Seven main agencies have funded the LHI Weed Eradication Program, collectively contributing more than \$6.4 million dollars over the 10-year period (LHIB 2016).

3.1 Measuring progress towards eradication

The Weed Eradication Program has achieved significant results, reducing the abundance and distribution of highly invasive weeds over the past 10 years as reported in the *Lord Howe Island Weed Eradication Program – Results 2004–2014* (LHIB 2016). The results were quantified through collection of data, analysis of the numbers of target weeds counted and removed between first and last treatments, and comparison of mapping of weed density and distribution done in 2002–03 and 2013–14 through (LHIB 2016).

Within the PPP, there has been a reduction of 80% of weed plants of all life-stages (seedlings, and juvenile and mature plants) and a reduction of 90% of mature plants (LHIB 2016; Figure 3). The top 10 weeds on LHI, based on the total number of individuals removed over the ten years 2004–14, are listed in Table 7. Six species of invasive weed with restricted distributions are considered eradicated (LHIB 2016; Table 8).

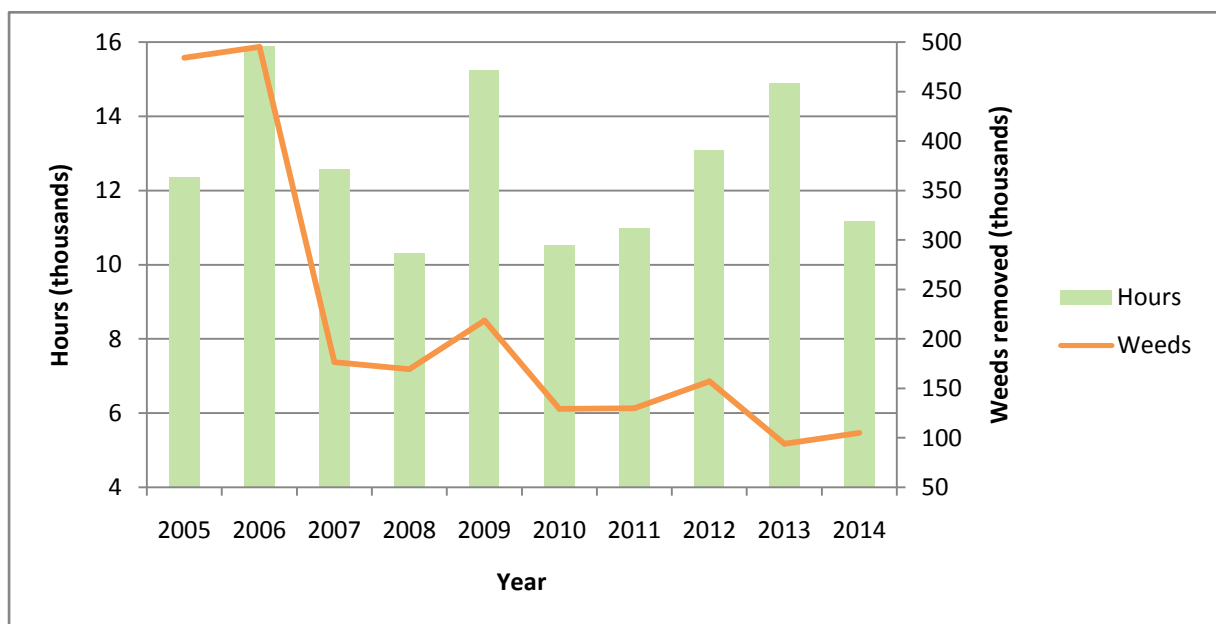


Figure 3 Hours of search effort and total counts of target weeds removed from 2005 to 2014. A strong downward trend in weed numbers is evident. The hours of search effort per year and numbers of weeds removed is a function of funding inputs; a stronger downward trend could have been achieved with consistent funding to maintain annual search effort (15,000 hours per year) and with no other setbacks. (Source: LHIB 2016.)

Table 7 The 10 most abundant weed species on LHI in terms of numbers removed over the decade 2004–14, and the area of occupancy (the sum of the area of all blocks in which a weed is detected, not actual area of weed infestation).

Weed species	Number of plants removed	Area (ha)
Cherry Guava (<i>Psidium cattleianum</i> var. <i>cattleianum</i>)	704,266	1064
Ground Asparagus (<i>Asparagus aethiopicus</i>)	665,831	1018
Ochna (<i>Ochna serrulata</i>)	485,168	648
Bridal Creeper (<i>Asparagus asparagoides</i>)	110,794	328
Sweet Pittosporum (<i>Pittosporum undulatum</i>)	84,729	394
Climbing Asparagus (<i>Asparagus plumosus</i>)	53,840	260
Cotoneaster (<i>Cotoneaster glaucophyllus</i>)	26,211	266
Glory Lily (<i>Gloriosa superba</i>)	13,655	55
Night Jasmine (<i>Cestrum nocturnum</i>)	13,380	81
Bitou Bush (<i>Chrysanthemoides monilifera</i> subsp. <i>rotundata</i>)	3,459	215

Table 8 Invasive weeds considered eradicated from LHI.

Weed species	Plants removed
Cat's Claw Creeper (<i>Dolichandra unguis-cati</i>)	25
Cocos Palm (<i>Syagrus romanzoffiana</i>)	3
French Broom (<i>Genista monspessulana</i>)	1
Potato Vine (<i>Solanum wendlandii</i>) (not Madeira Vine)	1
Turkey Rhubarb (<i>Acetosa sagittata</i>)	1
Tipuana (<i>Tipuana tipu</i>)	1

Another measure of success is to compare the number of weeds intercepted per hour by a weeder. Comparing first treatment in blocks in 2005 to treatment in 2014 (across similar extent of terrain), the number of Cherry Guava intercepted per hour (all life-stages) has declined from by 22 plants per hour to 1.06 plants per hour, a 95% reduction.

Successful weed management: Cherry Guava and Ground Asparagus

Cherry Guava, the most abundant weed on LHI, where first recorded in 1898, has been removed from 165 weed management blocks across 1064 ha of the island (Figure 4, Figure 5, Figure 23), and Ground Asparagus, the second most abundant weed on LHI and first recorded in 1930, has been removed from 192 weed management blocks across 1018 ha (Figure 6, Figure 7; see Table 7). Both species have demonstrated island-scale invasiveness on potential and cumulative biodiversity impacts, occupying a range of strata from the ground to the tree layer. Despite being present on LHI for 32 years or less, the invasion range of Ground Asparagus matches that of Cherry Guava (Bower 2016).

The scale of the numbers of weeds removed to do indicates the extent of the threat to the ecosystems of LHI and the importance of continuing the effort to contain and eradicate them. In total, over 2 million individual weeds have been removed from habitats across LHI (LHIB 2016). The outcomes achieved over the past decade have improved the feasibility for eradication of priority species.

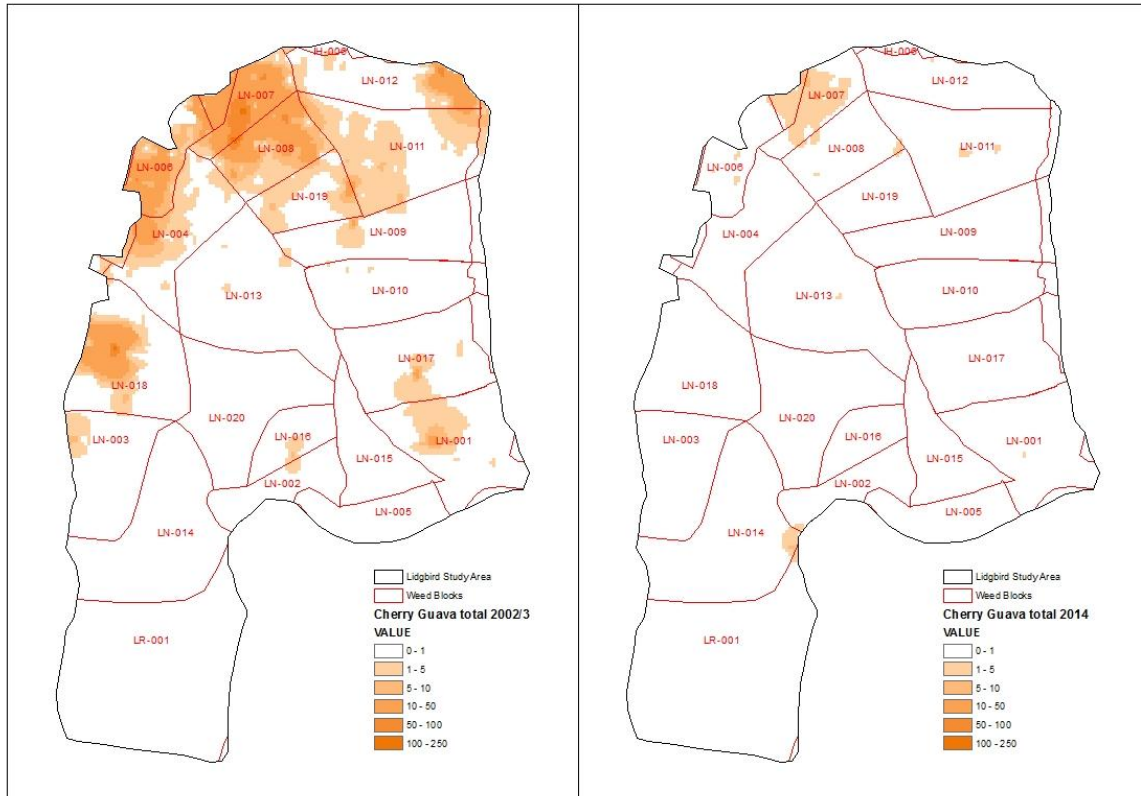


Figure 4 Changes in the density and distribution of Cherry Guava from the Lidgbird North weed management landscape unit between 2002–03 and 2013–14. Individuals remaining in 2014 are mainly juvenile plants.



Figure 5 Weed management block LN007 in the northern portion of the Lidgbird North landscape unit with piles of chain-sawed Cherry Guava in 2005 (left; Photo I. Hutton) and during follow-up for residual weeds in 2010 (right).

The LHI WMS (LHIB 2006) identified 25 species as priorities for eradication, all but two of which remain the focus of eradication effort. The remaining two – Mauritian Hemp (*Furcraea foetida*) and Sea Spurge (*Euphorbia paralias*) – are treated as control targets as, firstly, they are not declared weeds (so their control across all tenures is not mandatory) and, secondly, it is not considered feasible to eradicate Sea Spurge as it will continue to be dispersed to LHI through sea-drift.

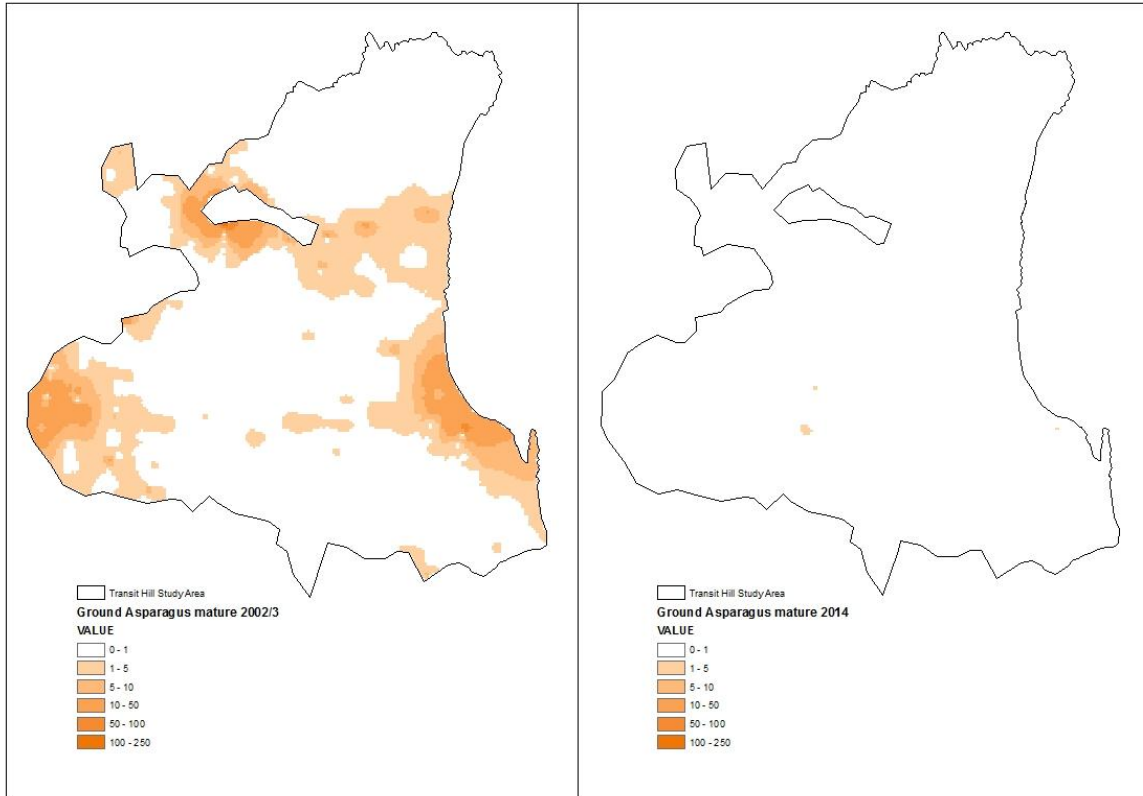


Figure 6 Changes in the density and distribution of mature Ground Asparagus from the Transit Hill landscape unit between 2002–03 and 2013–14. The area has received repeat follow-up for juvenile plants.



Figure 7 Weed management block TH025 in the Transit Hill landscape unit before treatment, in 2011 (left), and after treatment in 2016 (right). Ground Asparagus, which was formerly common and widespread, is now uncommon owing to weed management effort.

Under Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014) additional weeds were declared in a bid to allow early intervention for weeds that had escaped into the PPP and to enable an all-tenure approach to management.

Removal of outliers (nascent foci of Mack & Lonsdale 2002) is needed to prevent a build up of populations in the areas where they occur, especially in remote and rugged terrain. . Failure to deal with outlier weeds will compromise weed management and eradication success, and outlier weeds need to be a priority for management. Invasive weed populations have significantly reduced in extent on LHI, yet they still pose a risk to the environment until they are completely removed or contained. The outcomes achieved over the past decade have improved the feasibility of this for the diversity of weed species on LHI.

Weed eradication programs often require 10 or more years to achieve their objectives and may require a period of gradual elimination to precede eradication (Holloran 2006). This is relevant for LHI given the prior scale of abundance and distribution of ecosystem-transforming weed species. However, the significant progress made can be measured in the great reduction in the number of mature plants, delimitation of the extent of infestation, and containment and extirpation of seed-banks (Panetta 2007). The LHI program has not reached the stage of extirpation of seed-banks (island-scale) as mature weeds are still present in the landscape, but mature plants have already been reduced by 90% since commencement of the program.

How are we planning to manage weeds on Lord Howe Island?



Cherry Guava at Stevens Reserve in the 1990s. Cherry Guava is now hard to find on LHI as a result of the past 10 years of island-scale search and removal of weeds.



4 Weed management on islands

The management of weeds, on island and mainland environments, requires an assessment of the ecological and economic threat presented by a weed invasion, the stage of invasion and the implementation of management strategies appropriate to these factors. Figure 8 illustrates schematically the various stages of weed invasion, the strategies to be adopted and an indicative economic cost–benefit of control.

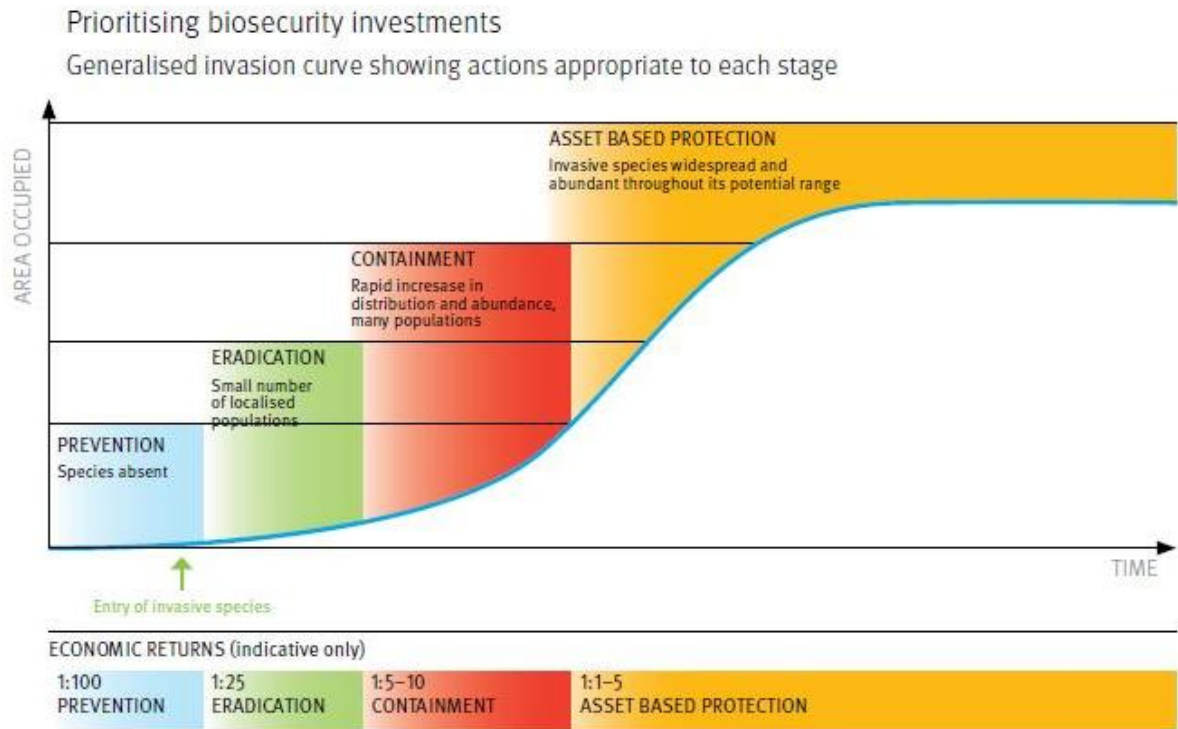


Figure 8 The invasive species curve showing management actions appropriate to each stage of invasion. (From NSW Biosecurity Strategy 2013–2021, DPI 2013.)

Prevention

The most cost-effective mechanism for managing the threat of weeds is to prevent the introduction of invasive weeds (DPI 2013; Figure 8). To address this approach, the importation of invasive weed species is prohibited under the *LHI Act* and Lord Howe Island Regulation 2014 (see www.legislation.nsw.gov.au/regulations/2014-497.pdf [accessed 8 Nov 2016]), with details explained in the Plant Importation Policy 2014 (LHIB 2014). The importation of plant species new to LHI requires a weed risk assessment (WRA) to screen the invasive potential of the plant and the potential threat to the island, both in the short and long term. The Plant Importation Policy 2014 for LHI adopted the WRA methodology of Pheloung (1995). Under a WRA, plants are assessed as approved or rejected for importation, or require further information before an assessment is finalised. The WRA is a consistent, partially quantitative, question-based screening system that considers the biogeography of a plant, and its historical, biological and ecological characteristics. An informed WRA may take up to two days to complete, requiring searches of weeds databases and summaries of knowledge of the ecological and reproductive traits of the plant species.

Eradication, Containment and Asset-based protection

The feasibility of eradicating a weed species is a significant consideration in determining current and future management priorities. Although adequate funding is a key component of effective weed management and eradication, the feasibility of eradication must be based on a range of criteria including life-traits, biology and ecology, distribution of the weed species, and management regimes (Gherardi and Angiolini 2004; Pannetta & Timmins 2004; Panetta 2007; Panetta *et al.* 2011, Parks & Wildlife Service 2014). Criteria associated with weed eradication are summarised in Table 9.

Table 9 Criteria likely to lead to successful eradication of weed species (based on Gherardi and Angiolini 2004; Pannetta & Timmins 2004; Panetta 2007; Panetta *et al.* 2011, Parks & Wildlife Service 2014).

Biological characteristics and life-history traits
Easy to detect or identify at all life-stages (in differing vegetation types)
Responds to control treatments – all reproductive individuals must be at risk of effective treatment
Target species can be detected at low densities
Immigration is zero
Long juvenile periods with low rates of persistence in seed-banks
Management considerations
Suitable socio-political environment and community support for the program
Effective organisation and operational structure
Committed funding and on-going financial support, until eradication end-point
Cost effective – discounted benefit:cost analysis favours eradication over control
Species prohibited from re-introduction with sufficient barriers and effective quarantine in place
Ability to gain access – target species can be logistically removed from all areas
Implementation team highly capable and motivated, dedicated to applying program methodology and committed to the eradication goal
The rate of removal can exceed the rate of reproduction

Where eradication is not considered feasible, strategies of containment or asset-based management are needed.¹ These strategies require ongoing inputs compared with the end-point that is achieved through eradication (Grice *et al.* 2012). Weed management categories are more fully described in Section 6, and species assigned to each category are listed in Appendix 1.

The LHI WMS 2006 (LHIB 2006) projected a 30-year time-frame with the aim of applying sufficient resources to eradicate or contain widely dispersed, ecosystem-transforming weed species and introduced species in the early stages of establishment. The LHI WMS aimed to reverse the invasive trends of weeds and to eradicate species entirely where possible.

In a mainland environment, the sheer extent and diversity of invasive weeds present on LHI before 2004 may have been subject to containment² or asset-based protection management owing to the likelihood of low returns on the investment in weed management (e.g. Pannetta *et al.* 2011). In a mainland situation, eradication may be less feasible owing to uncertainty of the species invasive range and likelihood of re-invasion from adjacent areas. LHI, owing to its geographical distance from the mainland (more than 550 km of ocean to nearest point), small size (1455 ha), limited entry points, and increasing biosecurity awareness and restrictions on imports, provides an opportunity for an effective island-wide approach to the eradication of weeds.

The weed species identified for **eradication** on LHI are:

- those species for which eradication is considered feasible given the life-history traits of the species, adequate resourcing and technical applications; or
- those species that, by failing to eradicate them, will continue to seriously endanger the island's ecosystems, threatened native species, human health or economy.

Eradication of high-priority invasive weeds on LHI is considered to be a better investment (cost–benefit) compared to an ongoing control program in which the island's World Heritage values would remain at ongoing risk from invasive weeds. Compared with an eradication program, which aims to provide long-term protection of the ecological assets of LHI from weed reinvasion, a control program provides only a limited insurance policy.

The economic returns on the investment in the LHI Weed Eradication Program may not be fully realised until the program reaches its 20th or 30th year. However, the results achieved over the past decade have greatly improved the weed management prospects for the next two decades. Continued investment while weeds are at low densities will drive downward trends in density and distribution of weeds, the elimination of remaining mature weeds, further depletion of weed seed-banks, and will maximise the benefits of investments made to date and improve the feasibility of eradication.

Further, the continuation of island-scale weed eradication will address the risk of weed populations rebounding following the proposed eradication of exotic rodents (Lord Howe Island Rodent Eradication Program; see <http://www.lhib.nsw.gov.au/environment/environmental-programs/rodent-eradication> [accessed 8 Nov 2016]). The NZDOC weed-management program on Raoul Island reported increased regeneration success of target weeds after the eradication of rodents (West 2002). Other benefits of reducing invasive weeds on LHI include improved ecosystem resilience in the event of spread of a plant pathogen.

The implementation of this current 10-year Weed Management Strategy and continuation of the Weed Eradication Program will have multiple benefits in protecting and maintaining the integrity of threatened and endemic plant and animal species and their habitats over the long term. The significant reduction in weed densities and distributions over the 10 years 2004–14 has increased the feasibility of achieving the goals of the WMS. However, the most abundant and widespread weed species (e.g. Cherry Guava and Ground Asparagus), will require ongoing suppression to approach or achieve eradication in the next decade or two. The smaller populations of localised weeds species (estimated up to 30 species), initially limited in occurrence or depleted due to search effort are likely to reach an eradication end-point in the coming decade.

² Containment also describes the phase of an eradication program whereby no new mature weed plants are found, there is no new seed-set and the extent of the infestation is delimited (Figure 13).

5 Weed eradication methodology on Lord Howe Island

The methodology of the LHI Weed Eradication Program (LHIB 2006, 2016) was developed from the Raoul Island Weed Eradication Program managed by the New Zealand Department of Conservation (NZDOC) as part of its island conservation programs (West 2002). This methodology is considered best practise for LHI (Le Cussan 2004a, 2004b; LHIB 2006).

For the management and eradication of weeds on LHI, the entire 1455 ha of the island has been divided into nine landscape units (Figure 9), as follows:

- Malabar (191 ha)
- Settlement North (186 ha)
- Transit Hill (83 ha)
- Settlement South (92 ha)
- Intermediate Hill (170 ha)
- Lidgbird North (129 ha)
- Lidgbird Remote (155 ha)
- Lidgbird South (309 ha)
- Gower (255 ha)

These units are further divided into a total of 395 weed management blocks, which are based around terrain, tracks or leasehold boundaries (Figure 9).

Of the 1455 ha of island, 1024 ha of terrain with known weed infestations is a priority for on-ground, grid-based weed search and removal (unshaded areas in Figure 10). This excludes 160 ha of leasehold land within the Settlement (being the responsibility of leaseholders) and 271 ha of remote terrain that is assumed to be largely or wholly weed free (determined by planned and incidental surveillance, on ground and by air, and in consideration of current invasive range of known weed species) (shaded areas in Figure 10). There is approximately 34 km of cliff-line with 12 km of that known to have infestations of target weeds.

5.1 Weed search, treatment and data recording

The LHI Weed Eradication Program is a multispecies program combining search and control, with all target weeds removed progressively as they are detected in a block. The procedure aims to detect, and remove, all mature plants in the early stages of the Weed Eradication Program to prevent fruiting, or further fruiting, and the spread of seeds and to then, during

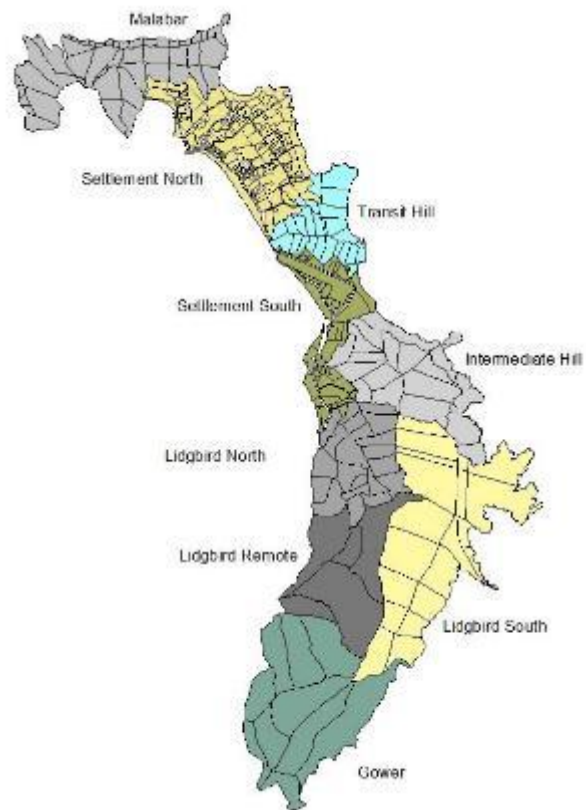


Figure 9 Map of LHI landscape units and weed management units.

follow-up grid-searches, detect and remove all missed plants, seedlings and re-shooting plants before they are able to mature and set fruit. This process eventually depletes seed-banks to deliver eradication.

Optimally, all weed management blocks on LHI need to be searched and all target weeds removed every 24 months. A target of 500 ha of on-ground search effort every 12 months is needed to treat an area of 1000 ha every 24 months. The 24-month search cycle is based on the life-history traits of the commonly encountered and broadly dispersed invasive weeds on LHI, with most requiring 3–4 years to reach reproductive maturity and having a short-term seed-bank persistence (1–5 years; Kleyer *et al.* 2008). However, the search-cycle relies on quality of search effort to avoid missing early stage and residual mature weed plants. Yearly search effort can be applied given adequate funding but such a timeframe may not be effective in detecting seedlings or allow sufficient time for soil seed-banks to germinate, but will assist in detection of missed juvenile and mature plants. Equally, analysis of the LHI Weeds Database shows that a 36-month treatment cycle is inadequate in suppressing weeds, particularly for Ground Asparagus, where missed juveniles in preliminary search effort can reach reproductive maturity within the 36-month interval.

The shaded zones in Figure 10 are blocks of the Settlement leases (with leaseholders having the responsibility for weed management) or remote terrain assumed to be largely weed-free and that are not priorities for search at 24-month intervals. The unshaded areas are to be completely searched over a 24-month period.

A number of weed species, including Madeira Vine (*Anredera cordifolia*), Climbing Asparagus (in former hot spots), Glory Lily and Bitou Bush, can reach reproductive capacity within one year and require annual search and treatment to prevent seed production and spread of the species. With the exception of Bitou Bush, most of these species occur in the Settlement and management is the responsibility of leaseholders. However, the LHIB provides assistance and monitors weed management through the leasehold inspection process for declared weeds.

Weed management blocks that are not trending downwards (following analysis of the LHI Weeds Database) will be subject to increased search frequency and scrutiny of search efficacy.

Each weed management block is searched systematically to ensure that all terrain is covered and target weeds both detected and removed. Systematic searches are used when working in accessible terrain or in inaccessible areas, such as cliff-lines. Where outlier weeds are

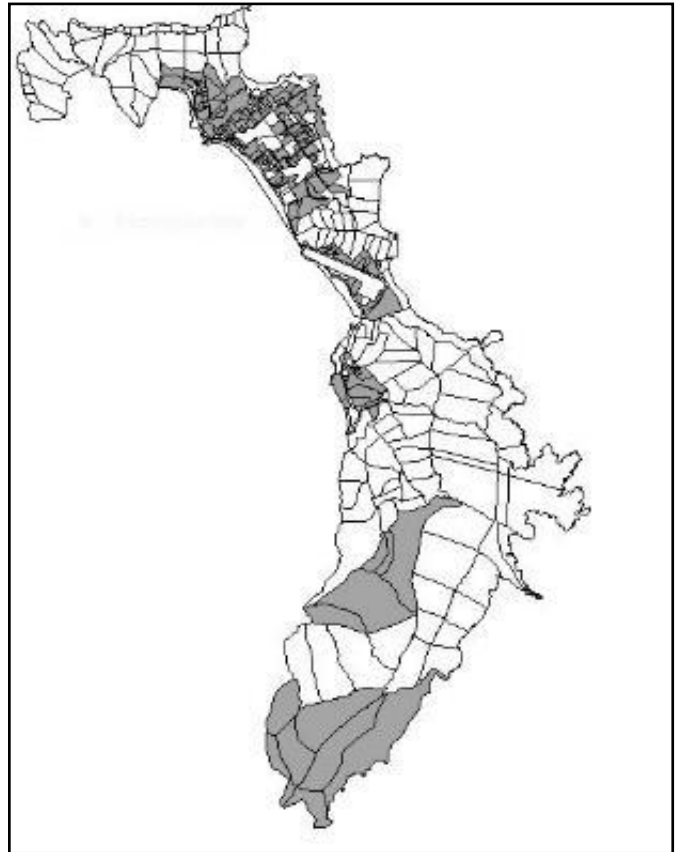


Figure 10 LHI showing priority areas for on-ground grid-search every 24 months (white), which excludes leasehold tenure and remote terrain assumed to be largely or wholly weed free (grey shading).

detected in remote terrain, they will be treated rapidly and the location, including a dispersal buffer zone, incorporated into repeat search programs.

Accessible terrain

Effective search effort requires all terrain to be searched in a tight grid-pattern. In accessible terrain, grid-search is undertaken with teams forming an 'emu parade' and physically walking to search and find weeds. Effective searching requires each team member to be able to overlap their area of visual search for weeds on the ground, mid strata or canopy weeds. On average this may equate to a 5 m distance between team members, but it is dictated by weed lifestage, density and density of vegetation; ultimately you need to be able to see your team member.

Currently, stringlines and flagging tape are used to delineate the edge of a sweep of search effort. Weed-search teams line up along the edge of a weed-management block and work along the boundary tape in a staggered line (emu parade) towards the end of the block. The person on the marked edge effectively leads the team. The weeder on the opposite end of the team deploys a stringline that delineates the next edge of search effort. The team leader retrieves the set stringline and progressively leads a new run of search effort while the person at the outer end of the search line deploys a new stringline. This is repeated until the weed management block has been fully searched and treated. Weed search and treatment is recorded using a global positioning system (GPS) to enable accurate mapping and review of treatment areas.

Remote or cliff terrain

To detect and remove weeds in remote terrain or other areas that are difficult or impossible to reach on the ground, it is necessary to use technical methods, such as rope access systems or helicopter winching, or to use aerial equipment, such as helicopter lance-spray programs.

Rope access or work positioning systems (rope systems that are set up to enable safe access and prevent fall from a height) are needed to search for and remove weeds in the areas that fall between the areas readily accessible for on-ground grid-search effort and those areas searched and treated by aerial methods. The areas require a means of attachment to improve safety and quality of search effort.

Two **helicopter programs** are required annually to deal with different weed species and to work around seasonal constraints such as seabird breeding periods.

- **Helicopter winch programs** need to be undertaken annually to search for Cherry Guava in steep and remote terrain in the southern mountains. This work needs to be undertaken outside the breeding period of Providence Petrels (*Pterodroma solandri*; September to the end of February).
- **Helicopter lance-spray programs** (Figure 11) are required to complete surveillance and treatment of Bitou Bush and Ground Asparagus and to continue to treat established infestations in the northern hills. The heli-lance spray apparatus has a 200-litre capacity, which is critical for reducing large weed infestations within a short period. Ideally, this work needs to be undertaken between June and mid-August to avoid breeding by migratory seabirds (Sooty Terns *Onychoprion fuscata* and Red-tailed Tropicbirds *Phaethon rubricauda*).

Unmanned Automated Vehicles (UAV, or drones) and Herbicide Ballistic Technology (HBT) applications are being developed for surveillance and treatment of weeds in remote areas. Infestations of Bitou Bush on cliff-lines need to be treated every 12 months. These two

techniques may allow better and more efficient treatment for Bitou Bush, and reduce the search and removal effort on rope and by helicopter. These new techniques will complement current aerial applications, until cliff-line weed infestations are reduced significantly as UAVs have limited carrying capacity.



Figure 11 Helicopter lance-sprayer in action (left) and mature Ground Asparagus on a cliff on Mt Lidgbird being precision sprayed by the lance (right); latter image from inside the cockpit.

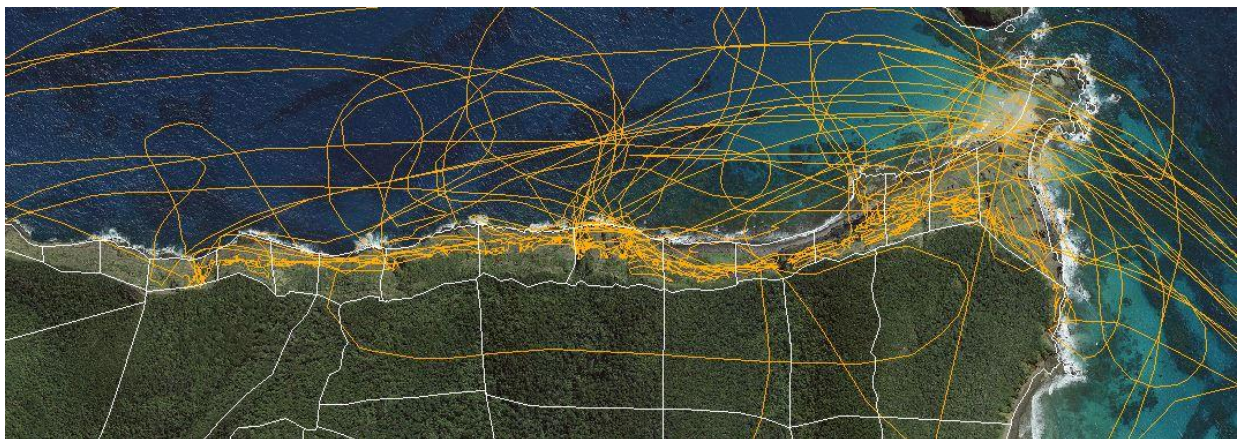


Figure 12 GPS track of helicopter search and control effort during lance-spraying operations.

Data recording

All life-stages of all target weeds are removed during weed grid-search and treatment. Data are recorded for each life-stage of each weed species for each weed management unit, including number of hours of search effort, and numbers of plants of each stage. These data are entered into the LHI Weeds Database (Microsoft Access) program. The Weeds Database will need to be modified to allow recording the stage of maturity of weed plants (e.g. vegetative mature, in flower or in fruit); this information will be increasingly important as mature weed populations become scarce. All search effort is recorded on GPS and downloaded into a geographic information service (GIS) program for monitoring and reporting (e.g. Figure 12).

Recording and marking isolated weed infestations or mature plants. Isolated or mature weed infestations are recorded as a waypoint on GPS, uniquely coded and marked in the field with flagging tape. The recording and flagging of sites alerts the weed team to the former location of mature plants to increase awareness and the quality of weed search for new recruits within a 30-m radius of the site. Such sites remain labelled through the Weed Eradication Program phases until the plant is deemed eradicated in the location. For example, sites that supported a weed with seed-bank persistence of 4 years will need to be flagged for

10 years from the initial removal of a mature plant. Eventually – in the reduced-weed environment and as the eradication program reaches a monitoring phase – residual **juvenile** weeds will need to be marked and mapped to enable teams to navigate to locations.

Weed-treatment techniques

Weeds are treated in a number of ways, including: removal by hand (crowning out or digging up); by cut, scrape and paint; scrape and paint; foliar spray using spray packs (see recommended generic weed control techniques for LHI at www.lhib.nsw.gov.au/environment/environmental-programs/weed-eradication-program/noxious-weeds). Other technical application are also applied by splatter gun; or applied by helicopter (lance-spray; Figure 11). All herbicide treatments are applied in accordance with product labels, Australian Pesticides and Veterinary Medicines Authority (APVMA; <http://apvma.gov.au/>) off-label permits for environmental weeds, and the LHI Pesticide Use Notification Plan 2015 (LHIB 2015a).

5.2 Other methods of weed management

Biological control

Biological control is another tool in an integrated approach to weed management. Biological control agents are particularly important when eradication of weed species is not a management option, because such agents are a long-term management option that can reduce the vigour, spread and impacts of weed species. Biological control programs are largely managed by CSIRO in accordance with the *Biological Control Act 1984* (Commonwealth).

Four biological control agents are currently present on LHI, although their effects have been variable or limited so far. They are Bridal Creeper Rust (*Puccinea myrsiphylli*), Crofton Weed Stem Gall Fly (*Procecidochares utilis*), Crofton Weed Leaf-spot Fungus (*Cercospora eupatoris*) and Crofton Weed Rust (*Baeodromus eupatorii*). The latter was released on LHI in July 2016. It has been widely used on the east coast of mainland Australia where it has shown promising results (see <http://www.csiro.au/en/Biological-control/Crofton-weed>). Endemic and native plants of the family Asteraceae from LHI were tested before release to ensure they would not be affected by the release of the Rust.

A reduction in the extent and spread of Crofton Weed (*Ageratina adenophora*) on LHI will benefit agricultural land on LHI as well as aiding the protection of significant plant communities of the waterfall cliff-line and improve access and detection of target weeds. Crofton Weed also competes with the endemic and critically endangered Lord Howe Island Morning Glory (*Calystegia affinis*) in the southern mountains. It is too early to measure the success of the Crofton Weed Rust release on LHI.

Biological control agents for other weed species should be investigated, including for Wandering Trad (*Tradescantia fluminensis*), Parramatta Grass (*Sporobolus africanus*), Mother-of-millions (*Bryohpyllum delagoense*), Sea Spurge (*Euphorbia paralias*) and Formosan (Tiger) Lily (*Lilium formosanum*). With the exception of Formosan Lily, effective biological agents for each of these species have already been trialled in Australia (A. Mc Connachie, personal communication, 2016).

Detection dogs

Detection dogs are being used in other weed management programs to find small, cryptic plants, such as seedlings, that may be overlooked during human searches. However, detection

dogs are effective only when weed populations are small, when they can be used to verify eradication from an area and the quality of human search effort. Use of a multi-weed species detector dog should be considered on LHI to assist detection when weeds only exist at low densities or in seedling or juvenile stages. Weeds such as Ground Asparagus, Ochna and Cherry Guava, which can be difficult to detect when small, could be effective targets, once populations are reduced to low levels. NSW OEH has been using weed detection dogs for the Orange Hawkweed (*Hieracium aurantiacum*) eradication program (OEH 2016). The Raoul Island Weed Eradication Program managed by NZDOC has used detection dogs for management of Cherry Guava and other weed species (DOC 2015). The Raoul Island program provides a good reference point for LHI as the weed species and challenging terrain are similar.

Genetic control techniques

The use of genetic drivers to modify weeds to reduce their vigour and spread may prove to be useful for future environmental weed management on LHI. Genetic drivers avoid the need for the use of herbicides to control invasive plant species.

Genetic drivers are developed through identifying potential weaknesses in a weed species and developing and breeding plants with these features. The modified plants are then established with the intent that they interbreed with existing weed populations and that subsequent generations of weed plants have reduced reproductive capacity, less vigour or increased vulnerability to climatic regimes or environmental stressors and, ultimately, have less environmental impact.

While strict and high-level checks and balances will be required before release of such plants on LHI, the weeds targeted should be restricted to introduced species that are not related to native and endemic plants on LHI. The technique may be particularly relevant for invasive weeds such as Panic Veldt Grass (*Ehrata erecta*) and Ground Asparagus that have established in rugged terrain that is difficult to access.

5.3 Maintaining effective search effort for low-density weed populations

As weed populations are reduced, the effort required to detect individual weeds increases because plants are harder to find. Mature weed populations on LHI have been reduced by 90% across areas that have received repeated search effort, and the removal of the remaining mature plants is critical to prevent replenishment of weed seed-banks. Once all mature weeds are removed, adequate and continuous search pressure is critical to ensure juvenile weeds are removed before they mature and set fruit. It is also important to map and control isolated mature weeds to ensure repeat search effort removes any seedling recruits.

For weed management blocks that have received repeat visits and experienced a significant reduction in weed numbers, the time needed for search and treatment within blocks has not declined significantly across the island (LHIB 2016). Search effort is also not likely to reduce in future because eradication requires a sustained search effort across the entire area subject to invasion and repeat surveillance must be conducted at intervals that do not allow target species to flower or set seed.

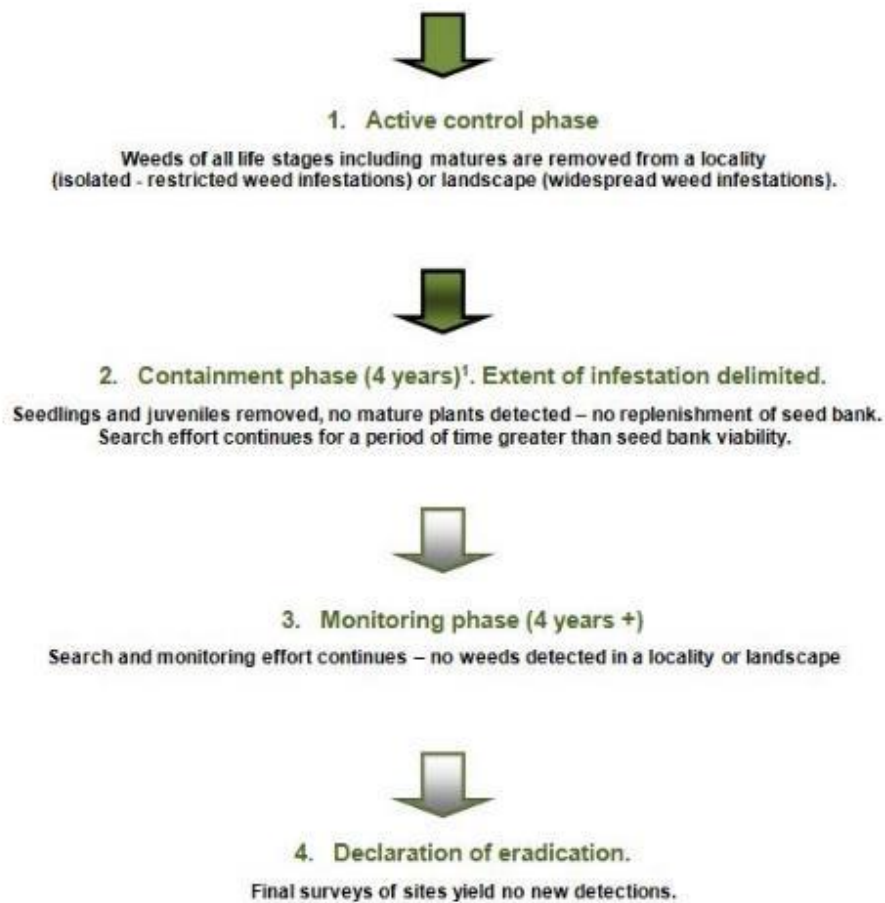
Personnel undertaking weed searches (LHIB staff, volunteers and contractors) must be capable, motivated and dedicated to the goal of eradication, as quality of search effort is critical to program success (Appendix 4).

Given the lack of reduction in search and treatment times, resourcing of future search and treatment needs to match prior inputs (see section 8 for details of estimated costs and staffing level to maintain effective weed management).

5.4 Declaring the eradication of a weed species

Panetta (2007) describes four main operational phases in weed eradication programs based on the life-history traits and reproductive biology of weed species (Figure 13).

Weed eradication – program phases



¹ Example of a weed species with seed bank viability of 4 years.

Figure 13 Four phases of a weed eradication program (after Panetta 2007).

To declare a weed species eradicated, all individuals of that species and their propagules must be completely removed from the landscape and remain absent (undetected) over a monitoring period greater than the time that seed or propagules can persist in the environment. For example, if a weed has seed that is viable for three years in the environment, eradication cannot be declared until no plants, including seedlings, are detected for three or more years.

For most of the weeds targeted for eradication on LHI, they have short-term persistent seed-bank viability, from one to less than 5 years. However, Madeira Vine and Glory Lily establish

underground storage organs and may remain dormant, thus requiring longer monitoring periods before eradication can be declared. As populations of most broadly dispersed weeds are reduced, searches of weed management blocks needs to continue at adequate intervals to monitor populations to prevent weed maturation confirm absence and, if necessary, undertake active treatment; Bitou Bush, Glory Lily and Mairera Vine are exceptions, requiring annual grid-search and treatment.

For widespread weeds, the LHI Weed Eradication Program is still within the Active Control phase of Panetta (2007; Figure 13), owing to the high density of the weed infestations that had to be controlled. It is expected that in the next few years, and given adequate resources, the program should transition to the Containment phase at least for some weed species, and then to the Monitoring phase. After the Active Control phase, progress towards eradication can be measured stepwise, by the delimitation and containment of weed incursions (in preventing spread) and depletion or extirpation of soil seed-banks. On LHI the eradication of a weed may be achieved firstly within weed management blocks then landscape units and, ultimately, island-wide.

Within the Settlement, isolated or small populations of target weeds that had not spread elsewhere on the island and have been removed are considered eradicated if they remain undetected during consecutive noxious weed inspections that correspond to the period of seed persistence for the species within a 100-m radius of the location of the weed before removal.

Promoting island stewardship with good gardening practice

Good gardening practices can help reduce the spread of potentially invasive species. De-seeding or de-heading spent flowers will stop plants setting seed and spreading (for example removing spent flower heads of *Agapanthus* and Mauritius Hemp (*Furcraea foetida*) and pruning bushes (for example Snow Plant *Breynia nivosa*). Community education is required for widespread adoption of this approach.

Many plants were introduced – and are still being introduced – to the island without approval. This risks the introduction of plant pests, pathogens and diseases. There are many plants already present in gardens on LHI, that are not invasive and could be shared rather than bringing new, foreign species to the island. The LHI Plant Importation Policy (LHIB 2014) allows an array of fruit, vegetable and ornamental plants that are permissible for import.

Cooperative effort in monitoring the invasiveness of introduced plants is the responsibility of the LHIB and the local community. Everyone plays a vital role in raising the alarm about plants that are showing signs of spread.

Everyone plays a role in the prevention of the establishment of weeds and management of them and **stewardship of the island's environment for future generations**. The challenge is to make good gardening choices and using plants that are sustainable, don't spread and are safe for the island environment.

Exotic plant pests and diseases — Biosecurity

While this Weed Management Strategy is focused on invasive weed species, the LHIB remains alert to current and future risks from exotic plant pests and disease-causing pathogens and pest animals. The importation of plants and quarantine-risk materials is managed under the LHI Plant Importation Strategy (LHIB 2014), the draft LHI Biosecurity Strategy (AECOM 2016) and the Lord Howe Island Regulation 2014 (see www.legislation.nsw.gov.au/regulations/2014-497.pdf [accessed 8 Nov 2016]). It is prohibited to import invasive plants to LHI, with a weed risk assessment (WRA) needed for all imports (Pheloung 1995).

Introduced animal and plant pests and diseases pose a cumulative threat to the integrity of the terrestrial ecosystems of LHI. They may cause the decline or death of native plant species and plant communities, increasing the opportunity for the expansion of weeds.

There are currently two serious plant pathogens on LHI: the root-rot fungus *Pythophthora cinnamomi* and, recently, an outbreak of Myrtle Rust (*Puccinia psidii*; detected 14 Oct 2016).

The root-rot fungus is confined to a property in the Settlement South landscape unit and is treated with a fungicide quarterly and with soil testing undertaken annually. The perimeter of the infestation is clearly marked with quarantine tape. Boot scrub-stations (containing Quatsan) are installed at the heads of tracks in an effort to prevent spread into the PPP from local people, returning residents and visitors. Up to 15 endemic plant species on LHI have congeners elsewhere that can be affected by root-rot fungus (DECC 2007).

The outbreak of Myrtle Rust is currently limited to two sites in the north of the Settlement and mostly infecting the introduced Rose Apple (*Syzygium jambos*). At this early stage, the LHIB plans to contain and eradicate the pathogen. The infestation has been treated with fungicide and plants controlled. All the endemic plants of the family Myrtaceae on LHI are susceptible to Myrtle Rust. No new infections have been detected in the Settlement or on tracks in the PPP as of November 2016.

Risk of spread of plant pathogens by LHIB staff

LHIB staff undertaking weed search across the PPP are potential vectors of plant pathogens (and weeds), as their search effort is off track and covers all terrain (DECC 2007). LHIB staff are required to use foot scrub-stations at any point where they enter the PPP on a daily basis (LHI Weeds Operational Manual in preparation).

Returning residents and visiting contactors or volunteers working in the PPP are advised to wash and decontaminate all their bush gear, including footwear, if they have been in an area infected by Myrtle Rust before coming to LHI.

Adherence to basic hygiene and quarantine measures will help to address current and future biosecurity risks on LHI.



Over the past 10 years, more than 700,000 individual Cherry Guava plants (of all life-stages) have been removed from LHI across 165 weed management blocks (which cover an overall area of 1065 ha). Cherry Guava is an ecosystem-modifying invasive weed and considered to be the worst invasive plant species in Hawaii (GISD 2016). On LHI, Cherry Guava has been progressively advancing into the southern mountains but suppression through repeated grid-search effort and treatment has achieved significant reductions in numbers and the opportunity to provide long-term protection for the island's ecosystem. (Photo: C. Jones, Parks Australia.)

6 Weed management categories on LHI

Three management categories were developed for weeds on LHI. These are based on their level of threat (invasiveness and environmental impact) and the feasibility of their eradication (WRA) combined with the outcomes of weed management over the past 10 years in reducing the extent of weed invasions. These categories aim to align with those of the *Biosecurity Act 2015*, which will replace the control classes of the *Noxious Weeds Act*.

The categories are:

Category 1: Eradicate (immediate removal or suppression leading to eradication);

Category 2: Alert (sleepers weeds – watch and act as needed);

Category 3: Control (effectively manage).

Appendix 1 provides a list of all species in each of these categories and identifies the operational phase in which they currently fall.

Category 1: Eradicate (immediate removal or suppression leading to eradication)

Category 1 includes invasive weed species that are:

- established in the PPP and require strategic management and continued suppression to achieve their eradication over the short to long term to protect the island ecosystems;
- new arrivals to LHI (including unauthorised imports) or recently detected invasive weed species that pose a high risk; and
- recently declared eradicated.

Currently 68 weed species – all declared species under the NSW *Noxious Weeds Act 1993* – are targeted for eradication, including 40 species with limited distribution on LHI (Appendix 1).

Category 1 species are managed through a cross-tenure approach. Highly invasive weed species detected on leasehold land need to be removed as rapidly as possible while their distribution and effects are restricted and minimal. The preferred approach is through education and liaison, although a legislative and enforcement approach may be required in some instances.

In the past ten years, eradication grid-search effort has achieved a 90% reduction in numbers of broadly dispersed mature weeds. Given adequate funding over the next decade the **containment** of the broadly dispersed species (removal of all matures to reach a monitoring phase) and **eradication** of limited species will be realised in the current or next decade. Species considered eradicated will remain as Category 1 to allow for ongoing awareness and monitoring.

Examples of Category 1 weeds

Kahili Ginger (*Hedychium gardnerianum*; Figure 14) is a major environmental weed, and listed as one of the World's 100 Worst Invasive Alien Species. It has spread widely in New Zealand and Hawaii, where it is transforming and degrading native habitats.

Fewer than 150 plants have been recorded as removed on LHI, mostly from the PPP, and plants in gardens within the Settlement need to be removed. Curtailing the spread of this highly invasive weed will have significant benefits in avoiding future impacts and costs. This species is currently in the Active Control phase, with mature plants remaining in the environment. Given the small numbers on LHI and low seed-bank persistence, it could feasibly be eradicated within the next ten years.



Figure 14 Kahili Ginger.

Ground Asparagus (*Asparagus aethiopicus*), is a WoNS and has been detected in 192 weed management blocks (total area of blocks is 1018 ha), although dense and extensive (evenly distributed) infestations of Ground Asparagus are no longer present (LHIB 2016; Figure 15). It is essential that seedling and early stage juvenile plants that may have been missed in initial searches are detected and prevented from reaching maturity. Ground Asparagus can reach reproductive maturity within two



Figure 15 Ground Asparagus on the eastern flank of Transit Hill (2011). Dense and widespread infestations of this species, such as this, are no longer evident on LHI. Infestation and outliers on cliffs are being treated progressively with the helicopter lance-spray program.

years (OEH 2013) but field observations on LHI suggest a maturation period of 2–3 years is more likely. Low-density infestations with small seedlings do pose a detection challenge which may be improved with a weed detector dog.

Outliers of mature Ground Asparagus occur at high elevation in the southern mountains. With adequate suppression, this species may reach a Containment phase (with no new seed inputs) within the next decade. However, owing to the wide distribution and tenacity of this species, this may take longer. Without eradication over the entire island, this species will continue to represent a serious and ongoing serious threat to the ecology of LHI.

Eradicated species

Six weed species are considered eradicated from LHI (LHIB 2016): Cocos Palm (*Syagrus romanzoffiana*), Cat's Claws Creeper (*Dolichandra unguis-cati*), Tipuana (*Tipuana tipu*), Potato Vine (*Solanum wendlandii*), Turkey Rhubarb (*Acetosa sagittata*) and French Broom (*Genista monspessulana*). Monitoring for these plants continues however through weed inspections and weed search throughout the PPP.

Tipuana, or African Rosewood, is listed on the National Environmental Alert Weed List and was identified in a garden on LHI. It produces seeds that are widely spread by wind so early intervention was undertaken. It occurred on LHIB land and so consent for control was immediate. The mature tree, 20 m tall, was removed by an arborist.

Turkey Rhubarb only known from one garden on LHI and was controlled with permission from the leaseholder. This plant is prohibited from sale in NSW, is declared noxious in Western Australia and in some control areas in NSW, and has been identified as a Significant Environmental Weed (Groves *et al.* 2005) and a NSW State high-priority weed (Natural Resource Commission 2014).

Cat's Claw Creeper is a WoNS and a highly invasive, transformer species (Figure 16). Immature plants were detected in a garden in 2006 and removed and have remained undetected since then. This weed is spread by wind, and is capable of smothering and killing trees, displacing native vegetation and forming a monoculture of Cat's Claw Creeper.



Figure 16 Cat's Claw Creeper.

Category 1 species in the containment or monitoring phases

A number of declared invasive weeds are currently considered within a containment or monitoring phase. A number of species that were last removed between 2014 and 2016 had not reached reproductive maturity at that stage and have remained undetected since, including Giant Reed (*Arundo donax*), Ming Fern, Mirror Bush (*Coprosma repens*) and Red Cedar (*Toona ciliata*).

Pampas Grass (*Cortaderia selloana*) was last recorded as reproductively mature plants from three sites between 2010 and 2014 (Settlement South in 2010, Malabar in 2012, and Transit Hill in 2014) and has not been detected since they were treated. The seed-bank persistence of Pampas Grass is only two years (Pausas *et al.* 2006) and the species is entering a containment phase. Sites where the species was recorded will continue to be monitored.

Category 2: Alert (sleeper weeds – watch & act as needed)

Category 2 species includes sleeper weed species that are:

- known environmental weeds or introduced plants that may invade following a 'lag' phase and showing characteristics of local spread;
- weed plants recently detected in the PPP that are not declared and not currently targeted for eradication; and
- introduced plants highly susceptible to serious plant diseases, such as Myrtle Rust.

Category 2 weeds are primarily ornamental plants that are known to be invasive elsewhere in the world (identified on regional or global alert lists) or plants that may be demonstrating weediness in gardens or have spread into the PPP (see Appendix 1). When a new weed is detected in the PPP, this indicates that the species is likely to invade elsewhere on the island.

Environmental weeds that are known to be highly invasive and are newly detected on the island should be removed immediately before they spread (early intervention). This is the most economical method to prevent the species becoming a problem. Such species may be treated opportunistically where they are encountered during grid-search effort in the PPP or where landholders are willing to remove them.

Category 2 weeds will be elevated to Category 1 if they are identified as highly invasive. To enable corrective management across all tenures, weeds will be assessed under the NSW WRM system to enable their declaration. The current list of Category 2 weeds will in future be subject to WRM assessments.

When identifying the invasiveness of new weed species the precautionary principle is to be applied, as early stages of invasion may be missed and the price of inaction are ecological impacts and compounding management costs.

Examples of Category 2 weeds

Sleeper weed species on LHI include Kangaroo Grass (*Themeda australis*), Golden Rain Tree (*Koelreuteria paniculata*), Dutchman's Pipe (*Aristolochia elegans*), Buddleja (*Buddleja madagascarensis*), New Zealand christmas bush (*Metrosideros kermadecensis* and *M. excelsa*) and Velvet Groundsel (*Roldana petasitis*).



Dutchman's Pipe (Figure 17) is a recognised environmental weed on the mainland. It has been recorded from two locations on LHI yet remains at one location. Owing to its invasive potential, toxic properties and wind-dispersed seeds it has the capacity to spread widely. Early intervention and removal of this plant is warranted. This species is being applied a WRM assessment to enable all tenure management.

Figure 17 Dutchman's Pipe flower, foliage and seeds.

New Zealand christmas bush (*Metrosideros kermadecensis* and *M. excelsa*) was planted along the lagoon foreshore. New Zealand christmas bush plants have been treated in the PPP at Malabar, west of Mutton Bird Point and from the northern flanks of Mt Lidgbird. Plants that appear to be hybrids between New Zealand christmas bush and Lord Howe Island Mountain Rose (*M. sclerocarpa*) have also been treated. Genetic testing of plants that appear to be hybrids is required. New Zealand christmas bush has robust growth characteristics and a broader environmental tolerance than the endemic LHI species.

Velvet Groundsel (*Roldana petasitis*) is considered a sleeper weed on LHI (Figure 18). An isolated outbreak was detected from a helicopter near Middle Cave on the eastern flanks of Mt Lidgbird in 2009. This location is identified in the Flora of Australia (Green 1994). Plants have been removed from within the PPP and from the edges of the PPP where it has spread from

gardens. An outlying infestation of 30 juveniles was removed from Intermediate Hill in bushland above Mutton Bird Point. It has a wind-dispersed seed and, thus, a potentially broad range for expansion on LHI.

Rose Apple (*Syzygium jambos*) occurs only in gardens, with some localised spread into the edges of regrowth forest. This plant is highly susceptible to Myrtle Rust infection and with the recent outbreak of Myrtle Rust on LHI creates an immediate localised source of spores. To contain and eradicate this pathogen, before it affects the endemic Myrtaceae species of the island, Rose Apple will be upgraded to Category 1: Eradicate. A specimen of Rose Apple was retained to act as an early indicator of the spread of Myrtle Rust to LHI, but that purpose has now been achieved.

Non-native plants of the family Myrtaceae and that are highly susceptible to Myrtle Rust should be removed as a priority, at least until native endemic species become infected. Introduced Myrtaceae will be treated as Category 2: Alert unless they show susceptibility to Myrtle Rust, in which case they may be upgraded to Category 1: Eradication. There are 38 introduced Myrtaceae species recorded on LHI (see <http://www.lhib.nsw.gov.au/board/publications/information-sheets>).



Figure 18 Velvet Groundsel infestation near Middle Cave on Mt Lidgbird (2009).

Category 3: Control (effectively manage)

Category 3 includes all introduced plants that are considered to have invasive characteristics but are not feasible to eradicate, are of lower risk to the environment, or where intermittent

control delivers the desired management outcomes of preventing their spread or reducing their impact. The Control approach is applied to Category 3 species until such time that eradication is deemed possible or the plant species demonstrates a significant threat, requiring intensive management.

Investment in controlling weeds that are of low risk to the environment should not be undertaken at the expense of allowing highly invasive weed species to spread. Active control of weeds may be undertaken on a site or species basis to reduce their extent or to exclude weeds from certain areas (e.g. public areas, revegetation sites) or to reduce the impact of the weeds (e.g. for threatened species).

Ornamental plants that have spread from gardens into the PPP are removed during weed eradication grid-search within the PPP. Until source plants are completely removed from the Settlement, these species can only be controlled.

At least 50 weed species have been detected and treated within the PPP over the past 10 years.

Examples of Category 3 weeds

Management actions for Category 3 weeds include the localised reduction of Kikuyu (*Pennisetum clandestinum*) and Buffalo Grass (*Stenotaphrum secundatum*) in habitat of the threatened species Lord Howe Island Morning Glory (*Calystegia affinis*) at Old Settlement and in revegetation plantings, the reduction of Crofton Weed, and the removal of regenerating Norfolk Island Pines (*Araucaria heterophylla*), which can inhibit regeneration of native vegetation. Norfolk Island Pines tend to spread only locally but stands need to be actively managed to remove seedlings and will need to be monitored after rodent eradication on LHI (see <http://www.lhib.nsw.gov.au/environment/environmental-programs/rodent-eradication> [accessed 8 Nov 2016]). On Raoul Island, Norfolk Island Pine regeneration increased after the eradication of exotic rodents (C. West, personal communication).

Panic Veldt Grass (*Ehrharta erecta*) (Figure 19) and **Broadleaf Paspalum** (*Paspalum mandiocanum*) are non-native grasses that are common on LHI. They are dispersed by rats, birds, on footwear, by vehicles and, previously, by Goats (now eradicated). These grasses can establish in low light conditions and invade intact bushland, spreading inwards from edges. It is not feasible to eradicate either species because they have a short life-cycle, reach maturity quickly, have massive seed production and are widespread in pastures and lawns. Localised control on tracks and roadsides will reduce the extent of their spread. These species may suit control through genetic drivers (see section 5.2). Low-level infestations of Broadleaf Paspalum should be actively controlled on tracks in the southern mountains to prevent further spread.



Figure 19 Panic Veldt Grass.

Tobacco Bush (*Solanum mauritianum*) (Figure 20) is removed from accessible terrain during weed grid-search effort. It is not feasible to eradicate the species owing to its life-history traits (e.g. it can produce up to 2000 seeds per year, with seed-bank longevity of 39 years). This plant is removed as teams undertake weed grid-search but it is not possible for removal across all tenures. Only localised control can be achieved.



Figure 20 Tobacco Bush.

Spear Thistle (*Cirsium vulgare*) (Figure 21) is an annual species that produces many seeds that are dispersed broadly by wind. Spear Thistle prefers exposed situations, such as disturbed and agricultural land. Effective control requires all plants at a location to be removed simultaneously. Localised control is undertaken by the LHIB during maintenance of the PPP fencelines and in planting areas, but widespread control is not feasible.



Figure 21 Spear Thistle.

Sea Spurge (*Euphorbia paralias*) (Figure 22) was an eradication target in the 2006 LHI WMS (LHIB 2006) but it has now been categorised as a Control weed, as seed inputs will continue to arrive on LHI through sea-drift. Sea Spurge is mostly restricted to the dunal system on the lagoon foreshore. It can form monocultures and exclude native dune species and should be considered for containment. The limitations of its distribution and ease of access provides an opportunity for a containment program involving volunteers.



Figure 22 Sea Spurge.

7 The vision of the Weed Management Strategy

The long term vision of this strategy is to protect Lord Howe Island's unique ecosystems and World Heritage Values from current and future threats posed by invasive weeds and to improve the island's resilience to future disturbances and associated impacts.

7.1 Weed management goals, objectives and actions

The goals of the Weed Management Strategy, and the objectives under each, aim to deliver best-practice weed threat abatement and management outcomes on LHI:

Goal 1 – Exclude: Prevent the establishment of new invasive weeds.

- Objective 1.1 Identify high-risk pathways and intercept high-risk species.
- Objective 1.2 Develop and implement early detection capabilities.

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds.

- Objective 2.1 Respond rapidly to eradicate and contain new species and outliers of priority invasive weeds.
- Objective 2.2 Continue to suppress and eliminate priority invasive weeds in the PPP (including offshore islands) and Settlement areas.

Goal 3 – Effectively manage: Reduce the impact of widespread invasive weeds.

- Objective 3.1 Investigate the application of biological control agents on LHI, and implement biological control programs where applicable.
- Objective 3.2 Apply effective on-ground control where benefits are greatest.

Goal 4 – Build capacity: Ensure that Lord Howe Island has the ability and commitment to manage invasive weeds; and to promote awareness of invasive weeds within the community.

- Objective 4.1 Build partnerships to effectively manage the threat and impact of weeds on LHI.
- Objective 4.2 Maintain competent, skilled and motivated weed-eradication staff.
- Objective 4.3 Monitor progress of the Weed Management Strategy and eradication trajectories.
- Objective 4.4 Improve knowledge base, build local capacity and involvement in sharing the responsibility of weed management
- Objective 4.5 Improve effectiveness in weed management through research and development.
- Objective 4.6 Implement and enforce legislation and policies for consistent and effective weed management.



Figure 23 Cherry Guava growing close to the threatened Lord Howe Island Broom (*Carmichaelia exsul*) on the North Face of Mt Gower, west of Eddies Cave, in 2008 (weed management block GW001). A total of 1300 Cherry Guavas have been removed from the northern face of Mt Gower. If Cherry Guava were left untreated, dense thickets would establish and out-compete the Broom. Not only does the Cherry Guava present a risk to the individual plant species but it is here growing close to the Gnarled Mossy Cloud Forest Critically Endangered Ecological Community on Mt Gower. (Photo: S. Bower, LHIB.)

Goal 1 – Exclude: Prevent the establishment of new invasive weeds

The challenge

Preventing the introduction of high-risk weed species to LHI provides the most cost-effective means to mitigate future impacts. Situated 550 km east of mainland Australia, the ocean provides an effective barrier from the natural spread of weed incursions or re-invasion of weeds (except for ocean-dispersed species like Sea Spurge) that have been eradicated. The intentional or incidental importation of new weed species to LHI by residents or visitors, however, remains a risk. Risk pathways are identified in the Draft Lord Howe Island Biosecurity Strategy (AECOM 2016) and Plant Importation Policy (LHIB 2014). Education and awareness of import restrictions, the species that are allowed to be imported, and improved biosecurity measures are required.

Outcomes

The introduction of high-risk, invasive weeds is prevented and new weed risks intercepted and eradicated. LHI remains free of any new serious invasive weeds.

Goal 1 – Exclude: Prevent the establishment of new invasive weeds			
Action		Outputs & Performance Indicators	Responsibility
Objective 1.1 Identify high-risk pathways and intercept high-risk species			
1.1.1	Implement the LHI Biosecurity Strategy (AECOM 2016) and LHI Plant Importation Policy (LHIB 2014)	Increased awareness of import requirements, restrictions and species permissible to import	LHIB, local community, suppliers, stevedores, Qantas, other transport agencies
1.1.2	Undertake weed risk assessments (WRA) (Pheloung 1995) to screen requests to import new species to LHI for their weed risk	No new weeds intentionally imported to the island without approval Plants approved or rejected under WRAs	LHIB, prospective importers, suppliers
1.1.3	Register approved imports to enable tracking of a weed or disease outbreak	New approved plant imports are monitored	LHIB
1.1.4	Provide information to plant suppliers about LHI importation requirements and restrictions	Awareness material prepared and distributed to suppliers, local community (as hard copy and digitally)	LHIB, residents, prospective importers, suppliers, the LHI plant nursery

Goal 1 – Exclude: Prevent the establishment of new invasive weeds

Action	Outputs & Performance Indicators	Responsibility
1.1.5 Detect and remove illegally imported plants in accordance with LHI Regulations 2014 (www.legislation.nsw.gov.au/regulations/2014-497.pdf [accessed 8 Nov 2016])	New weed risks intercepted	LHIB
1.1.6 Review of Category 3 or non-listed species as per NSW Department of Primary Industry (DPI) Weed Risk Management (WRM) criteria (or equivalent) as per <i>Biosecurity Act 2015</i>	New weeds risks and latent sleeper weeds put on alert and categorised	LHIB, Flora Management Officer (FMO), DPI and Office of Environment and Heritage (OEH)

Objective 1.2 Develop and implement early detection capabilities

1.2.1 Continue inventory of garden plants on LHI; maintain LHI Herbarium and database	Increased knowledge base of introduced species on LHI	FMO, LHI Museum, LHI Herbarium and other herbaria
1.2.2 Undertake annual declared weed inspections to monitor for potential new weeds not currently identified as Category 1, 2 or 3 species	New weed risks identified	LHIB, local community, DPI, Noxious Weed Control Authority
1.2.3 Increase botanical and plant recognition skills of weeding staff and interested locals	Staff and community capable of alerting of new weed risks	LHIB
1.2.4 Inform community and LHIB staff of new weed risks	Staff and community alert to new weed risks	LHIB, local community, DPI

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds

The challenge

Early intervention to achieve the complete removal of new or emerging weed risks is a cost-effective measure to protect the ecosystems of LHI. Priority weed species targeted for eradication on LHI are classified as Category 1 species. They include Weeds of National Significance (WoNS), National Environmental Alert List for weeds, World’s 100 Worst Invasive Alien Species or Australian natives that have spread and are impacting the island’s ecosystems. Category 1 weeds are declared noxious to enable an all-tenure approach to their management. Isolated occurrences of serious invasive weeds are also removed through mutual agreement with leaseholders. The continuation of the Weed Eradication Program and grid-search effort across the whole island every 2 years is required to continue to contain and suppress populations of target invasive weeds to achieve eradication in the long-term.

Outcomes

Priority invasive weeds eliminated.

Eradicated species are monitored to ensure they do not re-invade.

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds			
Action	Outputs & Performance Indicators		Responsibility
Objective 2.1 Respond rapidly to eradicate and contain new species and outliers of priority invasive weeds			
2.1.1	Undertake annual declared weed inspections to monitor removal of Category 1 species (refer to Action 1.2.2)	50% of Settlement inspected annually	NSW Weeds Action Program 2015–2020 (WAP), LHIB, weed inspectors from DPI
2.1.2	Ensure new invasive plant species detected in Settlement or PPP during grid-search are controlled and recorded	Level of threat determined and source location identified; species listed as noxious or controlled or both	LHIB, Weed Team Supervisor and other staff
2.1.3	Undertake WRM for new weeds and assign control classes as per <i>Biosecurity Act 2015</i> .	Weeds upgraded to Category 1 or removed through mutual agreement with leaseholder Records entered in the LHI Weeds Database	LHIB, FMO, DPI

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds

Action	Outputs & Performance Indicators	Responsibility
2.1.4 Remove newly declared noxious weeds or identified high-risk species Document location and extent	Eradication achieved; monitoring ongoing	FMO, Weed Team Supervisor and other staff
2.1.5 Undertake strategic surveillance; record and control reported outbreaks or priority locations of mature plants of Category 1 target weeds	All plants treated and locations recorded; Maturation and seed-set of target weeds prevented	LHIB, Weed Team and other supervisors, community
2.1.6 Prepare maps of distribution of priority weeds and known locations of outliers	Locations of outlier weeds updated	FMO

Objective 2.2 Continue to suppress and eliminate priority invasive weeds in the PPP (including offshore islands) and Settlement

PART I: GRID-SEARCH ACCESSIBLE TERRAIN IN THE PPP

2.2.1 Implement LHI weed eradication methodology	Multiple invasive weed species effectively managed Plants removed before maturation, with reduction in number of mature weeds detected with repeat visitation	LHIB, Weed Team Supervisor and other staff
2.2.2 Undertake grid-search and weed treatment across accessible blocks in the PPP and suppress to eradicate Category 1 species	Search for and treat priority species every 24 months or at other specified intervals (refer Action 2.2.3) Nine full-time equivalent (FTE) staff engaged annually (equivalent hours) dedicated to weed grid-search	FMO, Weed Team Supervisor, staff, volunteers, contractors
2.2.3 Search for and treat Bitou Bush and contain isolated mature plants	Annual search for and treatment of Bitou Bush Location of new mature plants recorded accurately (GPS) and added to search schedule A reduction in total counts of Bitou Bush is measured over time	LHIB, Weed Team Supervisor
2.2.4 Search for and treat Glory Lily twice per year, between December and April	Glory Lily sites are searched and treated twice annually; reduction in total counts achieved; Location of new sites recorded and added to the search schedule	LHIB, FMO, Weed Team Supervisor

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds

Action	Outputs & Performance Indicators	Responsibility	
2.2.5	Analyse weeds database to determine if residual mature plants (e.g. of <i>Ochna</i>) in weed management blocks are trending downwards	Increased search effort of weed management blocks and target species and scrutiny of search effectiveness to increase downward trend in mature plants	FMO, Weed Team Supervisor
2.2.6	Identify low-density target weeds requiring improved detection capacity with detector dogs (refer to Action 4.5.3)	Dog trainer and handler identified and target weed species confirmed	LHIB, FMO, consultant

PART II: RUGGED TERRAIN AND CLIFFS IN THE PPP

2.2.7	Priority given to search effort of high-elevation weed management blocks with known Category 1 weeds (blocks LN001, 002, 005, 021; LR001–003; LS009–018; and GW001–003)	Island-wide search effort of priority areas completed in 24 months	FMO, Weed Team Supervisor
2.2.8	Implement helicopter winch programs annually Complete search and treatment of northern face of Mt Gower Begin search effort on Mt Lidgbird and continue for 5 years	High-elevation infestations of target weeds removed Repeat treatment of a swathe of terrain between 450 and 600 m above sea level every 24 months	LHIB, helicopter contractor
2.2.9	Yearly implementation of helicopter lance-spray program, for 5 years	Surveillance and treatment across cliff-lines undertaken and weed status monitored	LHIB, helicopter contractor
2.2.10	Investigate approvals to apply HBT to remove outliers of Cherry Guava Repeat treatment until zero detections	Outliers of Cherry Guava on cliffs treated	LHIB, University of Hawaii Manoa, NSW OEH, Australian Pesticides and Veterinary Medicines Authority (APVMA)
2.2.11	Continue progressive search effort on-rope or at height at the interface between aerial and on ground access	Interface weeds detected and treated Priority sites include cliff-edges on Malabar, above the Lower Road, between Round Face and Barrow Flats treated Linear extent of search effort recorded Time-frame and costs to repeat treatments in this terrain	LHIB, On-rope Access Team

Goal 2 – Eradicate: Eliminate or prevent the spread of invasive weeds

Action	Outputs & Performance Indicators	Responsibility	
	understood		
2.2.12	Trial UAV (drones) to undertake surveillance, weed monitoring and control, including HBT to remove outlier weeds	UAV and HBT methods trialed and improved	LHIB, FMO
2.2.13	Continue surveillance and rapid response to outliers on cliffs after helicopter operations	Treatment of missed weeds by UAV or via on-rope access undertaken	LHIB, Weed Team Supervisor
PART III: OFFSHORE ISLANDS			
2.2.14	Undertake sea-based routine surveillance for priority invasive weeds every 2 years	Prevent spread and build up of invasive weed populations on offshore islands	FMO, LHIB rangers
2.2.15	Ensure research activities on offshore islands include incidental surveillance of weeds	Researchers informed of priority weeds and advised of their obligation for incidental weed surveillance and reporting	FMO, LHIB rangers
2.2.16	Trial digital surveillance methods to monitor weeds on offshore islands, including UAV	Survey methodology established for surveillance of weeds on offshore islands	FMO, LHIB rangers
PART IV: SETTLEMENT			
2.3.17	Treat Madeira Vine 2–4 times per year	All sites searched and treated Infestation reduction recorded (mass, in kg)	LHIB, leaseholders
2.3.18	Undertake grid-search and treatment of all Climbing Asparagus sites	Area of annual search effort measured Reduction in plants treated and quantity of herbicide used	LHIB, leaseholders
2.3.19	Search and treat tracks and blocks with Palm Grass and Castor Oil, before seed-set Map locations of priority blocks	Reduction in plants detected	LHIB, LHIB rangers, visitors
2.3.20	Treat all target invasive weeds in revegetation areas during maintenance	All target invasive weeds controlled from revegetation areas	LHIB, field supervisor

Goal 3 – Effectively manage: Reduce the impact of widespread weeds

The challenge

Over 270 introduced plants recorded on LHI may have invasive characteristics (LHIB 2006; DECC 2007), yet not all of these pose a significant risk to the environment, agriculture or human health. However they may have localised impact or be a nuisance. While eradication may not be feasible, intermittent treatment may achieve desired management outcomes. Biological control agents may assist in reducing the extent of widespread weeds.

Outcomes

Widespread weeds effectively managed on a site and species basis.

Goal 3 – Effectively manage: Reduce the impact of widespread weeds			
Action		Outputs & Performance Indicators	Responsibility
Objective 3.1 Investigate the application of biological control agents on LHI			
3.1.1	Release Crofton Weed Rust (<i>Baeodromus eupatorii</i>) biological control agent for Crofton Weed (<i>Ageratina adenophora</i>) and monitoring of effectiveness	Density and spread of Crofton Weed reduced over time	LHIB, CSIRO, DPI
3.1.2	Investigate suitability of other biological control agents (e.g. Parramatta Grass Smut) to reduce further spread of common weeds	Other agents to aid in management of widespread species	LHIB, CSIRO, DPI
Objective 3.2 Apply effective on ground control where benefits are greatest			
PART I: GENERAL WEED CONTROL			
3.2.1	Undertake removal of Tobacco Bush from localised infestations as they are encountered	Density and spread of Tobacco Bush reduced	LHIB Weed Team

Goal 3 – Effectively manage: Reduce the impact of widespread weeds

Action	Outputs & Performance Indicators	Responsibility
3.2.2 Implement LHIB strategies and plans: Lagoon Foreshore Management Plan (LHIB 2015b), Revegetation Plan (LHIB 2002b), and PPP Plan of Management (DECCW 2010)	Weeds in planting areas and along edges of native vegetation and foreshore reduced Native vegetation along edge of PPP gradually expanded Exotic grasses along tracks reduced	Manager Environment World Heritage (MEWH), Senior Field Supervisor

PART II: WEED CONTROL IN THREATENED SPECIES HABITAT

3.2.3 Implement threatened species habitat management actions (e.g. Saving our Species program) and LHI BMP (DECC 2007)	Threatened species actions implemented	MEWH, FMO
3.2.4 Undertake localised site-based treatment for threatened species habitat management	Direct competition of exotic grasses in habitat of threatened species (e.g. Lord Howe Island Morning Glory <i>Calystegia affinis</i>) reduced and habitat improved	MEWH
3.2.5 Reduce the extent of Coastal Morning Glory (<i>Ipomoea cairica</i>) from the Banyan tree on Blackburn Island and near the main Lord Howe Island Phasmid food tree Expand control onto adjacent ledges (2 visits per year)	Coastal Morning Glory reduced and native species regeneration on Blackburn Island increased Habitat improved	MEWH, FMO, LHIB rangers

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community

The challenge

To protect the island’s ecosystems from priority invasive weeds a 30-year eradication program was forecast in the 2006 LHI Weed Management Strategy (LHIB 2006). Over the past 10 years populations of weeds have decreased. As weed populations reduce, the job on the ground gets harder and poses a greater mental challenge. The retention of local program knowledge is important and engagement of staff with the dedication and drive to ‘get the last weed’ is critical. The collective effort in weed management on LHI is shown by the more than 60 people employed to work on weeds in the past 10 years, 155 LHIB supported volunteers and 752 Friends of Lord Howe Island volunteers.

Ongoing support from the community in understanding the importance of eradicating priority invasive weeds (Appendix 1) and preventing the introduction of new weeds is critical to program success. Everyone plays a role and has a shared responsibility in preventing and managing the impacts of weeds on LHI.

Outcomes

Weed management on LHI demonstrates a cooperative approach with community and program implementation recognised as global best practice in island conservation management.

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.			
Action	Outputs & Performance Indicators		Responsibility
Objective 4.1 Build partnerships to effectively manage the threat and impact of weeds on LHI			
4.1.1	Engage key stakeholders and work with them to build a commitment to implement the LHI WMS and eradication program methodology	LHI weed management program recognised and represented on national, state and regional conservation priorities and weed committees	LHIB, FMO
4.1.2	LHIB committed to seeking ongoing project partners and funding to fully implement the LHI WMS and Eradication Program, including ongoing support from Federal and State governments	Project partners established or maintained; consistent and adequate funding secured WAP and other Federal and State government weed strategies and business plans implemented	LHIB, FMO, MEWH, DPI

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility	
4.1.3	Engage with external weed eradication professionals	Currency with global and national weed eradication and management approaches maintained	FMO, LHI Weed Team, MEWH
4.1.4	Update the LHI Weeds Technical Panel (LHIWTP) on results of the Weed Eradication Program and seek advice where necessary	Technical panel informed of progress and or constraints, and feedback provided	FMO
4.1.5	Report progress to project partners, stakeholders and government agencies as required, including LHIB	Stakeholders and project partners informed of progress and engaged in delivery of the LHI Weed Management Strategy	FMO, project partners including government agencies
4.1.6	Establish LHI Weed Eradication Program Trust Fund (or equivalent) to receive donations for weed eradication project work	Fund established and promoted; contributions secured, partners informed of progress	LHIB, trust fund directors, project partners

Objective 4.2 Maintain competent, skilled and motivated weed-eradication staff

4.2.1	Ensure the weed management program maintains a high proportion of experienced, qualified and dedicated weed eradication staff (including casual, temporary and permanent staff)	Personnel selected through merit-based selection process All staff inducted in program methodology, targets and expected outputs Recruitment of local staff with demonstrated high performance encouraged Local program knowledge maintained and enhanced to deliver high-quality search effort on ground.	LHIB, FMO, TAFE NSW, LHIB Weed Team
4.2.2	Establish a core group of four LHIB permanent staff, with rope access and heights safety training. ³	Funding for recurrent positions secured Core team with heights safety and rope access skills are maintained	LHIB, FMO, registered training organisations
4.2.3	Engagement and retention of staff, volunteers and contractors with experience and demonstrated good performance on LHI	Improved efficiency and effectiveness in search effort and gaining access to remote weed management blocks Contract and volunteer register maintained	FMO, Weed Team Supervisor, LHIB administration

³ A team of 4 LHIB staff working on a part time basis throughout the year, to the equivalent of 1 FTE position is recommended. This technical project work can be fulfilled on a contract basis if skill-set is not available locally.

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility
4.2.4	Improve competency and knowledge of eradication target species and sleeper weeds; inform staff of new weed risks	Ongoing training in botanical skills and weed recognition provided FMO, Noxious Weeds Inspector
4.2.5	Standards in Work Health Safety and work procedures updated as new risks arise	Near-miss reports and incidents reduced FMO, Weed Team Supervisor and staff
4.2.6	Ensure staff maintain competencies in key operational areas	Skilled tasks undertaken by certified staff FMO, Weed Team Supervisor
4.2.7	Investigate opportunities for staff to improve skills, knowledge and understanding of the importance of island conservation	Staff encouraged to undertake TAFE or natural resource management training or exchange programs; increased capacity and understanding of island conservation programs including the Weed Eradication Program FMO, Island Conservation project partners
Objective 4.3 Monitor progress of the Weed Management Strategy and eradication trajectory		
4.3.1	Download GPS track-log weekly and merge data monthly to review quality and extent of search effort on ground	Gaps in search data or effort filled Progress of search effort improved FMO, Weed Team Supervisor and staff
4.3.2	Maintain LHI Weeds Database Entry of data from weed management blocks (monthly – or as blocks are completed) Analyse database inputs and change in weed populations	Weed management block treatment priorities confirmed; eradication trends evident FMO, Weed Team Supervisor and staff
4.3.3	Redefine data categories of weed life-stages to measure change in status of mature weeds and monitor program progress	Definitions and recording fields in database reflect change in weed populations, e.g. mature weeds categorised as vegetative, flower and fruit or age (early mature, mature) FMO, LHI Weeds Database manager, Weed Team Supervisor and staff
4.3.4	Monitor and evaluate effectiveness of on-ground weed search effort to determine detection and treatment rate	Review of search effort and weed treatments (in field and desktop) undertaken Detection and thoroughness of search effort and treatments maintained at a high level FMO, project partners, Weed Team Supervisor and staff

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility	
4.3.5	Repeat weed-density mapping across four landscape units using methodology of Le Cussan (2002b) ⁴ This action may be superseded by Action 4.3.6 as weeds further reduce	Mapping results analysed and compared, reduction in weeds demonstrated Frequency of mapping based on reporting needs otherwise undertaken every decade	FMO
4.3.6	Map residual locations of weeds removed as part of weed search effort, to improve spatial awareness and monitoring of weed distribution	Methodology to record spatial capture of weed distribution by teams developed and implemented Teams informed of location of residual weed distributions before start of search effort	FMO, Weed Team Supervisor and staff
4.3.7	Undertake external program review every 3–5 years	Priorities confirmed; new risks identified; improvements made; eradication trajectory and funding needs understood	FMO, Weeds Technical Panel
4.3.8	Ensure the Weed Eradication Program is future proofed for successional management	LHI Weed Operations Manual and Procedures prepared linking to the LHI Weed Management Strategy and Biodiversity Management Plan (LHI BMP) Weed profiles, key operational projects, distribution maps and site descriptions of Category 1 weed species prepared	FMO, Weeds Technical Panel

Objective 4.4 Improve knowledge base, build local capacity and involvement in sharing the responsibility of weed management

4.4.1	Undertake LHI Central School Weed Awareness program – four times per year	Awareness and involvement in weed management	FMO, LHIB ranger, LHI Central School teachers
4.4.2	Report annually on program outcomes in the LHIB annual report	Community informed of annual progress	FMO
4.4.3	Introduce digital media for information sharing and reporting of program updates among all stakeholders	LHI Weed Program facebook page maintained (www.facebook.com/protectingparadiseLHI)	FMO, LHIB administration,

⁴ Weed-density mapping should be repeated in 2020 and in 2025. Density mapping should be repeated at halfway point of the eradication program (Year 15), which hopefully coincides with high-level funding to enable repeat treatment of the island twice so that by Year 15 considerable reductions in weed populations will be evident; which may improve modelling eradication trajectories and investment needs.

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility	
	including the community	Content of LHIB website (www.lhib.nsw.gov.au) updated and linked with websites of project partners	Weed Team
4.4.4	Support the Friends of LHI, LHIB-sponsored volunteers and promote local volunteering on LHI	Ongoing involvement in weed management on LHI from volunteers	MEWH, LHIB ranger, FMO
4.4.5	Establish Island Stewardship Program to promote and acknowledge sustainable gardening practices with safe, non-invasive ornamental and native species	Reduced number of potential invasive species spreading into the PPP and across Settlement Recognition and celebration of sustainable gardeners under the Island Stewardship Program	LHI plant nursery, LHIB, FMO
4.4.6	Support opportunities for visitors to participate in weeding on LHI (e.g. Sea Spurge control)	Reduction in the extent of Sea Spurge and other weeds on LHI	Friends of LHI, FMO
4.4.7	Provide opportunities for local community to increase skills in operation of weed program & weed identification	Local community offered to participate in relevant training when practical	LHIB and LHIB administration, FMO
4.4.8	Recognise and celebrate weeding effort on LHI	Events staged and involvement in weeding recognised and support for future effort ongoing	FMO, LHIB, project partners
4.4.9	Continue the LHI garden plant inventory	Knowledge of plant species and invasive capacity understood by leaseholders	FMO, Ian Hutton, LHI Museum, Weed Team
4.4.10	Ongoing updates in the local LHIB <i>Community Information Bulletin</i> and the community newspaper, the <i>Lord Howe Island Signal</i> regarding current and new weed risks and program outcomes	Residents kept up to date with weed program updates and weed risks	LHIB Chief Executive Officer, FMO, Weed Team, <i>Lord Howe Island Signal</i> editorial team
Objective 4.5 Improve effectiveness in weed management through research and development			
4.5.1	Network with other agencies on investment into research and development in eradication methodology and technical applications	Partnerships established to further research and add value to LHI project work	FMO, key Project Partners

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility	
4.5.2	Ensure the methodology of the LHI Weed Management Strategy and Weed Eradication Program remains current, with outcomes shared with other natural resource management and island conservation programs	LHIB monitors progress of weed eradication programs on other islands Deliver presentations at relevant conferences and participation in workshops	FMO, key project partners
4.5.3	Investigate the feasibility and application of a multispecies weed-detector dog for LHI	Feasibility study for multispecies weed-detector dog undertaken	NZDOC, NSW OEH, LHIB, FMO, DPI
4.5.4	Continue investigation of new technologies, such as UAVs and HBT, for weed surveillance and treatment	New technologies (UAV, HBT) trialled, weed populations in remote terrain depleted	NSW OEH, FMO, Weeds Technical Panel, project partners
4.5.5	Monitor responses of weeds after implementation of LHI Rodent Eradication Program (see http://www.lhib.nsw.gov.au/environment/environmental-programs/rodent-eradication [accessed 8 Nov 2016])	New weed risks identified and categorised for management	LHI Rodent Eradication Program team, FMO, NSW OEH
4.5.6	Investigate seed-bank persistence of priority weeds after eradication of rodents	Weed seed-bank persistence after rodent eradication is understood Search interval adjusted based on outcomes	FMO, research partners, Weed Team Supervisor and staff
4.5.7	Assess the cost–benefit of the LHI Weed Eradication Program and methodology in island biodiversity conservation	LHI program measured against other island weed eradication programs	FMO, NZDOC, Weeds Technical Panel
Objective 4.6 Implement and enforce legislation and policies for consistent and effective weed management			
4.6.1	Ensure the LHIB complies with obligations under the NSW <i>Noxious Weed Act 1993</i> until subsumed by the <i>Biosecurity Act 2015</i>	Active management and monitoring of declared weeds undertaken across the LHI Local Control Authority (LCA)	DPI, MEWH, FMO, LHIB rangers, Noxious Weed Inspectors

Goal 4 – Build Capacity: Ensure the LHIB has the ability and commitment to manage invasive weeds, and promote awareness of invasive weeds within the community.

Action	Outputs & Performance Indicators	Responsibility	
4.6.2	Align weed declarations and control classes to legislative changes under the <i>Biosecurity Act 2015</i>	Weed risk and control categories for LHI aligned to <i>Biosecurity Act 2015</i>	DPI, MEWH, FMO
4.6.3	Seek assistance from external strategic weeds officers undertake annual declared weed inspections on LHI	Planned 50% of Settlement to be inspected annually (to match 24-month search frequency of weed management blocks required for the PPP)	CEO, FMO, MidCoast Council (Hastings River – Taree)
4.6.4	Ensure LHI environmental management plans and policies are consistent with the goals, objectives and actions in the LHI WMS	LHIB policies and management plans aligned to the goals, objectives and actions in the LHI WMS Weed treatment measures applied in accordance with plans and policies	LHIB
4.6.5	Demonstration of best-practise weed management and compliance on leases by LHIB staff	LHIB staff demonstrate best-practise control of weeds on leases and acknowledged for their efforts in the Island Stewardship Program	LHIB, Noxious Weed Inspectors
4.6.6	Ensure residents manage weeds in accordance with Property Management Plans (special leases) and declared weed management requirements on perpetual lease and permissive occupancies	Leaseholders are compliant with weed management	LHIB, Noxious Weed Inspectors, leaseholders

8 Program budget 2016–25

The 2006 LHI WMS (LHIB 2006) projected a timeframe of 30 years to achieve the eradication of widespread invasive weeds on LHI. This Weed Management Strategy outlines the priorities and program requirements for the next decade 2016 – 2025, with the expected continuation of the program to at least 2035. The costing of this Strategy is focused on weed-eradication priorities.

The LHI Weed Eradication Program is shifting into a new era, with significantly reduced weed densities across the island. For the next decade, an initial four-year budget is proposed to enable two complete sweeps of the island (Table 10) this includes a program review (in Year 3, 2018–19) to measure performance, and identify improvements, new weed risks and resource needs for the following years (to 2025). It is projected that expenditure will need to be sustained as the labour effort to gain access to and physically search the same area of weed management blocks is still required. Future budgeting and assessment of the program end should be progressive, with assessment of weed population data at least every three years.

Within the next decade of this Weed Management Strategy, an estimated 30 invasive weed species with limited occurrence (reduced with the past effort or initially restricted in numbers and those permissible for removal across tenures) are projected to be eradicated (see Appendix 1). More broadly distributed target weeds are expected to reach the containment phase (achieving no new seed inputs) and monitoring phase within the next decade, given adequate funding and technical applications.

The LHI Weed Management Strategy requires resourcing to deliver seven core elements of the program:

- 1 Grid-search of weeds across 500 ha of LHI per year, with the effect that all weed management blocks are visited every 24 months.**
- 2 Annual search for Bitou Bush and targeting weed management blocks with residual mature weeds, such as Ochna.**
- 3 Technical access to weeds along cliff-lines and in rugged and remote terrain (on-rope access, helicopter winch access, helicopter lance-spray operations).**
- 4 Dealing with current and future weed risks in the Settlement.**
- 5 Research and development of new methods for detection and control of weeds (e.g. UAV, HBT, weed-detector dogs), of seed-bank persistence and response of weeds following eradication of rodents on LHI.**
- 6 Monitoring and review of the Weed Eradication Program and Weed Management Strategy.**
- 7 Capacity building on and off LHI, fund-raising, networking with weed and botany specialists, developing and maintaining connections with project partners and the Friends of LHI.**

The LHI Weed Eradication Program is administered by the LHIB and staffing accords with the LHIB Crown Employees (Lord Howe Island Board Salaries and Conditions) Award. A proposed staffing strategy, and associated staff grades are provided in Appendix 4.

Table 10 Proposed budget, secured funding and remaining funds sought for LHI Weed Eradication Program for initial four years of decade 2016–25 (note some expenditure already undertaken in 2016–17). Costs cover program administration, on-ground and technical operations, and research and development; funding indicates LHIB recurrent inputs (dependent on LHIB budgets). FTE = full-time equivalent; PT = part-time.

Activities	Year 1 2016–17	Year 2 2017–18	Year 3 2018–19	Year 4 2019/20
Program management, administration & extension				
Project Assistant	23,000	37,152	38,081	39,033
Administration	8,000	17,465	17,902	18,349
Program review	35,000	0	30,000	0
Data management system support and analysis	0	5,000	5,125	5,253
Noxious weeds supplement	5,000	5,125	5,253	5,384
Community engagement & training	2,000	10,000	10,125	10,253
Materials	25,000	30,000	30,750	31,519
On-ground operations				
Field staff – 9 FTE	667,719	684,412	701,522	719,060
Rope-access team – 1 FTE (4 PT)	78,000	79,950	81,949	83,997
Settlement project (0.4 FTE)	30,000	30,750	31,519	32,307
Ochna contract teams (0.55 FTE)	70,305	72,063	73,864	75,711
Volunteers	10,000	10,250	10,506	10,769
Special operations				
Helicopter – lance-spray	(Completed)	120,000	123,000	126,075
Helicopter – winch operations	100,000	100,000	102,500	105,063
Research & trials				
UAV trials (estimated)	65,000	5,000	5,125	5,253
HBT trials (estimated)	63,000	0	10,000	0
Weed detector dog (maintenance)	0	25,000	10,000	10,000
Weed persistence before and after rodent eradication	0	0	10,000	10,000
Total expenditure	1,309,182	1,362,503	1,430,816	1,442,961
Secured funding (see Table 11 for breakdown in secured funding in 2016–17 and 2017–18)				
Total LHIB inputs (pending budget)	390,871	449,535	460,773	472,293
Special operations	283,000	5,125	5,253	5,384
On-ground	438,850	55,000	0	0
In-kind hours on-ground Green Army	60,000	0	0	0
Total secured funding	1,172,721	509,660	466,027	477,677
Remaining funding sought	136,461	852,843	964,789	947,284

Table 11 Current secured funding for 2016–17 and 2017–18. NCLLS = North Coast Local Land Services; SoS = Saving our Species Program, NSW State Government (www.environment.nsw.gov.au/savingourspecies); NSWET = NSW Environmental Trust; WAP = NSW Weeds Action Program 2015–2020 (DPI 2015).

Program	Activity and staffing	FTE	\$
2016–17			
LHIB	Project management, materials, volunteers, grid-search	3.6	\$390,871
NCLLS	Grid-search team & helicopter winch (80K)	1.6	\$196,000
SOS ^A	Grid-search team, including supervisor capacity + helicopter (\$20,000)	3	\$268,850
NSWET	Grid-search team and special projects	1	\$252,000
Green Army	Grid-search team (average output)	1	\$60,000
WAP	Declared weeds	0	\$5,000
Total 2016–17		10.2	\$1,172,721
2017–18			
LHIB ^B	Project management, materials, volunteers, grid-search	4	\$449,535
NCLSS	Grid-search team	0.75	\$55,000
WAP	Declared weeds	0	\$5,125
Total 2017–18		4.75	\$509,660

^A Funds allocated in table identify weed eradication component of this grant only.

^B Proposed LHIB inputs pending 2017–18 budget

Funding recommendations

It is important that the Weed Eradication Program attracts adequate and ongoing funding over the duration of this WMS to allow forward planning, to secure staff and to offer employment security (important on an isolated island with resource limitations).

Further, the 24-month treatment schedule of weed management blocks is necessary for adequate management of nearly all widespread weeds and to deliver effective landscape-scale weed management and eradication.

The funding for the program has varied over the life of the program, but the program has shown a degree of robustness, with data management systems that enable prioritisation of search effort in times of lean funding. Funding shortfalls do not necessarily mean an open-ended control program but do entail the need to work smart and that the overall timeframe for eradication may then extend.

The LHIB are working to secure long-term funding for a fully resourced multi-year program to improve outcomes in weed eradication on LHI. Future funding and project partners and investment include 'Adopt a Block – Protecting Paradise LHI' (a local fundraising group being developed) and mainstream government funding, including applications to the NSW State Government to fund conservation project work in the PPP.

9 Conclusion

The impact of weeds on the unique environment of Lord Howe Island has long been recognised. Local island elder Bill Retmock recalls his mother brought Ground Asparagus to LHI. When it started to spread onto the lagoon foreshore he was worried that it was going to harm the island, so he started pulling it out. Bill was possibly the first bush regenerator, or weeder as they are referred to locally, on the island.

When we walk around Lord Howe Island today the weeds are getting hard to find, so much so that we could be excused for thinking that there has never been a serious weed problem on the island. Another resident, Chris Murray, refers to Transit Hill as 'Transformation Hill' because it is now free of the monocultures of Climbing Asparagus, Cherry Guava and Ground Asparagus that once smothered the native vegetation in that area. The results of the past 10 years of the Weed Eradication Program (LHIB 2016) demonstrate – with hard data – the significant reduction in weeds achieved island-wide.

It is hoped that the outcomes of reducing weeds and their impacts on LHI have provided a valuable lesson in the need for extreme caution in importing new plants to the island – the introduction of 'one small invasive weed plant' can have a major economic and environmental impact in the long term. It has taken millions of dollars, the concerted actions of the community – both island and mainland – and more than a decade of hard work to achieve the significant gains made in reducing the numbers and distribution of weeds on the island and protecting the ecosystems and native vegetation of LHI. We have also demonstrated that we can make a change and reverse the trend and impacts of widespread invasive weeds.

The outcomes to date would not have been possible without the support and effort of the whole island community, especially Ian Hutton, the Friends of Lord Howe Island, and funding agencies, including the Commonwealth and State governments, and their agencies such as the NSW Environmental Trust and North Coast Local Land Services. The hard work undertaken by the weeders – including staff of the LHIB, volunteers and contract teams – have ensured all of the island has been searched come rain or shine. The great gains made would not have been achieved without their dedicated boots on the ground.

Jenni Le Cussan also had the foresight to investigate the impact of weeds on other islands and to draw together global best-practice in weed eradication, which culminated in the 2006 *Weed Management Strategy for Lord Howe Island* (LHIB 2006) and implementation of the Weed Eradication Program methodology. This approach laid the foundation for the first decade of weed eradication on LHI, which in turn has set a sound benchmark for the work of the next two decades, the continuation of best-practice weed eradication and the continued restoration and protection of the island's World Heritage values.

The continuation of the Weed Management Strategy into the next decade will relieve the precious environment of LHI of the impacts of ecosystem-transforming weeds and maintain the vision of Protecting Paradise.



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Appendix 1 Weed management categories

Three management categories are applied to weeds on LHI based on their level of threat (invasiveness and impact), weed risk assessment (WRA) and the feasibility of eradication, combined with the reduction in the extent of widespread weed invasions resulting from weed management over the past 10 years. These three management categories aim to align with those of the new *Biosecurity Act 2015*, which will replace the control classes of the *Noxious Weeds Act 1993*.

The categories are:

Category 1: Eradicate (immediate or suppression leading to eradication);

Category 2: Alert (sleeper weeds – watch and act as necessary); and

Category 3: Control (effectively manage).

It is important to note that this categorisation is not static, and as threats develop or new threats arise, categories and management priorities may change.

The following tables list the species of weeds (alphabetically by common names) within each of the three categories, with:

- **Common name** (and alternative common names).
- **Scientific name**.
- **Control class:** The control class under the *Noxious Weeds Act* (see Table A1); an * indicates a plant that must not be sold, propagated or knowingly distributed.
- **Other class:** Identifies other categorisations of weeds (see section 2 for further details of these listings):
 - WoNS** = Weeds of National Significance (as at April 2012);
 - IUCN** = World's 100 Worst Invasive Alien Species;
 - Alert** = National Environmental Alert List;
 - NRC**, extreme (NRCx) to very high (NRCv) priority invasive species that pose a threat to biodiversity in NSW;
 - AUS** = Australian species introduced to LHI; and
 - EW** = Environmental Weed (Weeds Australia database; Groves *et al.* 2005).
- **# removed 2004–15:** The number of plants removed between 2004 and 2014–15. These figures indicate the scale of weed infestation at the start of the program. With a 90% reduction in mature plants of the widespread weed species, remaining populations average roughly 10–20% of populations at start of program.
- **Last seen:** The year the species was last removed and last observed on LHI.
- **Area (# WMB):** The total area of the blocks in which a weed has been recorded and the number of weed management blocks (WMB) in which a species has been recorded; ~ indicates the number of WMBs is an estimate. The area does not equate to the actual size of a weed infestation, as most weeds are variously dispersed in the blocks.
- **Location (WMB):** Notes on the landscape units, WMBs or sites where a species has been recorded (and the WMB identifiers where relevant). Information for this column is incomplete for Categories 2 and 3.

- **Current abundance:** Described in terms of density (number of individuals) and dispersion of all life-stages of a species across the island. These estimates are based on data from the preceding 24-months search effort (LHI Weeds Database).

Density	Number of individuals	Dispersion	Description
Common	50,000 – 150,000	Widespread	
Occasional	15,000 – 50,000	Localised	
Uncommon	1,000 – 15,000	Isolated	Unique individual
Few	<100	Outliers	Disjunct or isolated infestations of weeds separate from main area of weed infestation
Zero	0	Nil	Not evident but not necessarily absent

- **Propagule persistence:** Provided for Category 1 species only. Weed species propagule persistence indicates the longevity in the environment of **seeds** (seed-bank persistence), other **vegetative** structures (e.g. underground storage organs, such as bulbs or tubers, aerial tubers, offsets), or **spores** (for ferns). Understanding propagule persistence, particularly soil seed-banks, is critical for planning treatment regimes to achieve eradication; the feasibility of eradication is greater for weed species with low propagule persistence. Most weed species on LHI have seed propagules. Eradication target species on LHI that bear seeds (or spores) have been divided into three persistence groupings (LEDA categories, after Kleyer *et al.* 2008; see <http://www.research/projects/LEDA>):
Transient (T) – seed-persistence <1 year;
Short-term persistent (STP) – seed-persistence of 1–5 years; and
Long-term persistent (LTP) – seed-persistence >5 years.

Weed species with vegetative propagules or spores are indicated as such. Vegetative structures are expected to have long-term persistence.

Propagule persistence will be further detailed for each eradication target species in the LHI Weeds Operational Manual (LHI WOM), which is in preparation.

Throughout table,
 ? indicates status or data uncertain and further research needed.

Table A1 Weed control classes and control measures as defined under the *Noxious Weeds Act 1993* (adapted from <http://www.dpi.nsw.gov.au/aboutus/about/legislation-acts/noxious-weeds>). Under Example control requirements, an * indicates that, in some cases, the species may not be sold, propagated or knowingly distributed.

Control class	Weed type	Example control requirements
1	Plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent	The plant must be eradicated from the land and the land must be kept free of the plant The weeds are also 'notifiable' and a range of restrictions on their sale and movement exist
2	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent	The plant must be eradicated from the land and the land must be kept free of the plant The weeds are also 'notifiable' and a range of restrictions on their sale and movement exist
3	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area	The plant must be fully and continuously suppressed and destroyed*
4	Plants that pose a potentially serious threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread*
5	Plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State	There are no requirements to control existing plants of Class 5 weeds However, the weeds are 'notifiable' and a range of restrictions on their sale and movement exists

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Eradicated – monitor									
Cat's Claw Creeper	<i>Dolichandra unguis-cati</i>	2	WoNS, NRCv	25	2006	1.99 ha (1 WMB)	Settlement North (SN171, SN083)	Zero	T – STP
Cocos Palm	<i>Syagrus romanzoffiana</i>	3*		3	2014	0.72 ha (3 WMBs)	Settlement North (SN149, SN071, SN009)	Zero	T
French Broom (Montpellier Broom, Cape Broom)	<i>Genista monspessulana</i>	2*	WoNS	1	2011	0.28 ha (1 WMB)	Settlement South (SS179) In fruit, but site modified	Zero	LTP
Potato Vine (not Madeira Vine)	<i>Solanum wendlandii</i>			1	2012	0.2 ha (1 WMB)	Settlement North (SN205)	Zero	LTP?
Tipuana (African Rosewood)	<i>Tipuana tipu</i>		Alert	1	2008	2 ha (1 WMB)	Settlement North (SN901)	Zero	STP
Turkey Rhubarb	<i>Acetosa sagittata</i>		NRCv	1	2015	0.4 ha (1 WMB)	Settlement North (SN149)	Zero	STP?
Active management – Top 10 (most broadly spread species)									
Bitou Bush	<i>Chrysanthemoides monilifera</i> subsp. <i>rotundata</i>	2	WoNS, NRCx	3,459	2016	215 ha (48 WMBs)	Transit Hill, Blinky Beach, Lower Road, Nobbin, northern hills, Mostly on cliff-lines and at edges of bushland	Occasional – Localised; Outliers	T
Bridal Creeper	<i>Asparagus asparagoides</i>	3*	WoNS, NRCv	110,794	2016	328 ha (60 WMBs)	Mainly northern hills, close to cliff-lines, including	Common – Localised;	STP + Vegetative

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
							Curio Point, Mt Eliza and Malabar and Middle Beach Outliers on Lagoon Foreshore, Intermediate Hill (IH002–003), Lidgbird South (LS006) and Lidgbird North (LN006)	Outlier sites	
Cherry Guava	<i>Psidium cattleianum</i> <i>var. cattleianum</i>	3*	IUCN	704,266	2016	1064 ha (165 WMBs)	Most areas except remote south-facing terrain in the southern mountains Uncommon northern hills and Settlement	Occasional – Widespread; Localised	STP
Climbing Asparagus	<i>Asparagus plumosus</i>	3*	WoNS	53,840	2016	260 ha (93 WMBs)	Transit Hill, Middle Beach to Neds Beach; outliers removed from Malabar and Intermediate Hill Prefers calcarenite soils	Occasional – Localised	STP
Cotoneaster (Large-leaf Cotoneaster)	<i>Cotoneaster glaucophyllus</i>	3*		26,211	2016	266 ha (52 WMBs)	Scattered throughout, excluding remote terrain	Occasional – Widespread	STP
Glory Lily	<i>Gloriosa superba</i>	3*	Alert	13,655	2016	55 ha (15 WMBs)	Isolated locations in Settlement Main infestations at Soldiers Creek (SS127) and Evies Hill (LN006)	Uncommon – Localised	T + Vegetative
Ground Asparagus	<i>Asparagus aethiopicus</i>	3*	WoNS, NRCv	665,831	2016	1018 ha (192 WMBs)	Main infestations Transit Hill and northern hills, including cliff-lines	Common (northern hills) – Occasional –	STP

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
							Less common in the southern mountains Arboreal plants infrequent	Widespread – Outlier sites	
Lady-of-the-night	<i>Cestrum nocturnum</i>	4*		13,380	2016	81 ha (32 WMBs)	Settlement, with outliers on edges of PPP at Transit Hill and Malabar	Occasional – Localised	LTP?
Ochna	<i>Ochna serrulata</i>	3*	NRCv	485,168	2016	648 ha (97 WMBs)	Most common on Intermediate Hill and Lidgbird North Outliers in northern hills, Lidgbird South and two juvenile plants removed from Mt Gower at 400 m above sea level	Common – Localised – Occasional – Widespread	T – STP
Sweet Pittosporum	<i>Pittosporum undulatum</i>	3*	AUS	84,729	2016	394 ha (84 WMBs)	Mostly located on Transit Hill, with outliers in northern hills and Lidgbird North	Occasional – Widespread	STP

Active management – Less abundant species

African Boxthorn	<i>Lycium ferocissimum</i>	3*	WoNS	460	2016	68 ha (9 WMBs)	Restricted to edges, mostly on cliffs, including Middle Beach (SN290, SN291, SN912), Clear Place (point) and cliffs on Transit Hill (TH021–023) Outliers removed from	Uncommon – Localised	STP
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Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
							Malabar (cliff-blocks MB006)		
African Olive	<i>Olea europaea</i> subsp. <i>cuspidata</i>	4*		4	2016	– (~15 WMBs)	Settlement and spreading into edges of PPP Where mature plants have set fruit, they have been removed	Occasional – Localised	STP
Arum Lily	<i>Zantedeschia aethiopica</i>	4*		2	2016	– (~2 WMBs)	Settlement North and South	Few	T (Vegetative)
Arundinaria Reed (Simon Bamboo)	<i>Arundinaria</i> spp.	3*		556	2016	1 ha (2 WMBs)	Valley Garden near Clear Place (TH021); regrowth last removed in 2016 Southern edge of golf course (SS299) Potted plants recently removed	Few	Vegetative
Black Locust	<i>Robinia pseudoacacia</i>	3*		45	2016	1 ha (1 WMB)	Settlement North (SN208)	Few	T – STP
Blue Lilly Pilly	<i>Syzygium oleosum</i>	3	AUS	0	?	– (5 WMBs)	Settlement North and South	Few	STP
Blue Morning Glory	<i>Ipomoea indica</i>	3*	NRCv	1,845 (5 blocks)	2016	3 ha (5 WMBs)	Settlement North (SN041, SN078, SN319, SN339, SN340)	Uncommon – Localised	STP
Blue Passionflower	<i>Passiflora caerulea</i>	3*		280	2016	21.46 ha (>10 WMBs)	Settlement and edges of the PPP, spreading from old gardens (IH016, IH018, SN031, SN279)	Uncommon – Localised	STP

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMBs)	Location (WMB)	Current abundance	Propagule persistence
Blue Periwinkle (Greater Periwinkle)	<i>Vinca major</i>	3*		110	2016	– (~30 WMBs)	Settlement North and South	Occasional – Localised	Rarely sets seed
Bower Vine	<i>Pandorea jasminoides</i>	3*	AUS	13	2016	1 ha (3 WMBs)	Settlement North (SN019, SN164, SN359) Plants have recruited	Few	T
Broad-leaf Privet (Large-leafed Privet)	<i>Ligustrum lucidum</i>	2	NRCv	3	2011	5.8 ha (1 WMB)	Mature plants (in flower) removed on old fenceline south of Soldiers Creek, foothill of Mt Lidgbird (LN007) No recruits found	Few – Zero?	STP
Broad-leaved Lilly Pilly	<i>Syzygium hemilampra</i>	3	AUS	0	?	– (~5 WMBs)	Settlement	Few	STP
Brush Cherry (Magenta Cherry)	<i>Syzygium paniculatum</i>	3*	AUS	22	2014	7.4 ha (2 WMBs)	Settlement South (SS300) Recruits removed from foothills of Mt Lidgbird (LN006)	Few	STP
Camphor Laurel	<i>Cinnamomum camphora</i>	3*		81	2016	45 ha (11 WMBs)	Mature plants remain in Settlement, recruitment is evident Lidgbird North, Intermediate Hill, Settlement	Uncommon – Localised	STP
Cape Ivy	<i>Delairea odorata</i>	3*	NRCv	56	2016	– (5 WMBs)	Settlement North	Uncommon – Localised	Rarely sets seed
Cassia (Senna,	<i>Senna pendula</i>	3*		21	2016	– (10 WMBs)	Settlement North and	Uncommon –	LTP

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Winter Senna, Easter Cassia)	<i>var. glabrata</i>						South	Localised	
Castor Oil Plant	<i>Ricinus communis</i>	3*		1074	2016	19 ha (6 WMBs)	Settlement North and South (SS914, SS191, SS348, SN236), Evies Glenn (TH011), foreshore – Waste Management Facility	Uncommon – Isolated	LTP
Climbing Nightshade (Brazilian Nightshade)	<i>Solanum seaforthianum</i>	2		3	2015	– (3 WMBs)	Settlement North (SN137, SN284, SN316) Mature plants removed, and seedlings located and removed	Few	LTP?
Coastal Tea-tree	<i>Leptospermum laevigatum</i>	3*	AUS	10		8 ha (2 WMBs)	Lagoon foreshore and Settlement North (SN298, SN913)	Few	STP
Common Thornapple	<i>Datura stramonium</i>	3*		2	2015	1 ha (3 WMBs)	Special lease – Settlement South (SS123) and Settlement North (SN032), including Fierce Thornapple (<i>D. ferox</i>) (SN357)	Few	STP
Flame Tree	<i>Brachychiton acerifolius</i>	3*	AUS	120	Current	96 ha (18 WMBs)	Mature trees recently removed from Settlement (last in 2015); recruits mostly found in the northern hills	Uncommon	STP

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Freckle-face	<i>Hypoestes phyllostachya</i>	3*		40	Current	– (~10 WMBs)	Settlement North and South	Uncommon	STP
Giant Reed (Elephant Grass)	<i>Arundo donax</i>	3*		93	2015	1 ha (2 WMBs)	Near Windy Point; Last rhizome dug up in 2014 and no regrowth evident to date	Zero?	Vegetative
Ginger Lily (Kahili Ginger)	<i>Hedychium gardnerianum</i>	2	IUCN	123	Current	68 ha (15 WMBs)	Mostly restricted to gardens in the Settlement, Intermediate Hill and outliers at Lidgbird North (LN004) and Malabar (MB028) Plants spreading into bushland edges	Uncommon – Localised	STP (Vegetative)
Holly Fern	<i>Cyrtomium falcatum</i>	4		26	Current	28 ha (~30 WMBs)	Mostly Settlement, with removal progressing under the Noxious Weed Inspection process A few plants removed from Middle Beach and PPP, and outlier at Red Point (LS010)	Uncommon – Localised	STP (Spore)
Japanese	<i>Lonicera japonica</i>	3*	NRCv	15	Current	– (~5 WMBs)	Settlement North	Few	T

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Honeysuckle									
King Orchid	<i>Dendrobium speciosum</i>	3*	AUS	7	Current	– (~10 WMBs)	Intermediate Hill (potentially planted) and in Settlement Note this species is used by orchid growers for creating hybrids	Few	STP
Lantana (all forms)	<i>Lantana camara</i>	2	WoNS, NRCx	451	2016 one juvenile removed	45 ha (12 WMBs)	Restricted. Individual plants removed from IH016 – near golf course, southern side Transit Hill in gardens/bush edges, Malabar (east), isolated patch Middle Beach	Uncommon – Isolated	LTP?
Leaf Cactus (Satan Plant)	<i>Pereskia aculeata</i>	2	Alert	5	2016	– (~15 WMBs)	Settlement North and South	Few	STP?
Lilly Pilly (Small-leaved Lilly Pilly)	<i>Acmena smithii</i>	3	AUS	0	?	– (~5 WMBs)	Settlement	Few	STP
Madeira Vine	<i>Anredera cordifolia</i>	3*	WoNS, NRCx	5,245 kg	Current	71 ha (49 WMBs)	Mostly in gardens, with outlying patch found off Little Island track in patch of dead Tobacco Bush, which may have been dispersal by a weeder	Uncommon – Localised	Vegetative
Ming Fern (Ming Asparagus Fern)	<i>Asparagus macowanii</i>	2*		1	2015	0.25 ha (1 WMB)	Individual plant removed in 2015 estimate to have been on island for 4 years;	Zero?	STP?

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
							no recruits evident.		
Mirror Bush (Coprosma)	<i>Coprosma repens</i>	2		7	2014	– (3 WMBs)	Propagated by cuttings and planted on LHI – since removed	Few – Zero?	STP
Mother-of-millions	<i>Bryophyllum delagoense</i>	4*		20	current		Settlement North and South	Few	STP (Vegetative)
Murraya (Orange Jessamine)	<i>Murraya paniculata</i>	3*		3	current	– (~15 WMBs)	Mostly Settlement but two sites in PPP	Uncommon – Localised	STP
Narrow-leaf Privet (Small-leafed Privet)	<i>Ligustrum sinense</i>	2	NRCv	897	current	68 ha (26 WMBs)	Most common in the Settlement and Malabar; less common Intermediate Hill	Uncommon – Widespread	STP
Native Frangipani	<i>Hymenosporum flavum</i>	3*	AUS	2	2016 (mature – no seed)	– (3 WMBs)	Settlement North	Few	STP
Palm Grass	<i>Setaria palmifolia</i>	3*		1,071	2016	68 ha (22 WMBs)	Tracks and edges of bushland in the Settlement, including Stevens Reserve, and in PPP at Transit Hill (Clear Place and Valley of the Shadows), Goat House and edge of PPP opposite the Catalina wreck	Uncommon – Localised	LTP?
Pampas Grass	<i>Cortaderia selloana</i>	3*		13	2014	20 ha (4 WMBs)	Last recorded plants removed from Transit Hill	Few – Zero	STP

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMBs)	Location (WMB)	Current abundance	Propagule persistence
							(TH005 in 2014), Malabar (MB039 in 2012) and Settlement South (2010)		
Red Cedar	<i>Toona ciliata</i>	3	AUS	0	2015	– (2 WMBs)	Settlement North Mature trees removed in 2015	Few – Zero	LTP
Resurrection Plant (Mother-of-millions)	<i>Bryophyllum pinnatum</i>	4*	NRCv	210	2016	– (15 WMBs)	Mostly Settlement, edge of Crown Land – Neds Beach Common Outlier from Intermediate Hill (D. Kennedy, personal communication)	Occasional – Localised	STP (Vegetative)
Rhizomatous Bamboo	<i>Phyllostachys</i> spp.	3*		0	?	?	Settlement	Few	Vegetative
Rhus Tree	<i>Toxicodendron succedaneum</i>	4*		36	2014	11 ha (4 WMBs)	Transit Hill, Settlement North	Few	STP
Rice Paper Plant	<i>Tetrapanax papyrifer</i>	3*		824	2015	19 ha (3 WMBs)	Settlement, and Transit Hill, at Evies Glenn (TH011) and forest edge of TH008	Few – Zero	STP
Salvinia	<i>Salvinia molesta</i>	2	WoNS	0	2016	– (~15 WMBs)	Settlement North and South Mostly contained in water features; outbreak on dam at golf course (A. Wright, personal communication)	Uncommon – Localised	Vegetative

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Silky Oak	<i>Grevillia robusta</i>	3*	AUS	271	2016	323 ha (48 WMBs)	Mostly in Settlement, northern hills, and Intermediate Hill; outliers from Worlds End (LS015) and Lower Rd; mature specimens recently removed from Transit Hill (TH025) Few mature plants remaining in Settlement	Occasional – Widespread	STP
Singapore Daisy	<i>Sphagneticola trilobata</i>	2	IUCN	119	2016	– (3 WMBs)	Foreshore – waste management facility Settlement North (SN254, SN326)	Few	STP (Vegetative)
Siratro	<i>Macroptilium atropurpureum</i>	3*		51	2016	1 ha (2 WMBs)	Airport (around fuel shed), patches on lawn and entrance to golf club	Uncommon – Localised	LTP
Smooth Senna (Arsenic Bush, Brazilian Buttercup)	<i>Senna septemtrionalis</i>	3*		186	2016	28 ha (~3 WMBs)	Stevens Reserve and Settlement North and South	Few	LTP
Spanish Moss (Old Man's Beard)	<i>Tillandsia usneoides</i>	2		0	2016	– (~15 WMBs)	Settlement North and South	Uncommon – Localised	Vegetative
Staghorn Fern	<i>Platyserium superbum</i>	3*	AUS	9	2016	– (10 WMBs)	Settlement Most plants sent off island Last two removed 2016	Few	STP Spores

Category 1: Eradicate (immediate or suppression leading to eradication)

Common name (Alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Last seen	Area (# WMB)	Location (WMB)	Current abundance	Propagule persistence
Umbrella Tree	<i>Schefflera actinophylla</i>	3*	AUS	702	2016	151 ha (30 WMBs)	Settlement, with recruits mostly found in the northern hills	Uncommon – Widespread	STP
Water Hyacinth	<i>Eichhornia crassipes</i>	2	WoNS	0	2016	– (~10 WMBs)	Settlement North and South Mostly contained in water features	Few	LTP (Vegetative)
Water Lettuce	<i>Pistia stratiotes</i>	1		0	2015	– (2 WMBs)	Settlement North Major environmental weed – plant should not be shared; mostly contained in water features	Few – Zero	Vegetative
White Cedar (Chinaberry)	<i>Melia azedarach</i>	4	AUS	292	2016	60 ha (17 WMBs)	Mostly restricted to Settlement Seedlings also removed from Malabar and near Big Waterfall (LN020)	Uncommon – Widespread	STP

Category 2: Alert (sleeper weeds – watch and act as necessary)

Common name (alternate names)	Scientific name	Control class	Other class	# removed 2004–15	Area (# WMBs)	Location and invasive potential	Current abundance
African Tulip	<i>Spathodea campanulata</i>		EW		– (5 WMBs)	Settlement North Seed spread by wind; invasive in Queensland and northern NSW	Few (<10 plants)
Agapanthus (African Lily)	<i>Agapanthus praecox</i>			584	46 ha (8 WMBs)	Settlement North and South Outliers removed from PPP at Malabar (MB021, MB042) and Round Face – Lidgbird North (LN021) Reported as planted on site although plants are spreading at LN021 Remove from PPP Actively remove seed-heads	Occasional – Localised
Argentine Ombu	<i>Phytolacca dioica</i>				– (1 WMB)	Settlement South	Few (<2 plants)
Bathurst Burr	<i>Xanthium spinosum</i>			1	– (1 WMB)	One plant removed from Settlement near a chicken pen Imported in chicken feed	Few
Buddleia	<i>Buddleja madagascariensis</i>		EW	35	– (3 WMBs)	Settlement North and South Environmental weed	Few
Bushman's Poison (Wintersweet)	<i>Acokanthera oblongifolia</i>			373	– (~40 WMBs)	Settlement North and South	Occasional – Localised
Climbing Fig	<i>Ficus pumila</i>					Settlement North and South	Occasional – Localised
Cordyline	<i>Cordyline fruticosa</i>				– (~40 WMBs)	Settlement North and South Plants observed fruiting Invasive on Raoul Island	Uncommon – Localised
Crocosma	<i>Crocosmia crocosmiiflora</i>				– (~19 WMBs)	Settlement North and South	Few

Common name (alternate names)	Scientific name	Control class	Other class	# removed 2004–15	Area (# WMBs)	Location and invasive potential	Current abundance
Cunjevoi	<i>Alocasia brisbanensis</i>		AUS	3	– (2 WMBs)	Settlement South Invasive on Raoul Island	Few
Edible Grape	<i>Vitis vinifera</i>				– (~15 WMBs)	Settlement	Few
English Ivy	<i>Hedera helix</i>		EW	20	– (~40 WMBs)	Settlement North and South	Occasional – Localised
Everlasting Pea	<i>Lathyrus latifolius</i>			275	– (3 WMBs)	Settlement North, near Blinky Beach Sets viable seed	Uncommon – Localised
Fan Flower	<i>Scaevola calendulacea</i>		AUS	0	– (1 WMB)	Settlement South (SS911) Introduced with revegetation work on Blink Dune (I. Hutton, personal communication); smothering the habitat of the endangered Sand Spurge (<i>Chamaesyce psammogeton</i>)	Uncommon – Localised
Fierce Thornapple	<i>Datura ferox</i>				– (~2 WMBs)	Settlement	Few
Firethorn	<i>Pyracantha crenulata</i>				?	Settlement	Unknown
Golden Wreath Wattle	<i>Acacia saligna</i>		AUS		– (~10 WMBs)	Settlement North and South	Uncommon – Localised
Indian Hawthorn	<i>Rhaphiolepis indica</i>		EW	44	– (~20 WMBs)	Settlement, with outliers on Intermediate Hill (west side) and Lidgbird North (lower flanks and LN014) Seed spread by birds	Uncommon – Localised
Indian Shot	<i>Canna indica</i>		EW		– (~20 WMBs)	Older variety of Canna produces viable seed that can be spread by birds	Uncommon
Jacaranda	<i>Jacaranda mimosifolia</i>		EW		– (~10 WMBs)	Weed of dry rainforest; seed spread by wind	Few
Mauritis Hemp	<i>Furcraea foetida</i>		EW		– (~20 WMBs)	Settlement North and South, localised spread observed; weed on Raoul Island	Occasional – Localised

Common name (alternate names)	Scientific name	Control class	Other class	# removed 2004–15	Area (# WMBs)	Location and invasive potential	Current abundance
Moreton Bay Fig	<i>Ficus macrophylla</i>				– (1 WMB)	Settlement North (one plant) May hybridise with Banyan Fig (<i>Ficus macrophylla</i> subsp. <i>columnaris</i>)	Few
New Zealand Christmas Bush	<i>Metrosideros excelsa</i>			?	– (9 WMBs)	Planted in the Settlement; outliers removed Identity of outliers needs to be confirmed (whether <i>M.excelsa</i> and <i>M kermadecensis</i> or potential hybrids)	Uncommon – Localised
New Zealand Christmas Bush	<i>Metrosideros kermadecensis</i>			36	– (9 WMBs)	Planted in the Settlement; outliers removed from Malabar, Intermediate Hill and Lidgbird North Concern re potential hybridisation	Uncommon – Localised
Panadus	<i>Pandanus tectorius</i>			2	– (2 WMBs)	Settlement Concern about hybridisation	Few
Roldana	<i>Roldana petasitis</i>			113	30 ha (~40 WMBs)	Mostly in the Settlement (North and South) and detected in PPP with a large patch at Middle Cave, Mt Lidgbird (LS012) and Intermediate Hill (IH010)	Occasional –Localised
Rose Apple	<i>Syzygium jambos</i>			>100	– (5 WMBs)	Mostly in Settlement North and one site in Settlement South Initial control undertaken Highly susceptible to Myrtle Rust	Uncommon – Localised
Snow Plant	<i>Breynia nivosa</i>				– (~20 WMBs)	Settlement Seedling regeneration observed; seeds potentially spread by wind	Uncommon –Localised
South African Iris	<i>Dietes biflora</i>		EW		– (~20 WMBs)	Edge of PPP at Intermediate Hill, and Settlement May hybridise with endemic Wedding Lily (<i>Dietes robinsoniana</i>)	Uncommon – Localised

Common name (alternate names)	Scientific name	Control class	Other class	# removed 2004–15	Area (# WMBs)	Location and invasive potential	Current abundance
Striped Trad (Silvery Inch Plant)	<i>Tradescantia zebrina</i>		EW	50	– (~20 WMBs)	Settlement North and South	Occasional – Localised
Tree of Heaven	<i>Ailanthus altissima</i>		EW		– (2 WMBs)	Settlement North (suckering root stock and seedling observed) Windblown seed; known invasive plant on mainland	Few (<10 plants)
Trumpet Vine	<i>Campsis radicans</i>				– (~5 WMBs)	Settlement North and South	Localised
Wandering Jew (Wandering Trad)	<i>Tradescantia fluminensis</i>		EW	30	– (~20 WMBs)	Settlement North and South	Occasional – Localised
Widow's-thrill	<i>Bryophyllum fedtschenkoi</i>				– (~30 WMBs)	Settlement North and South Only localised spread observed	Occasional – Localised

Category 3: Control (effectively manage)

Common name (alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Area (# WMB)	Location and invasive potential	Current abundance
African Plum (Kaffir Plum)	<i>Harpephyllum caffrum</i>			146	– (~40 WMBs)	Settlement North and South	Occasional – Localised
Begonia	<i>Begonia spp.</i>			42	33 ha (1 WMB)	Escaped garden plant removed from Goat House (LS006)	Occasional – Localised
Brazil Cherry	<i>Eugenia uniflora</i>			30	– (2 WMBs)	Limited spread on island	Few
Broadleaf Paspalum	<i>Paspalum mandiocandum</i>					Tracks – Mutton Bird Point, Rocky Run – Intermediate Hill	Occasional – Widespread
Buffalo Grass	<i>Stenotaphrum secundatum</i>					Lagoon Foreshore	Occasional – Localised
Chinese Elm	<i>Ulmus parvifolia</i>			1		Mature plants in Settlement; semi-mature plant removed from Malabar	Few
Coastal Morning Glory	<i>Ipomoea cairica</i>		EW			Throughout the PPP	Common – Widespread
Coffee	<i>Coffea arabica</i>		EW			Settlement North Plants removed from the PPP	Uncommon – Localised
Coral Tree	<i>Erythrina cristi-gali</i>		EW	9		Settlement North and South Spreads by seed	Few
Crofton Weed	<i>Ageratina adenophora</i>		EW			More prevalent in the southern mountains	Common – Widespread
Dwarf Umbrella Tree	<i>Schefflera arboricola</i>					Settlement North and South; Plants observed fruiting	Uncommon
Farmer's Friend	<i>Bidens pilosa</i>					Tracks and disturbed area	Occasional – Widespread
Formosan Lily (Tiger Lily)	<i>Lilium formosanum</i>		EW			Mostly in the PPP	Common – Widespread

Common name (alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Area (# WMB)	Location and invasive potential	Current abundance
Fruit Salad Plant (Monstera)	<i>Mostera deliciosa</i>			8		Settlement North and South	Occasional – Localised
Giant Fishbone Fern	<i>Nephrolepis biserrata</i>					Settlement North and South	Common – Localised
Golden Trumpet	<i>Solandra maxima</i>				– (~10 WMBs)	Settlement	Few
Golden Trumpet Vine	<i>Allamanda cathartica</i>		EW			Settlement North and South.	Occasional – Localised
Hoop Pine	<i>Araucaria cunninghamii</i>		AUS	140		Settlement North	Uncommon – Localised
Indian Coral Tree	<i>Erythrina crista gali</i>		EW		– (3 WMBs)	This species produces viable seed	Few
Kikuyu	<i>Pennisetum clandestinum</i>					Settlement North and South, edges of the PPP, Lower Rd and Get Up Place	Common – Widespread
Lemon	<i>Citrus x taietensis</i>			22		Plants regularly harvested by the local community along tracks are to be retained	Uncommon – Localised
Loquat	<i>Eriobotrya japonica</i>			10		Plants removed from the edge of the PPP	Uncommon – Localised
Molasses Grass	<i>Melinus minutiflora</i>					Settlement South – Intermediate Hill	Uncommon – Localised
Montbretia	<i>Crocasmia x crocosmiiflora</i>		EW			Settlement North	Uncommon – Localised
Mulberry	<i>Morus spp.</i>			21		Plants removed from the PPP	Uncommon – Localised
Norfolk Island Pine	<i>Araucaria heterophylla</i>		NFI			Isolated plants removed from the PPP	Common – Localised
Painted Spurge	<i>Euphorbia cyathophora</i>				– (~20 WMBs)	Settlement, Lagoon Foreshore	Occasional – Localised
Panic Veldt Grass (African Panic Veldt Grass)	<i>Ehrhata erecta</i>				– (~150 WMBs)	Settlement North and South, PPP Common in the northern hills, above the Get Up Place – Mt Gower	Common – Widespread

Common name (alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Area (# WMB)	Location and invasive potential	Current abundance
Parlor Palm	<i>Chamaedorea elegans</i>					Settlement North and South	
Parramatta Grass	<i>Sporobolus africanus</i>					Tracks throughout the PPP, road edges, special leases	Common – Widespread
Peach	<i>Prunus persica</i>			108		Plants removed from the PPP	Uncommon
Pellitory	<i>Parietaria judaica</i>		EW			Settlement North	Common – Localised
Peruvian Lily (Parrot Alstroemeria)	<i>Alstroemeria pulchella</i>		EW	54		Settlement North and South, Transit Hill Lookout	Occasional – Localised
Pink Periwinkle	<i>Catharanthus roseus</i>		EW			Settlement North and South	Uncommon – Localised
Redhead Cottonbush (Red-heart Cottonbush, Blood Flower)	<i>Asclepias curassavica</i>					Settlement North and South	Occasional – Widespread
Rhodes Grass	<i>Chloris gayana</i>					Common on Blackburn Island	Occasional – Localised
Rose Apple	<i>Syzygium jambos</i>					Settlement North and South; Highly susceptible to Myrtle Rust (<i>Puccinia psidii</i>)	Occasional – Localised
Rubber Tree	<i>Ficus elastica</i>			1		Settlement North	Few
Seaside Daisy	<i>Erigeron karvinskianus</i>					Settlement North and South	Uncommon – Localised
Shasta Daisy	<i>Leucanthemum maximum</i>					Settlement North and South	Uncommon – Localised
Spanish Bayonet (Dagger Plant)	<i>Yucca aotifolia</i>		EW	35		Settlement North and South	Uncommon – Localised
Spear Thistle	<i>Cirsium vulgare</i>					Special Leases at edges of PPP; fence-lines	Occasional
Swamp Oak	<i>Casuarina glauca</i>		AUS			Settlement North and South	Uncommon – Localised

Common name (alternate names)	Scientific name	Control class	Other class	# Removed 2004–15	Area (# WMBs)	Location and invasive potential	Current abundance
Tobacco Bush (Wild Tobacco Tree)	<i>Solanum mauritianum</i>		EW	7,083	384 ha (63 WMBs)	Throughout settlement and disturbance zones in the PPP Mature stand established on erosion scar at Big Pocket – Mt Gower	Occasional – Widespread
Tung Oil	<i>Vernicia fordii</i>			32		Settlement North and South	Uncommon – Localised
Umbrella Sedge	<i>Cyperus eragrostis</i>					Settlement Prefers damp environments, disturbed edges of creeklines	Uncommon – Widespread
Willow Myrtle	<i>Agonis flexulosa</i>		AUS	2	– (2 WMBs)	Seedlings observed	Few
Yellow Guava	<i>Psidium guajava</i>		EW	6,931	– (37 WMBs)	Settlement North and South Edges of PPP at Transit Hill, Lidgbird North, Intermediate Hill Introduced about the same time as Cherry Guava but it is not as invasive	Occasional – Localised
Yellow Oleander	<i>Thevetia peruviana</i>					Settlement North and South Localised spread observed	Uncommon – Localised

Appendix 2 History of weed management on Lord Howe Island

The following table summarises the history of weed management actions on LHI.

Year	Weed management actions and investment
1930s	The local Island Authority (predecessor of the LHIB) raised concerns about, and urged residents to remove, asparagus ferns.
1970s	Biological surveys undertaken by the Australian Museum and Royal Botanical Gardens (Recher & Clark 1974). Concerns about the threat posed by invasive weeds on LHI, particularly Cherry Guava were first formally reported. The surveys noted that 120 introduced species – including invasive species – had naturalised on the island and recommended that the importation of introduced species be prohibited.
1990s	Efforts to manage weeds on LHI increased. The LHIB applied significant effort to control 13 invasive weed species at key locations, including the back of the golf course, Grey Face, Lagoon Foreshore, the Settlement, northern hills, including Curio Point, and abseil access to remove Bitou Bush from the Nobbin on Mt Lidgbird, Kims Lookout and Malabar (LHIB 2002).
1995	The first Weeding Ecotour initiated by Ian Hutton, curator of the LHI Museum, which eventually led to the formation of the volunteer Friends of Lord Howe Island (in 2001). There are currently 108 members. The volunteers have collectively contributed more than 24,000 hours of weeding, with a focus on Transit Hill.
1997	16 weeds declared noxious under the NSW <i>Noxious Weeds Act 1993</i> .
1999	The NSW Department of Primary Industries (DPI) assisted in weed management by implementing a leasehold (urban) weed inspection program and introduced new selective herbicides (metsulfuron-methyl for foliar spraying of Ground Asparagus, and triclopyr for cut-and-paint applications on Cherry Guava and Ochna).
2001	The World Wildlife Foundation sponsored Ian Hutton to attend the Island Invasives Conference in Auckland, New Zealand. This facilitated contact with the NZDOC and their weeding programs on Raoul Island and raised further awareness that Cherry Guava was potentially the worst weed occurring on LHI. Ian Hutton and Jenni Le Cussan prepared an outline for a weed control strategy and inventory of weeds for LHI (Hutton & Le Cussan 2001).
2001–03	The NSW Environmental Trust awarded major grants (a total of \$139,640) for two weed management projects: Stop the Spread of Pittosporum (2001, \$71,240) and Cherry Guava in the southern mountains (2003, \$68,400).
2002	Strategic Plan for Weed Management on LHI prepared (LHIB 2002a), identifying priority weeds and areas for treatment. Other structural elements of the program were identified – training, volunteers, noxious weed inspections. The Churchill Trust awarded a fellowship to Jenni Le Cussan (LHIB field officer) to investigate the impacts of invasive woody weed species, including Cherry Guava, on Indo-Pacific islands. This research informed a large part of the LHI WMS 2006 (LHIB 2006). A garden plant inventory recorded 670 introduced species, of which at least 270 had invasive characteristics (DECC 2007).
2002–03	Landscape-scale mapping and monitoring was undertaken to quantify the extent of

	invasive weeds on LHI (Le Cussan 2002a, 2002b, 2003a, 2003b). This mapping found that eight weed species had spread extensively into the PPP and posed an immediate and serious threat to the terrestrial ecology of the island. The mapping identified the need for an island-wide and time-driven weed eradication program, without which the island would remain at significant risk from invasive weeds.
2004	\$1.2 million awarded from the NSW Environmental Trust (NSW Government) kick starting an eradication approach to weed management including data recording systems. The LHIB undertook to eradicate all noxious weeds (with the exception of Crofton Weed and Formosan (Tiger) Lily (<i>Lilium formosanum</i>)).
2005	Bridal Creeper Rust (<i>Puccinea myrsiphylli</i>) released but extent of effect variable.
2005–09	Long-line cone-spray apparatus applied to treat Bitou Bush on cliff-lines in June 2005 and July 2009.
2006	The position of Flora Management Officer created. The LHIB prepared and began implementation of the <i>Weed Management Strategy for Lord Howe Island</i> (LHIB 2006) with the aim of eradicating 25 species of weeds on LHI.
2006–14	\$6.4 million invested to implement the <i>Lord Howe Island Weed Management Strategy 2006 and Weed Eradication Program of which the following was given:</i> NSW Environmental Trust (\$2,857,974); LHIB (\$1,835,937); Northern Rivers Catchment Management Authority / Local Land Services (\$935,710); Caring for our Country (CFOC, \$825,000); Foundation for National Parks (\$2,700); and DPI 10-year noxious weed inspection program (\$32,273).
2010–15	Four heli-winch programs undertaken to increase extent of search effort on Mt Gower; with surveillance runs undertaken on Big Slope and Big Pocket, free of target weeds (March 2011, October 2012, February 2013, February 2015).
2011	The program stopped using triclopyr and switched to a glyphosate–metsulfuron-methyl mix on all woody weeds.
2013–14	The NSW Noxious Weeds (Weed Control) Order 2014 – under the NSW <i>Noxious Weeds Act 1993</i> introduced 45 new noxious weed declarations for the LHI Local Control Authority area. This includes species listed under the LHI Regulations 2004 and additional species currently limited in distribution; listed in a bid to reduce their spread, impacts and future costs.
2014	The LHIB adopted a revised Plant Importation Policy and Strategy.
2015	Review of Weed Eradication Program and its results 2004–2014 (LHIB 2016). First successful trial of helicopter lance-spray apparatus; 10 km of cliff-lines and 1500 weeds treated. Funding secured to engage an arborist to remove large mature weed trees from leasehold land in the Settlement (Camphor Laurel, Flame Tree, White Cedar and Silky Oak) through Local Land Services and Friends of LHI (\$10,000).
2016	Publication of <i>Lord Howe Island Weed Eradication Program – Results 2004–2014</i> (LHIB 2016) Publication of <i>A Systematic Flora Survey, Floristic Classification and High-resolution Vegetation Map of Lord Howe Island</i> (Sheringham <i>et al.</i> 2016) Draft of this report placed on public display for comment.

Appendix 3 Relevant legislation and strategies

International obligations

World Heritage Convention

The World Heritage Convention (see <https://www.iucn.org/theme/world-heritage>), concerning the protection of the World Cultural and Natural Heritage which was adopted in 1972 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), provides for the declaration of heritage of outstanding universal cultural and natural value as part of the World Heritage List. The Convention and the associated Operational Guidelines provide guidance for the protection and conservation of World Heritage properties.

As a signatory to the World Heritage Convention, Australia has obligations under Article 5, including:

- to protect, conserve and present the World Heritage values of the property;
- to integrate the protection of the area into a comprehensive planning program;
- to give the property a function in the life of the Australian community;
- to conduct scientific and technical research and develop operating methods to counteract threats to World Heritage values; and
- to take appropriate scientific, technical, legal, administrative and financial measures necessary for achieving the foregoing objectives.

Commonwealth legislation, plans and strategies

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The *EPBC Act* provides a national framework for environmental management (including the recognition of nationally threatened species and ecological communities) and the listing of Key Threatening Processes (KTPs) that affect threatened species and their habitats. Relevant KTPs that relate to biosecurity on LHI include (but are not limited to):

- the loss and degradation of native plant and animal habitat by invasion of escaped garden; and plants, including aquatic plants; and
- novel biota and their impact on biodiversity.

The Australian Weeds Strategy

The Australian Weeds Strategy (NRMMC 2007) recognises that weeds impact on Australia's economy, environment and society, and provides a framework to establish consistent guidance for all parties. It identifies priority weeds for management across Australia with the aim of minimising their impacts. This strategy emphasises the importance of preventing new weeds from establishing and the need to respond quickly to incursions.

The Australian Weeds Strategy identifies the following goals and objectives:

Goal 1: prevent new weed problems;

Goal 2: reduce the impact of existing priority weed problems; and

Goal 3: enhance Australia's capacity and commitment to solve weed problems.

These goals are translated through strategies and actions within the following three sub-strategies:

- National Weed Spread Prevention Action Plan;
- Weeds of National Significance (Strategic Plans); and
- National Weed Awareness Action Plan.

New South Wales legislation, plans and strategies

Biosecurity Act 2015

The *Biosecurity Act 2015* (the 2015 Act in following), which is expected to come into effect in 2017, will provide regulatory controls and powers to manage noxious weeds in NSW and will repeal the *Noxious Weeds Act 1993*. The 2015 Act is based on the principle that biosecurity is a shared responsibility between governments, industries and individuals. The 2015 Act underpins the *New South Wales Biosecurity Strategy 2013–2021* (DPI 2013), and provides a range of new regulatory tools to manage biosecurity risks pertaining to animal and plant pests and diseases, weeds and contaminants. Invasive weeds will be prioritised under the General Biosecurity Duty using the NSW Weed Risk Management (WRM) system, *NSW Invasive Species Plan 2008–2015* (DPI 2008; currently being updated, with a draft having been available for public consultation [NSW Government 2015]), and Biosecurity Threat Decision Tree.

Weeds will be managed under the broad categories of Prohibited Matter, Control Order, Biosecurity Zone, General Biosecurity Duty, Mandatory Measures Regulation, Emergency Order, Biosecurity Direction and Biosecurity Undertaking. Lord Howe Island is being considered for designation as a Biosecurity Zone. Until this determination, weeds will be prioritised and categorised as part of the North Coast Local Land Services Regional Strategic Weed Management Plan 2017–2020 (in prep).

Local Land Services Act 2013

Local Land Services (LLS) bring together agricultural production advice, biosecurity, natural resource management and emergency management into a single organisation. The Act established LLS, repealed the *Rural Lands Protection Act 1998*, the *Rural Lands Protection Amendment Act 2008* and the *Catchment Management Authorities Act 2003*. The Act became fully operational in January 2014.

LLS have now replaced all Catchment Management Authorities (CMAs) as statutory authorities in newly defined regions. CMAs, Livestock Health and Pest Authorities and some advisory services of the Department of Primary Industries, which previously operated separately, form the integrated LLS.

In this Act, local land services means programs and advisory services associated with agricultural production, biosecurity, natural resource management and emergency management, including programs and advisory services.

North Coast LLS Regional Strategic Weed Management Plan 2017–2020

The North Coast Regional Strategic Weed Management Plan 2017–2020 (in preparation) will prioritise and categorise weed species for the North Coast region in accordance with legislative provisions under the *Biosecurity Act 2015*. Weeds will be prioritised under State and Regional

objectives and assigned management outcomes and actions based on the NSW Weed Risk Management System. LHI will be represented under this plan until designated as a Special Biosecurity Zone under the *Biosecurity Act 2015*.

NSW Biosecurity Strategy 2013 – 2021

The NSW Biosecurity Strategy outlines how government, industry and the community need to work together to identify, minimise, respond to and manage biosecurity risks. It identifies eight objectives that are aligned to the *Biosecurity Act 2015*. The objectives of the strategy are summarised:

- communicate and build support for a strong and integrated biosecurity system;
- work towards a strong economy, strengthen local environments and communities;
- increase State capacity to respond to, manage and control biosecurity threats according to our state and national obligations;
- foundation building – stakeholders collaborate and share knowledge and expertise;
- identify clear goals, outcomes and strategies meaningful to the NSW community;
- provide guidance for prioritisation, decision-making and actions at state level;
- detailed planning, monitoring and reporting of biosecurity programs; and
- provide a clear direction for biosecurity research.

Noxious Weeds Act 1993

The *Noxious Weed Act 1993* is to be repealed with the enactment of the *Biosecurity Act 2015*, discussed above. Until that time the current legislative basis for weed management on LHI and NSW continues to apply.

Under the NSW *Noxious Weeds Act 1993* and the Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014), declared noxious weeds are those plants that have the potential to cause harm to the economy, environment, community and individuals, can be controlled by reasonable means and have the potential to spread within an area and to other areas.

The Noxious Weeds (Weed Control) Order 2014 (NSW Government 2014) lists all weeds declared noxious in NSW, their class (five classes of noxious weeds are defined) and the area to which the order applies. Noxious weeds are declared for a LCA area or state-wide. A LCA has a responsibility for inspections and enforcement on private lands as well as control of noxious weeds on their own lands, and the LCA for LHI is the LHIB. Declared noxious weeds require all-tenure management in accordance with the Act.

The NSW Weed Risk Management (WRM) system is used to evaluate noxious weed declarations and to guide weed management practise. The NSW WRM system uses a series of questions to arrive at a score for weed risk (invasiveness, impacts, potential distribution) and feasibility of coordinated control (control costs, persistence, current distribution) (refer to dpi.nsw.gov.au/__data/assets/pdf_file/0004/279958/INT09-54079-revised-Weed-Risk).

Currently, 68 weed species declared under Weed Control Order 2014 occur on LHI and all are targeted for eradication (Appendix 1). Although management of these species may seem an onerous task, 40 of those species had small populations (less than 1000 individuals on the island) or restricted distributions at a limited number of sites, mainly close to the Settlement, when declared.

Lord Howe Island Act 1953

The *Lord Howe Island Act 1953* provides for the care, control and management of LHI to protect its unique values and the interests of its residents. The Act contains provisions for the

management, protection, restoration, enhancement and conservation of the Island's environment in a manner that recognises the World Heritage values of LHI. This Act is administered locally by the LHIB.

Local Land Services Act 2013

Local Land Services (LLS) brings together agricultural production advice, biosecurity, natural resource management and emergency management into a single organisation. The Act established LLS, repealed the *Rural Lands Protection Act 1998*, the *Rural Lands Protection Amendment Act 2008* and the *Catchment Management Authorities Act 2003*. The Act became fully operational in January 2014.

LLS have now replaced all previous Catchment Management Authorities (CMAs) as statutory authorities in newly defined regions. CMAs, Livestock Health and Pest Authorities and some advisory services of the Department of Primary Industries, which previously operated separately, form the integrated LLS.

In this Act, local land services means programs and advisory services associated with agricultural production, biosecurity, natural resource management and emergency management, including programs and advisory services.

Pesticides Act 1999

This Act controls and regulates the use of pesticides in NSW. The key objectives of the Act are to promote the protection of human health, the environment, property and trade in relation to pesticide use, having regard to the principles of ecologically sustainable development. Regulations and other measures support the Act's objectives.

The Act regulates pesticides storage, use, disposal, labels and containers. "Pesticide" is defined by s5 to include herbicides, insecticides, defoliants and fungicides, but not fertilisers.

Registered pesticides must be used in accordance with the label and a permit is required to use an unregistered pesticide.

Plant Diseases Act 1924

The *Plant Diseases Act*, administered by the NSW Department of Primary Industries (DPI), has provisions that regulate the importation of listed plants and plant diseases or pests into the State (or into any specified portion thereof) and have powers to control the pests should they become established. This Act is to be integrated into the NSW Biosecurity Act 2015.

New South Wales Weeds Action Program 2015–2020

The NSW Weeds Action Program 2015–2020 (WAP; DPI 2015) aims to:

- deliver regional strategic weed management plans;
- facilitate and coordinate regional strategic weed planning; and
- assist with education and community outreach programs.

Regional committees will comprise LCAs, public and private landholders and community members. The establishment of Regional Weed Committees is a high priority for Local Land Services to support regional planning under the *Biosecurity Act* and to utilise WAP funds.

Lord Howe Island Board regulations, plans and policies

Lord Howe Island Regulation 2014

This is the primary piece of legislation regulating the importation of plants and potential weed species to LHI. *Part 5 – Protection of the Environment, Division 2 – Flora and Fauna* of this Regulation requires:

- Approval from the LHIB for the importation of seeds, plants or any part of a seed or plant to the Island (Clause 61).
- Any seed, plant, part of seed or plant, animal or bird that is brought to the Island in contravention of the requirements in *Division 2*, may be seized by the LHIB and destroyed or otherwise disposed of (Clause 63).

Lord Howe Island Pesticide Use Notification Plan 2015

The LHI Pesticide Use Notification Plan has been prepared in accordance with the requirements of the Pesticides Regulation 2009 (the Regulation). The aim of this plan is to meet the community's general right to know about pesticide applications made to outdoor public places that are owned or controlled by public authorities. The plan sets out how the LHIB will notify members of the community of pesticide applications made by the LHIB to public places that it owns or controls. Further information on the LHIB's pesticide use can be obtained from the LHIB.

Lord Howe Island Biosecurity Strategy

The Draft LHI Biosecurity Strategy (AECOM 2016) aims to ensure that the biodiversity and natural values of LHI (and the economies those values support) and the health and safety of the community are provided an Appropriate Level of Protection (ALOP) from biosecurity risks in the least trade-restrictive manner. The Strategy lists potential pathways for weeds to the Island, and includes risks associated with domestic and international movement of goods, people, vessels and aircraft. The Strategy also considers risks associated with postal items.

The Strategy provides guidance for the prevention of new weed species and pathogens being introduced to the Island through the development and implementation of the LHIB Plant Importation Policy (LHIB 2014).

Lord Howe Island Plant Importation Policy 2014

This Policy (see Appendix 1 in LHIB 2014) aims to protect LHI against the risks that may arise from introduced plants and pathogens entering, establishing and spreading on LHI.

The Policy is based on the principle that the most cost-effective means of managing weeds, plant pests and diseases is to prevent their initial incursion. This requires a collaborative effort between the LHIB, Commonwealth and State government agencies, suppliers, transport companies and the community.

This Policy plays a critical role in preventing further introduction of new weed species to LHI, as well as the reintroduction of weeds targeted for eradication.

Lord Howe Island Lagoon Foreshore Management Plan

The LHI Lagoon Foreshore Management Plan (LHIB 2015b) provides the framework within which the LHIB will manage the foreshore for the next ten years. It outlines the main values, issues, management directions and priorities for managing the foreshore consistent with the

values of the area and the resources available for management. The lagoon foreshore is a special and unique part of the island, with important scenic, conservation, tourism and recreation values and it provides opportunities for limited commercial use, and contains a number of privately held assets and essential public utilities. The foreshore is on the western side of the island, extending from the northern end of Old Settlement Beach to the southern end of Kings Beach, generally between Lagoon Road and the mean high water mark. The foreshore is Crown Land occupied under various forms of tenure, including Government Reserves, Special Leases, Permissive Occupancies and Commercial Leases pursuant to the *LHI Act*.

Lord Howe Island Permanent Park Preserve Plan of Management

The PPP covers approximately 75% of the LHIG. The PPP is not a national park but is similar in that the primary management emphasis is conservation and preservation of natural values. However, unlike a national park, the management of the PPP allows for sustainable harvesting of some natural resources (mainly palm seeds).

The PPP Plan of Management (DECCW 2010) provides specific management directions for the preservation and protection of natural values and ecological processes, restoration of disturbed areas, and scientific reference areas with minimal human interference while providing opportunities for low-impact recreation, restrictions on development and permitting of exploitative activities, which are essential to the LHI economy, under strict guidelines.

Strategic Plan for the Lord Howe Island Group World Heritage Property

This Strategic Plan (LHIB 2010) provides an overarching ten-year framework for consistent and coordinated management of the LHIG World Heritage Property by the NSW and Commonwealth agencies with responsibilities in the area. It is intended to ensure that day-to-day management of the Property complies with Australia's obligations under the World Heritage Convention and that appropriate consideration is given to protection, conservation, presentation and transmission of World Heritage values.

Lord Howe Island Revegetation Plan 2002

This Plan (LHIB 2002b) is being redrafted and aims to restore pre-existing or degraded native vegetation communities and to extend buffering of disturbed edges on LHI using the most appropriate revegetation techniques. This plan recognises that weeds play a significant role in the management of revegetation sites.

This Weed Management Strategy will inform the drafting of a revised Revegetation Plan in terms of methodologies needed to manage weeds within all revegetation sites.

Lord Howe Island Biodiversity Management Plan

The LHI Biodiversity Management Plan (DECC 2007) constitutes the formal national and NSW Recovery Plan for threatened species and ecological communities listed under the *EPBC Act* and *TSC Act* on LHI. This Plan addresses threats and management actions relevant to the Island's overall biodiversity, with a particular focus on rare and significant species and communities. The plan identifies weed invasions as one of the main threats to the Islands biodiversity. The recovery actions relevant to weed management include:

- implementing the LHIB Biosecurity Strategy (AECOM 2016);
- protecting existing native vegetation;
- on-ground eradication and control of weeds;

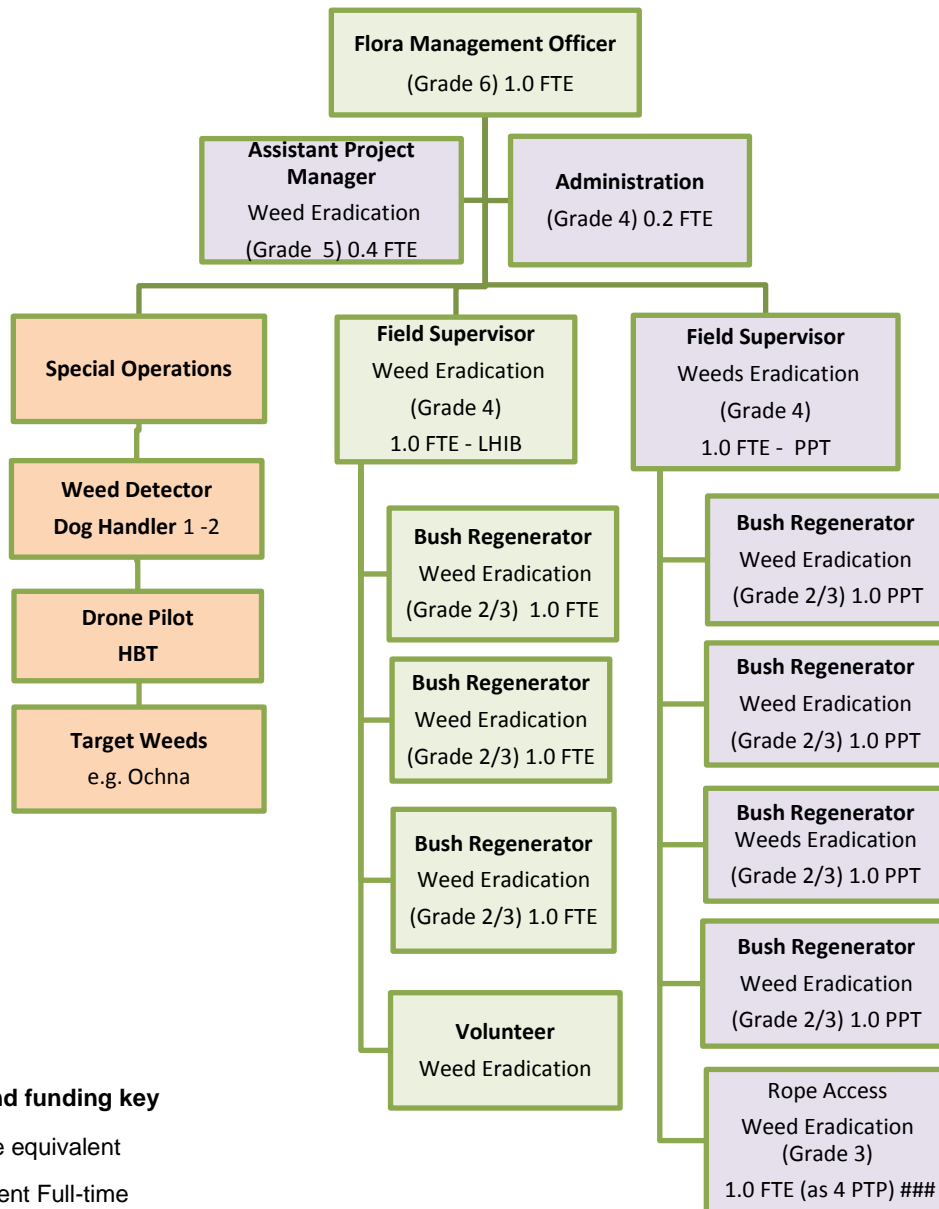
- revegetation of priority sites;
- research and monitoring into species' ecology and management options;
- monitoring the impacts of climate change; and
- community awareness.

The LHI BMP provides overall guidance for other LHI Strategies and Policies relating to maintaining LHI's biodiversity, including weed management, biosecurity and revegetation.

Appendix 4 Staffing strategy

Lord Howe Island Board Weed Eradication Program Organisational Chart

Grades are Lord Howe Island Officer in accordance with the Crown Employees (Lord Howe Island Board Salaries and Conditions) Award. Weeding positions have previously been identified as Bush Regenerators. Positions need to be aligned to 'eradication' project work noting that the approach to weeding is more time-driven and may require a higher level of physical exertion to gain access to remote areas. It is also recommended that a local four-person rope-access team is formed, working on a part-time basis (equivalent to 1 FTE; as per Section 8). Positions are subject to recurrent LHIB funding and raising funds from external sources.



Positions and funding key

FTE Full-time equivalent

PFT Permanent Full-time

PPT Permanent Part-time

Special Operations

LHIB Funding

External funding

LHIB/EXT pending skills base

Cherry Guava *Psidium cattleianum* var. *cattleianum*
Family MYRTACEAE

Life-form: Shrub to small tree.

Seed-bank persistence: Short-term persistent >1 year.

Seed: Multi-seeded fleshy fruit.

Age to reproductive maturity: 4 years.

Persistence: Shade tolerant.

History on LHI: Cherry Guava was introduced to LHI as a fruit tree, possibly as early as 1880 (Hutton & Le Cussan 2001). Plants were established in bushland gardens at Transit Hill, Lidgbird North and near Rocky Run. Cherry Guava was identified to be the most serious weed threat on LHI, growing so thickly that it crowds out other plants (Green 1994). Repeated grid-search and removal effort (to date) has depleted infestations throughout the PPP and Settlement.



Dispersal agents: Birds, potentially people; formerly Feral Pigs (*Sus scrofa*).

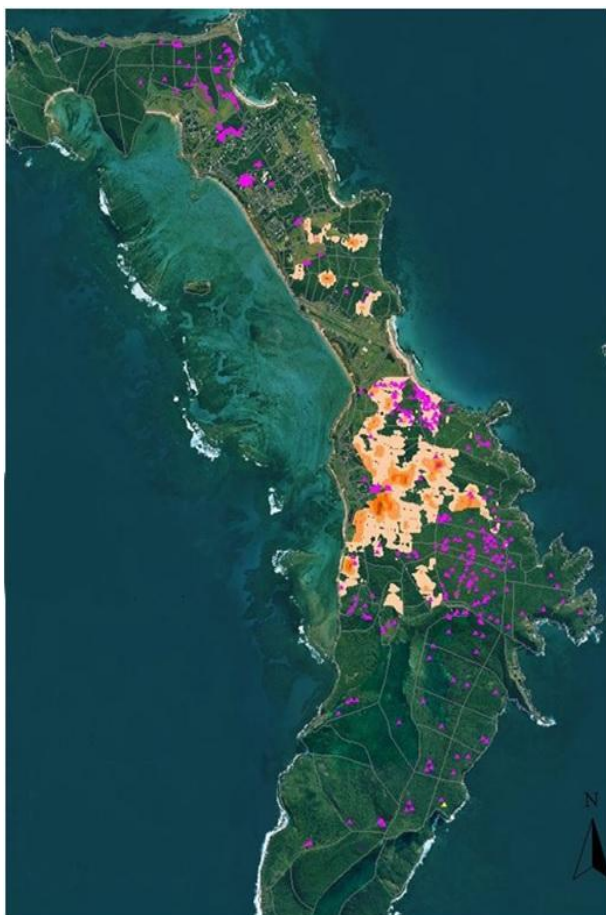
Current management status: Eradication – Active control phase.

Current abundance – 2016: Occasional and widespread, across an estimated 1064 ha, including localised patches. **Current treatment:** 2500 mature plants removed 30 June 2015 to 30 October 2016 (22 months) (LHI Weeds Database).

Numbers removed 2004–14: 704,266 plants (502,689 seedlings and juvenile plants; 201,577 mature plants). One of the most common weeds removed on LHI 2004–14.

Density and distribution: Map shows prior density mapping (orange shading) in 2002–03 and point location of plants removed (pink). Island-scale invasion capacity. The summit of Mt Lidgbird and Mt Gower, and adjacent south-facing terrain are assumed free of Cherry Guava (based on surveillance runs).

Feral Pigs were eradicated in 1979. It was a major disperser of Cherry Guava (Diong 1982), but could not reach the summit of Mt Gower (owing to cliff-lines), which is reflected in the absence of Cherry Guava there. Isolated patches of Cherry Guava on the northern flanks of Mt Gower in rugged terrain seem indicative of prior dispersal by Pigs.



Control techniques: Cut, scrape and paint, HBT.

Management challenges: Gaining access to remote terrain and outliers in the southern mountains.

Management priorities: Remote weed blocks LN-001, LN-005, LN-021, LS 009, LS 018 and Gower (north face) are a priority for repeated and timely search effort. Advance search effort and monitoring in the southern mountains (HBT, UAV, heli-winch access). Trial weed detector dogs to improve detection of low density infestations.

Key threats & impacts: Cherry Guava is a mature phase, long-lived plant that can invade and persist in undisturbed plant communities, outcompeting native plants over time will form dense monocultures.

Ecosystems or species at risk:

- Gnarled Mossy Cloud Forest
- Lord Howe Island Broom (*Carmichaelia exsul*)
- Mountain Xylosma (*Xylosma parvifolium*)
- Lord Howe Island Currant Bush (*Coprosma inopinata*)
- Hutton's Geniostoma (*Geniostoma huttonii*)