Commonwealth of Australia

Environment Protection and Biodiversity Conservation Act 1999

Section 269A

Instrument Making a Recovery Plan

I, MELISSA PRICE, Minister for the Environment, under subsection section 269A(2) of the *Environment Protection and Biodiversity Conservation Act 1999*, herby make a recovery plan for the listed threatened ecological community specified below:

Listed Ecological Community	**Recovery Plan**
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	National Recovery Plan for the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Ecological Community

Dated this 15th day of February 2019

Melissa Price

Melissa Price

Minister for the Environment

This recovery plan will come into force on the day after it is registered on the Federal Register of Legislation.

Australian Government
Department of the Environment and Energy

National Recovery Plan for the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Ecological Community

February 2019

Prepared by: Department of the Environment and Energy

Made under the *Environment Protection and Biodiversity Conservation Act 1999*

Images credits

Cover page: A patch of Littoral Rainforest in the Broken Head Nature Reserve south of Byron Bay in New South Wales (© Bill O'Donnell).

General Acknowledgements

The Department of the Environment and Energy is grateful to the organisations and individuals who contributed to or provided information for the preparation of the Recovery Plan and who were or are still involved in implementing conservation and management actions that benefit the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community.

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Acknowledgement of Traditional Owners and Country

The Australian Government acknowledges Australia's Traditional Owners and pays respect to Elders past and present. We acknowledge the deep spiritual, cultural and customary connections of Traditional Owners to the Australian land and sea country, including the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community.

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Acronyms

ARI	Average Recurrence Interval
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Commonwealth)
DEHP	Department of Environment and Heritage Protection (Queensland)
DELWP	Department of Environment, Land, Water and Planning (Victoria)
DoEE	Department of the Environment and Energy (Commonwealth)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FFG Act	*Flora and Fauna Guarantee Act 1988* (Victoria)
IBRA	Interim Biogeographic Regionalisation for Australia
MNES	Matter of National Environmental Significance
NGO	Non-government Organisation
NRM	Natural Resource Management
NSW	New South Wales
OEH	Office of Environment and Heritage (New South Wales)
RE	Regional Ecosystem (Queensland – vegetation mapping system)
SPRAT	Species Profile and Threats Database
TSC Act	*Threatened Species Conservation Act 1995* (New South Wales)
TSSC	Threatened Species Scientific Committee (Commonwealth)
VMA	*Vegetation Management Act 1999* (Queensland)

Executive summary

The Australian Government Department of the Environment and Energy has prepared this Recovery Plan to provide for the long term survival and protection of the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community (hereafter referred to as Littoral Rainforest or the ecological community), listed as Critically Endangered under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Littoral Rainforest was listed as Critically Endangered because its geographic distribution is severely fragmented and primarily consists of numerous small and disjunct patches, there are demonstrable threats impacting upon it and there have been very severe reductions in the integrity of the ecological community.

The key historic and ongoing threat to Littoral Rainforest is coastal development and, given its distribution, Littoral Rainforest is also highly susceptible to the interacting effects of climate change and sea level rise, both of which exacerbate the existing threats of habitat fragmentation and invasion by transformer weeds (Lavorel et al. 2015). Littoral Rainforest also continues to be reduced and fragmented by land clearance, weed invasion, recreational disturbance, animal browsing/grazing, fire and natural disturbance.

The objectives of the *National Recovery Plan for the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Ecological Community* (hereafter referred to as the Recovery Plan) are that by 2029:

- The management actions necessary to stop the decline of the ecological community across its distribution are well understood and being implemented;
- The known extent (area) of Littoral Rainforest has been maintained or extended;
- The condition of the ecological community has been improved across its distribution; and
- The chances of the long term persistence of Littoral Rainforest in nature have been maximised.

The Recovery Plan will be implemented through a series of hierarchical objectives, strategies and actions across both specific bioregions and the entire ecological community collectively. The key strategies designed to meet the objectives of the Recovery Plan are to:

- Implement planning, regulatory policies and actions to protect Littoral Rainforest;
- Implement management strategies and actions to reduce threats to Littoral Rainforest;
- Improve and extend Littoral Rainforest through active restoration;
- Engage with the broader public to increase awareness and community involvement in management and rehabilitation; and
- Improve knowledge on the distribution and condition of Littoral Rainforest, and monitor and report on the status of the ecological community.

Critical to the success of these objectives is the implementation of active management through natural regeneration and restoration using best practice standards and systems (as set out in the 'National Standards for the Practice of Ecological Restoration in Australia' (SERA 2015)) to prevent further degradation of the remaining patches of Littoral Rainforest within the fragmented landscape, and to promote recovery within those degraded patches. Without active management, detrimental activities like coastal development and vegetation clearing, weed invasion, feral grazing, and recreational impacts will continue. Active management includes the use of assisted natural regeneration and revegetation techniques to increase the extent and condition of vegetation in the ecological community.

1 Introduction

Before European settlement Littoral Rainforest existed as a semi-continuous group of patches distributed along the east coast of Australia. However, Littoral Rainforest has been significantly reduced since this time as a result of extensive coastal development and land clearing, weed invasion, recreational disturbance, feral animal browsing/grazing, fire and natural disturbance. Patches of Littoral Rainforest now have limited distributions and are highly fragmented throughout their range. At the time of listing, there were thought to be over 1400 separate patches of Littoral Rainforest within the areas of the defined ecological community, with a total mapped area of only 18 000 hectares (ha) (TSSC 2008).

Littoral Rainforest was listed as Critically Endangered under the Australian Government's *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2008. Littoral Rainforest provides habitat for over 70 threatened species and it provides an important buffer to coastal erosion and wind damage.

Littoral Rainforest is typically made up of rainforest and vine thickets, and occurs close to the coast and on offshore islands. The distribution of the ecological community extends from northern Queensland southwards to eastern Victoria. Littoral Rainforest occurs as a series of naturally disjunct and localised stands, on a range of landforms which have been influenced by coastal processes including dunes and flats, headlands and sea cliffs.

Although Littoral Rainforest is highly fragmented, it is also a relatively resilient ecological community. Littoral Rainforest can still maintain the features of a functioning ecosystem even after some disturbances, such as storm events and weed invasion. Nevertheless, given the range of threats impacting upon it, long term protection will be required to ensure the persistence of Littoral Rainforest into the future. Working with local land managers to implement favourable land use and management practices at sites containing this ecological community will be an essential component of broader recovery efforts.

The primary purpose of this Recovery Plan is to provide the research and management actions necessary to stop the decline, and support the recovery, of Littoral Rainforest so that the chances of its long-term survival in nature are maximised. A major focus of this Recovery Plan is to address threats affecting Littoral Rainforest. It is also intended to support the involvement of Traditional Owners in the protection and management of Country and to support decision making for environmental regulation. Importantly, under Section 139(1)b of the EPBC Act, the Minister "must not act inconsistently with ... a recovery plan" when approving referred activities. Also, under Section 268, "A Commonwealth agency must not take any action that contravenes a recovery plan or threat abatement plan."

This Recovery Plan is not intended to provide a comprehensive literature review of all of the available information for Littoral Rainforest. Rather, it includes the minimum information necessary to support funding and on-ground implementation of actions that support the recovery of Littoral Rainforest. The Recovery Plan includes the key requirements for a recovery plan under the EPBC Act. The Recovery Plan draws on and complements the information provided in the *Commonwealth Listing Advice on Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and the *Commonwealth Conservation Advice on Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* on the Species Profile and Threats Database pages at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

1.1 Community description

Littoral Rainforest is comprised of a complex of wet or monsoon tropical to warm temperate rainforests and coastal vine thickets varying in structure, dominant species leaf size and deciduousness (Webb 1959). Littoral Rainforest differs from other types of rainforest (such as lowland or upland rainforest) in its location; it is typically located within two kilometres of the coast or adjacent to a large salt water body, such as an estuary. The unifying feature of Littoral Rainforest is the adaptation of the rainforest and vine thicket community to the often harsh coastal environments through adaption to the saline conditions delivered via salt-laden winds, saline water tables and occasional inundation.

Littoral Rainforest is naturally distributed as a series of disjunct and localised stands occurring on a range of landforms derived from coastal processes, including dunes and flats, cheniers, berms, cobbles, headlands, scree, sea cliffs, coastal knolls, marginal bluffs, spits, deltaic deposits, coral rubble and islands. As a result, the ecological community is not associated with a particular soil type and can occur on a variety of geological substrata. Littoral Rainforest often forms mosaics, or transitions into, other rainforest communities on its landward side, and can merge with heath, sclerophyll forest, swamp or woodland vegetation (Keith 2004).

Littoral Rainforest is distributed across warm temperate, subtropical and tropical climate zones. The diversity of plant taxa (particularly canopy species) and the species composition within Littoral Rainforest changes on the macro-scale throughout the range, driven primarily by changes in temperature. Typically, species diversity declines in north to south direction (i.e. with increasing latitude).

Within Littoral Rainforest, structure can vary from low, closed thickets (approximately 5 m tall) to tall, closed forests (approximately 30 m high), with factors such as the amount of rainfall, shelter from wind and salt spray, and the depth of soil development, all influencing patch structure (BAAM 2013). Patches generally exhibit a closed canopy (with > 70 percent projected foliage cover) but may also be patchy and include emergents, and, due to wind sheering, stand profile generally increases in height with the progression from seaward to landward edge (Keith 2004). Those stands that occur in exposed coastal situations can have many rainforest gaps caused by storm events which, in turn, may lead to canopy decapitation. In these exposed sites, there is often a secondary canopy that has developed below the old canopy.

Littoral Rainforest's canopy species are well adapted to coastal exposure (e.g. strong and persistent salt-laden winds and storm events), while less tolerant species and propagules in the understorey are protected by the canopy. Canopy species vary from evergreen to semi-evergreen (facultative drought-deciduous) to obligate dry-season deciduous and common emergent species can include conifers such as hoop pine (*Araucaria cunninghamii)* and kauri pine (*Agathis robusta)* (Queensland Herbarium 2011). Leaf size and structure within Littoral Rainforest tends to vary along a latitudinal gradient. Larger-leaved (i.e. 12.5-25 cm in length) mesophyll species typically occur where warmer temperatures and high rainfall are prevalent (Webb 1959; Gourlay 1994) and smaller-leaved (i.e. 2.5-7.5 cm in length) microphyll species tend to occur in drier climates. However, medium-sized (i.e. 7.5–12.5 cm in length) notophyll species are predominant in most areas of Littoral Rainforest (BAAM 2013).

At its northern extent, particularly in high-rainfall sites, Littoral Rainforest can exhibit a complex rainforest structure (i.e. with features including large woody vines, epiphytes, palms and trees with buttressed roots), while at its southern extent, and in drier climes, structure tends to be simple and lacking complex features (Webb 1959). The presence and diversity of special life forms varies across the range of Littoral Rainforest, with large woody vines common in wetter and warmer areas and thinner vines more prevalent in dryer and cooler areas (BAAM 2013). Buttressed tree roots, feather palms, fan palms (*Livistona* spp.) and large-leaved epiphytes tend to be rare, except in the Wet Tropics where they are abundant (Worboys 2006), while strangler figs are common across the range of the ecological community with the exception of Victoria.

1.2 Distribution

Littoral Rainforest occurs primarily within two kilometres of the coast or adjacent to a large salt water body, such as an estuary. The listed portion of the ecological community is distributed as a series of scattered and fragmented patches from Princess Charlotte Bay on southern Cape York, Queensland to East Gippsland in Victoria, including on estuarine and offshore islands (Figure 1). However, the actual extent of littoral rainforest is known to extend beyond these boundaries. Based on available mapping data, the historical, pre-clearing extent (circa 1750) of the ecological community is estimated to have been between approximately 35 000 ha and 67 000 ha (BAAM 2013). At the time of listing, the extent of Littoral Rainforest was estimated to be approximately 18 000 ha (TSSC 2008). More recent mapping data indicate that the current extent of Littoral Rainforest may be larger than the 2008 estimate (BAAM 2013).

The total area of Littoral Rainforest in Victoria is under 300 ha (TSSC 2008). It occurs in the East Gippsland region from the Nicholson River to the west along the coastal strip to the eastern shore of Mallacoota Inlet near the New South Wales border (DEPI 2014). The total area in New South Wales is approximately 1600

ha (TSSC 2008). Many, but not all, stands of Littoral Rainforest in New South Wales have been included in mapping within the *State Environmental Planning Policy No 26—Littoral Rainforests*. The total area in Queensland is approximately 16 000 ha (TSSC 2008). In parts of Queensland, Littoral Rainforest is also referred to as 'beach scrub'. Area estimates vary depending on whether only vegetation units that wholly correspond with the ecological community definition are included or whether those that partially correspond are also included.

1.3 Objective and strategies

The overarching objective of the Recovery Plan is to:

- Provide for the management and research actions necessary to stop the decline, and support the recovery, of Littoral Rainforest so that its chances of long term survival are maximised.

The primary threats to Littoral Rainforest are human mediated as they are either a direct result of human activity (e.g. habitat clearing, degradation from human activity) or an indirect consequence of human actions (e.g. feral animals and weeds, climate change).

The following strategies are designed to achieve the Recovery Plan objective:

Strategy 1: Implement planning, regulatory policies and actions to protect Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, NRM bodies, private land owners/managers and industry bodies.

Protect the remaining distribution of Littoral Rainforest and its surrounds from:

- coastal development and land use change, including urban development, mining and industrial development
- climate change, particularly sea level rise impacts

Strategy 2: Implement management strategies and actions to reduce threats to Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, NRM bodies, community organisations, researchers.

Reduce threats to Littoral Rainforest posed by:

- livestock grazing
- feral animal activity
- invasive weeds
- pathogens and disease
- changes in fire regime (particularly increased frequency)
- damage and degradation by recreational and other use (vehicles, camping)
- damage and degradation by storm surge events and extreme tides, and
- hydrological change (e.g. to drainage and runoff from adjacent areas).

Strategy 3: Restore and extend Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, private land owners/managers, NRM bodies, community organisations.

Implement the following:

- Rehabilitation and restoration activities to restore vegetation structure and control invasive plant species, and
- Actions to increase connectivity, enhance migration and create natural buffers

Strategy 4: Engage with the public to increase awareness and community involvement in management and rehabilitation

Relevant for: Australian, state and local government, Indigenous land managers, private land owners/ managers, NRM bodies, community organisations, science organisations.

Carry out the following:

- Engage with Indigenous land managers to help protect and rehabilitate Littoral Rainforest on country
- Engage with the public and local land owners/managers to promote the values of Littoral Rainforest and drive community involvement in management, and
- Assist with funding applications for management and rehabilitation activities.

Strategy 5: Improve knowledge on the distribution and condition of Littoral Rainforest, and monitor and report on the status of the ecological community

Relevant for: state and local governments, science organisations, Indigenous land managers, NRM bodies, community organisations.

Conduct the following:

- Fine-scale mapping of Littoral Rainforest, across the extent of the ecological community, to establish distribution at local and regional management scales
- Establish baseline conditions at local and regional scales and compare these against the condition thresholds (i.e. patch size, transformer weed cover, percent native species and percent rainforest species in canopy cover)
- Monitor and evaluate patches at regular (maximum 5 yearly) intervals and report trends in extent and/or condition to the relevant management agencies
- Improve understanding of fragmentation impacts on Littoral Rainforest and the contribution of small patches to the long-term viability of the ecological community
- Monitor structural and compositional change at a sample of sites with varied levels of protection and exposure to threats
- Develop effective restoration techniques tailored to specific species assemblages and threat contexts.

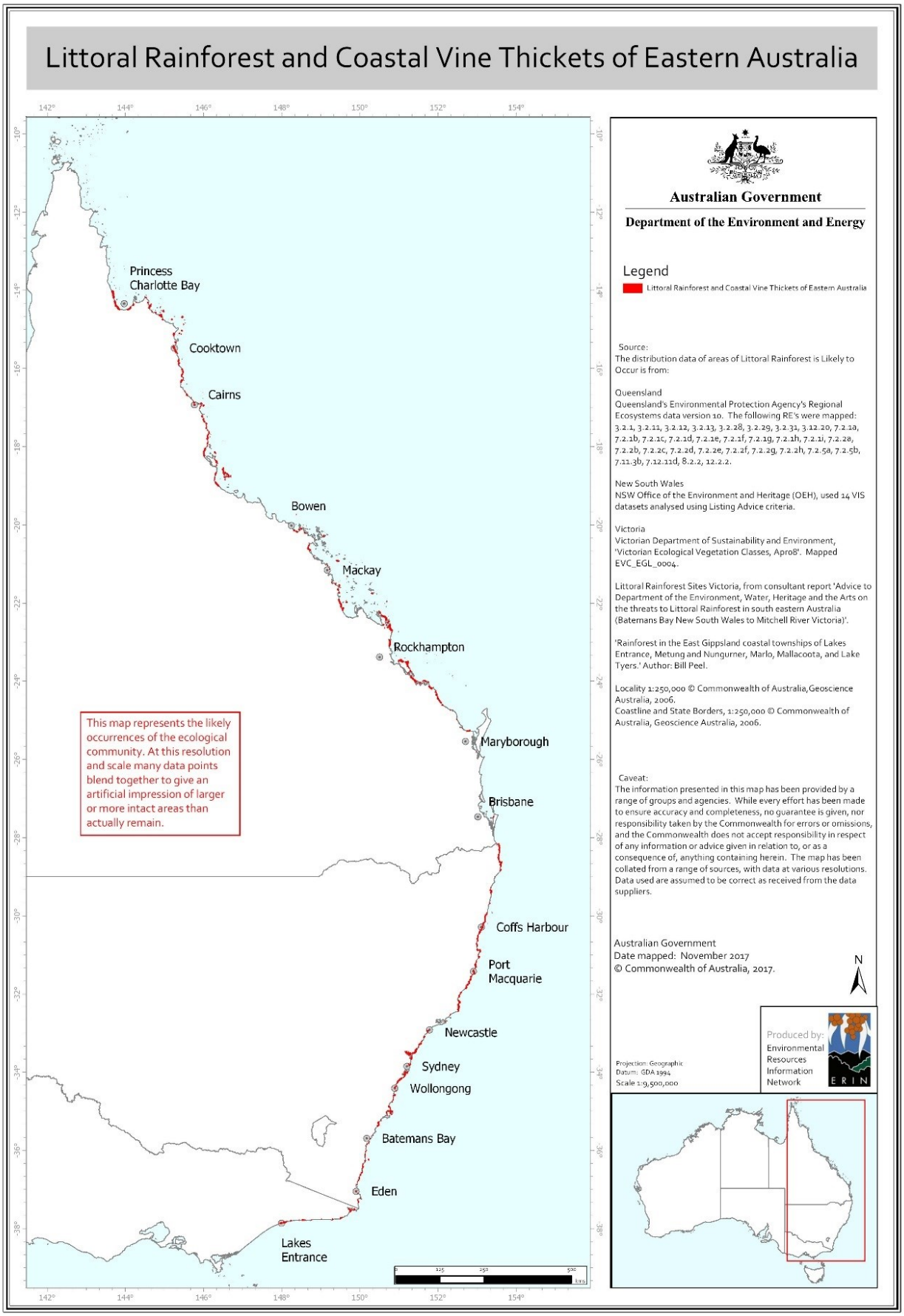

Figure 1: *Map of the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community.*

1.4 Legislative context

Recovery plans are a legislative instrument under the EPBC Act that detail the threats impacting on listed species and ecological communities, and identify the management responses required to protect, restore and recover the listed entity.

This is the first national recovery plan for the ***Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community***, listed as Critically Endangered under the EPBC Act.

1.4.1 National conservation status

Littoral Rainforest is typically considered threatened due to:

- A very restricted geographic distribution coupled with demonstrable threats, and
- A severe reduction in community integrity across its range.

Listing under national legislation means that any new or intensified activities that may have a significant impact on Littoral Rainforest require approval under the EPBC Act. Relevant national policies and resources for Littoral Rainforest, including the national Listing and Conservation Advices can be found at: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=76

1.4.2 State conservation status

Littoral Rainforest is also attributed various levels of protection under State legislation within the different states in which it occurs, as shown in Table 1.

Table 1: *National and state conservation status of Littoral Rainforest (as of November 2016).*

Legislation*	Conservation Status
Environment Protection and Biodiversity Conservation Act 1999	Critically Endangered
Threatened Species Conservation Act 1995 (NSW)**	Endangered
Vegetation Management Act 1999 (Qld)***	Least concern / Of concern / Endangered

*At the time of writing, Littoral Rainforest (as defined within the Commonwealth Listing Advice) was not included in the list of 'Taxa and Communities of Flora and Fauna which are Threatened' under the Victorian *Flora and Fauna Guarantee Act 1988*.

**The above-listed conservation status of Littoral Rainforest in New South Wales only applies to patches identified in the 'Littoral Rainforest in NSW North Coast, Sydney Basin and South East Corner Bioregions – endangered ecological community listing', which can be found at:

http://www.environment.nsw.gov.au/determinations/LittoralRainforestEndSpListing.htm

***The *Vegetation Management Act 1999* status (i.e. conservation status) of patches of Littoral Rainforest in Queensland varies in relation to the Regional Ecosystem unit with which each patch is associated. Some patches that meet the EPBC Act listing are too small to be mapped as a Regional Ecosystem, and therefore have no Vegetation Management Act 1999 status.

1.5 Stakeholders and other interests

The groups listed below are likely to be affected by the Recovery Plan's implementation because they own or manage (or may otherwise influence management of) relatively large areas of land on which the ecological community occurs.

The major affected groups are:

- Private landholders/residents and property developers with remnant patches of Littoral Rainforest
- Australian Government and Queensland, New South Wales and Victorian state government agencies and organisations
- Local councils and other public land management agencies
- Traditional Owners
- Non-government organisations, NRM bodies and community groups
- Organisations operating in National Parks and State Forests

This list should not be considered exhaustive. It is necessary for parties to fully understand their obligations to avoid significant impacts to Littoral Rainforest, and to act consistently with the actions outlined in this plan.

1.5.1 Indigenous knowledge, role and interests

There is a strong relationship between Littoral Rainforest and sites of important cultural significance for Indigenous people. The rainforest provides rich sites for hunting and gathering and its location by the sea is ideal for meeting and camping. A number of Littoral Rainforest sites are located on Aboriginal Land and some have Native Title recognition.

Littoral Rainforest is a highly valued ecosystem for Indigenous Australians who have lived within, and felt a connection to, this ecological community. Cultural artefacts have been found in patches of Littoral Rainforest from across the range of the ecological community and, in Victoria, a women's sacred site and birthing place have been discovered in Littoral Rainforest (B Peel pers. comm. cited in BAAM 2013). Across the distribution of the ecological community, Indigenous Australians utilise patches of Littoral Rainforest as places of recreation and learning, including for the teaching of traditional practices, arts and craft, and shelter construction and for the collection of bush foods and medicine (BAAM 2013).

Littoral Rainforest was historically important to Indigenous coastal communities due to the provision of foods, fibres and medicines. In particular, an important component of the diet of local communities was provided in the form of the vitamins, trace elements, proteins and fats that were acquired from the wide range of fruits harvested (BAAM 2013). Fruits found in Littoral Rainforest vary across the distribution of the ecological community. Common and/or well known fruits include: gooseberry (*Buchanania arborescens)*, broad-leaved native cherry (*Exocarpos latifolius)* and wild apple (*Syzygium suborbiculare)* in the Cape York region; banyan (*Ficus virens)*, Burdekin plum (*Pleiogynium timoriense),* cheese fruit (*Morinda citrifolia)* and lawyer cane (*Calamus caryotoides)* in the Wet Tropics region; lilly pilly (*Syzygium smithii)* and wild grapes (*Cissus hypoglauca),* and young shoots and leaves of pandanus (*Pandanus* spp.) in south-eastern Queensland, northern New South Wales and Sydney Basin regions (Isaacs 2002). In south-east New South Wales and northern Victoria fruits of the lilly pilly and the cabbage-tree palm (*Livistona australis)* were important food sources, rhizomes from common bracken (*Pteridium esculentum)* were beaten into a paste, roasted and eaten and flowers of *Callistemon* species were sucked for nectar (Isaacs 2002). Basket weaving material

often included the leaves of long-leaf mat-rush (*Lomandra longifolia),* while leaf bases were eaten raw (Low 1989).

Gathering of fruit in Littoral Rainforest habitats was also accompanied by hunting of a variety of mammals and birds that were attracted to the fruiting plants, as well as hunting of snakes which were drawn in by the high abundances of mammals and birds. Numerous insect larvae, snails and other invertebrate taxa were also collected from the moist environments of Littoral Rainforest (Isaacs 2002). Large shell middens have been found around the Clarence Estuary near Iluka in New South Wales (Grantley 2010).

Many plant species were valued for their medicinal purposes: stingray and stonefish stings were treated with heated leaves from the peanut tree (*Sterculia quadrifida)*; swelling and diarrhoea were remedied using the leaves of the sandpaper fig (*Ficus opposita)*, wounds were treated with a bark infusion made from the cocky apple (*Planchonia careya)*; coughs and chest trouble were healed by a tonic created from native sarsaparilla (*Smilax glyciphylla);* rheumatism and sprains were treated with boiled leaves or a poultice created from stinging nettle (*Urtica incisa);* and the seeds of the buttercup orchid (*Cymbidium madidum)* were said to confer sterility (Isaacs 2002). Stomach ailments, muscular pains and toothaches were remedied with various concoctions derived from the young leaf tips, bark and wood of the red ash (*Alphitonia excelsa)* (Low 1990).

Many Indigenous groups continue to have a deep connection with Littoral Rainforest. However many Traditional Owners may know patches of the ecological community by place name, rather than by vegetation type. There are a number of Indigenous groups and Traditional Owners that have in the past or are currently involved in the rehabilitation of Littoral Rainforest sites.

1.5.2 Values of local ecological communities and native vegetation to people

As Littoral Rainforest occurs at the transition zone between terrestrial and aquatic ecosystems, it provides numerous vital ecosystem services that benefit humans and the coastal communities they inhabit (Lavorel et al. 2015). Littoral Rainforest protects the land from coastal erosion, mitigates the effects of flooding and wind damage caused by heavy storms, filters sediments, nutrients and pollutants and provides habitat for biodiversity (Lavorel et al. 2015). Coastal communities and their associated infrastructure and industries, including roads, marinas, agricultural areas (e.g. fruit, nut and sugar cane farms) and aquaculture operations, are all provided a degree of protection by the foreshore vegetation and natural dunes associated with Littoral Rainforest (Lavorel et al. 2015).

In addition, Littoral Rainforest provides an important recreational space for activities such as camping, walking and picnicking (Lavorel et al. 2015), which may provide psychological benefits to local communities and other users (Fuller 2007). Many of the ecosystem services provided by Littoral Rainforest also confer ‘climate adaptation services’, defined as benefits to humans that may be derived from the “capability of ecosystems to moderate and adapt to climate change and variability” (Lavorel et al. 2015).

2 Threats

2.1 Significant impacts from anthropogenic actions

An action is likely to have a significant impact on a Critically Endangered or Endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community overall and/or for a particular patch; refer to the Listing Advice and/or Policy Statement 3.9 for patch definitions, minimum size and condition thresholds, and other considerations;
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation;
- adversely affect habitat critical to the survival of an ecological community;
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;
- cause a substantial change in the species composition of a patch of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;
- cause a substantial reduction in quality or integrity of a patch of an ecological community, including, but not limited to: assisting invasive species to become established (refer to Listing Advice and/or Policy Statement 3.9 for condition thresholds);
- cause mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or
- interfere with the recovery of an ecological community.

If there is scientific uncertainty about the impacts of an action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on an ecological community (Matters of National Environment Significance: Significant impact guidelines 1.1).

2.1.1 Guidance on Significant impacts

Patch sizes for Littoral Rainforest vary from < 1 ha to > 100 ha, although large patches are now rare. The loss of, or disturbance to, the highest quality patches, or habitat critical to the survival of Littoral Rainforest, is highly likely to lead to a long term loss in the overall extent of the ecological community.

Development related activities such as vegetation clearing, excavation and earthworks within and adjacent to Littoral Rainforest are highly likely to adversely affect the ecological community, if not directly then indirectly through impacts to individual sites and the subsequent accumulated losses across the ecological community as a whole. These activities reduce the size of patches and the extent of Littoral Rainforest by directly affecting small clumps or indirectly destroying or degrading the quality of habitat. This further disrupts connectivity and effective functionality of Littoral Rainforest and its component parts, including species prevalence and habitat structure.

The option of a buffer and its width depends on the local landscape context and patch sizes. Decisions on buffer size should be informed by the guidance in Section 3.7 below, and an investigation of the project area. Information relevant to buffer definitions and width includes the degree of isolation of the site, patch size, the local availability of alternative patches, plus information

on the nature of the proposed impact, strategies to avoid or mitigate impacts, and the duration and intensity of the impact.

2.1.2 Avoiding or mitigating likely significant impacts

The primary way to prevent the decline of Littoral Rainforest is to protect remnant patches that meet the condition thresholds in the Listing Advice. This includes not undertaking activities within close proximity that could impact on the extent, quality and functionality of Littoral Rainforest. The primary goal should be to avoid all impacts to patches of Littoral Rainforest. Offsets should be considered a last resort after all avoidance and mitigation measures have been exhausted and residual impacts remain. Offsets do not mean proposals with unacceptable impacts will be approved (Section 6.2.2 Offsetting).

Nevertheless, restoration and revegetation activities are valuable options for patches lost or degraded by significant impacts. This requires an understanding of the value of the patch to be lost, based on the condition thresholds specified in the Listing Advice (i.e. its size, species composition and structure, and the prevalence of transformer weeds). Any proposals to restore or revegetate habitat to offset the loss of an existing patch need to consider carefully how and where best to implement the action and must include monitoring to ensure its success.

2.2 Key threats

There are numerous threats currently impacting upon Littoral Rainforest, or which may potentially impact the ecological community in the future. The majority of these threats can be considered to be human-mediated as they are either a direct result of human activity or an indirect consequence of human actions. These human-mediated threats interact with natural perturbations to Littoral Rainforest and can result in alterations to the healthy functioning of the ecological community.

What was once a semi-continuous archipelago of patches of Littoral Rainforest along the eastern coast of Australia, has been reduced and fragmented primarily by coastal development, sand mining and agriculture (Bradley & Merrilyn 1992). As Littoral Rainforest is located on, or in close proximity to, the coastline, which is a focal point for human settlement and urbanisation in Australia, coastal development is a key historic and ongoing threat to the ecological community (Lavorel et al. 2015). This distribution also makes Littoral Rainforest highly susceptible to the interacting effects of climate change and sea level rise, both of which exacerbate the existing threats of habitat fragmentation and invasion by transformer weeds (Lavorel et al. 2015). Littoral Rainforest continues to be reduced and fragmented by land clearance, weed invasion, recreational disturbance, animal browsing/grazing, fire and natural disturbance. These threats have serious implications for the long term persistence of Littoral Rainforest, particularly for smaller, isolated patches or heavily degraded patches. Current and ongoing threats to the ecological community are summarised in Table 2 and described below. Further information is available in the Listing Advice and Policy Statement 3.9. Recovery actions (Section 5.4) aim to address these threats in a strategic and cost effective manner.

2.2.1 Urban development

The principal threat to the biodiversity of Littoral Rainforest is the further loss and fragmentation of habitat likely to result from ongoing coastal development, with urban development recognised as a key pressure on Australia's coastal environment (Beeton et al. 2006). The coastal areas of eastern Australia support the majority of the region's population (60-70 percent) (BAAM 2013). Coastal development is likely to intensify over time due to the predicted increase of the population, particularly along the east coast of Australia (Beeton et al. 2006). Statistics show that coastal urban development continued to increase from 1980 to 2004, and this trend is not predicted to change in the near future. Projections indicate that more than 40 percent of the Nowra (NSW) to Noosa (Queensland) coastline will be urbanised by 2050, resulting in significant losses of Australia's temperate and tropical coastal systems (Beeton et al. 2006), including Littoral Rainforest (TSSC 2008).

Along the Queensland coast, the human population is projected to increase significantly, with the total population in Queensland predicted to rise by five million people in 50 years, from 4.1 million in 2006 to 9.1 million in 2056. Overall, population growth is predominantly centred on coastal areas. For example, within the Mackay and Northern statistical divisions (which overlap with the Wet Tropics Bioregion), the population is projected to grow by approximately 43 percent and 40 percent, respectively, between 2006 and 2031 (Queensland and Statistical Divisions 2011). In New South Wales, coastal regions will continue to have the fastest growth rates in the state. The Department of Planning and Environment projects that between 2011 and 2036 the total population of New South Wales will grow by 2.71 million (NSW Planning & Environment 2016). In Victoria the population in East Gippsland is projected to grow by approximately 10 000 people between 2011 and 2031 (DELWP 2016). Major population centres likely to be impacted in East Gippsland include Lakes Entrance, where Littoral Rainforest occurs, Bairnsdale and Orbost (DELWP 2016). As well as development pressures associated with local and regional population growth, there is likely to be additional pressure associated with tourist infrastructure and second dwellings owned by non-residents.

Figure 2: *Clearing of vegetation for a residential development adjacent to Littoral Rainforest. The patch was incorrectly defined in Regional Ecosystem mapping but following ground surveys was identified as Littoral Rainforest (© Helen Murphy).*

In addition to the direct impacts of land clearing, coastal development can also result in a wide range of other indirect impacts to Littoral Rainforest, such as increased weed invasion, dumping of garden waste and other rubbish, pollution and disturbance to native fauna from domestic pets (BAAM 2013). Pollutants (such as detergents) that break down the protective waxy cuticle on leaves may threaten Littoral Rainforest species, such as coast banksias (*Banksia integrifolia)* and hoop pines (*Araucaria cunninghamii),* by allowing salt to penetrate and damage the plant (Morris 2003).

2.2.2 Tourism and visitor disturbance

Tourism and visitor disturbance within Littoral Rainforest pose an ongoing threat. According to the Bureau of Tourism Research (DISR 2001), 50 percent of international visits and 42 percent of domestic visits are to coastal areas. Due to the ongoing demand for tourism and recreational facilities to cater for users of coastal and marine ecosystems (Ward & Butler 2006), this trend is likely to increase over time. Such pressure is likely to result in more development on coastal land and a rise in visitor numbers in conservation areas where Littoral Rainforest occurs (TSSC 2008).

Visitor disturbance in conservation areas includes soil compaction and disturbance, erosion from foot, cycle, trail bike and four wheel drive tracks, the introduction of pests and the creation of new planned

and unplanned tracks. Increased visitation results in increased demand for and use of visitor facilities, such as walking tracks, viewing platforms, toilet blocks and picnic areas, many of which are located in Littoral Rainforest patches because of their attractive landscape features (shade, open understorey and proximity to the sea). These impacts hinder the recruitment of key canopy species, slowing regeneration rates and facilitating establishment of weeds. Other impacts include the dumping of cars; rubbish; and garden waste, which has the potential to cause weed infestation (NSW Scientific Committee 2004). For example, in the Central Mackay Coast Bioregion, the ecological community receives high use by recreational vehicles and foot traffic where it occurs close to urban areas. At Corringle Slips and near Orbost, Wingan Inlet and Mallacoota in Victoria recreational development, such as campgrounds, is the most common and ongoing key threat to Littoral Rainforest (Peel 2010).

Figure 3: *Beach access track through a Littoral Rainforest patch in the Cape York Peninsula bioregion of Queensland (© Andrew Ford).*

2.2.3 Climate change

Another significant threat is climate change, which has the capacity to augment the detrimental effects of natural disturbances and other threats, including fire and invasive weeds. As a result of climate change, the following changes are likely to impact Littoral Rainforest: rising sea levels; increased rainfall variability; and increased frequency of severe weather events which are projected to lead to major coastal erosion events, storm surges and saline inundation (DSE 2004b; Lavorel et al., 2016). In north-east Queensland climate change scenarios are predicted to result in increased temperature and increased potential evaporation, possible overall deceases in rainfall but increases in rainfall intensities, and changes in the frequency and intensity of tropical cyclones resulting in potentially widespread impacts across tropical rainforests and the Great Barrier Reef (Suppiah et al. 2010).

Given its coastal location, sea level rise is of particular concern for Littoral Rainforest, as it will expose the ecological community to increased inundation and disturbance and is likely to result in increased habitat fragmentation and create opportunities for further weed invasion (Lavorel et al. 2016). Under conservative climate change predictions, Littoral Rainforest is likely to experience reductions in diversity and changes in community composition as plant tolerance limits are exceeded in response to temperature and water availability: As climate change scenarios increase in severity, the structure of the ecological community is expected to undergo a process of simplification (Lavorel et al. 2016), resulting in physical canopy damage, loss of emergent trees, reduced canopy height and increased

canopy gaps (Kellner & Asner 2009). Dieback within patches of Littoral Rainforest may also be exacerbated by climate change (BAAM 2013).

Predicted rising sea levels, increases in storm surges, flood occurrences and cyclone intensity, and potential increases in extreme fire events during the dry season, are all expected to result in transformative changes to the structure, function and composition of Littoral Rainforest (Lavorel et al. 2016). The proliferation of coastal developments, together with natural barriers along the margins of many patches, considerably restricts the potential shoreward migration of Littoral Rainforest, thus many patches of this ecological community may be lost or transformed to mangroves as the impacts of climate change unfold (Lavorel et al. 2016).

2.2.4 Weed invasion

Weed species are dispersed across the landscape by people, animals and through physical processes such as wind and water. Due to its naturally fragmented distribution, Littoral Rainforest is susceptible to weed invasion, which is further exacerbated by natural and human-induced disturbances (BAAM 2013). Weed species compete with native plants for space, water and nutrients, and weeds have been observed to kill mature Littoral Rainforest trees (Peel 2010). Weed invasion has the potential to reduce native plant diversity in Littoral Rainforest patches (BAAM 2013).

Transformer weeds are highly invasive taxa with the potential to seriously alter the structure and function of the ecological community. Whilst it is accepted that the ecological community can tolerate a significant amount of weed cover due to its relative resilience, if left unchecked, such weeds will eventually take over and destroy the affected patch. Some weeds that invade Littoral Rainforest, notably pond apple *(Annona glabra)*, lantana (*Lantana camara*), bitou bush *(Chrysanthemoides monilifera* subsp*. rotundata)*, asparagus fern (*Asparagus aethiopicus*) and rubber vine *(Cryptostegia grandiflora)* are recognised as Weeds of National Significance (i.e. high impact, highly invasive species) (TSSC 2008).

The establishment of transformer weeds in Littoral Rainforest patches have been observed to have a significantly detrimental effect (TSSC 2008). For example, an assessment of littoral forest in the Wet Tropics of far north Queensland, found that exotic coconuts (*Cocos nucifera*) are a major transformer weed species and a significant threatening process to remnant forest in the littoral zone. Coconuts are highly invasive and form monocultures that compete with, and suppress recruitment and seedling development of, native littoral species. In parts of the Daintree coast, especially in the Cape Tribulation region, coconuts now occupy 80-100 percent of the littoral zone (Spencer et al. 2010).

Transformer weeds of the warm temperate climate zone of south-eastern Australia, such as cape ivy *(Delairea odorata),* bitou bush, lantana and madeira vine *(Anredera cordifolia)*, also extend into the sub-tropical zone of northern New South Wales (Williams 1993; Peel 2010). Rubber vine and Siamese cassia *(Senna siamea)* are currently a problem near Princess Charlotte Bay and within Lakefield National Park, Cape York Peninsula, and have the potential to expand if left unchecked. This indicates certain transformer weeds have the capacity to significantly expand their range on the eastern coastline (TSSC 2008).

Whether the ecological community is protected in reserves or not, the risk of weed infestation increases where patches of the ecological community are located near human habitation and/or are subject to visitor disturbance (TSSC 2008). This is supported by Peel's (2010) study where a positive correlation was found between proximity to human activity and weed invasion based on a sample of 251 sites, with the majority of weeds recorded having been incidentally introduced through human activities such as agriculture, recreation, domestic gardens and associated refuse dumping.

Weed invasion also occurs through seed dispersal by birds and mammals. For example, this mode of dispersal has led to weed infestations of wilderness areas, such as Croajingolong National Park and Howe Wilderness in Victoria (TSSC 2008). In New South Wales, many coastal habitats have been

invaded by bitou bush through the spread of fruit by birds and flying foxes (TSSC 2008). Bitou bush smothers canopy and may form dense growth around the edge of Littoral Rainforest (Adam 1992). This transformer weed has also spread into Queensland where it has the potential to flourish in rainforest stands in the south-east. In the Cape York Peninsula Bioregion transformer weed invasion is mainly attributable to disturbance by cattle and pigs (Stanton & Fell 2005).

Figure 4: *Weed infestation, by Singapore daisy (Sphagneticola trilobata), in the understorey of a patch of Littoral Rainforest in the Wet Tropics (© Andrew Ford).*

2.2.5 Fire

The fire tolerance of Littoral Rainforest varies across its distribution. In general, Littoral Rainforest is a fire-sensitive class of vegetation, with high intensity fires posing a risk to both mature trees and seedlings (Miles & Kendall 2006). However, some Littoral Rainforest plant species are capable of re-sprouting following low intensity fires (Miles & Kendall 2006) and some vegetation types, such as brush box (*Lophostemon confertus)* habitat along the headlands of northern New South Wales, are relatively fire tolerant (Floyd 1990b).

Coastal processes (including high humidity, oceanic aerosols, wind direction, abundance of surface water) associated with Littoral Rainforest, and the presence of fire retardant vegetation (such as mangroves and salt marshes), confer some degree of fire protection. The presence of a salt haze around patches can also reduce risk as salt retards fire and can slow combustion of potential fuels (BAAM 2013). Nevertheless, the accumulation of fuel loads derived from highly flammable weeds increases the risk of fire which, depending on its intensity and frequency, can destroy a patch if not suppressed. Research by Peel (2010) indicates that fire has the potential to eliminate complete stands of Littoral Rainforest. If fire were to occur in the early stages of succession development, Littoral Rainforest may return to a woodland state (BAAM 2013). The fragmented nature of Littoral Rainforest, and the relatively small-sized patches, increases the risk of irreversible damage from fire.

2.2.6 Agriculture

Grazing is the most extensive land use in Australia (DoEE 2016b), with most historical clearing of Littoral Rainforest having been driven by the conversion of land for agricultural uses (BAAM 2013). Many patches of Littoral Rainforest are within the vicinity of, or adjoining, agricultural land uses including grazing. Biodiversity can be affected in a number of ways as a result of the grazing impacts of introduced herbivores, primarily cattle and sheep (DoEE 2016b). The impacts of grazing can include trampling and fouling of waterholes, selective, indiscriminate or close grazing of vegetation

and the introduction and spread of weeds, in addition to the physical removal of vegetation to free up land for stock (DoEE 2016b). These impacts can affect the biodiversity of forest and woodland ecosystems through reductions to the quality of mid-storey and understorey vegetation. As the ecosystems are simplified subsequent declines in the number of species, or their genetic variability, can occur causing ecosystem resilience to decrease (DoEE 2016b).

2.2.7 Feral animals

Across its' distribution Littoral Rainforest is impacted by the grazing, browsing, trampling and digging activities of a number of feral herbivores, including deer, rabbits and pigs. The impacts of these feral species can prevent the establishment of seedlings, open up the understorey and create gaps in vegetation that may facilitate weed invasion, all of which can alter community composition and vegetation structure (Taylor et al. 2011).

Grazing and browsing by feral Sambar deer *(Cervus unicolor),* hog deer *(Axis porcinus)* and Rusa deer *(C. timorensis)* has been shown to detrimentally impact the ecological community on both a local and landscape level. These activities can result in structural modification, erosion and altered species composition within Littoral Rainforest. Rubbing causes direct physical damage to established trees, while browsing prevents regeneration of Littoral Rainforest canopy and understorey species and creates gaps in the vegetation which allows colonisation by weeds. This has occurred in the area near Genoa River, in Victoria, where the vegetation gaps have been colonised by cape ivy (*Delairea odorata*) and dense thickets of Madeira Winter-cherry *(Solanum pseudocapsicum*). When infestations are severe these weeds contribute significantly to the collapse of existing Littoral Rainforest patches through the smothering of shrubs and young trees (Peel et al. 2005). Severe damage to Littoral Rainforest by feral deer has also been observed from Twofold Bay in New South Wales to the Gippsland Lakes in Victoria. Persistent deer infestations are documented as causing the local loss of rainforest species and whole sections of mature rainforest in Victoria (Peel et al. 2005). The coastal expansion of feral deer has reached at least as far north as Bermagui. Within the range of the deer patches of littoral rainforest (e.g. Marl Island) have been destroyed (Peel 2010). In the Royal National Park in New South Wales, herbivory by Rusa deer has led to a 54 percent reduction in understorey plant species richness in sites where deer densities are high (Moriarty 2009) and caused a 75 percent reduction in cover of the threatened plant magenta lilly pilly *(Syzygium paniculatum)* (Keith & Pellow 2005). In the East Gippsland region of Victoria, Sambar deer are the most damaging feral species impacting upon Littoral Rainforest (Peel et al. 2005). 'Herbivory and habitat degradation caused by feral deer' is a listed Key Threatening Process under the New South Wales *Threatened Species Conservation Act 1995.* 'Reduction in biodiversity of native vegetation by *Cervus unicolor* (Sambar Deer)' is a listed Key Threatening Process under the Victorian *Flora and Fauna Guarantee Act 1988.*

Feral rabbits are also impacting upon Littoral Rainforest, with documented cases of herbivory causing damage to the understory of patches of the ecological community on Cabbage Tree Island, New South Wales (Werren & Clough 1991), and exposing nesting Gould's petrels (*Pterodroma leucoptera)* to increased predation risk. In the Tambo River region of East Gippsland, the initially limited regeneration of Littoral Rainforest was attributed to herbivory by rabbits, with rapid recruitment of native ground cover and shrubs beginning to occur following the implementation of a rabbit control program (Peel 2010).

Native fauna species inhabiting patches of Littoral Rainforest are threatened by predation and competition from feral animals. In particular, feral cats *(Felis catus)* and foxes *(Vulpes vulpes)* are known to prey on native mammals, birds, reptiles and insects (DoEE 2016a). Cane toads *(Bufo marinus)* can poison native predators, such as snakes and quolls, and can compete with native animals for shelter (DEWHA 2010). Black rats *(Rattus rattus)* can compete with native species such as the bush rat *(Rattus fuscipes)* and exclude them from relatively undisturbed patches of Littoral Rainforest (Stokes et al. 2009).

Interactions between exotic scale insects and invasive ant species which farm them for their honeydew can also be detrimental to Littoral Rainforest, particularly on coral cays. When invasive African big-headed ants (*Pheidole megacephala)* and coastal brown ants (*Pheidole megacephala)* are present, scale insects, such as the Caribbean species *(Pulvinaria urbicola)*, can reach such high densities that they defoliate trees (Smith & Papacek 2001). Repeated defoliation over time can kill trees and reduce the extent of Littoral Rainforest patches (Smith et al. 2004), as has been documented on the coral cay, Tryon Island, Queensland (Smith & Papacek 2001). Native impacts that are introduced to areas outside of the natural biogeographic range can also pose a threat to Littoral Rainforest. For example, the planthopper (*Jamella australae)* caused massive damage to pandanus trees (*Pandanus tectorius)* when it was introduced to south-east Queensland and north-east New South Wales, particularly in Burleigh Heads National Park and Noosa National Park where 75 percent of pandanus trees were destroyed (Smith & Smith 2000).

2.2.8 Mining and industrial development

Mining and industrial development pose a threat to Littoral Rainforest, especially in Queensland where these activities are increasing in some regions. For example, in the Gladstone area, ports and gas terminals are under construction or proposed on Curtis Island, and the development of an alumina refinery south of the city has resulted in clearance of vegetation on Boyne Island to create room for tailings dams (BAAM 2013).

In northern New South Wales, sand mining historically posed a significant threat that resulted in the destruction of numerous stands of Littoral Rainforest (Floyd 1990b), including near Harrington just south of Port Macquarie (Williams 2002). Sand mining is now primarily limited to North Stradbroke Island and Cape Flattery on southern Cape York in Queensland (BAAM 2013). At Cape Flattery sand mining is responsible for the ongoing clearing of vegetation in patches of Littoral Rainforest, while on North Stradbroke Island sand mining is not directly threatening any known patches of Littoral Rainforest but may be indirectly impacting the ecological community through hydrological changes (Worboys 2006).

2.2.9 Exotic pathogens

Exotic pathogens may impact upon the integrity and survival of patches of Littoral Rainforest. Of the greatest concern is the exotic fungal pathogen from South America known as myrtle rust (*Puccinia psidii)* which infects species in the Myrtaceae family, a prominent plant family in Littoral Rainforest. Myrtle rust is known to infect dominant canopy species of the genus *Syzygium* and may thus pose a significant threat to patches of Littoral Rainforest (Queensland Herbarium 2011; Keith 2004). The spread of myrtle rust is difficult to control as the pathogen is wind dispersed. However, fungicides can be used effectively to treat individual infected plants (Carnegie & Cooper 2011).

Myrtle rust infestations are known to overlap with parts of the range in Victoria, New South Wales and Queensland. Myrtle rust predominantly effects new plant growth and does not appear to kill most of its host species, with the exception of some particularly susceptible species such as *Rhodamnia* species and native guava (*Rhodomyrtus psidioides)* (BAAM 2013). Nevertheless, as the potential effects of myrtle rust are increased in the seedling stage, impacts to recruitment and changes to patterns of species dominance may become evident over longer timeframes. Conversely, some species may evolve resistance to the effects of myrtle rust over time, thus reducing the scale of potential impacts (BAAM 2013).

Native pathogens may also impact patches of Littoral Rainforest. For example, the root rot pathogen *Phellinus noxius* is known to affect tree and shrub species found in Littoral Rainforest. *P. noxius* is known to lead to the death of its host plants by attacking tree roots, causing decay and cutting off water and nutrient supplies to the crown (DEEDI 2010). Literature shows that this native pathogen has caused the death of an endangered scented Acronychia (*Acronychia littoralis*) individual, and several

other plant species, in a patch of Littoral Rainforest in Cape Byron State Conservation Area, New South Wales, in 2003 (Pegg & Ramsden 2003).

2.2.10 Other natural disturbance

In addition to the above anthropogenic sources of impacts, the ecological community is subject to natural disturbances, such as storm events and cyclones, which, depending on their intensity and frequency, can have a detrimental effect. For example, a severe storm can cause coastal erosion and accelerate the rate of weed invasion as the canopy and ground layer are disturbed. In northern Queensland, patches of Littoral Rainforest are highly vulnerable to cyclone damage (Murphy et al. 2008), as was evident in 2011 when Cyclone Yasi destroyed several hectares of Littoral Rainforest (Metcalfe et al. 2011). Cyclone damage appears greatest for early-successional tree species. However, these species tend to recover quickly while late-successional species tend to incur less damage but take much longer to recover (Metcalfe et al. 2011).

3 Biodiversity considerations

Littoral Rainforest is known to provide significant habitat for a number of endemic and threatened flora and fauna species, as detailed in the Listing Advice and Policy Statement 3.9. Persistence of this ecological community is critical to the survival of a number of these national and state listed species.

Other ecosystems and habitats adjoining the ecological community will also benefit directly and indirectly from actions to improve landscape health within patches of Littoral Rainforest. For example, some patches of Littoral Rainforest are known to overlap with, or closely adjoin, a number of other ecological communities including the *Semi-Evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions* ecological community (Endangered) and the *Lowland Rainforest of Subtropical Australia* ecological community (Critically Endangered).

3.1 Connectivity

The spatial distribution and size of native vegetation patches are important considerations in the long term survival of Littoral Rainforest and the species that depend on this ecological community. Given many species move between different parts of the landscape on a daily or seasonal basis, and migratory species move at even larger scales, the conservation status of many flora and fauna species depends on the network of habitat available to support their populations. Conversely, highly-mobile fauna such as flying foxes and birds can be key seed dispersers for many rainforest trees and shrubs. Many of the biodiversity benefits of protecting and restoring patches of native vegetation and their component species and structures are tied up in the connectivity between them; thus, the landscape connectivity matrix is important.

Connectivity can be enhanced through the restoration of physically intergraded, adjoining systems, and/or dispersed patches providing stepping-stones across the landscape. Stepping stones (including small clumps of native vegetation) can facilitate movement and dispersal of some flora and fauna species between habitat patches as effectively as contiguous corridors (Doerr et al. 2010). The position of patches in the landscape is important for improved management, as is the proximity of smaller remnants to larger remnants, and conserving the habitat values and functionality of corridors or 'stepping stones' for fauna and flora.

The concept of connectivity is slightly unusual for Littoral Rainforest which occurs as a series of naturally disjunct and localised stands, on a range of landforms which have been influenced by coastal processes including dunes and flats, headlands and sea cliffs. Patches of Littoral Rainforest along the eastern coast of Australia has been significantly reduced and fragmented, primarily as a result of coastal development and other anthropogenic activities. Thus, maintaining and enhancing

the ‘stepping stone’ connectivity between remaining patches, and increasing patch size and habitat quality, will be critical to the ongoing persistence of this ecological community.

3.2 Patch size

Across the full range of Littoral Rainforest, many patches of remaining vegetation are too small to meet the condition thresholds for the ecological community. However, patches of all sizes are critical to the connectivity issue. The minimum patch size threshold for Littoral Rainforest is 0.1 ha. However, even very small or degraded patches that do not meet EPBC Act listing thresholds may provide connectivity between other patches, making them critical for the ongoing viability of the ecological community. Whilst small patches of native vegetation are often insufficient on their own to support viable species populations within them, they act as critical ecological linkages between large, ecologically viable areas. Yet, despite the important connectivity role these small patches play in the landscape, they face greater pressures, particularly from natural disturbance. The edge effects are significantly worse in these patches as their small size makes resilience and robustness difficult to achieve, and raises the likelihood of isolated negative impacts, such as weed invasion and feral animals degrading the patch to such an extent that it loses its ability to operate as a functioning component of the landscape.

3.3 Structural and component complexity

Biodiversity requires heterogeneity of ecological community structure and of the component flora, fauna, soil and water attributes. These requirements for heterogeneity apply from the smallest patch to the scale of landscapes, because a mosaic of habitats and microhabitats is needed to meet the array of species’ and ecosystem functions.

The loss of component species/guilds and ecosystem services are a threat to ecological communities. Consequently, the recovery of such components needs to be considered in any recovery program (SERA 2015). Maximising the structural and floristic heterogeneity of patches and revegetation plantings will enhance the number of component species likely to benefit, although such active revegetation can be expensive and labour intensive, and opportunities for passive revegetation (e.g. fencing or restricting access) need to be explored as a way of augmenting this activity (SERA 2015). Protecting remnants from encroaching developments and building resilience into patches will be critical to the survival of Littoral Rainforest. Retaining or restoring the ecological community structure to include structural layer species, provides the best opportunity for natural resilience and patch survival. Fauna are another essential component of a functioning ecosystem that needs to be included in any restoration process or activity; it is important to ensure restoration activities take a holistic approach to the restoration of key ecosystem components (Doerr et al. 2010; SERA 2015).

Fine-scale mapping of Littoral Rainforest shows that patches can be divided into three functional categories based on frequency of inundation: “leading edge”, “buffer” and refugia” (Murphy et al., 2016). Leading edge areas are classified as those areas exposed to inundation frequently (up to 100 year Average Recurrence Interval (ARI)) and often comprise the vegetation closest to the foreshore, in depressions behind the foreshore or in low-lying areas behind sand dunes. Leading edge vegetation can provide invaluable ecosystem and climate adaptation services in the form of protection from the impacts of storm surges, severe weather events and sea level rises. The conservation of these areas should be prioritised, particularly when they are providing critical ecosystem services to local communities. Management and planning activities should focus on restoring areas that have been degraded following inundation events, to increase the rate of recovery, and ensuring leading edge vegetation has room to retreat, where available, in the face of sea-level rise (Murphy et al., 2016).

Buffer areas are classified as those that experience inundation of moderate frequency (200-1000 year ARI) and are generally located behind the leading edge or other coastal vegetation such as

mangroves. Buffer vegetation can provide connectivity between leading edge and refugial vegetation and help enhance the resilience of leading edges through the provision of a seed source for natural regeneration. Managers should seek to reduce pressures (e.g. invasive species and visitor disturbance) on buffer vegetation and, where necessary, restore degraded areas (Murphy et al., 2016). It should be noted that "buffer" vegetation as defined here refers to within-patch areas of Littoral Rainforest and differs from the "buffer zones" discussed in Section 3.6, which relate to development buffers that should be applied outside patches of Littoral Rainforest.

Refugial areas are classified as those that experience infrequent inundation (>10 000 year ARI) and thus have the greatest capacity to persist in the long-term in the face of potential sea-level rises and increased frequency of storm surges. Management should focus on the incorporation of these areas into National Parks or formal reserves, where not already occurring, and revegetation activities to increase patch size and decrease fragmentation, in addition to threat reduction measures and the restoration of degraded patches (Murphy et al., 2016).

3.4 Guidance for identification and assessment

Condition varies between patches of Littoral Rainforest owing to the previous and ongoing threats and pressures applying. The listed Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community comprises those patches that meet the key diagnostic characteristics and the condition thresholds described within the *Commonwealth Listing Advice on Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* (TSSC 2008a), with specific reference to Attachment A from the Listing Advice, the Flora Species of Littoral Rainforest and Coastal Vince Thickets of Eastern Australia by Bioregion (TSSC 2008b).The key diagnostic characteristics are described below.

Key Diagnostic Characteristics

- The ecological community occurs in the following IBRA bioregions: Cape York Peninsula (from Princess Charlotte Bay southwards), Wet Tropics, Central Mackay Coast, South Eastern Queensland, New South Wales North Coast, Sydney Basin and South East Corner.
- Patches of the ecological community occur within two kilometres of the east coast, including offshore islands, or adjacent to a large body of salt water, such as an estuary, where they are subject to maritime influence.
- The structure of the ecological community typically is a closed canopy of trees that can be interspersed with canopy gaps that are common in exposed situations or with storm events. Usually, several vegetation strata are present. However, where there is extreme exposure to salt laden winds, these strata may merge into a height continuum rather than occurring as distinct vegetation layers. The canopy forms a mosaic due to canopy regeneration, typically in the form of basal coppice following canopy decapitation due to prevailing salt laden winds and storm events. Wind sheared canopy can be present on the frontal section leading to closed secondary canopies. Emergents may be present, for example, species from the genera *Araucaria* (northern bioregions only), *Banksia* or *Eucalyptus*. The ground stratum of the vegetation typically is very sparse.
- The ecological community contains a range of plant life forms including trees, shrubs, vines, herbs, ferns and epiphytes. To the north, most plant species diversity is in the tree and shrub (i.e. canopy) layers rather than in lower strata. The converse generally occurs from the Sydney Basin Bioregion southwards. Feather palms, fan palms, large leaved vascular epiphytes and species that exhibit buttressing are generally rare. Ground ferns and vascular epiphytes are lower in diversity in littoral rainforests compared to most other rainforest types.
- Plants with xeromorphic and succulent features are generally more common in littoral rainforest than in hinterland rainforest types. Canopy stem sizes also tend to be smaller

compared to that in hinterland rainforest. Trunks rarely host mosses though lichens are usually common.

- Whilst species can be regionally predictable, there may be considerable variation in the composition of individual stands of the ecological community within any given bioregion. Attachment A from Listing Advice provides a list of flora species for each relevant bioregion.

Condition thresholds

The condition thresholds of Littoral Rainforest are as follows:

- Small patches can be resilient and viable, but minimum size of a patch needs to be 0.1 ha;

and

- The cover of transformer weed species (as identified in Attachment A from the Listing Advice) is 70 percent or less. Transformer weeds are highly invasive taxa with the potential to seriously alter the structure and function of the ecological community. This threshold recognises the relative resilience and recoverability of the ecological community to invasion by weed species;

and

The patch must have:

- at least 25 percent of the native plant species diversity characteristic of this ecological community in that bioregion (Attachment A from the Listing Advice);

or

- at least 30 percent canopy cover of one rainforest canopy (either tree or shrub) species (Attachment A from the Listing Advice; excluding *Banksia* and *Eucalyptus* species that may be part of the ecological community).

Condition Threshold Notes

Where gaps in the canopy exist, they should be in the process of regenerating with the usual suite of rainforest gap species for the site. Natural regeneration of native gap species may be limited where weed invasion is significant, or where the natural geology and soil condition do not allow for regeneration.

As species diversity diminishes from northern to southern latitudes, it is important to take into account the natural diversity of a patch in a particular bioregion when examining specific sites. For example, it is possible to find littoral rainforest stands that are dominated by single tree species or a small number of species (Miles & Kendall 2006). If such patches are in good condition, they will be representative of the ecological community and they may also contain rainforest dependent fauna species.

The flora lists in Attachment A from the Listing Advice are not exhaustive. Additional rainforest species encountered when surveying sites need to be included when determining the condition thresholds. These additional species should added to both the numerator and the denominator when determining percentage of native plant species diversity present in a patch.

The condition criteria outlined above represent the minimum level for patches to be included in the listed ecological community.

3.5 Derived native vegetation

In addition to habitat patches that meet the condition thresholds for Littoral Rainforest, there may be other ‘derived native vegetation structural forms’ that are of benefit to the recovery and conservation of the ecological community. For example, ‘partially corresponding’ patches that feature some

components of the ecological community, but do not exhibit enough characteristics to meet the thresholds for listing, may correspond during certain stages of their successional development (BAAM 2013). These patches may provide useful targets for rehabilitation whereby the extent of Littoral Rainforest may be increased through replanting or restoration of particular components of the ecological community. Furthermore, 'practically corresponding' patches on a successional trajectory towards Littoral Rainforest may be suitable targets for protection and/or restoration.

3.6 Threatened species and species of conservation significance

Threatened fauna

Vertebrate fauna play an essential ecological role in Littoral Rainforest, particularly processes such as seed dispersal and pollination that structure and maintain plant diversity within the ecological community. For example, the grey-headed flying-fox (*Pteropus poliocephalus*) is an effective pollinator, travelling many kilometres between foraging sites (BAAM 2013). Littoral Rainforest itself provides habitat for many threatened fauna species listed under the EPBC Act. The most iconic being the endangered southern cassowary (*Casuarius casuarius johnsonii)*, restricted to Cape York Peninsula and the Wet Tropics bioregion of Queensland, and Gould's petrel (*Pterodroma leucoptera leucoptera)*, which is Australia's rarest seabird and breeds on only four islands, including Cabbage Tree Island in New South Wales. Within northern New South Wales a coastal population of emus (*Dromaius novaehollandiae),* listed as threatened under State legislation, is also known to visit patches of Littoral Rainforest where they feed upon, disperse and enhance germination of plants such as the riberry (*Syzygium luehmannii)* (Floyd 1990a) Similarly, the eastern long-eared bat (*Nyctophilus bifax*), listed as vulnerable under state legislation, has been recorded roosting in the Littoral Rainforest of Iluka World Heritage Area in northern NSW during its lactation and mating seasons (Lunney et al., 1995).

Littoral Rainforest also supports several threated invertebrates, including: Mitchell's rainforest snail (*Thersites mitchellae)* and the southern pink underwing moth (*Phyllodes imperialis)* southern subspecies, listed as critically endangered and endangered respectively under the EPBC Act; the Richmond birdwing butterfly (*Ornithoptera richmondia),* listed as near threatened under Queensland legislation; the Sutherland celtis beetle (*Menippus darcyi),* listed as an endangered population under New South Wales legislation; and, the Burleigh Heads spider (*Namirea insularis)* which may warrant listing as threatened but for which there is currently insufficient data to assess conservation status.

Threatened flora

Littoral Rainforests also provide important habitats for a large number of threatened flora species, with more than 60 species listed under State or Federal legislation occurring in the ecological community. A few threatened plant species are endemic to Littoral Rainforest, including: the coastal Fontainea (*Fontainea oraria)* which is listed as endangered under the EPBC Act; Smyrell's clausena (*Clausena smyrelliana)* which is listed as endangered under Queensland legislation; and, a rainforest vine (*Parsonsia sankowskyana)* which is listed as endangered under Queensland legislation. A small number of other threatened plant species are endemic to the islands of the Great Barrier Reef, including: a native tree (*Berrya rotundifolia)* listed as vulnerable under Queensland legislation; a native plant (*Buchanania mangoides)* listed as vulnerable under Queensland legislation; and, numerous silk plants (*Albizia* spp.) (Turner & Batianoff 2007). Two species listed as extinct under the EPBC Act and Queensland legislation, the vine *Marsdenia araujacea* may also have occurred in Littoral Rainforest (Forster 1995; CHAH 2012). The small shrub *Rhaphidospora cavernarum,* listed as extinct in Queensland, was recently rediscovered on Cape York (CSIRO 2012).

3.7 Buffer zones

A buffer zone is an area adjacent to a patch that is important for protecting the integrity of the ecological community. As the risk of damage to an ecological community is usually greater for actions

close to a patch, the purpose of the buffer zone is to minimise this risk by guiding planners and land managers to be aware when the ecological community is nearby and take extra care around the edge of patches. The buffer zone helps protect the root zone of trees at the edge of the patch, and other components of the ecological community, from damage that may result from nearby activities.

The buffer zone is not part of the ecological community; so whilst having a buffer zone is strongly recommended, it is not formally protected as a Matter of National Environmental Significance. For EPBC Act approvals, changes in use of the land that falls within the buffer zone must not have a significant impact on the ecological community. If the use of an area (e.g. grazing land) that directly adjoins a patch of the ecological community is going to be intensified (e.g. fertilised) approval under the EPBC Act may be required. However exemptions may apply to activities classified as 'continuing use'. Further information on the referral and assessment process under the EPBC Act is available from: http://www.environment.gov.au/protection/environment-assessments.

The recommended minimum buffer zone is 100 m from the outer edge of a patch, unless a scientific justifiable alternative buffer can be identified. This typically accounts for the maximum height of the vegetation and likely influences on the root zone. A larger buffer zone needs to be applied to protect patches of very high conservation value, or if patches are downslope of drainage lines or a source of eutrophication. Buffer zones should be large enough to ensure that biodiversity, structural integrity and ecosystem functioning are not adversely affected within the Littoral Rainforest patch to which the buffer is being applied.

3.8 International obligations

Littoral Rainforest is not specifically listed under any international agreements. However, protection of the ecological community is consistent with Australia's international obligations under a number of agreements and conventions, namely:

- protection of the ecological community is consistent with Australia's International obligations under the Convention on Biological Diversity
- Iluka Littoral Rainforests are included as the Coastal Group in the Gondwana Rainforests of Australia World Heritage Area (WHA)
- significant areas of Littoral Rainforest in the Wet Tropics fall within the Wet Tropics WHA
- some stands of Littoral Rainforest on the Fraser Island and Cooloola sand masses within two kilometres of the coast may be included in the listed ecological community and are within the Great Sandy WHA
- numerous islands of the Great Barrier Reef support the ecological community adjacent to the Great Barrier Reef WHA; protection of the ecological community assists in the protection of the Great Barrier Reef WHA through reduction in sediment loads to the Great Barrier Reef
- Littoral Rainforest provides habitat for several migratory bird species listed under the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
- Littoral Rainforest occurs adjacent to wetlands protected under the Ramsar Convention, thus their conservation is consistent with this agreement, and
- Littoral Rainforest provides habitat for a number of flora and fauna species listed as threatened under the IUCN Red List of Threatened Species.

4 Habitat critical to the survival of Littoral Rainforest

Current knowledge indicates that significant areas of Littoral Rainforest that existed at the time of European settlement have been cleared or converted to other land uses. Remaining remnants of the ecological community are highly fragmented and isolated across the natural distribution range; many remnants are degraded and in lower condition states.

The Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community is rated nationally as Critically Endangered. Given the small area remaining, all sites that meet the criteria for the listed community should be considered habitat critical to the survival of the ecological community.

From an ecological perspective, derived native vegetation structures (or patches on the pathway of succession towards Littoral Rainforest) may also be habitat critical to survival of the ecological community, if they adjoin, buffer or connect high integrity remnants, provide habitat critical for functionally important or threatened species, expand the potential habitat available to some species, or have good potential for restoration.

5 Recovery program

5.1 Overarching objective

The overarching objective of the Recovery Plan is to:

- Provide for the management and research actions necessary to stop the decline, and support the recovery, of Littoral Rainforest so that its chances of long term survival are maximised.

5.2 Recovery strategies

The recovery strategies outlined below have been developed to achieve the overarching objective of the Recovery Plan. Strategies have been designed with the following outcomes in mind:

- Protect – actions that prevent further decline in the conservation status of Littoral Rainforest, principally its size, condition and functional integrity.
- Manage and restore– actions that improve the quality of patches or increase the extent of Littoral Rainforest, thus increasing the resilience of the ecological community and maximising its chances of long term survival in nature.
- Communicate – actions that tell the story about what is happening to Littoral Rainforest, and increase knowledge of its biodiversity and socio-economic values, conservation status, actual and potential changes, management and information needs.
- Research – actions that fill any gaps in our knowledge of Littoral Rainforest, including increasing understanding of its biodiversity values and socio-economic values, the relevant impact of threatening processes and the effectiveness of various management interventions.
- Monitor / report – actions that measure the condition of Littoral Rainforest, and any changes to its conservation trajectory, and report outcomes to relevant management agencies / organisations

Strategy 1: Implement planning and regulatory policies and actions to protect Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, NRM bodies, private land owners/managers and industry bodies.

Protect the remaining distribution of Littoral Rainforest and its surrounds from:

- coastal development and land use change, including urban development, mining and industrial development
- climate change, particularly sea level rise impacts

Strategy 2: Implement management strategies and actions to reduce threats to Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, NRM bodies, community organisations, researchers.

Reduce threats to Littoral Rainforest posed by:

- livestock grazing
- feral animal activity
- invasive weeds
- pathogens and disease
- changes in fire regime (particularly increased frequency)
- damage and degradation by recreational and other use (vehicles, camping)
- damage and degradation by storm surge events and extreme tides, and
- hydrological change (e.g. to drainage and runoff from adjacent areas).

Strategy 3: Restore and extend Littoral Rainforest

Relevant for: Australian, state and local government, Indigenous land managers, private land owners/managers, NRM bodies, community organisations.

Implement the following:

- Rehabilitation and restoration activities to restore vegetation structure and control invasive plant species, and
- Actions to increase connectivity, enhance migration and create natural buffers

Strategy 4: Engage with the broader public to increase awareness and community involvement in management and rehabilitation

Relevant for: Australian, state and local government, Indigenous land managers, private land owners/managers, NRM bodies, community organisations, science organisations.

Carry out the following:

- Engage with Indigenous land managers to help protect and rehabilitate Littoral Rainforest on country
- Engage with the public and local land owners/managers to promote the values of Littoral Rainforest and drive community involvement in management, and
- Assist with funding applications for management and rehabilitation activities.

Strategy 5: Improve knowledge on the distribution and condition of Littoral Rainforest, and monitor and report on the status of the ecological community

Relevant for: state and local governments, science organisations, Indigenous land managers, NRM bodies, community organisations.

Conduct the following:

- Fine-scale mapping of Littoral Rainforest, across the extent of the ecological community, to establish distribution at local and regional management scales
- Establish baseline conditions at local and regional scales and compare these against the condition thresholds (i.e. patch size, transformer weed cover, percent native species and percent rainforest species in canopy cover)

- Monitor and evaluate patches at regular (maximum 5 yearly) intervals and report trends in extent and/or condition to the relevant management agencies
- Improve understanding of fragmentation impacts on Littoral Rainforest and the contribution of small patches to the long-term viability of the ecological community
- Monitor structural and compositional change at a sample of sites with varied levels of protection and exposure to threats
- Develop effective restoration techniques tailored to specific species assemblages and threat contexts.

5.3 Performance criteria

The key performance criteria to indicate the success of the Recovery Plan will be:

- The current known extent (area) of Littoral Rainforest has been maintained or extended and the condition of the ecological community has been maintained or improved.

High level performance criteria for measuring this success include:

- No further decline in extent of Littoral Rainforest
- No further declines of significant species of native plants associated with Littoral Rainforest
- Reduced abundance and extent of infestation of transformer weeds
- Increased representation of native biota in restored patches of vegetation, and
- Increased resilience of patches, through the maintenance of climate adaptation features.

More specific performance criteria are listed under each strategy in Section 5.4.

5.4 Recovery actions

The recovery actions in the Recovery Plan are informed by current knowledge, threats and regulatory arrangements, and expert opinion. Using an adaptive management approach, these recovery actions will be refined where new information becomes available and/or circumstances change.

Individual recovery actions play a part in building the resilience and integrity of remnant patches of Littoral Rainforest. No one action will address all issues, but collectively they will increase the robustness, functionality and sustainability of the ecological community as a whole. Many of the actions listed are underway and have been for many years. However, the proposed actions include a number of new initiatives that are expected to contribute further to the recovery of Littoral Rainforest.

Actions identified for the recovery and conservation of Littoral Rainforest are described below. It should be noted that some of the objectives are long term and may not be achieved prior to the scheduled five year review of the Recovery Plan. Priorities assigned to actions should be interpreted as follows:

High priority:	Taking prompt action is necessary in order to mitigate the key threats to Littoral Rainforest and also provide valuable information to help identify the conservation trajectory of the ecological community.
Medium priority:	Action would provide a more informed basis for the long term management and recovery of Littoral Rainforest.

Strategy 1: Protect	Planning and regulatory policies and actions to protect Littoral Rainforest
Action 1.1 ***High priority***	**Minimise the impacts of coastal development and urbanisation** ***On-ground*** *a.* Develop regional implementation strategies to provide a framework for the consistent protection and management of Littoral Rainforest, incorporating all land uses and including strategies to minimise impacts from: o Urban expansion o Water planning o Industry and infrastructure development o Agricultural expansion o Climate change *b.* Develop and implement guidelines to assist in the assessment and monitoring of actions that may impact upon Littoral Rainforest, including strategies to: o Avoid potential impacts and mitigate potential threats o Offset significant impacts o Consider, and manage, cumulative impacts o Undertake compliance and enforcement activities o Enhance resilience of Littoral Rainforest to the impacts of climate change *c.* Prevent further clearing or detrimental modification of Littoral Rainforest. *d.* Ensure all new developments in the proximity of Littoral Rainforest consider, and mitigate, potential changes to hydrological flow regimes. *e.* Ensure all new developments in proximity to Littoral Rainforest include a buffer zone between the development and the ecological community.

Action 1.2 ***Medium priority***	**Minimise the impacts of mining operations in the vicinity of Littoral Rainforest** ***Research / Information*** *a.* Identify areas where current mining operations may be impacting, or where historic operations may have left legacy impacts, on nearby patches of Littoral Rainforest. *b.* Provide guidance for maintaining natural catchment hydrology and water quality, and minimising other potential impacts associated with mining operations. ***On-ground*** *c.* Ensure that mining companies develop and implement long term restoration strategies where historic/legacy mining impacts have been identified. *d.* Ensure that mining companies undertake revegetation activities within current mining leases to create a natural buffer between operations and patches of Littoral Rainforest. *e.* Ensure any mining rehabilitation activities use vegetation appropriate for the natural succession trajectory of Littoral Rainforest. *f.* Ensure any new or revised mining management plans follow best practice standards and include: o pre-operation surveys to establish baseline conditions o identification of environmental thresholds that would trigger mitigation measures if exceeded o monitoring of environmental conditions throughout the life of the mine o appropriate and progressive rehabilitation strategies to be implemented throughout life of mine and upon mine closure o identification of criteria against which to measure the success of rehabilitation activities o ongoing monitoring of environmental conditions for an appropriate timescale post rehabilitation o confirmation of the return of biodiversity, structural integrity and functionality Littoral Rainforest.
Action 1.3 ***Medium priority***	**Minimise the impacts of climate change on Littoral Rainforest** ***Research / Information*** *a.* Assess patches of Littoral Rainforest to determine areas most at risk from climate change, particularly rising sea levels and increased storm surges (see Murphy et al. 2016) *b.* Identify high quality areas where climate change impacts will be most severe and identify ways to ameliorate this impact. *c.* Classify patches of Littoral Rainforest at local and regional scales in terms of their leading edge, buffer and refugial zones (see Section 3.3. and Murphy et al. 2016). ***On-ground*** *d.* Improve the resilience of Littoral Rainforest by undertaking management activities appropriate to the different functional categories (leading edge, buffer, refugial), as characterised in Murphy et al. (2016). *e.* Maintain tree canopy integrity, establish buffer zones and avoid changes to

	hydrology and drainage in high quality patches (as identified in Action 1.3b) *f.* Develop a landward migration strategy to ensure patches of Littoral Rainforest have 'room to move'.
Performance Criteria:	• Regional implementation strategies developed and implemented at the appropriate scale. • Guidelines developed to help assess impacts on Littoral Rainforest. • Buffers between developments and patches of Littoral Rainforest are preventing reductions in habitat quality. • Mining rehabilitation efforts are successfully restoring sustainable and ecologically-functional patches of Littoral Rainforest. • Areas that may provide for the landward migration and/or regeneration of Littoral Rainforest are incorporated into in local government planning processes and given increased protection status.
Partners and *potential contributors*	• Australian government agencies (e.g. DoEE, CSIRO) • State government agencies (e.g. DEHP, OEH, DELWP, National Parks) • Local government agencies • Indigenous land managers • NRM bodies • Private land owners/managers • Industry operators

Strategy 2: Reduce threats	**Management strategies and actions to reduce threats to Littoral Rainforest**
Action 2.1 ***High priority***	**Invest in the control and management of transformer weeds** ***Research / Information*** a. Identify areas where transformer weeds may be impacting upon Littoral Rainforest and develop priorities based on patch values, cost and benefits. b. Investigate potential vectors contributing to the spread of transformer weeds. c. Undertake research to inform the control of transformer weeds. d. Develop best practice guidelines for the control and management of transformer weeds. ***On-ground*** e. Invest in the control and management of transformer weeds in patches of Littoral Rainforest (as identified under action 2.1a). f. Use appropriate techniques to control weeds, following best practice guidelines (as developed under action 2.1d). g. Educate land managers on the impact of transformer weeds in Littoral Rainforest and circulate best practice guidelines for their management.

Action 2.2 ***Medium priority***	**Minimise the impacts of grazing and agriculture on Littoral Rainforest** ***Research / Information*** *a.* Identify areas where grazing and agricultural impacts may pose a threat. ***On-ground*** *b.* Support land managers to reduce/remove grazing pressure from within the vicinity of Littoral Rainforest, including excluding livestock. *c.* Provide guidance for maintaining catchment hydrology and water quality.
Action 2.3 ***High priority***	**Develop and implement a control program for feral animals** ***Research / Information*** *a.* Identify and map areas where feral animals may be impacting upon patches of Littoral Rainforest. *b.* Quantify impacts of feral animals and identify critical densities of key pests *c.* Investigate effective control methods for feral animals in Littoral Rainforest. ***On-ground*** *d.* Develop best practice guidelines for the management and control of feral animals in Littoral Rainforest. *e.* Implement appropriate control strategies in areas where feral animals are identified as impacting upon Littoral Rainforest. *f.* Monitor the effects of removing feral animals from patches of Littoral Rainforest. *g.* Ensure domestic and rural animals (e.g. pigs) are appropriately managed to prevent future feral animal populations establishing in Littoral Rainforest. *h.* Educate local councils and land managers on the role of feral animals.
Action 2.4 ***Medium priority***	**Mitigate the potential impacts of disease and pathogens on Littoral Rainforest** ***Research / Information*** *a.* Identify and map areas where disease and pathogens may be impacting upon patches of Littoral Rainforest. *b.* Investigate the potential interactions between the spread of disease and pathogens and the nursery industry. *c.* Develop local and regional protocols for the management of disease and pathogens in Littoral Rainforest. ***On-ground*** *d.* Implement protocols for the management of disease and pathogens in Littoral Rainforest. *e.* Integrate disease and pathogen control protocols into other local and regional conservation priorities. *f.* Monitor the spread and impacts of disease and pathogens (such as myrtle rust) and communicate information on this threat to local land managers.

Action 2.5 ***Medium priority***	**Develop and implement appropriate strategies to reduce fire risk in Littoral Rainforest at a bioregional level** ***Research / Information*** *a.* Investigate the ecological interactions occurring between different fire regimes and weed incursions. *b.* Undertake research to assess the broader effects of different fire regimes on Littoral Rainforest. *c.* Develop a set of criteria for determining when control burns may be acceptable for reducing fuel loads in the vicinity of Littoral Rainforest. ***On-ground*** *d.* If control burns are undertaken, implement appropriate hazard reduction zones in the vicinity of patches of Littoral Rainforest. *e.* Ensure post-fire monitoring is undertaken and, where required, implement post-fire rehabilitation activities.
Action 2.6 ***Medium priority***	**Minimise the impacts of tourism and visitor disturbance** ***Research / Information*** *a.* Undertake sociological research to better understand tourist use of Littoral Rainforest and identify potential methods for reducing visitor disturbance *b.* Identify high-traffic areas where tourism is likely to be impacting upon Littoral Rainforest. *c.* Assess whether introduced pathogen levels and weed invasion are correlated with visitation rates. *d.* Investigate the effectiveness of various environmentally friendly tourism infrastructure options, such as raised walking platforms. ***On-ground*** *e.* Develop site specific management actions for high traffic sites to reduce impacts on Littoral Rainforest from the use of existing infrastructure. *f.* Identify opportunities for infrastructure, including roads, tracks and aqueducts that are no longer required, to be removed or altered to restore Littoral Rainforest. *g.* Ensure appropriate placement of any new paths/tracks and public amenities within the vicinity of patches of Littoral Rainforest. *h.* Ensure that new infrastructure, including roads, tracks, trails and other infrastructure, is planned to avoid impacts to the biodiversity, structural integrity and functionality Littoral Rainforest.

Action 2.7 ***Medium priority***	**Reduce the risk of coastal erosion or changed depositional environment** ***Research / Information*** a. Identify key sites at risk of erosion, inundation and landward retreat. b. Identify areas where there is room for the landward migration of Littoral Rainforest. c. Undertake research to improve understanding of Littoral Rainforest ecology (e.g. biotic and abiotic interactions, range shifts and succession trajectories). ***On-ground*** d. Increase the size of natural buffers around patches of Littoral Rainforest at risk of erosion, inundation and landward retreat. e. Increase protection of areas that may provide potential habitat for the landward migration of Littoral Rainforest. f. Undertake regular monitoring to identify changes in the extent (loss and gain) of the ecological community in response to natural processes. g. Protect and manage areas where the regeneration of Littoral Rainforest is identified.
Action 2.8 ***Medium priority***	**Reduce the risk, or mitigate the impacts, of natural disasters (stochastic events such as cyclones and storm surges)** ***Research / Information*** a. Develop guidelines for best practice management of Littoral Rainforest in preparation for, and in response to, natural disasters, including protocols for pre-event mitigation measures and post-event clean-up activities. ***On-ground*** b. Implement the guidelines for best practice management of Littoral Rainforest in response to natural disasters. c. Monitor at risk patches of Littoral Rainforest pre and post-event and assess the effectiveness of management actions.
Performance Criteria:	• New transformer weed infestations are prevented in patches of Littoral Rainforest. • The extent and/or severity of transformer weed infestation is reduced in patches of Littoral Rainforest. • Appropriate fire management strategies are developed and implemented in the vicinity of patches of Littoral Rainforest. • Feral animal numbers are reduced in patches of Littoral Rainforest. • Domestic and rural animals are appropriately controlled in the vicinity of patches of Littoral Rainforest. • Appropriate disease and pathogen management strategies are developed and implemented for patches of Littoral Rainforest. • Natural buffers are established, where possible, around patches of Littoral Rainforest and these areas are given increased protection

	• Areas that may provide for the landward migration and/or regeneration of Littoral Rainforest are given increased protection status. • Guidelines for the best practice management of Littoral Rainforest in preparation for, and in response to, natural disasters are developed and implemented. • New tourism developments are designed to avoid impacts to Littoral Rainforest. • Existing tourism infrastructure is being upgraded, where possible, to reduce impacts to Littoral Rainforest.
Partners and *potential contributors*	• Australian government agencies (e.g. DoEE, CSIRO) • State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies) • Local government agencies • Indigenous land managers • Private land owners/managers • NRM bodies • Community groups • Researchers

Strategy 3: Improve and extend	**Actions that improve the quality and increase the extent of Littoral Rainforest through protection and restoration**
Action 3.1 ***High priority***	**Improve the conservation status of Littoral Rainforest through increasing the area protected in formal reservations and other conservation zoning areas** ***Research / Information*** a. Identify key patches that make a major contribution to the biodiversity, structural integrity and ecosystem functioning of Littoral Rainforest, and would benefit from the implementation of formal conservation arrangements, increased reservation status or conservation zoning. b. Identify patches that have the potential to be linked to other patches through the establishment of wildlife corridors. c. Prioritise patches for conservation activities or incorporation into new reserves. ***On-ground*** d. Increase protection of Littoral Rainforest through the incorporation of key patches into formal reserve networks or conservation zones. e. Increase protection of patches that have a key role in landscape connectivity. f. Support local councils to include Littoral Rainforest in conservation zones.

Action 3.2 ***High priority***	**Develop and implement stewardship mechanisms for private land tenures** ***Research / Information*** a. Identify key patches that could benefit from the implementation of stewardship mechanisms, including patches that have the potential to form wildlife corridors, to increase protection and/or management of Littoral Rainforest on private land. ***On-ground*** b. Implement mechanisms, such as conservation covenants, for the long term protection and management of identified high quality patches and the restoration of lower quality patches. c. Identify and implement alternative stewardship-style management agreements, like trust funds provided from offsetting arrangements with industry or development organisations.
Action 3.3 ***Medium priority***	**Develop and implement best practice guidelines for restoration** ***Research / Information*** a. Develop Best Practice Guidelines, based on the the Australian Standard for Ecological Restoration (McDonald et al. 2016) and informed by the outcomes of Actions 5.1, 5.2 and 5.3, that provide a methodology for the rehabilitation/restoration of Littoral Rainforest, including strategies to: o plant appropriate vegetation o improve condition and complexity o restore degraded patches o extend existing patches o establish natural buffers o improve connectivity o manage and/or reduce threats o prioritise investment at both a local and national scale. ***On-ground*** a. Implement strategies from the Best Practice Guidelines to restore patches of Littoral Rainforest, and enhance degraded patches so that they meet the condition criteria for the ecological community, or create buffer zones to protect and extend existing patches. b. Collect and store seeds in appropriate regional seedbanks to ensure the long term conservation of key species. c. Propagate seeds of key species for use in restoration plantings.
Performance Criteria:	• The amount of Littoral Rainforest formally protected in reservation systems is increased and/or protection measures within existing reservations are improved. • The amount of Littoral Rainforest protected on private land through conservation covenants, zoning or other stewardship mechanisms, is increased. • Best practice guidelines for the restoration of Littoral Rainforest are being implemented across the range of the ecological community. • Protection and management of Littoral Rainforest is focussed on improving

	resilience within managed patches of the ecological community. • Structural integrity and biological diversity in restored patches is recovering or has achieved the level of high quality patches. • Active restoration efforts are increasing the extent of occurrence, and resilience, of Littoral Rainforest.
Partners and potential contributors	• Australian government agencies (e.g. DoEE, CSIRO) • State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies) • Local government agencies • Indigenous land managers • NRM bodies • Private land owners/managers • Researchers

Strategy 4: Communicate	• **Actions that increase awareness of, and community involvement in, the management and rehabilitation of Littoral Rainforest**
Action 4.1 ***High priority***	**Increase community awareness of, and participation in, recovery efforts** ***Research / Information*** a. Develop promotional and educational materials, such as brochures, fact sheets, web pages and signage, that raise awareness about the presence and importance of Littoral Rainforest at local and regional scales, covering such topics as: o description of Littoral Rainforest o consequences of land clearing, fire and other anthropogenic activities o local weeds and pest animals, and appropriate management o opportunities for responsible tourism o threatened species habitats o human values associated with the ecological community, including Traditional Owner values o best practice guidelines for management and restoration o the status of recovery actions, including success stories and other learnings o stakeholder responsibilities under federal, state and local regulations o programs and funding opportunities to support conservation activities. ***On-ground*** b. Distribute promotional and educational materials to the local community, schools, visitor information centres, and relevant organisations and agencies. c. Support and encourage community group involvement in on-ground management. d. Promote partnerships between local councils, land holders and volunteers. e. Promote professional bush regenerators working alongside volunteers to

	enable skills and knowledge transfer. f. Develop interpretative signage highlighting the ecological values of Littoral Rainforest and promoting recovery activities and best practice management. g. Conduct field days or education programs that discourage removal of dead timber, dumping of rubbish, and use of off-road vehicles in environmentally sensitive areas. h. Support regional arts programs that highlight the values of Littoral Rainforest.
Action 4.2 ***High priority***	**Increase opportunities for Indigenous involvement in, and management of, the conservation of Littoral Rainforest** ***Research / Information*** a. Develop regional strategies for engaging traditional owners in the implementation of recovery actions for Littoral Rainforest. ***On-ground*** b. Engage and consult with Traditional Owners on their goals and aspirations for Littoral Rainforest. c. Identify, and where relevant support, the aspirations of Traditional Owners. d. Promote involvement of Indigenous Rangers in managing Littoral Rainforest. e. Promote and support Traditional Owner enterprises. f. Support interpretation activities (e.g. guided talks) by Traditional Owners. i. Facilitate the involvement of Indigenous communities in the activities outlined in Action 4.1, where desired by the community.
Performance Criteria:	• User friendly information on Littoral Rainforest is accessible to all stakeholders. • Communication strategies and tools are developed in consultation with community stakeholders. • Community groups, particularly schools, local and regional conservation organisations and Traditional Owners, are involved in on-ground recovery actions. • Community participation and awareness increases and people feel proud of local improvements.
Partners and potential contributors	• Local government agencies • Indigenous land managers • Private land owners/managers • NRM bodies • Community groups

Strategy 5: Monitoring and Research	• Actions that improve knowledge of Littoral Rainforest and its conservation, and report on the status of the ecological community
Action 5.1: ***High priority***	**Improve knowledge of the threats to, and recovery of, Littoral Rainforest** ***Research / Information*** a. Improve knowledge on the ecology of Littoral Rainforest through the investigation of: o factors that may limit or promote connectivity between nearby patches o the relationship between Littoral Rainforest and lowland rainforest and effects on succession processes o the relationship between Littoral Rainforest and different substrates (e.g. sand vs other substrates) o the tolerance to environmental extremes (e.g. fire, temperature, sea level and interactions between multiple threatening processes) o the roles of fauna within Littoral Rainforest (e.g. importance of seed dispersing birds) b. Improve understanding of how to best ensure the long-term viability of Littoral Rainforest by: o assessing the comparative value of remnant patches of Littoral Rainforest, natural regrowth patches and revegetated patches o assessing the value of small patches in peri-urban areas and the cumulative impacts of losing very small patches o refining knowledge of the comparative effects of different threats, and their cumulative impacts o identifying the most effective methods for regeneration of Littoral Rainforest o identifying the most effective management measures at both landscape and local scales.
Action 5.2: ***High priority***	**Improve knowledge of the extent and condition of Littoral Rainforest** ***Research / Information*** a. Finalise and distribute protocols for the fine-scale mapping and ground-truthing of Littoral Rainforest. b. Establish a baseline against which to measure condition and patch quality. c. Assess whether conditions exist for Littoral Rainforest to extend inland further than the recognised 2 km limit in particular bioregions, such as Cape York Peninsula where the ecological community may extend up to 10 km inland. ***On-ground*** d. Undertake local and regional level fine-scale mapping of Littoral Rainforest to confirm the extent and condition of the ecological community across its range. e. If there are circumstances in which Littoral Rainforest is found to extend further than 2 km inland, update key diagnostic characteristics to reflect this. c. Develop a mechanism for incorporating up-to-date mapping and condition assessment of the ecological community into relevant federal and state databases.

Action 5.3: ***Medium priority***	**Prioritise patches of Littoral Rainforest for conservation activities at local and regional management scales** ***Research / Information*** a. Prioritise patches of Littoral Rainforest at local and/or regional management scales, using a robust methodology (e.g. Marxan or Zonation), in order to guide the investment of resources into different conservation activities. ***On-ground*** b. Use prioritisation process to develop a list of representative sites across the full range of the Littoral Rainforest Ecological Community to ensure high quality sites are identified and capture latitudinal variation between patches. f. Apply the prioritisation process to ensure on-ground recovery activities are being implemented and conservation efforts are achieving the maximum possibly efficiency.
Action 5.4: ***High priority***	**Monitor the progress of recovery, including the effectiveness of management actions, in Littoral Rainforest** ***On-ground*** a. Collect and collate regional information on the status (area, condition and connectivity) of Littoral Rainforest and develop annual report cards that: ○ record losses (ha) due to direct human impacts; ○ record losses (ha) due to natural disturbances; ○ record gains (ha) due to restoration, revegetation and management; ○ utilise data from councils, Local Land Services, relevant state agencies, and Australian Government organisations. c. Conduct regular monitoring of the condition threshold parameters to detect any new or emerging threats. d. Report any changes in the conservation status and trajectory of Littoral Rainforest to relevant local, state and federal management agencies.
Performance Criteria:	• Knowledge on threats to Littoral Rainforest has improved. • Mechanisms (e.g. mitigation strategies) that will improve the status of Littoral Rainforest are identified and incorporated into adaptive management arrangements. • The extent and condition of Littoral Rainforest has been assessed. • The effectiveness of recovery efforts and trajectory of Littoral Rainforest are known.
Partners and potential contributors	• Australian government agencies (e.g. DoEE, CSIRO) • State government agencies (e.g. DEHP, OEH, DELWP, National Parks) • Local government agencies • Researchers • Indigenous land managers • NRM bodies

- Community groups

6 Implementation

The success or failure of a recovery plan depends on its implementation. This Recovery Plan is intended as a key resource that guides stakeholders including land managers and assists actions to support the recovery of the ecological community. Ideally, the priority actions identified in the plan will be incorporated into future versions of management plans, as well as other key local planning documents.

6.1 Factors influencing successful implementation of the recovery plan

The following factors will be important for successfully implementing the strategies of the Recovery Plan:

- Sufficient and enduring funding to complete priority actions.
- Recognition that maintenance and recovery of Littoral Rainforest requires commitment to on-ground actions and long term effort.
- Communities that value Littoral Rainforest and its role in conserving biodiversity conservation and providing ecosystem services.
- A culture of inclusiveness, transparency and accountability by recovery program partners for all aspects of the recovery program.
- Effective mechanisms for cross jurisdictional co-operation and coordination that implement priority actions efficiently and effectively.
- The integration of local and regional management with other threatened species recovery actions.
- A network of stakeholders and partners that includes relevant experts, delivery partners and stakeholders with affected interests.
- Effective mechanisms for communicating with stakeholders and partners.
- Monitoring to measure the extent and condition of identified patches of Littoral Rainforest, and effectiveness of management actions.
- A strong adaptive management framework for program delivery, with the capacity for adaptive and timely decision-making based on monitoring data.
- Implementing the actions identified in this plan will support the resilience and adaptation of the multiple ecological communities in the context of a changing climate.

This Recovery Plan is also intended to guide funding decisions. For example, projects consistent with a national recovery plan for a listed species or ecological community are targets for funding under National Landcare Programme, Reef Trust and the National Environmental Science Programme. Regional investment through such programs is necessary to support the implementation of the Recovery Plan.

6.2 Management considerations

In biodiversity terms, Littoral Rainforest is known to provide significant habitat for a number of endemic and threatened flora and fauna species, as detailed in Section 3.5. The persistence of this

ecological community is likely to be critical to the survival of a number of these listed species. Consequently, ensuring Littoral Rainforest is managed sustainably is essential to maintaining its biodiversity values. Below are a number of management related factors to consider across the distribution of Littoral Rainforest.

Furthermore, ecosystems adjoining the ecological community will benefit directly and indirectly from actions to improve landscape health within Littoral Rainforest.

6.2.1 Implications for environmental assessment and conservation management:

- Given the current state and prognosis of Littoral Rainforest, all sites at which the ecological community has been recorded are important and merit protection.
- The current reserve system alone may not be sufficient to maintain Littoral Rainforest, an increase in the extent of dedicated reserves, plus enhanced management in remaining areas, will greatly enhance the recovery of this ecological community.
- Patches of Littoral Rainforest should be managed strategically to facilitate connectivity, wherever possible, and maintenance of patch quality and protection.
- Although a range of prescriptions are in place to reduce impacts, development practices need to continue to adapt to minimise impacts to Littoral Rainforest.
- The current and projected status of Littoral Rainforest is precarious. Many small and isolated patches are unlikely to persist without significant ongoing management actions.
- The extent, quality and connectivity of suitable habitats are the critical factors for conservation of Littoral Rainforest. Conservation management actions should focus primarily on factors and actions that serve to increase (or most effectively reduce the rate of decline in) the current and prospective habitat extent, quality and connectivity.
- The extent and connectivity of suitable habitat should be enhanced through restoration of lower quality or derived patches of Littoral Rainforest.

Given the current listing status and ongoing threats to the ecological community, all sites at which the ecological community has been recorded are important and warrant protection. Likewise, all sites where there is a reasonable likelihood of the listed ecological community occurring, as indicated by vegetation mapping and modelling, are also important. The key to this is maintaining up-to-date vegetation mapping and modelling data in a creative-commons open access format, and associated reporting system.

6.2.2 Offsetting

Vegetation clearance is a major cause of past, current and future losses of biodiversity. Offsetting as a mechanism works as a trade-off between permanent immediate impacts on biodiversity and uncertain future biodiversity gains (Garrard et al. 2015). Consequently, offsetting is a last resort for biodiversity management, used only in an attempt to compensate for unavoidable damage to the ecological community. The best environmental option is to avoid clearing and activities that cause damage and death of native vegetation, particularly remnant patches of threatened ecological communities, without a compelling reason.

When considering development proposals or other activities in the vicinity of Littoral Rainforest, the mitigation hierarchy should be applied to avoid, then mitigate, then offset potential impacts on the ecological community, as follows:

- Plan projects to avoid the need to offset, by avoiding significant impacts to the ecological community.
- In circumstances where impacts cannot be totally avoided, then they should be minimised by:
  - retaining and avoiding damage to high quality patches, which should be managed to retain their benchmark state; and
  - protecting important habitat features, such as large mature trees or stags with hollows as these take many decades to develop and cannot be quickly replaced.
- Where impacts are unavoidable, offsets should be used as a last resort to compensate for the adverse impacts of the action deemed unavoidable. The outcomes of offsetting activities are generally highly uncertain. Any proposals considering offsets for this ecological community should aim to:
  - minimise the need to offset the ecological community by designing development around the ecological community and applying buffer zones;
  - retain medium and higher quality patches of the ecological community, rather than offset them (particularly with lower quality offset sites);
  - focus on retaining remnants of the ecological community with mature trees;
  - manage and protect offset areas in perpetuity in areas dedicated for conservation purposes - avoid risks that may reduce their size, condition and ecological function in the future;
  - select offset sites as close as possible to the impact site, to allow for local and regional variation in the ecological community, but also consider future sea-level rise and coastal erosion;
  - increase the area and improve ecological function of existing patches, for example by enhancing landscape connectivity, habitat diversity and condition;
  - focus on the restoration of good and moderate quality patches of the ecological community to achieve high quality condition;
  - extend protection to otherwise unprotected sites (e.g. sites that are currently too small or degraded to meet the condition thresholds for national protection, but can reasonably be restored to a better, more intact condition); and,
  - monitor offset areas and the outcomes they deliver over the long-term, to manage them adaptively and improve understanding of the best ways to manage offsets to deliver biodiversity benefits.

Despite an overall net loss to biodiversity, when used effectively and appropriately, offsetting provides an option to protect and fund ongoing management of sites in perpetuity. Guidance on the EPBC Act environmental offsets policy is available on the Department of the Environment and Energy website.

6.2.3 Reporting

The impact of cumulative actions is particularly important in the highly fragmented landscape of Littoral Rainforest. Therefore, the availability of up-to-date and accurate information about the status (size, extent and condition) of the ecological community is essential for effective management and planning. Councils and regional and state government agencies have access to habitat loss data from clearing for developments, as well as habitat gains from restoration works. This information needs to be collated annually, if not more frequently, to support ongoing management and to provide an early warning of the trend of recovery efforts throughout the ecological community. The use of aerial imagery and other remote sensing techniques can provide an efficient method for monitoring components of an ecological community and assessing changes in vegetation. However, components such as understorey species richness cannot be monitored using these techniques. In addition, these

techniques are only accurate at a coarse scale and ground-truthing is required to provide fine-scale resolution of the conservation status of Littoral Rainforest.

6.2.4 Existing programs and funding

Since 2013 the Australian Government has funded more than 50 projects across the range of Littoral Rainforest. These include projects funded under the Caring for our Country, Biodiversity Fund, National Landcare and Green Army programs. Funding recipients include local councils, regional Conservation Management Areas, state agencies, non-government organisations and local conservation groups.

This Recovery Plan provides information and guidance to assist future grant applicants to identify Matters of National Environmental Significance and relevant actions to support restoration and recovery of Littoral Rainforest.

Other funding options such as rate rebates for conservation activities could be used as an incentive for native vegetation management and retention, or to engage bush regenerators. Similarly, a proportion of development application fees could be allocated to a trust for conservation works. 'Community titles' may also provide a mechanism for conservation of Littoral Rainforest, whereby land is identified and protected on title for management of the ecological community. Neighbouring residential lots would pay into a trust for the ongoing management of that land under Community Title. This could be applied to management of restoration and offset sites, and proposed development sites.

Funding programs need to consider the advice provided throughout this Recovery Plan to ensure any activities undertaken are useful and effective, and that cumulative activities complement each other thus contributing to the overall objective of protecting and recovering the ecological community. Funding also needs to be available for ongoing management, which is essential for maintaining the structure, complexity, condition and resilience of ecological communities into the future (SERA 2015).

6.2.5 Communication

Clearly communicating the value of Littoral Rainforest, the threats to its persistence and the management options available for its conservation will be essential to establishing and maintaining community support for recovery efforts. Public engagement, particularly with schools and community groups, helps communicate messages and information into the wider community.

Some private organisations look for philanthropic opportunities for provide funding and management activities for environmental outcomes. These groups should to be identified and engaged, and encouraged to get involved. Early engagement of infrastructure agencies, industry and regulatory bodies, will also ensure impacts are minimised during the planning and implementation of any developments within the vicinity of the ecological community. A strong communication strategy will identify opportunities for collaborative conservation efforts across multiple sectors.

6.3 Projected funding needs

Due to the complexity of local, regional, state, Commonwealth and landowner involvement in the implementation of actions within the Recovery Plan, an overall costing figure is not provided. Instead, costings are based on a scalable cost per unit for the more common activities (Table 3). These costings were derived from the data provided to the Australian Government through grant-funded projects and the associated conservation activities implemented.

Table 2: **Estimated per unit costings for common recovery activities.**

Related action #	Action	Est. annual cost per unit
2.1	Fencing (livestock-proof)	$2000-$6000/km
2.2	Pest animal control treatment	$100-500/ha
3.1	Weed control treatment	$750/ha
3.4	Revegetation – tree/shrub planting	$3/tube-stock
4.1	Signage	$500-1000/sign
-	Project admin – project planning and management, communication, monitoring, and reporting	$120 000 (1-2 FTE)
-	Project admin – Operational works planning and programme implementation	$120 000 (1-2 FTE)

6.4 Social and economic considerations

Habitat clearance is a major threatening process to Littoral Rainforest. Due to the distribution of the ecological community along the east coast of Australia, often in proximity to urban development and agriculture, remnant Littoral Rainforest could be adversely affected by habitat degradation arising from anthropogenic activities. As habitat critical to the survival of the ecological community is identified as all remaining sites meeting the criteria for the listed community, as well as derived native vegetation structures that adjoin, buffer or connect high integrity remnants, there is potential for developments to be restricted under the EPBC Act assessment and approval process. Any measures to assist recovery of Littoral Rainforest that involve restrictions on the use of coastal areas may result in economic impacts to affected industries.

Conversely, habitat improvement of Littoral Rainforest from increased protection may address community concerns and be economically and socially advantageous. Increased public awareness of Littoral Rainforest and associated species may bring social and economic advantages to local communities through tourism. Local communities, including Traditional Owners, may benefit from involvement in recovery actions. Government support for protection of Littoral Rainforest on private land may be available.

6.5 Review

The Recovery Plan requires review within five years of commencement. It is intended that the review will measure the success of the Recovery Plan in achieving the overall objective using the performance criteria in Section 5.3 and under each strategy in Section 5.4.

A range of activities to address these factors are identified within the recovery actions identified to achieve each recovery strategy. They include research and analysis, collation and reporting of information, and communication of the information with stakeholders, particularly land managers and community groups.

The review will be coordinated by the Department of the Environment and Energy in association with relevant Australian and state government agencies and key stakeholder groups.

Key stakeholders involved in the review of the Recovery Plan include organisations likely to be affected by the actions proposed in the plan and are expected to include:

Australian Government

Department of the Environment and Energy

Commonwealth Scientific and Industrial Research Organisation

State and local governments

Department of Environment and Heritage Protection (Queensland)

Office of Environment and Heritage (New South Wales)

Department of Environment, Land, Water and Planning (Victoria)

Local government across the distribution

Non-government organisations

Natural resource management bodies across the distribution

Conservation groups

Local communities

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8 Appendices

Appendix A - Glossary of terms

Note 1: The glossary of terms is based on the 'National Standards for the Practice of Ecological Restoration in Australia (SERA 2015).

Abiotic - non-living materials that sustain biota within a given ecosystem, including sailor substrate, the atmospheric or aqueous medium, weather and climate, topographic relief and aspect, the nutrient regime, hydrological regime, fire regime and salinity regime.

Approach, restoration - the category of treatment (i.e. natural regeneration, assisted regeneration or reconstruction).

Assisted regeneration - the practice of deliberately removing obstacles and reinstating conditions to foster natural regeneration and recolonization. Interventions may be tailored to improve regeneration niches, trigger resprouting and germination and foster colonization. While this approach generally is typical of sites of low to intermediate degradation, even some very highly degraded sites have proven capable of natural recovery given appropriate treatment and sufficient time frames.

Attributes, of an ecosystem - the biotic and abiotic properties and functions of an ecosystem (including physical conditions, species composition, community structure, ecosystem function, mitigation of threats and external exchanges).

Biotic, biota - the living components of an ecosystem, including animals and plants, fungi, bacteria and other forms of life (large to microscopic).

Carbon sequestration - the capture and long term storage of atmospheric carbon dioxide (typically in biomass by way of photosynthesis and tree growth) to reduce the impacts of climate change.

Climate envelope - the climate in which a species currently exists. During climate change and where conditions become hotter, this envelope will move further poleward. (Movement due to changes in precipitation are more complex.)

Composition, of an ecosystem - the array of component species, both plant and animal.

Construction - methods involved in building something that did not occur previously at that site - e.g. see 'reconstruction', 'creation' and 'fabrication'.

Creation - construction of a different ecosystem to that which previously occurred, due to permanently changed physical conditions. (See alternative terms 'Fabrication' and 'biome conversion'.)

Damage (to ecosystem) - a level of deleterious impact that causes loss of structure or function

Degradation (of an ecosystem) - a persistent decline in the structure, function and composition of an ecosystem compared to its former state.

Destruction (of an ecosystem) - complete removal or depletion of an ecosystem.

Ecological restoration - the intentional practice of assisting the recovery of ecosystems that have been degraded, damaged or destroyed.

Ecological trajectory - a described pathway of development over time, which can be monitored by sequential measurements of biotic and abiotic ecological parameters.

Ecosystem - small or large scale assemblage of organisms (including plants animals, micro-organisms) together with non-living components (including the soil, water, air, fire, climate, topographic relief and aspect) that interact to form complex food webs, nutrient cycles and energy flows.

Ecosystem change - localised or broad scale change in ecosystem structure / composition / function including factors (such as climate, fire, flooding) and the responses of organisms to those factors. The term is also sometimes used to refer to more recent change caused by humans to the degree that these changes are now effectively irreversible.

Ecosystem services - are the benefits to humans provided by ecosystems. These include clean air, water and soils; as well as products and opportunities for recreation and the satisfaction of other human values. Restoration targets may specifically refer to the reinstatement of particular ecosystem goods or services

Five-star (5-star) recovery - a semi-quantitative rating system based on biotic and abiotic factors that provides comparative assessment in the achievement of a restored / rehabilitated state.

Fabrication - (also referred to as 'creation'). A rehabilitation approach, based on construction techniques, where the degree of degradation means current conditions are no longer suitable for the pre-existing ecosystem and a different, locally occurring ecosystem is the best alternative. (Note: This refers to shifts in whole communities rather than in an individual species).

Framework species - are those species from the reference ecosystem that can facilitate recovery or establishment of other species from the reference ecosystem. These can be from any stratum or successional phase.

Full recovery - the state whereby all ecosystem attributes are reinstated to reference ecosystem levels. A state of S-star recovery may not yet exhibit full recovery but is on a trajectory to full recovery without further repair-phase intervention.

Functions, of an ecosystem - the collective term for the roles and processes which arise from interactions between living and non-living components of ecosystems. Examples include nutrient cycling and sequestration (through biomass accumulation, food production, herbivory, predation and decomposition), water filtration and cycling, soil formation, succession, disturbance regimes (fire, flooding and drying), water filtration and storage, provision of habitat, predation, dispersal, reproduction, disturbance and resilience.

Indicators of recovery - characteristics of an ecosystem that a manager identifies as being suitable for measuring the progress of restoration goals or objectives at a particular site (e.g. measures of biotic or abiotic components of the ecosystem).

Local indigenous reference ecosystem - an ecosystem comprising taxa (excluding invasive non-indigenous species) that are either known to have existed in the local area for very long timeframes or, species from neighbouring localities that are recently migrating (or being assisted in their migration as a result of sound science) due to changing climates. Where local evidence is lacking, regional or historical information can help inform the most probable local indigenous ecosystems.

Maintenance (of an ecosystem) - activities intended to counteract processes of ecological degradation to sustain the attributes of an ecosystem. In a conservation management context this is directed to maintaining the attributes associated with its pre-impairment state, recognising the intrinsic values of natural systems, not merely their usefulness to humans.

Management (of an ecosystem) - a broad categorisation that can include maintenance and repair of ecosystems (including restoration).

Mandatory restoration - restoration that is required (mandated) by a government agency, court of law or statutory authority.

Mitigation - the activity of reducing impacts upon the environment to the highest practicable extent, to maintain potential for conservation of biodiversity while pursuing ecologically sustainable production and ecologically sustainable lifestyles.

Natural regeneration - recruitment of species on sites after removal of causes of damage (threats) alone. Natural regeneration can be intentionally adopted as a restoration approach.

Non-mandatory restoration - restoration that is voluntarily carried out rather than required (mandated) by a government agency, court of law or statutory authority.

Primary treatment - the first treatment of a site (e.g. removal of standing weed biomass), after which there will be subsequent follow up treatments referred to as 'secondary treatments'.

Reconstruction - a restoration approach where the pre-existing biota need to be entirely or almost entirely reintroduced as they cannot regenerate or recolonise within feasible timeframes, even after expert assisted regeneration interventions.

Recovery - the process of an ecosystem regaining its composition, structure and function relative to the levels identified for the reference ecosystem. As this can occur in full or in part, this term can apply to both ecological restoration and rehabilitation.

Reference ecosystem – a real or notional community of organisms able to act as a model or benchmark for restoration. A reference ecosystem usually represents a healthy version of the ecosystem complete with its flora, fauna, functions, processes and successional states that would have existed on the restoration site had degradation, damage or destruction not occurred - but it can be adjusted to suit changed current conditions.

Regeneration - see ‘natural regeneration’ and ‘assisted regeneration’.

Rehabilitation - the process of reinstating ecosystem functionality on degraded sites where ecological restoration is not the aspiration, to permit ongoing provision of ecosystem goods and services including support of biodiversity.

Restoration - see ‘ecological restoration’. The term ‘restoration’ is in common usage and can be used singly and in combination with other words to convey an intent to return something to a prior condition (e.g. restoring a species, a population or a particular ecosystem function such as carbon sequestration). Single species restoration can be considered complementary and an important component of ecological restoration.

Revegetation - actions to re-establish plants on sites / landscapes.

Site - discrete area/location. Can occur at different scales including patch and landscape.

Secondary treatment - the repeated follow-up treatments (e.g. to control weeds), required after primary treatment has triggered an ecological response.

Self-organising - a state whereby all the necessary elements are present and can now continue to develop without outside assistance. Self-organisation is evidenced by increasing plant size and biomass; reproduction; normal ratios between producers, herbivores, and predators; niche differentiation; and, overall increase in ecosystem complexity.

Self-referencing - referring to circumstances where degraded remnant vegetation serves as its own reference ecosystem.

Sod transfer - moving slabs or turves of herbaceous species and their substrate from a donor habitat to a receiving habitat.

Succession (ecological) - the process where species composition and abundances alter over time and space with later ‘seral’ stages dependent upon the composition and abundances of a prior state. Importantly for many of Australia’s most biodiverse ecosystems such as in the southwest Australian biodiversity hotspot, the climax community in terms of species composition is reflected in the immediate post-disturbance recruitment (under natural conditions this was usually after wildfire). Thus, restoration at the outset needs to reinstate as complete a species composition as is technically and practically feasible acknowledging that restoration may require ‘nurse species’ to amend soils or re-establish basic ecological processes (e.g. pollinators, hydrological processes etc).

Substrate - the soil, sand, rock, debris or water medium on or in which habitats develop.

Structure, of an ecosystem - the physical organization of an ecological system both within communities and at a landscape scale (e.g. density, stratification, and distribution of species populations, habitat size and complexity, forest canopy structure, pattern of habitat patches).

Threat - a factor causing degradation, damage or destruction (e.g. clearing, hydrological change, presence of invasive species, altered disturbance regimes).

Threshold (ecological) - a point at which external conditions causes a shift in an ecosystem property to a different state. Pushing that property over a threshold requires external assistance.

Translocation - moving organisms from a donor habitat to similar habitats in a different part of the landscape. Usually undertaken to secure conservation of the organisms.

Treatment - the particular interventions or actions undertaken to achieve restoration, such as substrate amendment, exotics control, habitat conditioning, reintroductions.