Australian Government
Department of the Environment and Energy

# Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Ecological Community

# Draft National Recovery Plan

February 2017

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 is grateful to the organisations and individuals who contributed to or provided information for the preparation of this draft recovery plan and 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

| | |
|---|---|
| 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 |
| 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), 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 overarching objective of the *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Ecological Community Draft National Recovery Plan* (hereafter referred to as the 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.

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 improved.

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 overarching objective of this recovery plan are to:

- Conserve Littoral Rainforest by managing threats from direct human activities.
- Conserve Littoral Rainforest by managing threats from natural disturbance.
- Improve and extend Littoral Rainforest through active restoration.
- Communicate with the broader public to increase awareness and community involvement.
- Research to improve knowledge of Littoral Rainforest and its conservation, 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 an almost continuous group of patches distributed along the eastern 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. There are now thought to be over 1400 separate patches of Littoral Rainforest within the areas of the defined ecological community, with a total area of occupancy of only 18,000 hectares (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 plants and animals 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 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 communities to coastal processes (TSSC, 2008), the community persists in often harsh coastal environments through adaption to the saline conditions delivered via salt-laden winds, saline water-tables or 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, seacliffs, 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 is distributed across warm temperate, sub-tropical and tropical climate zones from Princess Charlotte Bay on Cape York Peninsula in Queensland to the Gippsland Lakes in Victoria. 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).

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. The canopy is typically closed but may also be patchy and include emergents. 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.

## 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 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). 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). However, current extent is estimated to be approximately 16,000 hectares (TSSC, 2008).

The total area of occupancy 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 of occupancy in New South Wales is approximately 1600 ha (TSSC, 2008). Many, but not all, stands of Littoral Rainforest in NSW have been included in mapping within the *State Environmental Planning Policy No 26—Littoral Rainforests*. The total area of occupancy in Queensland is approximately 16,000 ha (TSSC, 2008). In parts of Queensland, Littoral Rainforest is also referred to as 'beach scrub'. Area of occupancy calculations 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.

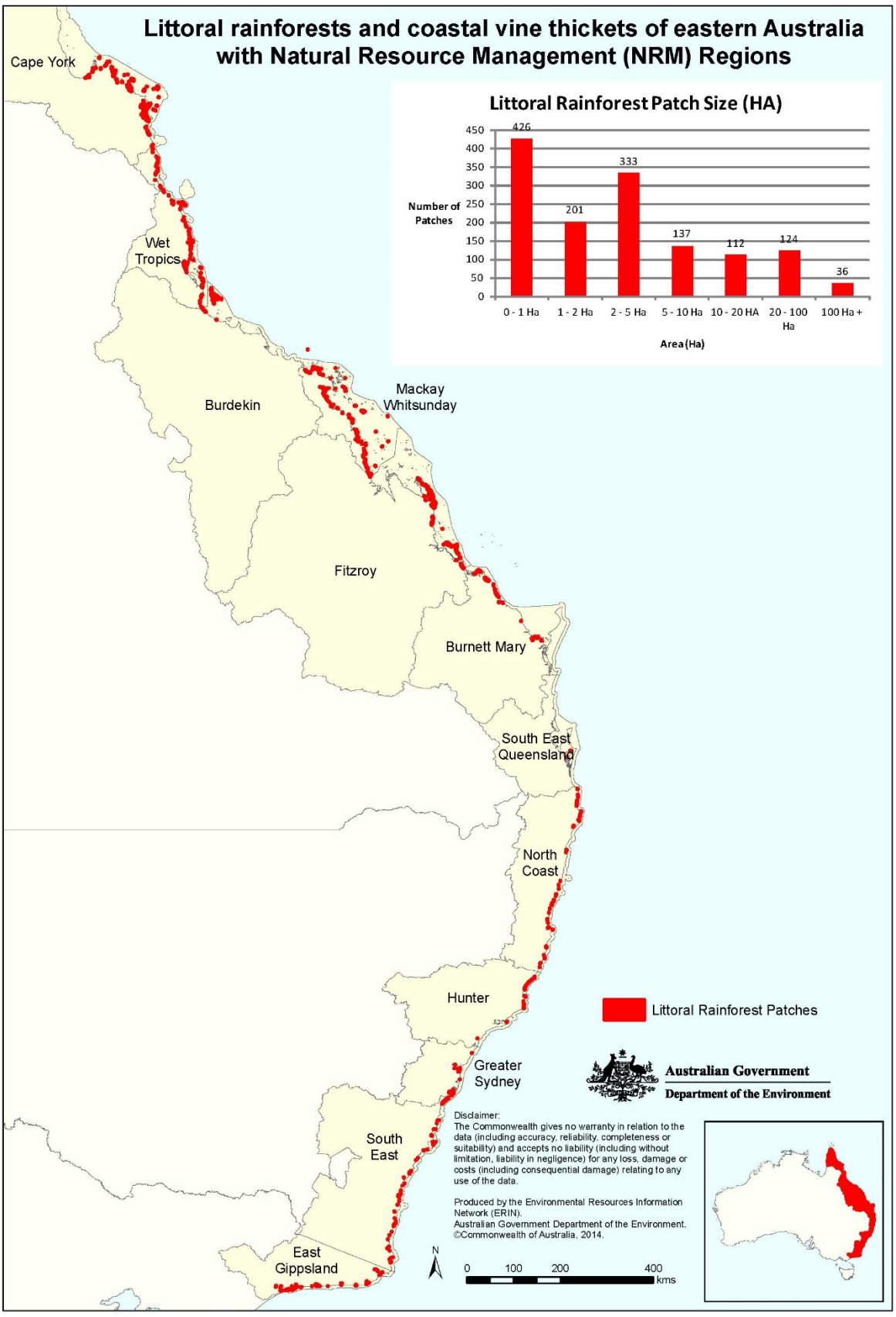


***Figure 1:*** *Map of the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community, showing Natural Resource Management regions and number of patches in different size classes.*

## 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 LR 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: Conserve Littoral Rainforest by managing threats from direct human activities***

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

Minimise and manage the following threats:

- Coastal development;
- Damage through use (vehicle tracks, camping);
- Land use on edges (e.g. livestock grazing);
- Changes to natural hydrology.
- Climate change

***Strategy 2: Conserve Littoral Rainforest by managing threats from natural disturbance***

Relevant for: state and local government, Indigenous land managers, NRM Groups, community organisations.

Manage the following threats:

- Invasive weeds, in particular transformer weeds;
- Grazing by introduced herbivores, such as deer;
- Pathogens and disease;
- Increased fire frequency and/or intensity.

***Strategy 3: Improve and extend Littoral Rainforest through active restoration***

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

Implement the following:

- Rehabilitation and restoration activities;
- Actions to increase connectivity and create natural buffers to allow for natural migration;
- Actions to increase the resilience of Littoral Rainforest patches.

***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 Groups, 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;
- Assist with funding application for management and rehabilitation activities.

***Strategy 5: Research to improve knowledge of Littoral Rainforest and its conservation, and monitor and report on the status of the ecological community***

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

Conduct the following:

- Fine-scale mapping of Littoral Rainforest at local and regional management scales;
- Prioritisation of patches for conservation activities;
- Assess the condition of Littoral Rainforest at regional scales and report any changes to conservation status and trajectory to relevant management agencies.

## 1.4 Performance criteria

The plan requires review within 5 years of commencement. It is intended that the review will measure the success of the recovery plan in achieving the overall objective. 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 improved.

High-level performance criteria for measuring this success include:

- No further decline in extent of Littoral Rainforest;
- No further declines of native plant or animal species associated with Littoral Rainforest;
- Reduced abundance and extent of infestation of transformer weeds;
- Increased resemblance 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.

## 1.5 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 and restore/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.

### 1.5.1 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 can be found here, including the national Listing and Conservation Advices.

### 1.5.2 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:*** *International, 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 NSW only applies to patches identified in the 'Littoral Rainforest in NSW North Coast, Sydney Basin and South East Corner Bioregions – endangered ecological community listing'.

***The Vegetation Management Act 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.

## 1.6 Stakeholders and other interests

The interests 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. Consequently, these parties may be affected by and/or have a role in the implementation of recovery actions, for instance, invasive species control and environmental monitoring, across different land tenures. The major affected interests 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 and community groups
- Organisations operating in National Parks and State Forests

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

### *1.6.1 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 for tens of thousands of years (Parsons & Lennard, pers comm., cited in BAAM, 2013). 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 (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 tucker 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 timorense),* cheese fruit (*Morinda citrifolia)* and lawyer cane (*Calamus caryotoides)* in the Wet Tropics region; lillypilly (*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 lillypilly (*Syzygium smithii)* and the cabbage-tree palm (*Livistona australis)* were important food sources, rhizomes from common bracken (*Pteridium esculentus)* were beaten into a paste, roasted and eaten, New Zealand spinach (*Tetragonia tetragonioides)* was an important green vegetable 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 the 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 (Isaacs, 2002). 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 incise);* 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.

### *1.6.2 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). Littoral Rainforest also provides food resources, shade and nesting sites for resident fauna and migratory species. 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 for roads or transmission lines;
- 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, that are harmful to a listed ecological community, 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.

For an action to be 'likely' to have a significant impact, it is not necessary to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. 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 Littoral Rainforest are highly likely to adversely affect the survival of 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 3.8 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 (see Section 3.8 buffer zones).

### 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 and Policy Statement 3.9. This includes not undertaking activities within close proximity that could impact on the extent, quality and functionality of Littoral Rainforest. Below is a summary of some of the key actions to avoid significant impacts. These are discussed in more detail in Section 5.4 Recovery Actions.

The following actions describe appropriate conservation and management activities to stop significant impacts on the ecological communities:

- Confirm the presence and condition of each patch of Littoral Rainforest against the condition thresholds specified in the Listing Advice or Policy Statement 3.9.
- Establish permanent buffer zones around suspected or confirmed patches to exclude all detrimental activities. Include buffer widths appropriate to the status of the patch of Littoral Rainforest, particularly the connectivity distance with other patches and sites nearby.
- Collect baseline information on the quality and quantity of patches of Littoral Rainforest, as part of a long-term standardised monitoring program. Include likely EPBC-triggers and contingencies for negative impacts from nearby development-related activity.
- Stop the loss of high-value patches by considering them in the design and planning of development projects, particularly when constructing roads and tracks, to prevent further fragmentation and isolation of patches of Littoral Rainforest across the landscape.
- Erect signage or barriers to restrict general access and protect known high quality remnant patches.
- 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, noting that offsets do not mean proposals with unacceptable impacts will be approved (section 6.2.2 Offsetting).

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 and Policy Statement 3.9 (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 (as conceptualised in Figure 2).

What was once an almost continuous archipelago of patches of Littoral Rainforest along the eastern coast of Australia has been reduced and fragmented primarily by coastal development, sandmining 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.

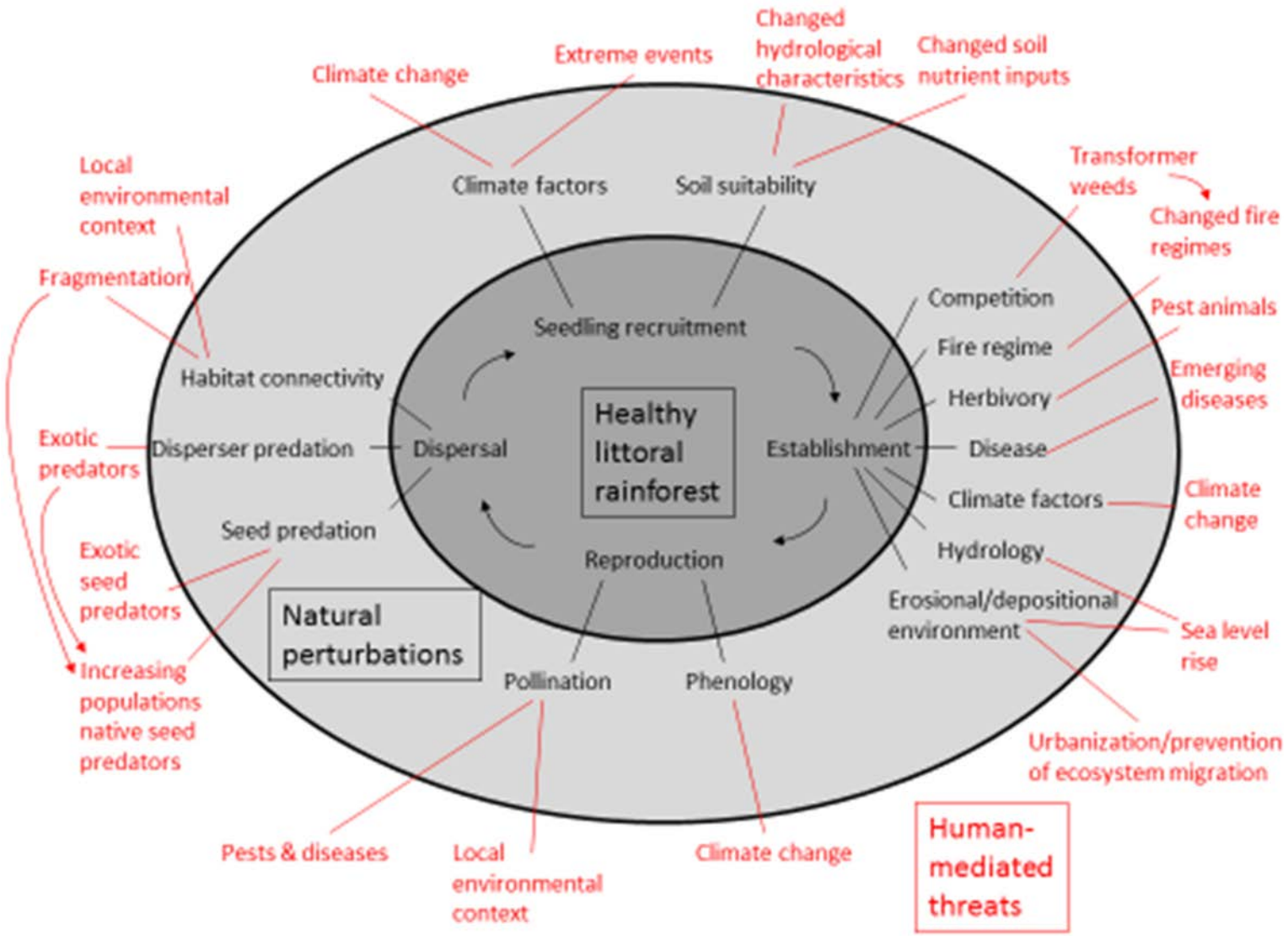


***Figure 2:*** *Conceptual diagram highlighting the relationship between human-mediated threats (red), natural disturbances (light grey) and healthy ecosystem functioning (dark grey) within Littoral Rainforest*

***Table 2:*** *Key threats*

| Category | Threat |
|---|---|
| **Human activities** | |
| **Coastal development** | Habitat loss, fragmentation and disturbance from urban development, roadwork and direct human disturbance |
| **Tourism and vector disturbance** | Soil compaction, erosion and introduction of pests |
| **Agriculture** | Grazing/trampling by domestic livestock, hydrology changes |
| **Mining** | Vegetation clearing and disturbance, pollution and run-off |
| **Natural disturbances** | |
| **Climate change** | Rising sea levels, increased rainfall variability, increased frequency of severe weather events, erosion events, storm surges and saline inundation |
| **Weed invasion** | Altered structure and function of the ecological community |
| **Fire** | Increased fire frequency and intensity |
| **Feral animals** | Grazing, browsing, trampling and digging impacts |
| **Exotic pathogens** | Inhibited plant growth from pathogens such as myrtle rust |
| **Other natural disturbances** | Storm events and cyclones leading to habitat disturbance, erosion and weed invasion |

### *2.2.1 Coastal 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 one of the main pressures on Australia's coastal environment (Beeton et al., 2006). Coastal development is likely to intensify over time due to the predicted increase of the human population along the eastern coastline of Australia. Statistics show that coastal urban development continued to increase from 1980 to 2004 (Beeton et al. 2006), and this trend is not predicted to change in the near future. Projections indicate that >40% of the Nowra (NSW) to Noosa (Qld) coastline will be urbanised by the year 2050, resulting in significant losses of Australia's temperate and tropical coastal systems (Beeton et al. 2006), including Littoral Rainforest.

Along the Queensland coast, the human population is projected to increase significantly, with the total population in Queensland predicted to increase by five million people in 50 years, from 4.1 million in 2006 to 9.1 million in 2056, with the combined South East Queensland statistical divisions accounting for 67.5% of the State's total population growth. 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% and 40% respectively between 2006 and 2031 (Queensland and Statistical Divisions, 2011).

In NSW, coastal regions will continue to have the fastest growth rates in the state. The NSW Department of Planning and Environment projects that between 2011 and 2036 the total population of NSW will grow by 2.71 million (NSW Planning & Environment, 2016). The population in the NSW North Coast region is predicted to grow by approximately 100,000 people between 2011 and 2036, while the population in the NSW South East and Tablelands region is predicted to grow by approximately 60,000 people (NSW Planning & Environment, 2016).

In Victoria the population in East Gippsland is projected to grow by approximately 10,000 people between 2011 and 2031, and the number of households is predicted to increase by more than 5,000 during this period (DELWP, 2016). Major population centres in East Gippsland (likely to be impacted) include Lakes Entrance, where Littoral Rainforest occurs, Bairnsdale and Orbost (DELWP, 2016).

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, and disturbance to native fauna from domestic pets (BAAM, 2013).

***Figure 3:*** *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).*

### *2.2.2 Tourism and vector disturbance*

In addition to coastal development, tourism and vector disturbance within Littoral Rainforest pose an ongoing threat. According to the Bureau of Tourism Research (DISR, 2001), 50% of international visits and 42% 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.

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 in such areas include the dumping of cars and rubbish and the dumping of 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, near Orbost, Wingan Inlet and Mallacoota, Victoria,

recreational development, such as campgrounds, is the most common and ongoing key threat to this ecological community (Peel 2010).

***Figure 4:*** *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). In north-eastern Queensland climate change scenarios are predicted to result in increases in temperature and increased potential evaporation, possible overall deceases in rainfall but increases in rainfall intensities, and changes in tropical cyclone behaviour resulting in potentially widespread impacts across tropical rainforests and the Great Barrier Reef (Suppiah et al., 2010).

Given its coastal location, potential 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 minor 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).

The 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*

The establishment of transformer weeds in littoral rainforest patches can have a significantly detrimental effect. 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. Weeds that invade littoral rainforest, notably pond Apple *(Annona glabra)*, lantana (*Lantana camara*), bitou bush *(Chrysanthemoides monilfera* subsp*. rotundata)* and rubber vine *(Cryptostegia grandiflora)* are all recognised as Weeds of National Significance (i.e. high impact, highly invasive species).

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 NSW (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.

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. 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 can also occur 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. In NSW, many coastal habitats have been invaded by bitou bush through the spread of fruit by birds and flying foxes. 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 5:*** *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 the brush box (*Lophostemon confertus)* habitat along the headlands of northern NSW, are relatively fire tolerant (Floyd, 1990b).

The 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 of Littoral Rainforest can also reduce the risk of fire 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 an adjacent 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 of the ecological community, 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 domestic 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 (DoEE, 2016b). 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 (Taylor et al., 2011). 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 *(C. 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 are contributing significantly to the collapse of the existing Littoral Rainforest patches through the smothering of shrubs and young trees (Peel et al., 2005). Severe damage to Littoral Rainforest has also been observed from Twofold Bay in NSW to the Gippsland Lakes in Victoria. Persistent 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 (Peel 2010). Where the ranges of the deer overlap patches of littoral rainforest (e.g. Marl Island) have been destroyed (Peel 2010). In the Royal National Park in NSW, herbivory by Rusa deer has led to a 54% reduction in understorey plant species richness in sites were deer densities are high (Moriarty, 2009) and caused a 75% reduction in cover of the threatened plant magenta lilly pilly *(Syzygium paniculatum)* (Keith & Pellow, 2005). In the East Gibbsland region of Victoria, Samba deer are the most damaging feral species impacting upon Littoral Rainforest (Peel et al., 2005). 'Herbivory and habitat degradation caused by feral deer' is listed as a Key Threatening Process under the NSW *Threatened Species Conservation Act 1995.* 'Reduction in biodiversity of native vegetation by *Cervus unicolor* (Sambar Deer)' is listed as a 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, NSW (Werren & Clough, 1991), and exposing nesting Gould's petrels (*Pterodroma leucoptera)* to increased predation risk. In the Tambo River region of East Gibbsland 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 the 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 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 NSW, particularly in Burleigh Heads National Park and Noosa National Park where 75% 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 NSW, 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 (*Uredo rangelli)* 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 genera *Syzygium* and *Acmena* 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, NSW 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* spp*.* 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 (BAAM, 2013). Conversely, some species may evolve resistance to the effects of myrtle rust over time, thus reducing the scale of potential impacts.

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, NSW in 2003 (Pegg & Ramsden, 2003).

### 2.2.10 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).

Patches of Littoral Rainforest can also be impacted by the process of tree dieback, with records indicating dieback has occurred within reserves such as the Broken Head Nature Reserve in NSW (NSW NPWS, 1998). A number of factors may contribute to the process of dieback, including pathogen infestation, drought and the resultant water stress to trees and the potential effects of these on a plant's salt-tolerance (McCune, 1991). Pollutants (such as detergents) that break down the protective waxy cuticle on leaves may also threaten Littoral Rainforest species, such as sensitive coastal banksias (*Banksia integrifolia)* and hoop pines (*Araucaria cunninghamii)* by allowing salt to penetrate and damage the plant (Morris 2003). Dieback within patches of Littoral Rainforest may also be exacerbated by land clearing, fire incursion and climate change (BAAM, 2013).

# 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. 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 mean physically intergrading and 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 flora and fauna species between habitat patches as effectively as contiguous corridors (Doerr et al., 2010; Paton and O'Connor, 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 habitat values and functionality as corridors or 'stepping stones' for fauna and flora.

Evidence suggests that “stepping stones need to be less than 100 m apart for most species to move between them, and that both stepping stones and corridors should not extend for more than 1 km before connecting to another habitat patch (preferably one at least 10 ha in size)”(Doerr et al., 2010; Paton & O’Connor, 2010).

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. Nevertheless, what was once an almost continuous archipelago of 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 listing thresholds may provide connectivity between other patches, making them critical for the ongoing viability of the ecological community (SERA, 2015).Work on habitat fragmentation suggests that smaller remnants only provide habitat for generalist fauna species, with additional opportunities for species diversity increasing as remnant size increases. This work also suggests that concentrations of forest dependent threatened fauna species tend to be found in larger, well connected remnants. 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. Within Littoral Rainforest, structure can vary from low, closed thickets (approx. 5 m tall) to tall, closed forests (approx. 30 m high), with factors such as the amount of 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% projected foliage cover) and, due to wind sheering, stand profile generally increasing in height with the progression from seaward to landward edge (Keith, 2004). 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). 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).

Leaf size and structure within Littoral Rainforest also tends to vary along a latitudinal gradient. Larger-leaved (i.e. 12.5-25 cm in length) mesophyll species typically occur north of Ingham in Queensland, where warmer temperatures and high rainfall are prevalent (Webb, 1959; Gourlay, 1994). While smaller-leaved (i.e. 2.5-7.5 cm in length) microphyll species tend to occur in drier climates, as can be found in the vicinity of Gladstone and Townsville in Queensland as well as southern NSW and Victoria. While medium-sized (i.e. 7.5–12.5 cm in length) notophyll species are predominant in most area of Littoral Rainforest (BAAM, 2013). With increasing latitude the proportion of compound-leaved species in a patch also tends to decrease (Webb, 1968). Leaves with tough, waxy coatings tend to be common across Littoral Rainforest while toothed-leaves are generally uncommon (Floyd, 1990b).

The presence and diversity of special life forms also 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. Canopy species vary from evergreen to semi-evergreen (facultative drought-deciduous) to obligate dry-season deciduous and common emergent species can include confers such as hoop pine (*Araucaria cunninghamii)* and kauri pine (*Agathis robusta)* (Queensland Herbarium, 2011).

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).

## 3.4 Condition

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 below.

***Key Diagnostic Characteristics***

The key diagnostic features of Littoral Rainforest are described below to aid its identification:

- 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, NSW 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 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 Appendix B) is 70% 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% of the native plant species diversity characteristic of this ecological community in that bioregion (Appendix B);

or

— at least 30% canopy cover of one rainforest canopy (either tree or shrub) species (Appendix B, 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. Where weed invasion is significant, natural regeneration of native gap species may be limited.

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 also be

representative of the ecological community and they may also contain rainforest dependent fauna species.

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

## 3.5 Threatened species and species of conservation significance

***Threatened fauna***

Littoral Rainforest provides habitat for many threatened fauna species listed under the EPBC Act. The most iconic being the endangered southern cassowary (*Casuarius johnsonii)* and Gould's petrel (*Pterodroma leucoptera leucoptera).* The species is restricted to Cape York Peninsula and the Wet Tropics bioregion of Queensland. The species declined in numbers by approximately 30-50% over the past five decades, however thanks to dedicated conservation efforts populations appear to have stabilised at around 2,500 mature individuals (Garnett et al., 2011). Gould's petrel breeds on only four islands, including Cabbage Tree Island in NSW, and is Australia's rarest seabird. Active recovery efforts have increased the species' breeding success (DEC, 2006), with populations increasing from 250 breeding pairs in 1989-1991 to 1000 breeding pairs in 2010 (Garnett et al., 2011). Within northern NSW a coastal population of emus (*Dromaius novaehollandiae),* listed as threatened under State legislation, is known to visit patches of Littoral Rainforest where they feed upon, disperse and enhance germination of plants such as the riberry (*Syzygium leuhmanii)* (Floyd, 1990a).

Another inhabit of Littoral Rainforest patches in northern NSW is the Critically Endangered Mitchell's rainforest snail (*Thersites mitchellae)* which has been significantly impacted by habitat destruction. Littoral Rainforest also supports other threated invertebrates, including: The southern pink underwing moth (*Phyllodes imperialis)* southern subspecies, listed as endangered 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 NSW legislation; and, the Burleigh Heads spider (*Nameria insularis)* which may warrant listing as a threatened species 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 and known only from Calder and Middle Percy Islands; a native plant (*Buchanania mangoides)* listed as vulnerable under Queensland legislation and known only from Snapper, High Bedarra and North Brook Islands; and, numerous silk plants (*Albizia* spp.) known from South Percy Island and other locations (Turner and Batianoff, 2007). Two species listed as extinct under the EPBC Act and Queensland legislation, the vines *Marsdenia araujacea* and *Argyreia soutteri,* 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).

## 3.6 Derived native vegetation structures

In addition to habitat patches that meet the condition thresholds for Littoral Rainforest, there may be other 'derived native vegetation structures' that are of benefit to the recovery and conservation of the ecological community. For example, patches that feature some components of the ecological community but do not exhibit enough characteristics to meet the thresholds for listing 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, habitat patches on a successional trajectory towards Littoral Rainforest (as described in case study 2) may be suitable targets for protection and/or restoration.

## CASE STUDY

# Succession and Littoral Rainforest in the Wet Tropics Bioregion*

***Information provided by Andrew Ford, CSIRO Land and Water, Atherton**

Succession in vegetation is generally regarded as a time-related progression from one type of vegetation to another through a series of frequently identifiable events. Change in vegetation is initiated by the reduction or addition of a number of underlying factors which have the potential to drive the current vegetation along a gradient of transition towards another type of vegetation. This gradient can vary dramatically, and is often a reflection of altitude, substrate, rainfall patterns or soil types.

The expected and classical rainforest successional theory proposes that a system initially has no vegetation. Over time small herbs and grasses colonise this vacant space, and with more time small shrubs begin to appear. Larger plants can only colonise these herb dominated areas once sufficient organic matter and soil (with sufficient minerals and nutrients) accumulates. Once larger shrubs and small trees become established they offer habitat to fruit-eating animals which then disperse many and varied species throughout the new ecosystem. The general pattern in tropical areas is for large-leaved and fast growing shade intolerant tree species to appear first, followed by slower growing and smaller leaved shade tolerant species. This is a very simplistic version of events, which theoretically holds for the majority of lowland to mid-elevation rainforest vegetation types.

Littoral Rainforest occurs in close proximity to the ocean and is influenced by maritime processes. Sands deposited from the ocean over millennia have created ideal conditions for the development of Littoral Rainforest, which follows a similar trajectory to that of classical rainforest succession. Colonisation of sand deposits starts with herbs, which initially stabilise the sand with root growth and later aid in the accumulation of organic matter which then supports woody species recruitment. Fire is crucial to the maintenance of sclerophyll vegetation on sand, reducing fire frequency will aid the transition towards rainforest.

The transition process on sand takes a slightly different trajectory to that encountered on other substrates. Invading rainforest species tend to be future long-lived canopy species, rather than the truly successional large-leaved, fast growing and short lived species. The vegetation seen in Littoral Rainforest today is a result of a long period of substrate stability.

In the Wet Tropics areas of sclerophyllous vegetation on sand deposits are being invaded by rainforest species in the absence of fire. Without fire these species continue to grow and, with additional recruitment via frugivores, the sclerophyll community transitions towards rainforest with emergent eucalypts. The grass, herbs, small sedges and light demanding shrubs are replaced by shade tolerant rainforest species. Over time eucalypts can no longer germinate under the prevailing shady conditions and rainforest saplings grow into canopy trees and replace the eucalypts. Once full replacement of species has occurred, only catastrophic events can reverse this trend.

The most contested section of the sandscape appears to be the strand, as it is the least stable and the most likely to undergo dynamic seasonal change with storm surges and cyclonic activity. This zone is often dominated by beach she-oak (*Casuarina equisetifolia*), along with perennial grasses, training vines, herbs and soft shrubs. In the Wet Tropics this *Casuarina* zone is also frequently invaded by Littoral Rainforest species.

## 3.7 Buffer zones

A buffer zone is a contiguous 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 are contained within the Wet Tropics WHA;
- some stands of Littoral Rainforest on the Fraser Island and Cooloola sand masses within 2 km 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 mainly through reduction in sediment loads to the Great Barrier Reef;
- the ecological community provides habitat for a number of 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, the majority of which are also listed under Federal and State threatened species legislation.

# 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 this recovery plan. Strategies have been designed with the following outcomes in mind:

- Conserve – actions that prevent further decline in the conservation status of Littoral Rainforest, principally its size, condition and functional integrity.
- Improve / extend– 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 the relevant management agencies / organisations.

***Strategy 1: Conserve Littoral Rainforest by managing threats from direct human activities***

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

Minimise and manage the following threats:

- Coastal development
- Damage through use (vehicle tracks, camping)
- Land use on edges (e.g. livestock grazing)
- Changes to natural hydrology
- Climate change

***Strategy 2: Conserve Littoral Rainforest by managing threats from natural disturbance***

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

Manage the following threats:

- Invasive weeds, in particular transformer weeds
- Grazing by introduced herbivores, such as deer
- Pathogens and disease
- Increased fire frequency and/or intensity

***Strategy 3: Improve and extend Littoral Rainforest through active restoration***

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

Implement the following:

- Rehabilitation and restoration activities
- Actions to increase connectivity and create natural buffers to allow for natural migration
- Actions to increase the resilience of Littoral Rainforest patches

***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 Groups, 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;
- Assist with funding applications for management and rehabilitation activities.

***Strategy 5: Research to improve knowledge of Littoral Rainforest and its conservation, and monitor and report on the status of the ecological community***

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

Conduct the following:

- Fine-scale mapping of Littoral Rainforest at local and regional management scales
- Prioritisation of patches for conservation activities

- Assess the condition of Littoral Rainforest at regional scales and report any changes to conservation status and trajectory to relevant management agencies

## 5.3 Performance criteria

The plan requires review within 5 years of commencement. It is intended that the review will measure the success of the recovery plan in achieving the overall objective. 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 native plant or animal species associated with Littoral Rainforest;
- Reduced abundance and extent of infestation of transformer weeds;
- Increased resemblance 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 this 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:

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| *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: Conserve | Actions that conserve Littoral Rainforest by managing threats from direct human activities |
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| **Action 1.1** ***High priority*** | **Minimise the impacts of coastal development and urbanisation**<br><br>***Research/Information***<br>a. Develop regional management plans that provide a framework for the consistent protection and management of Littoral Rainforest, incorporating all land-uses and including strategies to minimise the impacts of :<br>o Urban expansion<br>o Water planning<br>o Industry and infrastructure development<br>o Agricultural expansion<br>o Climate change<br><br>b. Develop guidelines to assist in the assessment and monitoring of actions that may impact upon Littoral Rainforest, including strategies to:<br>o Avoid potential impacts and mitigate potential threats<br>o Offset significant impacts<br>o Consider, and manage, cumulative impacts<br>o Undertake compliance and enforcement activities<br>o Enhance resilience of LR to the impacts of climate change<br><br>***On-ground***<br>c. Prevent the further clearing or detrimental modification of Littoral Rainforest.<br>d. Ensure all new developments in the proximity of Littoral Rainforest consider, and mitigate, potential changes to hydrological flow regimes.<br>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 tourism and vector disturbance**<br><br>***Research/Information***<br>a. Identify high-traffic areas where tourism may be impacting upon Littoral Rainforest.<br>b. Assess whether introduced pathogen levels are associated with visitation rates.<br>c. Investigate the effectiveness of various environmentally friendly tourism infrastructure options, such as raised walking platforms, eco-toilets and shoe cleaning and hand sanitisation stations.<br><br>***On-ground***<br>d. Develop site-specific management actions to reduce impacts on Littoral Rainforest from existing infrastructure and maintenance activities.<br>e. Identify opportunities for infrastructure, including roads, tracks and aqueducts that are no longer required, to be removed or altered to restore Littoral Rainforest.<br>f. Ensure appropriate placement of paths/tracks and public amenities within the vicinity of patches of Littoral Rainforest.<br>g. 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 1.3** ***Medium priority*** | **Minimise the impacts of agriculture on Littoral Rainforest**<br><br>***Research/Information***<br>a. Identify areas where agriculture may be impacting upon Littoral Rainforest.<br><br>***On-ground*** |

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| | b. Support land managers to reduce/remove grazing pressure from within the vicinity of Littoral Rainforest, including excluding livestock from riparian areas.<br>c. Provide guidance for maintaining natural catchment hydrology and water quality. |
| **Action 1.4** ***Medium priority*** | **Minimise the impacts of mining operations in the vicinity of Littoral Rainforest**<br><br>***Research/Information***<br>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.<br>*b.* Provide guidance for maintaining natural catchment hydrology and water quality, and minimising other potential impacts associated with mining operations.<br><br>***On-ground***<br>c. Develop and implement long-term restoration strategies where historic/legacy mining impacts have been identified.<br>d. Undertake revegetation activities within current mining leases to create a natural buffer between operations and patches of Littoral Rainforest.<br>e. Ensure any mining rehabilitation activities use vegetation appropriate for the natural succession trajectory of Littoral Rainforest.<br>f. Ensure any new or revised mining management plans follow best practice standards and include:<br>o pre-operation surveys to establish baseline conditions;<br>o identification of environmental thresholds that would trigger mitigation measures if exceeded;<br>o monitoring of environmental conditions throughout the life of the mine;<br>o appropriate rehabilitation strategies to be implemented upon mine closure;<br>o identification of criteria against which to measure the success of rehabilitation activities;<br>o ongoing monitoring of environmental conditions for an appropriate timescale post rehabilitation;<br>o confirmation of the return of biodiversity, structural integrity and functionality Littoral Rainforest. |
| **Action 1.5** ***Medium priority*** | **Minimise the impacts of climate change on Littoral Rainforest**<br><br>***Research/Information***<br>a. Identify high quality areas of LR where climate change impacts, particularly through rising sea levels and increased storm surges, will be most severe and identify ways to ameliorate this impact.<br><br>***On-ground***<br>b. Implement strategies to reduce the impact of climate change at key LR sites |
| **Performance Criteria:** | • Coastal developments and urbanisation are not resulting in the further loss of Littoral Rainforest.<br>• Buffers between developments and patches of Littoral Rainforest are preventing reductions in habitat quality.<br>• New tourism developments are designed to avoid impacts to Littoral Rainforest.<br>• Existing tourism infrastructure is being upgraded, where possible, to reduce impacts to Littoral Rainforest.<br>• Agricultural activities are not resulting in loss or degradation of Littoral Rainforest.<br>• Mining operations are not resulting in the loss or degradation of Littoral Rainforest.<br>• Buffers between mining operations and patches of Littoral Rainforest are preventing reductions in habitat quality.<br>• Mining rehabilitation efforts are successfully restoring sustainable and ecologically-functional patches of Littoral Rainforest. |

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| | • Anthropogenic activities are not adversely affecting the biodiversity, structural integrity or functionality of Littoral Rainforest.<br>• No further loss of Littoral Rainforest.<br>• No population declines of native species associated with Littoral Rainforest. |
| **Partners and *potential contributors*** | • Australian government agencies (e.g. DoEE, CSIRO)<br>• State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies)<br>• Local government agencies<br>• Indigenous land managers<br>• Private land owners/managers<br>• Industry operators |

| **Strategy 2: Conserve** | **Actions that conserve Littoral Rainforest by managing threats from natural disturbance** |
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| **Action 2.1** ***High priority*** | **Invest in the control and management of transformer weeds**<br><br>***Research/Information***<br>a. Identify areas where transformer weeds may be impacting upon important patches of Littoral Rainforest.<br>b. Investigate potential vectors contributing to the spread of transformer weeds.<br>c. Undertake research to inform the control of transformer weeds.<br>d. Develop best practice guidelines for the control and management of transformer weeds.<br><br>***On-ground***<br>e. Invest in the control and management of transformer weeds in important patches of Littoral Rainforest (as identified under action 2.1a).<br>f. Use appropriate techniques to control weeds, following best practice guidelines (as developed under action 2.1d).<br>g. Educate land managers on the role of transformer weeds in Littoral Rainforest and circulate best practice guidelines for their management. |
| **Action 2.2** ***Medium priority*** | **Develop and implement strategies to reduce fire risk in Littoral Rainforest**<br><br>***Research/Information***<br>a. Investigate the potential for using fire as a management tool to address threats and encourage regeneration in and around Littoral Rainforest.<br>b. Conduct post-fire monitoring and undertake research to assess the effects of different fire regimes on Littoral Rainforest.<br>c. Investigate the ecological interactions occurring between different fire regimes and weed incursions.<br>d. Develop a set of criteria for determining when control burns may be required to reduce fuel loads in the vicinity of Littoral Rainforest.<br><br>***On-ground***<br>e. Implement hazard reduction zones in the vicinity of important patches of Littoral Rainforest.<br>f. Ensure post-fire monitoring is undertaken and, where required, implement post-fire rehabilitation activities. |
| **Action 2.3** ***High priority*** | **Develop and implement a control program for feral animals**<br><br>***Research/Information***<br>a. Identify and map areas where feral animals may be impacting upon important patches of Littoral Rainforest. |

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| | b. Investigate the impact of, and effective control methods for, feral animals in Littoral Rainforest.<br><br>***On-ground***<br>c. Develop best practice guidelines for the management and control of feral animals in Littoral Rainforest.<br>d. Implement appropriate control strategies in areas where feral animals are identified as impacting upon Littoral Rainforest.<br>e. Monitor the effects of removing pest animals from patches of Littoral Rainforest.<br>f. Ensure domestic pest animals (e.g. pigs) are appropriately managed to prevent future feral animal populations becoming established in Littoral Rainforest.<br>g. Educate local councils and land-managers on the role of pest animals in Littoral Rainforest. |
| **Action 2.4**<br>***Medium priority*** | **Mitigate the potential impacts of disease and pathogens on Littoral Rainforest**<br><br>***Research/Information***<br>a. Identify and map areas where disease and pathogens may be impacting upon important patches of Littoral Rainforest.<br>b. Investigate the potential interactions between the spread of disease and pathogens and the nursery industry.<br>c. Develop local and regional protocols for the management of disease and pathogens in Littoral Rainforest.<br><br>***On-ground***<br>d. Implement protocols for the management of disease and pathogens in Littoral Rainforest.<br>e. Integrate disease and pathogen control protocols into other local and regional conservation priorities.<br>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**<br>***Medium priority*** | **Reduce the risk of coastal erosion or changed depositional environment**<br><br>***Research/Information***<br>a. Identify key sites at risk of erosion, inundation and landward retreat.<br>b. Identify areas where there is room for the landward migration of Littoral Rainforest.<br>c. Undertake research to improve understanding of the dynamic ecology of Littoral Rainforest.<br><br>***On-ground***<br>d. Increase the size of natural buffers around patches of Littoral Rainforest at risk of erosion, inundation and landward retreat.<br>e. Increase protection of areas that may provide potential habitat for the landward migration of Littoral Rainforest.<br>f. Undertake regular monitoring to identify changes in the extent (loss and gain) of the ecological community in response to natural processes.<br>g. Protect and manage areas where the regeneration of Littoral Rainforest is identified. |
| **Action 2.6**<br>***Medium priority*** | **Reduce the risk, or mitigate the impacts, of natural disasters (stochastic events)**<br><br>***Research/Information***<br>a. Develop guidelines for best practice management of Littoral Rainforest in response to natural disasters, including protocols for pre-event mitigation measures and post-event clean-up activities.<br><br>***On-ground***<br>b. Implement the guidelines for best practice management of Littoral Rainforest in response to natural disasters. |

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| | 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.<br>• The extent and/or severity of transformer weed infestation is reduced in important patches of Littoral Rainforest.<br>• Appropriate fire management strategies are developed and implemented in the vicinity of important patches of Littoral Rainforest.<br>• Feral animal numbers are reduced in important patches of Littoral Rainforest.<br>• Domestic pest animals are appropriately controlled in the vicinity of important patches of Littoral Rainforest.<br>• Appropriate disease and pathogen management strategies are developed and implemented for important patches of Littoral Rainforest.<br>• Natural buffers are established, where possible, around important patches of Littoral Rainforest and these areas are given increased protection<br>• Areas that may provide for the landward migration and/or regeneration of Littoral Rainforest are given increased protection status.<br>• Guidelines for the best practice management of Littoral Rainforest in response to natural disasters are developed and implemented.<br>• No further loss of Littoral Rainforest.<br>• No further declines in native species associated with Littoral Rainforest. |
| **Partners and *potential contributors*** | • Australian government agencies (e.g. DoEE, CSIRO)<br>• State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies)<br>• Local government agencies<br>• Indigenous land managers<br>• Private land owners/managers<br>• NRM bodies<br>• Community groups<br>• Researchers |

| **Strategy 3: Improve / extend** | **Actions that improve the quality, and increase the extent, of Littoral Rainforest through active restoration** |
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| **Action 3.1** ***High priority*** | **Improve the conservation status of Littoral Rainforest**<br><br>***Research/Information***<br>a. Identify key patches that maintain and/or improve the biodiversity, structural integrity and ecosystem functioning of Littoral Rainforest, and would benefit from the implementation of formal conservation arrangements or increased reservation status.<br>b. Identify patches that have the potential to be linked to other patches through the establishment of wildlife corridors.<br><br>***On-ground***<br>c. Increase protection of Littoral Rainforest through the incorporation of key patches into formal reserve networks.<br>d. Increase protection of patches that would maintain and/or improve landscape connectivity. |
| **Action 3.2** ***High priority*** | **Develop and implement stewardship mechanisms for private land tenures**<br><br>***Research/Information*** |

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| | a. Identify key patches that could benefit from the implementation of stewardship mechanisms to increase protection of Littoral Rainforest on private land.<br>b. Identify patches that have the potential to form wildlife corridors linking to other patches of Littoral Rainforest.<br><br>***On-ground***<br>c. 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.<br>d. Identify and implement alternative stewardship-style management agreements, like trust funds provided from offsetting arrangements with industry or development organisations. |
| **Action 3.3**<br>***High priority*** | **Increase the resilience of Littoral Rainforest**<br><br>***Research/Information***<br>a. Classify patches of Littoral Rainforest at local and regional scales in terms of their leading edge, buffer and refugial zones (see Murphy et al., 2016).<br><br>***On-ground***<br>b. Prioritise management within patches of Littoral Rainforest as follows:<br>o prioritise protection of leading edge zones which provide critical services;<br>o prioritise restoration in areas where buffer vegetation provides connectivity between leading edge and refugial vegetation or where it provides critical ecosystem services;<br>o prioritise protection of refugial vegetation wherever possible.<br>c. Support local councils to include Littoral Rainforest in conservation zones.<br>d. Identify and implement methods to protect refugial zones of Littoral Rainforest.<br>e. Collect and store seeds in appropriate regional seedbanks to ensure the long-term conservation of key species.<br>f. Propagate seeds of key species for use in restoration plantings. |
| **Action 3.4**<br>***Medium priority*** | **Develop and implement best practice guidelines for restoration**<br><br>***Research/Information***<br>a. Develop Best Practice Guidelines that provide a methodology for the rehabilitation/restoration of Littoral Rainforest, including strategies to:<br>o plant appropriate vegetation;<br>o improve condition and complexity;<br>o restore degraded patches;<br>o extend existing patches;<br>o establish natural buffers;<br>o improve connectivity;<br>o manage and/or reduce threats.<br><br>***On-ground***<br>b. Implement strategies from the Best Practice Guidelines to restore important 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. |
| **Performance Criteria:** | • The amount of Littoral Rainforest formally protected in reservation systems is increased and/or protection measures within existing reservations are improved.<br>• The amount of Littoral Rainforest protected on private land through conservation covenants, or other stewardship mechanisms, is increased.<br>• Best practice guidelines for the restoration of Littoral Rainforest are being implemented across the range of the ecological community. |

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| | • Protection and management of Littoral Rainforest is focussed on improving resilience within managed patches of the ecological community.<br>• Structural integrity and biological diversity in restored patches is recovering or has achieved the level of high-quality patches.<br>• 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)<br>• State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies)<br>• Local government agencies<br>• Indigenous land managers<br>• Private land owners/managers<br>• Researchers |
| **Strategy 4: Communicate** | **Actions that increase awareness of, and community involvement in, the management and rehabilitation of Littoral Rainforest** |
| **Action 4.1**<br>***High priority*** | **Increase community awareness of, and participation in, recovery efforts**<br><br>***Research/Information***<br>a. Develop promotional and educational materials, such as brochures, factsheets and webpages, that raise awareness about the presence and importance of Littoral Rainforest at local and regional scales, covering such topics as:<br>o consequences of land clearing and other anthropogenic activities;<br>o local weeds and pest animals, and appropriate management;<br>o opportunities for responsible tourism;<br>o threatened species habitats;<br>o human values associated with the ecological community;<br>o best practice guidelines for management and restoration<br>o the status of recovery actions, including success stories and other learnings;<br>o stakeholder responsibilities under federal, state and local regulations;<br>o programs and funding opportunities to support conservation activities.<br><br>***On-ground***<br>b. Distribute promotional and educational materials to the local community, schools and relevant organisations and agencies.<br>c. Support and encourage community group involvement in on-ground management.<br>d. Promote partnerships between local councils, landholders and volunteers.<br>e. Promote professional bush regenerators working alongside volunteers to enable skills and knowledge transfer.<br>f. Develop interpretative signage highlighting the ecological values of Littoral Rainforest and promoting recovery activities and best-practice management.<br>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.<br>h. Support regional arts programs that highlight the values of Littoral Rainforest. |
| **Action 4.2**<br>***High priority*** | **Increase opportunities for Indigenous involvement in, and management of, the conservation of Littoral Rainforest**<br><br>***Research/Information***<br>a. Develop regional strategies for engaging traditional owners in the implementation of recovery actions for Littoral Rainforest.<br><br>***On-ground***<br>b. Engage and consult with traditional owners.<br>c. Identify, and where relevant support, the aspirations of traditional owners.<br>d. Promote involvement of Indigenous Rangers in managing Littoral Rainforest.<br>e. Promote and support traditional owner enterprises. |

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| | f. Support interpretation activities (e.g. guided talks) by traditional owners. |
| **Performance Criteria:** | • Communication strategies and tools are developed in consultation with community stakeholders.<br>• Community groups, particularly schools, local and regional conservation organisations and traditional owners, are involved in on-ground recovery actions.<br>• Community participation increases and people feel proud of local improvements. |
| **Partners and potential contributors** | • Local government agencies<br>• Indigenous land managers<br>• Private land owners/managers<br>• NRM bodies<br>• Community groups |
| **Strategy 5: Research/ Monitor** | **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**<br><br>***Research/Information***<br>a. Capture and collate information on regeneration of Littoral Rainforest.<br>b. Assess the comparative value of remnant patches of Littoral Rainforest, natural regrowth patches and revegetated patches.<br>c. Improve knowledge of the threats to Littoral Rainforest and the most effective management measures, at both landscape and local scales.<br>d. Identify factors that may limit or promote connectivity between nearby patches.<br>e. Investigate the relationship between Littoral Rainforest and lowland rainforest, including potential management implications and effects on succession processes.<br>f. Assess the value of small patches in peri-urban areas and the cumulative impacts of losing very small patches.<br>g. Investigate the tolerance of Littoral Rainforest to environmental extremes (e.g. fire, temperature, sea level and interactions between multiple threatening processes).<br>h. Investigate the relationship between Littoral Rainforest and different substrates (e.g. sand vs other substrates).<br>i. Investigate the roles of fauna within Littoral Rainforest (e.g. importance of seed dispersing birds).<br>j. Assess the accuracy of flora species lists for each bioregion, and update lists as necessary.<br>k. Identify the most effective methods for regeneration of Littoral Rainforest.<br>l. Develop a landward migration strategy to ensure important patches of Littoral Rainforest have ‘room to move’. |
| **Action 5.2:** ***High priority*** | **Improve knowledge of the extent and condition of Littoral Rainforest**<br><br>***Research/Information***<br>a. Finalise and distribute protocols for the fine-scale mapping of Littoral Rainforest.<br>b. Establish a baseline against which to measure condition and patch quality.<br>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.<br><br>***On-ground***<br>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.<br>e. If there are circumstances in which Littoral Rainforest is found to extend further than 2 km inland, update the key diagnostic characteristics to reflect this. |

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| | f. 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**<br><br>***Research/Information***<br>a. Develop a robust methodology for prioritising patches of Littoral Rainforest, at local and/or regional management scales, in order to guide the investment of resources into different conservation activities.<br><br>***On-ground***<br>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 which capture the latitudinal variation between patches.<br>c. 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**<br><br>***On-ground***<br>a. Collect and collate regional information for annual report cards of the status (area, condition and connectivity) of the ecological community:<br>o record losses (ha) due to direct human impacts;<br>o record losses (ha) due to natural disturbances;<br>o record gains (ha) due to restoration, revegetation and management activities;<br>o utilise data from councils, Local Land Services, relevant state agencies, and Australian Government organisations to ensure due consideration has been given to the conservation of the ecological community.<br>b. Conduct general condition monitoring to detect any new or emerging threats.<br>c. 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.<br>• Mechanisms (e.g. mitigation strategies) that will improve the status of Littoral Rainforest are identified and incorporated into adaptive management arrangements.<br>• The extent and condition of Littoral Rainforest has been assessed.<br>• The effectiveness of recovery efforts, and trajectory, of Littoral Rainforest are known. |
| **Partners and potential contributors** | • Australian government agencies (e.g. DoEE, CSIRO)<br>• State government agencies (e.g. DEHP, OEH, DELWP, National Park bodies)<br>• Local government agencies<br>• Researchers<br>• Indigenous land managers<br>• NRM bodies<br>• 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 land management agencies 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;
- 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 Green Army, National Landcare Programme, 20 Million Trees, 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 3.6. 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.
- Monitoring to measure the effectiveness of management should be retained and expanded to include the extent and condition of identified patches of Littoral Rainforest.
- 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 revegetation and 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 ecologicial community occurring, as indicated by vegetation mapping and modelling, are also important. Key to this is maintaining up-to-date vegetation mapping and modelling data in a creative-commons open access format.

### 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, Bekessy and Wintle, 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 or the removal of native vegetation, particularly remnant patches of threatened ecological communities, without a compelling reason.

The outcomes of offsetting activities (for example habitat restoration) are generally highly uncertain, so any proposals for offsets in the ecological community should include commitments to:

- identify opportunities to avoid the need to offset;
- prioritise the retention and protection of the highest quality patches (Note: simply replanting vegetation is insufficient as an offset as there is no guarantee that habitat reconstruction will be successful and, if it is successful, restoration of a resilient and functioning patch of the ecological community is likely to involve a minimum time lag of several decades);
- manage and protect offset areas in perpetuity for conservation purposes;

- maintain the size, condition and ecological function of remaining patches of the ecological community that are adjacent to areas being cleared;
- focus on the restoration of lower quality patches to achieve high quality condition, and thereby extend protection to otherwise unprotected sites (e.g. sites that are currently too small or degraded to meet the criteria for EPBC protection, but can be restored to a better, more intact condition).

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.

Any proposal for offsetting destruction or damage to the littoral rainforest ecological community must demonstrate why avoidance of this damage was not possible and how the impacts on the community have been minimised. If any offsets are proposed, then they must also show how that offset will compensate for any damage caused.

If offsets are to be used, direct offsetting options (e.g. like for like habitat) should be considered first. Other offsetting options include requiring the developer/agency responsible for the clearing to make payments into a 'trust' fund for management of an offset, which is protected in-perpetuity. Similarly, a funding contribution from offsetting could be set aside for monitoring long-term health and management of patches, or engaging bush regenerators to work on restoration projects through a dedicated program (e.g. Greening Australia, Green Army).

Although some degraded/modified patches are not protected as the ecological community listed under the EPBC Act, it is recognised that patches that do not meet the minimum condition thresholds may still retain important natural values. Suitable recovery and management actions may improve these patches to the point that they are classified as part of the ecological community in the future, and thus fully protected under the EPBC Act. Furthermore, it is vital that offset areas are registered so that they can only be used as an offset once (i.e. a valid offset is only one that is not already protected under any other mechanism) and, to be effective, these areas need to be protected in perpetuity.

### *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 an ecological community and assessing changes in vegetation, however these techniques are only accurate at a course 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 >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 and commonwealth landowner involvement in the implementation of actions within this 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 3:*** *Estimated per unit costings for common recovery activities.*

| Related action # | Action | Est. annual cost per unit |
|---|---|---|
| 1.3 | Fencing (livestock-dingo proof) | $2,000-$6,000/km |
| 2.1 | Weed control treatment | $750/ha |
| 2.2 | Fire management | $5,000-10,000/ha |
| 2.3 | Pest animal control treatment | $100-500/ha |
| 3.3/3.4 | Revegetation – tree/shrub planting | $3/tube-stock |
| 4.1 | Signage | $500-1,000/sign |

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| - | 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 Review

The plan requires review within 5 years of commencement. It is intended that the review will measure the success of the recovery plan in achieving the overall objective and supporting objective using the performance criteria in Section 1.4 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 (Section 5.4) above. They include research and analysis, collation and reporting of information, and communication of the information with stakeholders, particularly land managers and community groups.

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# 8 Appendices

## *Appendix A - Glossary of terms* (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 weed, 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.

## *Appendix B – Flora species of Littoral Rainforest and Coastal Vine Thickets of Eastern Australia by bioregion*

**Note 1:** This ecological community is defined by habitat expressed in terms of structure, flora composition and ecology in response to coastal processes. 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. The diagnostic characteristics presented in the listing advice should be considered when determining the presence or absence of this ecological community.

**Note 2:** This flora list is not exhaustive. Additional rainforest species encountered when surveying a site need to be included when determining the condition thresholds. Species in this list may not always be exclusive to this ecological community.

### CAPE YORK PENINSULA

**FLORA SPECIES**

**Trees**

*Acacia crassicarpa*
*Acacia polystachya*
*Acacia solenota*
*Aglaia elaeagnoidea*
*Aidia racemosa*
*Alectryon reticulatus*
*Araucaria cunninghamii*
*Arytera bifoliolata*
*Asteromyrtus angustifolia*
*Atractocarpus sessilis*
*Beilschmiedia obtusifolia*
*Bossiaea arenicola*
*Buchanania arborescens*
*Canarium australianum*
*Celtis philippensis* var. *philippensis*
*Choriceras tricorne*
*Cochlospermum gillivraei*
*Cryptocarya cunninghamii*
*Cupaniopsis anacardioides*
*Cyclophyllum maritimum*
*Dillenia alata*
*Dinosperma erythrococcum*
*Diospyros compacta*
*Diospyros maritima*
*Drypetes deplanchei*
*Elaeodendron melanocarpum*
*Emmenosperma cunninghamii*
*Endiandra glauca*
*Erythrina variegata*
*Eugenia reinwardtiana*
*Exocarpos latifolius*
*Ficus opposita*

**Trees *(continued)***

*Ganophyllum falcatum*
*Garuga floribunda* var. *floribunda*
*Guettarda speciosa*
*Gyrocarpus americanus*
*Halfordia kendack*
*Litsea glutinosa*
*Mallotus nesophilus*
*Manilkara kauki*
*Mimusops elengi*
*Neofabricia myrtifolia*
*Niemeyera antiloga*
*Pisonia grandis*
*Polyalthia nitidissima*
*Pouteria sericea*
*Premna dallachyana*
*Premna serratifolia*
*Rhodamnia fordii*
*Stenocarpus verticis*
*Sterculia quadrifida*
*Strychnos lucida*
*Syzygium bamagense*
*Syzygium banksii*
*Syzygium suborbiculare*
*Terminalia muelleri*
*Vavaea amicorum*
*Vitex acuminata*
*Xanthostemon arenarius*

**Shrubs**

*Antirhea ovatifolia*
*Capparis lucida*
*Carissa laxiflora*

**Shrubs (*continued*)**

*Croton arnhemicus*
*Eugenia reinwardtiana*
*Glycosmis trifoliata*
*Ixora timorensis*
*Leucopogon ruscifolius*
*Leucopogon yorkensis*
*Lithomyrtus obtusa*
*Memecylon pauciflorum* var. *pauciflorum*
*Micromelum minutum*
*Pemphis acidula*
*Psydrax banksii*
*Suriana maritima*
*Tabernaemontana orientalis*
*Triflorensia australis*
*Vitex acuminata*

**Forbs**

*Xenostegia tridentata*

**Lilies**

*Dianella pavopennacea*

**Vines**

*Abrus precatorius*
*Alyxia spicata*
*Asparagus racemosus*
*Capparis sepiaria*
*Cassytha filiformis*
*Flagellaria indica*

**Orchid (epiphytic and ground)**

*Dendrobium discolor*

**TRANSFORMER WEEDS**

| | | |
|---|---|---|
| *Annona glabra* | *Cryptostegia grandiflora* | *Lantana camara* |
| *Bidens pilosa* var. *pilosa* | *Hyptis suaveolens* | *Senna siamea* |

**WET TROPICS**

| FLORA SPECIES | | |
|---|---|---|
| **Trees** | *Flindersia bourjotiana* | **Shrubs** |
| *Acacia crassicarpa* | *Ganophyllum falcatum* | *Aglaia elaeagnoidea* |
| *Acacia oraria* | *Garuga floribunda var. floribunda* | *Aglaia meridionalis* |
| *Acacia polystachya* | *Glochidion harveyanum* var. | *Alchornea rugosa* |
| *Acmena hemilampra* subsp. | *harveyanum* | *Allophylus cobbe* |
| *hemilampra* | *Gmelina dalrympleana* | *Atractocarpus sessilis* |
| *Acronychia acronychioides* | *Gomphandra australiana* | *Capparis lucida* |
| *Aidia cowleyi* | *Grevillea baileyana* | *Clausena brevistyla* |
| *Aidia racemosa* | *Guettarda speciosa* | *Codiaeum variegatum* var. |
| *Alectryon connatus* | *Guioa acutifolia* | *moluccanum* |
| *Aleurites moluccana* | *Heritiera littoralis* | *Cordyline cannifolia* |
| *Alphitonia excelsa* | *Hernandia nymphaeifolia* | *Cyclophyllum multiflorum* |
| *Anthocarapa nitidula* | *Hibiscus tiliaceus* | *Dichapetalum papuanum* |
| *Antidesma erostre* | *Intsia bijuga* | *Eugenia reinwardtiana* |
| *Antirhea tenuiflora* | *Ixora timorensis* | *Gardenia actinocarpa* |
| *Archidendron grandiflorum* | *Lepiderema sericolignis* | *Glycosmis trifoliata* |
| *Archontophoenix alexandrae* | *Lepidozamia hopei* | *Harpullia rhyticarpa* |
| *Arenga australasica* | *Licuala ramsayi* | *Ixora biflora* |
| *Argyrodendron polyandrum* | *Litsea bindoniana* | *Linospadix minor* |
| *Arytera divaricata* | *Litsea breviumbellata* | *Lithomyrtus obtusa* |
| *Backhousia hughesii* | *Litsea fawcettiana* | *Mackinlaya confusa* |
| *Beilschmiedia obtusifolia* | *Litsea glutinosa* | *Maytenus fasciculiflora* |
| *Blepharocarya involucrigera* | *Melaleuca leucadendra* | *Micromelum minutum* |
| *Brackenridgea australiana* | *Melia azedarach* | *Morinda citrifolia* |
| *Brucea javanica* | *Miliusa brahei* | *Opilia amentacea* |
| *Buchanania arborescens* | *Millettia pinnata* | *Pilidiostigma papuanum* |
| *Calophyllum inophyllum* | *Mimusops elengi* | *Pisonia aculeata* |
| *Calophyllum sil* | *Mischocarpus exangulatus* | *Pittosporum rubiginosum* |
| *Canarium australianum* | *Myristica insipida* | *Psychotria dallachiana* |
| *Canarium vitiense* | *Myrsine porosa* | *Rhodomyrtus trineura* subsp. |
| *Carallia brachiata* | *Normanbya normanbyi* | *trineura* |
| *Castanospermum australe* | *Ormosia ormondii* | *Salacia chinensis* |
| *Celtis paniculata* | *Palaquium galactoxylum* | *Tabernaemontana orientalis* |
| *Cerbera floribunda* | *Pandanus tectorius* | *Tabernaemontana pandacaqui* |
| *Chionanthus ramiflorus* | *Paraserianthes toona* | *Vitex trifolia var. trifolia* |
| *Cleistanthus apodus* | *Planchonia careya* | *Ximenia americana* |
| *Cryptocarya cunninghamii* | *Pleiogynium timorense* | |
| *Cryptocarya exfoliata* | *Pleomele angustifolia* | **Herbs** |
| *Cryptocarya hypospodia* | *Podocarpus grayae* | *Achyranthes aspera* |
| *Cryptocarya triplinervis* var. *riparia* | *Polyalthia nitidissima* | *Amorphophallus galbra* |
| *Cryptocarya vulgaris* | *Polyscias australiana* | *Cyrtococcum oxyphyllum* |
| *Cupaniopsis anacardioides* | *Polyscias elegans* | *Dianella bambusifolia* |
| *Darlingia darlingiana* | *Pouteria chartacea* | *Erythrina variegata* |
| *Dillenia alata* | *Pouteria obovata* | *Hypolytrum nemorum* |
| *Diospyros compacta* | *Pouteria sericea* | *Oplismenus hirtellus* subsp. |
| *Diospyros cupulosa* | *Pouteria xerocarpa* | *imbecillis* |
| *Diospyros uvida* | *Psydrax banksii* | *Pseuderanthemum variabile* |
| *Diospyros maritima* | *Psydrax tropica* | *Capparis sepiaria* |
| *Drypetes deplanchei* | *Ptychosperma elegans* | *Cassytha filiformis* |
| *Dysoxylum latifolium* | *Randia fitzalanii* | *Cissus hastata* |
| *Dysoxylum oppositifolium* | *Rhodamnia spongiosa* | *Colubrina asiatica* var. *asiatica* |
| *Dysoxylum setosum* | *Rhodomyrtus macrocarpa* | *Connarus conchocarpus* subsp. |
| *Elaeocarpus bancroftii* | *Sarcopteryx reticulata* | *conchocarpus* |
| *Elaeocarpus michaelii* | *Terminalia catappa* | *Smilax australis* |

**WET TROPICS**

| FLORA SPECIES Cont. | | |
|---|---|---|
| **Vines** | *Gynochthodes sessilis* | *Semecarpus australiensis* |
| *Abrus precatorius* | *Hibbertia scandens* | *Smilax blumei* |
| *Alyxia spicata* | *Hippocratea barbata* | *Smilax calophylla* |
| *Calamus australis* | *Hoya australis* subsp*. tenuipes* | *Stephania japonica* |
| *Calamus caryotoides* | *Hugonia jenkinsii* | *Syzygium angophoroides* |
| *Cansjera leptostachya* | *Hypserpa decumbens* | *Syzygium banksii* |
| *Derris* sp. Daintree (D.E.Boyland+ 469) | *Hypserpa* | *Syzygium forte* subsp*. forte* |
| | *Jasminum elongatum* | *Syzygium kuranda* |
| *Elaeodendron melanocarpum* | *Mallotus repandus* | *Syzygium monospermum* |
| *Elattostachys microcarpa* | *Melodorum uhrii* | *Terminalia arenicola* |
| *Emmenosperma cunninghamii* | *Mucuna gigantea* | *Terminalia muelleri* |
| *Endiandra glauca* | *Neosepicaea jucunda* | *Thespesia populnea* |
| *Endiandra hypotephra* | *Pachygone ovata* | *Tetrastigma nitens* |
| *Endospermum myrmecophilum* | *Parsonsia velutina* | *Tetrastigma thorsborneorum* |
| *Euroschinus falcatus* | *Pycnarrhena novoguineensis* | *Uvaria concava* |
| *Exocarpos latifolius* | *Rhamnella vitiensis* | *Vandasina retusa* |
| *Ficus destruens* | *Rourea brachyandra* | *Vavaea amicorum* |
| *Ficus obliqua* var*. obliqua* | *Salacia chinensis* | *Wilkiea pubescens* |
| *Ficus opposita* | *Salacia disepala* | *Wrightia laevis* |
| *Ficus racemosa* | *Sarcopetalum harveyanum* | *Xylopia maccreae* |
| *Ficus variegata* var*. variegata* | *Schefflera actinophylla* | |
| *Ficus virens* | *Scolopia braunii* | |
| *Flagellaria indica* | *Secamone elliptica* | |
| **Epiphytes** | **Ferns (terrestrial)** | |
| *Bulbophyllum baileyi* | *Drynaria sparsisora* | |
| *Cymbidium madidum* | *Schizaea dichotoma* | |
| *Dendrobium discolor* var*. discolor* | | |
| *Epipremnum pinnatum* | **Parasites** | |
| *Ophioglossum pendulum* | *Amyema glabra* | |
| *Platycerium hillii* | *Amyema villiflora* subsp*. tomentilla* | |
| *Pyrrosia longifolia* | *Cassytha filiformis* | |
| *Vittaria ensiformis* | | |

| TRANSFORMER WEEDS |
|---|
| *Agave* sp. (sisal hemp) |
| *Cenchrus echinatus* |
| *Hyptis suaveolens* |
| *Lantana camara* |
| *Opuntia* sp. (prickly pear) |
| *Megathyrsus maximus* |
| *Melinis minutiflora* |
| *Passiflora foetida* |
| *Passiflora suberosa* |
| *Sphagneticola trilobata* |
| *Tridax procumbens* |

**CENTRAL MACKAY COAST/CENTRAL QUEENSLAND**

| FLORA SPECIES | | |
|---|---|---|
| **Trees** | **Trees *(continued)*** | **Herbs** |
| *Acacia flavescens* | *Planchonia careya* | *Dianella caerulea* |
| *Acronychia laevis* | *Pleiogynium timorense* | *Pseuderanthemum variabile* |
| *Aglaia elaeagnoidea* | *Polyalthia nitidissima* | |
| *Aidia racemosa* | *Pouteria sericea* | **Sedges** |
| *Alectryon connatus* | *Psydrax odorata* | *Gahnia aspera* |
| *Alphitonia excelsa* | *Schefflera actinophylla* | *Cyperus eglobosus* |
| *Araucaria cunninghamii* | *Scolopia braunii* | *Cyperus enervis* |
| *Arytera divaricata* | *Sterculia quadrifida* | |
| *Banksia integrifolia* | *Xylosma ovatum* | **Grasses** |
| *Celtis paniculata* | | *Imperata cylindrica* |
| *Chionanthus ramiflorus* | **Shrubs** | *Oplismenus* spp. |
| *Clerodendrum floribundum* | *Alyxia ruscifolia* | |
| *Corymbia tessellaris* | *Capparis lucida* | **Orchids** *(epiphyic and ground)* |
| *Cryptocarya triplinervis* | *Clerodendrum inerme* | *Dendrobium discolor* |
| *Cupaniopsis anacardioides* | *Cyclophyllum coprosmoides* | |
| *Diospyros geminata* | *Eugenia reinwardtiana* | **Ferns** |
| *Drypetes deplanchei* | *Lithomyrtus obtusa* | *Drynaria sparsisora* |
| *Elaeodendron melanocarpum* | *Micromelum minutum* | *Microsorum punctatum* |
| *Euroschinus falcatus* | *Psychotria polyostemma* | |
| *Exocarpos latifolius* | *Tabernaemontana orientalis* | |
| *Ficus congesta* | | |
| *Ficus opposita* | **Vines** | |
| *Ficus rubiginosa* | *Alyxia spicata* | |
| *Ganophyllum falcatum* | *Cissus opaca* | |
| *Hibiscus tiliaceus* | *Eustrephus latifolius* | |
| *Jagera pseudorhus* | *Hoya australis* | |
| *Litsea glutinosa* | *Jasminum didymum* | |
| *Livistona decora* | *Jasminum simplicifolium* | |
| *Mallotus philippensis* | subsp*. australiense* | |
| *Mimusops elengi* | *Sarcostemma viminale* subsp*.* | |
| *Olea paniculata* | *brunonianum* | |
| *Pandanus tectorius* | *Smilax australis* | |
| *Paraserianthes toona* | *Stephania japonica* | |
| *Pittosporum ferrugineum* | *Trophis scandens subsp*. | |
| | *scandens* | |

| TRANSFORMER WEEDS |
|---|
| *Cryptostegia grandiflora* |
| *Lantana camara* |
| *Megathyrsus maximus (*var*. maximus and* var*. pubiglumis)* |
| *Passiflora suberosa* |

## NORTHERN SOUTH EASTERN QUEENSLAND

| FLORA SPECIES | | |
|---|---|---|
| **Trees** | **Trees *(continued)*** | **Vines** |
| *Acacia disparrima (A. aulacocarpa)* | *Ixora queenslandica* | *Cissus opaca* |
| *Acronychia imperforata* | *Jagera pseudorhus* | *Eustrephus latifolius* |
| *Acronychia laevis* | *Livistona decora* | *Flagellaria indica* |
| *Aidia racemosa* | *Mallotus discolor* | *Hoya australis* |
| *Alectryon connatus* | *Maytenus disperma* | *Jasminum didymum* |
| *Alectryon tomentosus* | *Petalostigma pubescens* | *Jasminum simplicifolium* subsp. *australiense* |
| *Alphitonia excelsa* | *Pittosporum ferrugineum* | *Geitonoplesium cymosum* |
| *Arytera divaricata* | *Pleiogynium timorense* | *Melodorum leichhardtii* |
| *Bridelia leichhardtii* | *Polyalthia nitidissima* | *Pandorea pandorana* |
| *Capparis arborea* | *Polyscias elegans* | *Pleogyne australis* |
| *Celtis paniculata* | *Pouteria sericea* | *Sarcostemma viminae* subsp. *brunonianum* |
| *Clerodendrum floribundum* | *Psychotria loniceroides* | *Trophis scandens* subsp. *scandens* |
| *Corymbia tessellaris* | *Psydrax odorata* | *Smilax australis* |
| *Cryptocarya triplinervis* | *Scolopia braunii* | *Stephania japonica* var. *discolor* |
| *Cupaniopsis anacardioides* | *Sterculia quadrifida* | *Secamone elliptica* |
| *Cupaniopsis shirleyana* | *Xylosma ovatum* | |
| *Diospyros fasciculosa* | | **Forbs** |
| *Diospyros geminata* | **Shrubs** | *Pseuderanthemum variabile* |
| *Drypetes deplanchei* | *Alyxia ruscifolia* | |
| *Elaeodendron melanocarpum* | *Breynia oblongifolia* | **Grasses** |
| *Euroschinus falcatus* | *Carissa ovata* | *Ancistrachne uncinulata* |
| *Exocarpos latifolius* | *Cyclophyllum coprosmoides* | *Imperata cylindrica* |
| *Ficus rubiginosa* | *Micromelum minutum* | |
| *Ficus opposita* | *Pavetta australiensis* | **Sedges** |
| *Fitzalania* sp. Gregory River (J.Randall 624) | *Pittosporum revolutum* | *Cyperus eglobosus* |
| *Geijera salicifolia* | *Psychotria loniceroides* | |
| *Glochidion lobocarpum* | *Myrsine variabilis* | |
| *Harpullia hillii* | *Turraea pubescens* | |
| | **Fern** | |
| | *Microsorum punctatum* | |

| TRANSFORMER WEEDS |
|---|
| *Lantana camara* |
| *Megathyrsus maximus (*var. *maximus and* var. *pubiglumis)* |
| *Passiflora suberosa* |
| *Psidium guajava* |
| *Schinus terebinthifolius* |
| *Cryptostegia grandiflora* |

## SOUTHERN SOUTH EASTERN QUEENSLAND AND NSW NORTH COAST

**FLORA SPECIES**

**Trees**

*Acacia disparrima*
*Acacia maidenii**
*Acacia melanoxylon**
*Acmena hemilampra* subsp. *hemilampra*
*Acmena smithii*
*Acronychia imperforata*
*Acronychia littoralis*
*Acronychia oblongifolia*
*Acronychia wilcoxiana*
*Alectryon coriaceus**
*Alphitonia excelsa*
*Aphananthe philippinensis**
*Archidendron grandiflorum*
*Archidendron hendersonii*
*Archontophoenix cunninghamiana*
*Arytera divaricata*
*Baloghia inophylla*
*Banksia integrifolia* subsp. *integrifolia**
*Bridelia exaltata*
*Callistemon salignus**
*Callitris columellaris*
*Celtis paniculata*
*Claoxylon australe**
*Clerodendrum floribundum**
*Clerodendrum tomentosum**
*Commersonia bartramia**
*Commersonia fraseri**
*Cryptocarya foetida*
*Cryptocarya triplinervis*
*Cupaniopsis anacardioides**
*Dendrocnide photinophylla*
*Diospyros australis**
*Diospyros fasciculosa*
*Diospyros geminata*
*Diospyros pentamera*
*Drypetes deplanchei* subsp *deplanchei*
*Duboisia myoporoides**
*Dysoxylum fraserianum*
*Elaeocarpus obovatus*
*Elaeocarpus reticulatus*
*Elattostachys nervosa**
*Endiandra discolor**
*Endiandra sieberi**
*Ficus coronata**
*Ficus fraseri**
*Ficus macrophylla*
*Ficus obliqua*
*Ficus rubiginosa*
*Ficus superba* var. *henneana*
*Ficus watkinsiana*
*Flindersia bennettiana*
*Flindersia schottiana*
*Glochidion ferdinandi* var. *ferdinandi**
*Glochidion sumatranum**
*Jagera pseudorhu**
*Litsea australis**
*Litsea reticulata*
*Livistona australis*
*Lophostemon confertus*

**Trees *(continued)***

*Macaranga tanarius**
*Mallotus discolor*
*Mallotus philippensis*
*Melia azedarach**
*Melicope vitiflora**
*Mischocarpus pyriformis**
*Notelaea longifolia**
*Olea paniculata*
*Pararchidendron pruinosum* var. *pruinosum**
*Pilidiostigma rhytispermum**
*Pittosporum undulatum**
*Podocarpus elatus*
*Polyalthia nitidissima**
*Polyscias elegans**
*Pouteria australis*
*Pouteria chartacea**
*Pouteria myrsinoides**
*Pouteria queenslandica*
*Psydrax lamprophylla**
*Psydrax odorata**
*Rhodamnia acuminata*
*Rhodamnia argentea**
*Rhodomyrtus psidioides**
*Sarcomelicope simplicifolia**
*Scolopia braunii**
*Syzygium australe*
*Syzygium francisii*
*Syzygium hodgkinsoniae*
*Syzygium luehmannii*
*Syzygium moorei*
*Syzygium oleosum**
*Toechima tenax**
*Trema tomentosa* var. *aspera**
*Trochocarpa laurina**
*Wilkiea hugeliana**

**Shrubs**

*Alocasia brisbanensis*
*Breynia oblongifolia*
*Capparis arborea*
*Cordyline congesta*
*Cordyline rubra*
*Cordyline stricta*
*Cyclophyllum coprosmoides*
*Elaeodendron australe*
*Eupomatia laurina*
*Euroschinus falcatus*
*Exocarpus latifolius*
*Hibiscus heterophyllus*
*Pellaea falcata* var. *falcata*
*Pittosporum multiflorum*
*Pittosporum revolutum*
*Psychotria loniceroides*
*Pteridium esculentum*
*Rhysotoechia bifoliolata*
*Senna acclinis*
*Sterculia quadrifida*

**Shrubs *(continued)***

*Symplocos stawellii*
*Synoum glandulosum*
*Wikstroemia indica*

**Epiphytes**

*Asplenium australasicum*
*Davallia solida* var *pyxidata*
*Platycerium bifurcatum*
*Pyrrosia confluens*

**Vines and scramblers**

*Austrosteenisia blackii*
*Cayratia clematidea*
*Cissus antarctica*
*Cissus hypoglauca*
*Cissus sterculiifolia*
*Cynanchum elegans*
*Dioscorea transversa*
*Embelia australiana*
*Flagellaria indica*
*Geitonoplesium cymosum*
*Hibbertia scandens*
*Hoya australis*
*Maclura cochinchinensis*
*Marsdenia rostrata*
*Morinda jasminoides*
*Pandorea pandorana*
*Parsonsia straminea*
*Ripogonum album*
*Sarcopetalum harveyanum*
*Smilax australis*
*Smilax glyciphylla*
*Stephania japonica*

**Herbs**

*Aneilema acuminatum*
*Calochlaena dubia*
*Commelina diffusa*
*Dianella caerulea*
*Doodia aspera*
*Gahnia aspera*
*Guioa acutifolia*
*Guioa semiglauca**
*Gymnostachys anceps*
*Halfordia kendack**
*Harpullia hillii**
*Harpullia pendula**
*Hodgkinsonia ovatiflora*
*Homalanthus populifolius*
*Hypolepis muelleri*
*Lomandra longifolia*
*Monococcus echinophorus*
*Myrsine variabilis*
*Neolitsea dealbata*
*Oplismenus imbecillis*

* Species are trees and shrubs

**SOUTHERN SOUTH EASTERN QUEENSLAND AND NSW NORTH COAST**

| TRANSFORMER WEEDS | | |
|---|---|---|
| *Anredera cordifolia* | *Desmodium uncinatum* | *Megathyrsus maximus* var. *maximus* |
| *Asparagus aethiopicus* | *Chrysanthemoides monilifera* subsp. *rotundata* | *Ochna serrulata* |
| *Asparagus africanus* | *Gloriosa superba* | *Schefflera actinophylla* |
| *Asparagus plumosus* | *Ipomoea cairica* | *Schinus terebinthifolius* |
| *Brachiaria mutica* | *Lantana camara* | *Senna pendula* var. *glabrata* |
| *Cardiospermum grandiflorum* | *Macfadyena unguis-cati* | |
| *Delairea odorata* | | |

**SYDNEY BASIN**

| FLORA SPECIES | |
|---|---|
| **Trees** | **Shrubs** |
| *Acmena smithii* | *Breynia oblongifolia* |
| *Acronychia oblongifolia* | *Notelaea longifolia* |
| *Banksia integrifolia* | *Pittosporum revolutum* |
| *Claoxylon australe* | *Syzygium paniculatum* |
| *Cupaniopsis anacardioides* | |
| *Diospyros pentamera* | **Vines/Creepers** |
| *Elaeodendron australe* | *Cissus antarctica* |
| *Eucalyptus botryoides* | *Cissus hypoglauca* |
| *Eupomatia laurina* | *Eustrephus latifolius* |
| *Ficus obliqua* | *Geitonoplesium cymosum* |
| *Glochidion ferdinandi* | *Hibbertia scandens* |
| *Guioa semiglauca* | *Marsdenia rostrata* |
| *Livistona australis* | *Parsonsia straminea* |
| *Pittosporum undulatum* | *Smilax australis* |
| *Podocarpus elatus* | *Stephania japonica* |
| *Myrsine howittiana* | |
| *Sarcomelicope simplicifolia* | **Ferns** |
| *Synoum glandulosum* | *Pellaea falcata* |

| TRANSFORMER WEEDS |
|---|
| *Asparagus aethiopicus* |
| *Chrysanthemoides monilifera* |
| *Delairea odorata* |
| *Ehrharta erecta* |
| *Lantana camara* |
| *Senna pendula* |
| *Tradescantia albiflora* (just goes across ground layer, not into canopy, but still impacts on the ecological community significantly if infestation is thick) |

**SOUTHEAST CORNER**

**FLORA SPECIES**

**Trees**

*Acacia caerulescens*
*Acacia maidenii*
*Acacia mearnsii*
*Acmena smithii*
*Acronychia oblongifolia*
*Alectryon subcinereus*
*Banksia integrifolia* subsp. *integrifolia*
*Claoxylon australe*
*Commersonia fraseri*
*Commersonia rossii*
*Elaeocarpus reticulatus*
*Elaeodendron australe* var. *australe*
*Eucalyptus botryoides*
*Exocarpos cupressiformis*
*Ficus coronata*
*Ficus rubiginosa*
*Glochidion ferdinandi* var. *ferdinandi*
*Livistona australis*
*Monotoca elliptica* s.s.
*Myoporum acuminatum*
*Myoporum insulare*
*Myrsine howittiana*
*Notelaea longifolia* forma *longifolia*
*Pittosporum undulatum*
*Pomaderris aspera*

**Shrubs**

*Acacia longifolia* subsp *sophorae*
*Alyxia buxifolia*
*Breynia oblongifolia*
*Coprosma quadrifida*
*Eupomatia laurina*
*Goodenia ovata*
*Helichrysum elatum*
*Leucopogon parviflorus*
*Melicytus dentatus* s.l.
*Notelaea venosa*
*Olearia viscosa*
*Omalanthus populifolius*
*Pittosporum revolutum*
*Pomaderris oraria* subsp. *calcicola*
*Solanum aviculare*
*Synoum glandulosum* subsp. *glandulosum*
*Trema tomentosa* var. *viridis*
*Westringia fruticosa*

**Vines**

*Aphanopetalum resinosum*
*Cassytha phaeolasia*
*Celastrus australis*
*Cissus antarctica*
*Cissus hypoglauca*
*Clematis glycinoides* var. *glycinoides*
*Eustrephus latifolius*
*Geitonoplesium cymosum*
*Glycine clandestina*
*Hibbertia dentata*
*Hibbertia scandens*
*Kennedia rubicunda*
*Marsdenia rostrata*
*Morinda jasminoides*
*Muehlenbeckia adpressa*
*Pandorea pandorana*
*Parsonsia straminea*
*Rhagodia candolleana*
*Sarcopetalum harveyanum*
*Smilax australis*
*Stephania japonica* subsp. *discolor*
*Tetragonia implexicoma*
*Tylophora barbata*

**Forbs**

*Apium prostratum* subsp. *prostratum*
*Commelina cyanea*
*Desmodium gunnii*
*Dichondra repens*
*Euchiton gymnocephalus*
*Galium propinquum*
*Geranium homeanum*
*Hydrocotyle hirta*
*Lagenophora stipitata*
*Lobelia anceps*
*Lobelia purpurascens*
*Oxalis perennans*
*Plantago debilis*
*Plectranthus parviflorus*
*Pseuderanthemum variabile*
*Rumex brownii*
*Senecio linearifolius* var. *7*
*Senecio minimus*
*Senecio tenuiflorus*

**Forbs *(continued)***

*Solanum pungetium*
*Solanum silvestre*
*Solanum stelligerum*
*Stellaria flaccida*
*Tetragonia tetragonioides*
*Urtica incisa*
*Veronica plebeia*
*Viola eminens*

**Ferns**

*Asplenium flabellifolium*
*Doodia aspera*
*Pellaea falcata* s.s.
*Pteridium esculentum*
*Pteris tremula*

Epiphytes and/or Lithophytes

*Asplenium australasicum*
*Dendrobium speciosum*
*Microsorum pustulatum* subsp. *pustulatum*
*Muellerina celastroides*
*Platycerium bifurcatum*
*Pyrrosia rupestris*
*Rumohra adiantiformis*

Graminoids

*Carex appressa*
*Carex longebrachiata*
*Dianella caerulea* s.l.
*Dianella tasmanica*
*Echinopogon ovatus*
*Entolasia marginata*
*Ficinia nodosa*
*Gahnia aspera*
*Gahnia melanocarpa*
*Lachnagrostis billardierei*
*Lepidosperma concavum*
*Lepidosperma gladiatum*
*Libertia paniculata*
*Lomandra longifolia*
*Luzula meridionalis*
*Microlaena stipoides* var. *stipoides*
*Notodanthonia longifolia*
*Oplismenus hirtellus*
*Poa ensiformis*
*Poa labillardierei*
*Zoysia macrantha*

**SOUTHEAST CORNER**

| TRANSFORMER WEEDS | | |
|---|---|---|
| *Acetosa sagittata* | *Crataegus monogyna* | *Lycium ferrocissimum* |
| *Agapanthus praecox* | *Delairea odorata* | *Olea europa* subsp. *cuspidata* |
| *Asparagus aethiopicus* | *Dolichos (*=Dipogon*) lignosus* | *Opuntia* sp. |
| *Asparagus asparagoides* | *Eriobotrya japonica* (Loquat*)* | *Oxalis incarnata* |
| *Asparagus densiflorus* | *Festuca arundinacea* | *Pennesetum clandestinum* |
| *Asparagus plumosus* | *Galium aparine* | *Phalaris* subsp. (previously |
| *Asparagus scandens* | *Hedera helix* | aquatica) |
| *Chlorophytum comosum* (spider plant) | *Jasminum polyanthum* | *Phoenix canariensis* |
| *Chrysanthemoides monolifera* subsp. | *Lantana camara* var. *camara* | *Pinus radiata* |
| *rotundata* | *Ligustrum lucidum* (large leaf) | *Polygala myrtifolia* |
| *Coprosma repens* | *Ligustrum sinense* | *Populus x canescens* |
| *Cortaderi selloana* (Pampas Grass) | *Ligustrum vulgare* | *Rhaphiolepis indica* |
| *Cotoneaster glaucophyllus* (large leaf) | *Lonicera fragrantissima* (hairy- | *Stenotaphrum secundatum* |
| *Cotoneaster pannosus* (small leaf) | stemmed version of *L. japonica)* | *Tradescantia albiflora* |
| *Crassula* sp. (long trailing) | *Lonicera japonica* | *Vinca major* |
| *Crassula multicava* | | *Zantedeschia aethiopica* |