

## **Conservation Advice (incorporating listing advice) for Robertson Rainforest in the Sydney Basin Bioregion**

1. The Threatened Species Scientific Committee (the Committee) was set up under the EPBC Act to give advice to the Minister for the Environment (the Minister) in relation to the listing and conservation of threatened ecological communities, including under sections 189, 194N and 266B of the EPBC Act.
2. The Committee conducted a listing assessment following the ecological community being placed on the 2017 Finalised Priority Assessment List.
3. The Committee provided its advice on the Robertson Rainforest in the Sydney Basin Bioregion ecological community to the Minister in 2019. The Committee recommended that:
  - the ecological community merits listing as Critically Endangered; and
  - a recovery plan is not required for the ecological community at this time.
4. A draft conservation advice for this ecological community was made available for expert and public comment for a minimum of 30 business days. The Committee and Minister had regard to all public and expert comment that is relevant to the consideration of the ecological community for listing.
5. In 2019 the Minister accepted the Committee's advice, adopted this document as the approved conservation advice and agreed no recovery plan is required at this time. The Minister amended the list of threatened ecological communities under section 184 of the EPBC Act to include Robertson Rainforest in the Sydney Basin Bioregion ecological community in the critically endangered category.
6. At the time of this advice, this ecological community was also listed as threatened under the New South Wales *Biodiversity Conservation Act 2016*.



*Robertson Rainforest in the Sydney Basin Bioregion, Robertson Nature Reserve.*

*Photo credit: Peter Woodard, Wikimedia Commons* 

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**Threatened Ecological Communities**

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## **1 CONSERVATION OBJECTIVE**

To prevent further loss and degradation of the ***Robertson Rainforest in the Sydney Basin Bioregion*** ecological community, and help recover its biodiversity and function through protecting it from significant impacts as a Matter of National Environmental Significance under national environmental law, and by guiding implementation of management and recovery, consistent with the recommended priority conservation and research actions set out in this advice.

This conservation advice contains information relevant to the conservation objective by:

- describing the ecological community and where it can be found
- identifying the key threats to the ecological community
- presenting evidence (listing advice) to support the ecological community being listed as nationally threatened under national environment law; and
- outlining the priority conservation and research actions that could stop decline and support recovery of the ecological community.

## **2 DESCRIPTION OF THE ECOLOGICAL COMMUNITY AND THE AREA IT INHABITS**

The Robertson Rainforest ecological community is a type of warm to cool temperate rainforest characterised by a low, dense tree canopy, a mesic<sup>1</sup> shrub stratum, lianas and a fern-dominated groundcover. It has a restricted distribution in the Southern Highlands of New South Wales, generally occurring on soils derived from basalt and basanite on the gently undulating Robertson Plateau and surrounds at altitudes between 500 and 800 metres above sea level. There are also small occurrences further south (e.g. on, and near to, the Sassafras Plateau, southwest of Nowra).

This section describes the assemblage of native species that characterises the ecological community throughout its range at the time of listing. More comprehensive species lists are in Appendix A. However, even these do not include all of the species that make up the ecological community and many sites may have species that are not mentioned in this Conservation Advice. The ecological community also includes fungi and cryptogamic plants; however, these are less well documented.

Characteristic species may be abundant or rare and only a subset of the complete list of species recorded in known examples of the community. The number and identity of species recorded at a particular site is partly due to natural variation across the range of the ecological community, historical biogeography and other environmental factors, such as disturbance regime and type. The species recorded can also be affected by sampling scale, survey season and effort and expertise. At some sites characteristic native species are now locally extinct and/or non-characteristic species have established themselves, or have become more abundant. In general, the number of species recorded is likely to increase with the size of the site.

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<sup>1</sup> Mesic: A mesic habitat has a moderate or well-balanced supply of moisture.

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Species presence and relative abundance (including dominance) vary from site to site, depending on a range of environmental factors, such as soil properties (e.g. chemical composition, texture, depth, drainage), topography and hydrology. They also vary over time, in response to factors such as disturbance (e.g. fire, logging, grazing), climate, and weather (e.g. flooding, drought, extreme heat or cold).

This Section also describes the area that the ecological community inhabits, including the location, physical environment and other factors that help determine where the ecological community occurs in nature.

### **2.1 Name of the ecological community**

The name of the ecological community is the ‘**Robertson Rainforest in the Sydney Basin Bioregion**’ (hereafter called ‘Robertson Rainforest’, or the ‘ecological community’). This matches the name of the corresponding ecological community listed under NSW legislation. The relationship between the Commonwealth and NSW listings is explained in section 3.5.

### **2.2 Location and physical environment**

The Robertson Rainforest in the Sydney Basin Bioregion is limited to the Sydney Basin IBRA<sup>2</sup> Bioregion, from the Moss Vale, Illawarra and Ettrema subregions. It primarily occurs within the Wingecarribee local government area with some patches extending into the adjacent Kiama, Shellharbour and Shoalhaven local government areas (all as designated at December 2018). The principal occurrence of the ecological community is on the Robertson Plateau around the town of Robertson in the Southern Highlands. There are also some other less extensive occurrences nearby, including on the higher parts of the Cambewarra Range to the south of Robertson (NSW Scientific Committee 2011; NSW OEH 2017a) and on the Sassafras Plateau, southwest of Nowra (Mills 2019a, b & c; REPS 2019a; NPA 2019).

The ecological community is found on highly fertile soils derived from Tertiary basalts, typically the Robertson Basalt but also others such as Kangaroo Valley Basanite and in transition zones between shale and basalt soils, at altitudes between 500 and 800 metres above sea level, on sites typically receiving high rainfall (1000–1600 mm per annum) (Mills & Jakeman 1995; NSW Scientific Committee 2011; NSW OEH 2017a).

### **2.3 Vegetation structure and flora**

The following description of the vegetation generally relates to the less disturbed, or ‘reference’ condition, occurrences of the Robertson Rainforest. The species listed in this Conservation Advice are based on those identified as characteristic of the ecological community by NSW Scientific Committee (2011), updated and augmented with new information that has become available since that listing. The Robertson Rainforest in the Sydney Basin Bioregion is classified within the Southern Warm Temperate Rainforest

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<sup>2</sup> IBRA refers to the Interim Biogeographical Regionalisation of Australia. IBRA regions are large geographically distinct areas of similar climate, geology and landform with corresponding similarities in their vegetation and animal communities. The version current at the time of this advice is IBRA v7 (DSEWPac 2013), which divides Australia into 89 bioregions and 419 subregions, including offshore islands.

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vegetation class (NSW OEH 2017b). This class of rainforests generally comprises closed-canopied forests dominated by few tree species, over an open shrub layer, occasional lianas and epiphytes, and a dense ground layer of ferns. The Cambewarra Range basalt rainforest (Kangaroo Mountain Basanite) is more exposed and it does not get as cold as on the plateau to the north, so this part of the ecological community is more diverse (Mills, pers. comm., 2019b).

The tree canopy of the ecological community is relatively low and dense (Tozer et al., 2010). The characteristic or common trees present include: *Quintinia sieberi* (Possumwood), *Polyosma cunninghamii* (Featherwood), *Doryphora sassafras* (Sassafras), *Acacia melanoxylon* (Blackwood), *Syzygium smithii* (syn. *Acmena smithii*) (Lilly Pilly) and occasionally *Ceratopetalum apetalum* (Coachwood) (NSW Scientific Committee 2011; NSW OEH 2017a; NSW OEH 2018a). The dominant species on the volcanics along the Cambewarra Range are different from those at the Robertson sites and may include Sassafras, Coachwood, Featherwood and Lilly Pilly, and additionally *Pennantia cunninghamii* (Brown Beech) and some subtropical species such as *Dendrocnide excelsa* (Giant Stinging Tree) and *Citronella moorei* (Silky Beech), with *Sloanea australis* (Maiden's Blush) observed to be prominent at one site (Mills, 2019a).

Common shrub species in the mid stratum include: *Meliccytus dentatus* (Tree Violet), *Coprosma quadrifida* (Prickly Coprosma), *Tasmannia insipida* (Brush Pepperbush), *Myrsine howittiana* (Brush Muttonwood) and *Notelaea venosa* (Veined Mock-olive) (NSW OEH 2017a). There are also some components of the mid layer that are more typical of cool temperate environments, such as *Olearia argophylla* (Musk Daisy Bush), *Hedycarya angustifolia* (Native Mulberry) and *Dicksonia antarctica* (Soft Tree-fern). Various climber and epiphytic species may occur on the trunks and stems of canopy trees and mid-storey shrubs. Climbing species include *Parsonsia brownii* (Mountain Silkpod), *Eustrephus latifolius* (Wombat Berry), *Marsdenia rostrata* (Milk Vine), *Pandorea pandorana* (Wonga Vine) and *Smilax australis* (Lawyer Vine) (NSW Scientific Committee 2011; NSW OEH 2018a). Epiphytic species include the ferns *Microsorium scandens* (Fragrant Fern) and *Pyrrosia rupestris* (Rock Felt Fern) (NSW Scientific Committee 2011; NSW OEH 2018a).

The ground cover typically comprises a dense cover of ferns and other herbs, including *Lastreopsis acuminata* (syn. *Parapolytichum acuminatum*) (Shiny Shield Fern), *Lastreopsis microsora* (Creeping Shield Fern), *Microsorium pustulatum* subsp. *pustulatum* (Kangaroo Fern), *Asplenium flabellifolium* (Necklace Fern), *Pellaea falcata* (Sickle Fern) and *Urtica incisa* (Stinging Nettle) (NSW Scientific Committee 2011; NSW OEH 2018a).

A more comprehensive list of flora species that are likely to occur in the ecological community can be found in Table A1 at [Appendix A](#).

### **2.4 Fauna**

Robertson Rainforest provides habitat for a range of vertebrates and invertebrates. These faunal components of the ecological community play critical roles in the functioning of the ecological community, for instance nutrient cycling and seed dispersal. Many fauna species in the ecological community will also use adjacent or nearby habitats, such as the nationally

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endangered Upland Basalt Eucalypt Forest of the Sydney Basin Bioregion that intergrades with rainforest, but there are some animals that are rainforest specialists.

The rainforest canopy and shrub layers support birds and arboreal mammals. *Pseudocheirus peregrinus* (Common Ringtail Possum) and *Trichosurus vulpecula* (Common Brushtail Possum) are arboreal mammals commonly found in rainforest in the Illawarra and Southern Highlands regions (Mills and Jakeman, 1995). Birds that live amongst rainforest trees and bushes include lorikeets, parrots and cockatoos, e.g. *Platycercus elegans* (Crimson Rosella), and smaller birds such as honeyeaters, wrens, robins and *Psophodes olivaceus* (Eastern Whipbird). The possums, cockatoos and parrots utilise tree hollows for shelter and nesting. The arboreal fauna variously feeds on nectar, flowers, leaves and fruit products of the canopy, as well as invertebrates that live on the leaves or beneath bark. Consequently, their activities in the canopy play important ecological roles for pollination, seed dispersal and regulation of insect populations.

The ecological community is likely to provide habitat for a range of bats, mainly microbats that typically are aerial insectivores. Flying foxes that feed on fruit and nectar of rainforest plants generally do not occur on Robertson Plateau, though the nationally vulnerable *Pteropus poliocephalus* (Grey-headed Flying-fox) has been observed in the region on rare occasions during summer.

Some butterflies may also be prominent in the rainforest as certain rainforest plants are food plants for them (Mills and Jakeman 1995). These include [with their food plants in square brackets]: *Chaetocneme beata* (Common Red-eye) [Lilly Pilly]; *Cephrènes augiades* (Orange Palm-dart) [Cabbage Palm]; *Graphium macleayanum* (Macleays Swallowtail) and *Graphium choredon* (Blue Triangle) [Sassafras]; and, to a lesser extent because its food plant is uncommon around Robertson, *Euploea corinna* (Common Crow) [Fig species].

The sheltered ground layer remains damp and comprises a deep litter layer over moist soil. It provides for a mass of invertebrate and other animal life, which helps in the turnover of litter nutrients that become rich plant foods. Typical invertebrates in the ground layer of the Robertson rainforest include forest snails, such as *Austrorhytida capillacea* (Common Southern Carnivorous Snail) and *Helicarion mastersi* (Royal Semi-slug), giant earthworms (e.g. *Oreoscolex grandis*), millipedes and leeches. All these invertebrates play a role in the ecosystem, for instance by cycling nutrients among vegetation layers and the soil, by providing food sources for ground-dwelling insectivores and omnivores.

Ground-dwelling vertebrate species that are present in rainforests of the region include pigeons, lyrebirds, wombats, bandicoots, echidnas, swamp wallabies, and a range of lizards, snakes and frogs. *Leucosarcia melanoleuca* (Wonga Pigeon) and *Chalcophaps indica* (Emerald Dove) both feed on the fruits of rainforest trees that lie fallen on the rainforest floor (Mills & Jakeman, 1995). In so doing, they help to remove litter and disperse seeds. *Menura novaehollandiae* (Superb Lyrebird) is abundant in both the rainforest and surrounding areas (REPS 2019a), scratching among the leaf litter for ground-dwelling invertebrates, small lizards and frogs on which they feed (NSW OEH (2018d). Ground-dwelling mammals such as *Vombatus ursinus* (Common or Bare-nosed Wombat) function as soil engineers that turn over soil and facilitate nutrient cycling and water infiltration as a result of their burrowing

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and foraging activities. Large numbers of wombats live in the forest as well as the surrounding fields around Robertson, and sightings of *Tachyglossus aculeatus* (Echidna) are quite common (REPS 2019a).

The ecological community is known to include habitat for a number of State and nationally-listed threatened fauna species, including *Chalinolobus dwyeri* (Large-eared Pied Bat), *Dasyurus maculatus* (Spot-tailed Quoll), *Isoodon obesulus* (Southern Brown Bandicoot), *Litoria littlejohni* (Littlejohn's Tree Frog), and *Mixophyes balbus* (Stuttering Frog).

A more comprehensive list of fauna species likely to occur in the ecological community is given in [Appendix A – Species lists](#).

### **3 IDENTIFYING AREAS OF THE ROBERTSON RAINFOREST PROTECTED UNDER NATIONAL ENVIRONMENT LAW**

The key diagnostic characteristics, condition thresholds and other information in this section are used to:

- identify patches of the threatened ecological community that are protected under national environment law (for example, to determine whether the referral, impact assessment, approval and/or compliance provisions of national environmental law are likely to apply to the patch); and
- distinguish between patches of different quality (to aid environmental protection and management decisions).

National listing focuses legal protection on areas or patches of the ecological community that are the most functional, in a relatively natural state and in comparatively good condition. Because the ecological community exhibits various degrees of disturbance and degradation, condition thresholds, classes and categories have been developed.

This section also includes guidance on defining a 'patch' and on sampling protocols; along with further information to have regard to when considering actions that may have a significant impact on the ecological community.

Protection as a matter of national environmental significance under national environment law is limited to areas of the ecological community that meet the key diagnostic characteristics and the minimum condition thresholds for this ecological community. If a proposed action will, or may have, a significant impact on the threatened ecological community, it must be referred to the Australian Government for approval prior to undertaking that action.

Although very degraded or modified patches are not protected under national environment law, some patches of the ecological community that do not meet the condition thresholds still have important natural values; and they may meet definitions for protection under state and local laws or schemes. These lower quality patches should not necessarily be excluded from recovery and other management actions, because these actions could improve the condition of a patch to the point where it is protected under national environment law. Recovery and management actions should also be designed to restore patches to good condition.

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In some cases, however, the loss and degradation are irreversible given changes in land use; or rehabilitation is impractical because too many natural characteristics have been lost. For example, most areas that have been converted to crops, exotic pasture or urban development are unlikely to be restored.

*Key diagnostic characteristics* (Section 3.1) summarise the main features of the ecological community. They are intended to help identify it, noting that more details are provided in the other sections of this document (for instance, where the ecological community occurs in nature and lists of species that characterise the ecological community). Species composition of this ecological community is influenced by, amongst other things: geographic location, the size of the patch; recent rainfall and disturbance history, including fire and grazing.

*Condition thresholds* (Section 3.2) are designed to help identify the relatively good quality patches for protection under national environment law. Because the ecological community has been heavily cleared and fragmented, many remnants are small, isolated and in a modified condition. Any remnants that remain largely intact (in terms of structure and/or diversity of characteristic species), or include mature trees, or are connected to other native vegetation and form a large patch, are a high priority for protection and management.

Very small, isolated and/or degraded patches (e.g. those subject to permanent or ongoing high disturbance) are less likely to have the structure, composition and function of the ecological community and will not meet the minimum condition thresholds for protection under national environment law (for example, a few rainforest trees on a farm or roadside, with limited diversity/structural elements).

The following steps outline how to identify patches of the ecological community that are protected under national environment law (e.g. for EPBC Act referral, assessment and compliance purposes). They are also useful to inform related activities, such as carrying out environmental impact assessments and projects to manage threats or restore the ecological community.

**Step 1:** Use the key diagnostic characteristics to determine whether the ecological community is present – Section 3.1.

**Step 2:** Determine the condition and size of the patch, using the criteria in Section 3.2 to determine whether it meets the minimum condition thresholds for protection under national environment law.

**Note:** Section 3.3 (Further information to assist in determining importance and avoiding significant impacts) must also be taken into account when considering the importance of a patch of the ecological community and how to protect it under national environment law.

**Note:** Boundaries for a patch may extend beyond the site boundary, or beyond the potential area of impact for a proposed action. The entire patch as a whole should be considered.

### **3.1 Step 1 – Key diagnostic characteristics**

Nature is an intergrading continuum and its ecological classification and mapping is an evolving process, open to subjective interpretation. The ecological community persists in a number of natural, modified and disturbed states. Also, environmental variables, such as climate (and the ecological community's response to them), fluctuate or change over time.

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For these and other reasons there will be ‘atypical’ occurrences of the ecological community; and so qualifiers such as “typically”, “relatively”, “unlikely”, “rarely” and “often” are used in the key diagnostic characteristics. A judgement should therefore be made as to whether the ecological community is present or not, based on: the key diagnostic characteristics; along with the description of the ecological community and the area it inhabits in Section 2 of this advice.

The ecological community<sup>3</sup> that is protected under national environment law consists of areas of vegetation (and associated biota) that meet the following key diagnostic characteristics:

- Distribution limited to the southern portion of the Sydney Basin Bioregion in New South Wales. Known occurrences are mostly on the Robertson Plateau in the Wingecarribee and Kiama local government areas (as designated in December 2018). The ecological community is also likely to occur further south in the higher parts of the Cambewarra Range and on, and near to, the Sassafras Plateau in the Shoalhaven local government area (as designated in December 2018).
- Landscape associations include:
  - presence on relatively high nutrient soils, generally derived from Tertiary basalts (typically Robertson Basalt or Kangaroo Valley Basanite). The ecological community typically does not occur on Wianamatta Shale, though may occur in transition zones between shale and basalt soils.
  - typically present at higher altitude (500 to 800 metres above sea level) sites.
- Vegetation is classified as a cool to warm temperate rainforest type that has these features:
  - a tree canopy consisting of one or more of: *Quintinia sieberi* (Possumwood), *Polyosma cunninghamii* (Featherwood), *Doryphora sassafras* (Sassafras) *Acacia melanoxylon* (Blackwood) and *Syzygium smithii* (syn. *Acmena smithii*) (Lilly Pilly); *Ceratopetalum apetalum* (Coachwood), *Pennantia cunninghamii* (Brown Beech), *Dendrocnide excelsa* (Giant Stinging Tree) and *Citronella moorei* (Silky Beech) may also be prominent in some patches, such as on the Cambewarra Range.
  - a mid storey with small trees and shrubs, sometimes with lianas and epiphytes. Typical species present may include *Melicytus dentatus* (Tree Violet), *Coprosma quadrifida* (Prickly Coprosma), *Tasmannia insipida* (Brush Pepperbush), *Olearia argophylla* (Musk Daisy Bush), *Hedycarya angustifolia* (Native Mulberry), *Dicksonia antarctica* (Soft Tree-fern) and *Parsonsia brownii* (Mountain Silkpod).
  - a ground layer that is typically dense with a high cover of ferns.

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<sup>3</sup> The EPBC Act defines an ‘ecological community’ as the “extent in nature in the Australian jurisdiction of an assemblage of native species that inhabits a particular area in nature” (e.g. a group of plants, animals and other organisms interacting in a specific habitat, under relatively similar environmental conditions).

### **3.2 Step 2 – Condition thresholds for national legal protection**

The minimum condition thresholds for this ecological community are designed to identify the relatively good quality patches for protection under national environment law.

In determining these conservation values, it is acknowledged that:

- there is very little Robertson Rainforest remaining;
- patches  $\geq 0.1$  ha in size that remain largely intact have significant conservation value;
- even patches with degraded understorey that retain the canopy characteristics of the ecological community need protecting;
- mature locally indigenous trees (and hollow bearing trees) are important for the range of habitats and resources they provide to species in the ecological community and the broader region;
- large intact patches are relatively uncommon in this landscape and;
- connectivity to other native vegetation areas is typically beneficial.

Other indicators of conservation value are detailed in Section 3.3.5, below.

The ecological community that is protected under national environment law comprises patches that meet the key diagnostic characteristics (above) and the **minimum condition thresholds** set out below.

- a patch size of at least 0.1 ha (1000 m<sup>2</sup>); AND
- at least 30% canopy cover<sup>4</sup>; AND
- a minimum of 5 native plant species from Table A1 per 0.04 ha sample plot<sup>5</sup> on average<sup>6</sup> for the patch OR an understorey comprising at least 30% total vegetation cover of native plant species.<sup>7</sup>

#### **Note in addition:**

- Sections 3.2.1 – 3.2.3: Defining a patch; Revegetated areas and areas of regeneration; and Sampling protocols.

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<sup>4</sup> **Canopy cover** (measured as foliage cover) should be based on representative areas within the whole patch of the ecological community. Foliage cover is “the percentage of the sample site occupied by the vertical projection of foliage and woody branches” (National Committee on Soil and Terrain, 2009: p.81). When measuring canopy cover, include emergents, canopy and the subcanopy layer (everything above the ground layer – e.g. above 2m).

<sup>5</sup> **0.04 ha sample plot** – for example, 20 m x 20 m.

<sup>6</sup> This threshold should be assessed using the mean average (‘richness for species from Table A1’ per sample plot) value for the patch. This is calculated by adding together the ‘number of species from Table A1’ result for each sample plot in the patch; this total is then divided by the number of sample plots for the patch. See also Section 3.2.1 *Defining a patch* and Section 3.2.3 *Sampling protocols*.

<sup>7</sup> The **understorey** comprises all vegetation below the canopy and subcanopy (e.g. below 2m). **Native plant species** should be those outlined in Appendix A and comprise at least 30% of the total understorey vegetation cover.

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- Assessments of a patch should initially be centred on the area of highest native floristic diversity and/or cover, i.e. the best condition area of the patch.
- The surrounding context of a patch must be taken into account when considering factors that add to the importance of a patch that meets the minimum condition thresholds.
- A relevant expert (e.g. an ecological consultant, or local NSW state or regional NRM officer) may be useful to help identify the ecological community and its condition.

AND also refer to Section 3.3 – Further information to assist in determining importance and avoiding significant impacts.

These thresholds typically exclude heavily degraded patches with isolated trees; or small narrow stands of trees over weeds (or non-native pastures) that may serve as windbreaks or shelter belts on farms. Although not protected under the EPBC Act, stands or patches that do not meet the minimum condition thresholds may still retain important natural values and may be protected through state and local laws or schemes. In addition, patches that can be restored should not be excluded from recovery and other management actions. Suitable recovery and management actions may improve a patch's condition, such that it subsequently can be included as part of the ecological community fully protected by national environment law.

### ***3.2.1 Defining a patch***

A patch is a discrete and mostly continuous area of the Robertson Rainforest ecological community<sup>8</sup> that meets the key diagnostic characteristics and minimum condition thresholds. It includes small-scale variations, gaps and disturbances, such as tracks, paths or breaks (including exposed soil, leaf litter, cryptogams and watercourses/drainage lines), or localised variations in vegetation that do not significantly alter the overall functionality<sup>9</sup> of the ecological community. This functionality includes processes such as the movement of wildlife and other pollinators, the dispersal of plant propagules, activities of seed and plant predators, biological water retention and cycling, and many other interactions.

Gaps in the canopy, degraded and regenerating areas of lower quality are still part of the patch, until a decision is made to the contrary. Initially, all areas should be considered together, in terms of identifying the entire patch of the ecological community and considering its protection, under national environment law. Small breaks or gaps are generally included in patch size calculations. However, where there is a break in native vegetation cover, from the edge of the tree canopy of 50 m or more (e.g. due to permanent man-made structures, wide roads or other barriers; or due to wide water bodies), the two areas of the ecological

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<sup>8</sup> Note that NSW vegetation assessment tools have defined a 'patch' differently – i.e. as an area of native vegetation, of one or more different communities that occur together, separated by a gap of no greater than a set distance (usually 100 m). The national Threatened Species Scientific Committee uses the term 'patch' to describe all of a discrete area of a single ecological community (e.g. for environmental impact assessments, do not only consider the area that may be directly impacted by an activity, or the area just within the boundary of a particular activity – consider the entire patch of the ecological community as a whole – property, lot or site boundaries should not be used to define the boundary of a patch.).

<sup>9</sup> Functionality refers to processes such as the movement of wildlife and pollinators, the dispersal of plant propagules, activities of seed and plant predators and many others.

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community are typically treated as separate patches. Two patches of the ecological community can also be separated by a different type of native vegetation (e.g. natural grassland, or a different type of forest or woodland such as a eucalypt forest).

Variation in canopy cover, quality or condition of vegetation across a patch should not initially be considered to be evidence of multiple patches. Patches can be spatially variable and some areas of a patch (if considered in isolation) might not meet all the key diagnostic characteristics and minimum condition thresholds. Average quality across the broadest area that meets the key diagnostic characteristic for the ecological community should be used initially in determining overall vegetation condition (ISSR-derived change) and patch boundaries. Where the average quality of a larger area falls below the minimum condition thresholds for the ecological community, the next largest area that meets the key diagnostics and minimum condition thresholds should be identified and protected. This may result in more than one patch of the ecological community being identified within the larger area first considered.

### ***3.2.2 Revegetated areas and areas of regeneration***

Revegetated or replanted sites, or areas of vegetation regrowth, can be included as part of the protected ecological community, provided that the revegetated area meets the key diagnostic characteristics and the minimum condition thresholds. It is recognised that reconstruction/revegetation often requires long term effort and commitment and results are uncertain. Reconstructing a woodland or forest ecological community to a state that resembles appropriate reference sites can, at best, be extremely slow and may ultimately prove unsuccessful (Wilkins et al. 2003).

However, the Robertson Rainforest ecological community has a relatively high potential for rehabilitation and natural regeneration where threats are sufficiently reduced. Rainforests are dynamic communities that can regenerate naturally following disturbance and structural damage if the threats are managed. Some rainforest species store viable seed in the soil (although viability varies between species); but more commonly, rainforest species rely on rapid germination and seedlings that sit dormant in the understorey (Big Scrub Rainforest Landcare Group 2005). As canopy gaps appear, the availability of light removes any suppression to seedling growth, allowing them to grow rapidly to re-establish the canopy within the gap. The inclusion of patches of natural and managed regeneration reflect the ecological community's ability to regenerate. Degraded patches that are actively managed (i.e. with weeds removed and/or with supplementary planting) are capable of re-establishing themselves and supporting a good ecologically functional state (as can be indicated by meeting moderate or high condition thresholds).

### ***3.2.3 Sampling protocols***

Evaluating/sampling a patch can involve developing a quick/simple map of the vegetation condition, diversity, landscape qualities and management history (where possible) of the site. An appropriate sampling strategy should be used that captures the diversity of the site and recognises any variation e.g. due to topography.

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Thorough and representative on-ground surveys are essential to accurately assess the extent and condition of the ecological community. The Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009) provides relevant survey guidance.

Patches can vary markedly in their shape, size, condition and features. As a general principle, sampling protocols and the number of sample plots should include, or allow for:

- area(s) with the highest apparent number of different native plant species and canopy cover; and
- an appropriate number of plots to provide a representative sample across the full extent of the patch (taking into consideration the shape and condition across the site, as well as providing a good representation of the species present).

Recording the search effort (identifying the number of person hours spent per plot and across the entire patch; along with the surveyor's level of expertise and limitations at the time of survey) is useful for future reference.

Timing of surveys is an important consideration because ecological communities may vary in their appearance through the year and between years, depending on seasonal or climatic conditions. Ideally, surveys should be held in more than one season to maximise the chance of detecting all species present. For example, flowering may be necessary to identify plant species and active growth will indicate population sizes of annual weeds. Immediately after disturbance some species, or groups of species, may not be evident for some time. The presence and detectability of some species may be affected by the time since disturbance such as fire or storms, so surveys should be planned to occur after an adequate time for recovery. At a minimum, it is important to note climate conditions and what kind of disturbance may have happened within a patch and when that disturbance occurred. Note that rainforests may take a long time to recover their structure after certain disturbances and transitional stages may persist for some time.

### **3.3 Further information to assist in determining presence and avoiding significant impacts**

The following information must also be taken into account when considering the importance of a patch of the ecological community and determining potential impacts and how to protect the patch under national environment law.

Land use and disturbance history will have influenced what remains of a patch of the ecological community. Its resulting structure (especially the loss of structural elements) will in turn affect species richness and diversity. The surrounding vegetation will also influence how important a patch of the ecological community is in the broader landscape. For example, whether it enables movement of native fauna or dispersal of plant material, or supports other ecological processes, such as nutrient cycling.

### ***3.3.1 Additional buffer zone around a patch***

In addition to the patch itself, a minimum buffer zone that extends 100 m beyond the canopy of the outermost trees in the patch is essential to assist in the conservation of the patch. Its purpose is not specifically to extend the patch through regeneration, although this would be beneficial. A larger buffer zone should be applied, where practical, to protect patches that are of high conservation value, or if patches are located near drainage lines or a source of nutrient enrichment or groundwater drawdown. Judgement should be exercised to determine an appropriate buffer distance depending on circumstances of how a patch may be impacted.

A buffer zone is an area immediately adjacent to a patch of the ecological community (but not part of the community) that is important for protecting it from likely negative impacts. Because the risk of damaging an ecological community is usually greater where actions occur close to a patch, a buffer zone helps shield the patch from nearby activity. The 100 m buffer zone encompasses an area large enough to protect the root zone of edge trees and other components of the ecological community from fertiliser, pesticide or herbicide applied or sprayed in adjacent land (e.g. spray drift), weed invasion, water runoff, soil erosion and other damage and edge effects.

The buffer zone is not part of the patch of the ecological community, but should ideally consist of other native vegetation that is retained wherever possible. Practical application of a buffer zone is strongly recommended. For instance, it is recommended that care be exercised in the buffer zone to minimise the risk of any significant adverse impacts extending into the ecological community, irrespective of the nature of the buffer zone.

To get approval under national environment law, actions/changes in land use in the buffer zone must not have a significant impact on the ecological community; but there are exemptions for continuing use (e.g. existing cropping, grazing or maintaining fire breaks). If the use of an area next to a patch of the ecological community will be intensified and this is likely to impact adversely upon the patch, approval under the national environment law is also likely to be required to ensure adverse impacts are avoided.

The buffer zone may also be a suitable focus for revegetation or other restoration initiatives to extend the patch.

### ***3.3.2 Surrounding environment, landscape context and other guidance for impact assessment and mitigation***

The minimum condition thresholds outlined above are the minimum level at which patches are protected under national environment law. These thresholds do not represent the ideal state of the ecological community. Patches that are larger, more species rich and less disturbed are likely to provide greater biodiversity value. Additionally, patches that are spatially linked, whether ecologically or by proximity, are particularly important, both as wildlife habitat and corridors and to the viability of the ecological community into the future. Conversely, patches that occur in areas where the ecological community has been most heavily cleared and degraded, or that are at the natural edge of its range, may also be important due to their rarity, genetic significance, or because of the absence of some threats.

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So, in the context of actions that may have significant impacts and hence require approval under national environment law, it is important to consider the environment surrounding patches of the listed ecological community. Some patches that meet the minimum condition thresholds occur in isolation and require protection, as well as priority actions, to link them with other patches. Other patches, which are interconnected to similar native vegetation associations, have additional conservation value.

The following indicators should be considered when assessing the impacts of actions or proposed actions under national environment law – or when considering recovery, management and funding priorities for a particular patch.

- Large size (for a patch of the ecological community and/or other surrounding native vegetation) and/or a large area to boundary ratio. Patches with larger area to boundary ratios are less exposed and more resilient to edge effect disturbances (such as weed invasion, other human impacts and storm damage). However, patches that occur in areas where the ecological community has been most heavily cleared and degraded, or that are at the natural edge of its range, may also be important due to their rarity, genetic significance, or because of the absence of some threats that are within larger patches.
- Evidence of recruitment of key native plant species or the presence of a range of age cohorts (including through successful assisted regeneration) – for example, tree canopy species are present in a range of sizes from saplings to large hollow-bearing trees.
- Good faunal habitat as indicated by patches containing mature (persistent residual) trees (particularly those with hollows), logs, watercourses, diversity of landscape, the diversity of plant species and vegetation structure, contribution to movement corridors, or natural rock outcrops.
- High native species richness – as shown by the variety of native species.
- Presence of nationally listed or state-listed threatened species, or key functional species such as key pollinator and dispersal animals.
- Areas with minimal weeds and feral animals, or where these can be efficiently managed.
- Connectivity to other native vegetation remnants or restoration works. In particular, a patch in an important position between (or linking) other patches in the landscape. Areas of mosaic native vegetation provide a wider range of habitats that benefits flora and fauna diversity.
- Patches that occur in areas where the ecological community has been most heavily cleared and degraded, or that are at the edge of its range, are also important due to their rarity, genetic significance, or because of the absence of some threats.

### ***3.3.3 Area critical to the persistence of the ecological community***

The areas considered critical to the survival of the Robertson Rainforest include all patches that meet the key diagnostic characteristics and the minimum condition thresholds for the ecological community plus the buffer zone, particularly where this includes surrounding

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native vegetation. This is because the ecological community has a very restricted geographic extent, is highly fragmented and, therefore, is vulnerable to further loss and degradation.

Additional areas, such as buffer zones around patches (see 3.3.1, above), while not part of the listed ecological community that is protected under national environment law, should be taken into consideration (e.g. to avoid adverse impacts on the patch, and as part of the broader surrounding environment and landscape context).

### **3.4 Relationship to other vegetation classification systems**

#### ***3.4.1 Caveat***

Any reference to vegetation and mapping units as corresponding to an equivalent or partial degree with a national ecological community, at the time of listing, should be taken as indicative rather than definitive. There are various systems of classification and nomenclature used, many of which have been created for a particular mapping exercise, so the descriptive units used do not fully correspond with each other.

Consideration of whether an ecological community that is protected under national environment law is present at a particular site should focus on how the patch of vegetation and its faunal components meets the description, particularly the key diagnostic characteristics and the minimum condition thresholds for the ecological community.

Most recently at the time of this assessment (2018-19), NSW OEHL has been compiling a comprehensive state-wide vegetation scheme based on the identification of Plant Community Types (PCT). PCTs build on existing studies, notably the vegetation classification and analysis undertaken by Tozer et al. (2010).

#### ***3.4.2 NSW Vegetation Units that correspond to the ecological community***

Bearing in mind the limitations stated above, the ecological community corresponds entirely or partly to the following mapped vegetation types as at April 2019:

- Tindall et al. (2004): RF 516
- Tozer et al. (2010): RF p516 Yarrawa Temperate Rainforest
- NSW OEHL (2018a): BioNet Vegetation Classification Plant Community Types (PCTs):
  - 1128 Sassafras – Blackwood – Lilly Pilly temperate rainforest of the Robertson area, Sydney Basin Bioregion; and
  - 1129 Sassafras – Blackwood – Lilly Pilly temperate rainforest on basalt soils in the Robertson area, southern Sydney Basin Bioregion

#### ***3.4.3 Similar or related Vegetation Units (or intergrades)***

As of the time of this assessment (2018-19), the range of the Robertson Rainforest ecological community potentially overlaps with two ecological communities listed under national environment law. Both differ from the Robertson Rainforest in that they are wet to dry sclerophyll forests and woodlands dominated by eucalypts rather than non-eucalypt species.

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- Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (listed as Endangered in 2011). The Upland Basalt Eucalypt Forests occurs at sites of similar altitude, rainfall and basalt-derived soils to the rainforest, and may include rainforest elements in the vegetation, for instance the presence of individual Sassafras trees in the mid-storey or canopy, and ferns in the understorey. However, these forests are dominated by a range of eucalypt species.
- Southern Highlands Shale Forest and Woodland in the Sydney Basin Bioregion (listed as Critically Endangered in 2015). The Southern Highlands Shale Forest community includes several forms, one of which is a tall, wet form that may include rainforest elements. These occurrences of rainforest species, however, are not typically common, diverse or dominant and the eucalypt canopy is always the key dominant feature that distinguishes these forests from the Robertson Rainforest.

There are other rainforest communities in the Sydney Basin bioregion that also are nationally listed or currently under assessment. The Western Sydney Dry Rainforest and Moist Woodland on Shale ecological community was listed as Critically Endangered in 2013. It occurs in drier, lower elevation locations on Wianamatta shale, from around Picton into the Cumberland Plain, so occurs in landscapes further north than the Robertson Rainforest. The plant species reflect a commensurately drier composition with *Melaleuca* species (Tea-trees) *Brachychiton populneus* (Kurrajong) and emergent eucalypts being common components of the Western Sydney Dry Rainforest.

The Illawarra and Shoalhaven Subtropical Rainforest community, currently under assessment for national listing, occurs typically on or below the escarpment, on the coastal side of the Great Dividing Range in the Illawarra and Shoalhaven regions. The Robertson Rainforest lies on plateaux or the upper escarpment, typically further inland at higher altitude than the Illawarra rainforests.

At the state level, Robertson Rainforest is closely related to Intermediate Temperate Rainforest (RF p116), which occupies fertile clay soils derived from shale on the Southern Highlands plateau or narrow bands of shales/volcanics/coal seams on the upper Illawarra Escarpment (Tozer et al. 2010). Robertson Rainforest also occurs in conjunction with Southern Highlands Basalt Forest (WSF p266), which includes the NSW-listed endangered ecological communities Robertson Basalt Tall Open-forest and Mount Gibraltar Forest, and their distributions may reflect historic fire frequencies (Tozer et al. 2010). These NSW-listed ecological communities are included within the nationally listed Upland Basalt Eucalypt Forest that was discussed above.

### **3.5 Existing protection**

#### ***3.5.1 Protection through reservation***

The majority of the remaining area of the ecological community occurs on private land. About 30 ha of the ecological community is known to be reserved (Tozer et al. 2010), including around 5 ha in Robertson Nature Reserve (WCS 2019), representing 3 to 7% of the estimated remaining extent and less than 2% of the original (pre-1750) extent.

### **3.5.2 Protection through State/Territory legislation**

At the time of national listing, the Robertson Rainforest in the Sydney Basin Bioregion is listed as an Endangered ecological community under the NSW *Biodiversity Conservation Act 2016* (NSW Government 2016). The national and state listings are intended to refer to the same assemblage of species. Nonetheless, some details may differ in the descriptions of the ecological community (e.g. species listed as being part of the assemblage) because of the different levels of knowledge and data available at the time of listing in NSW (2001, see NSW Scientific Committee 2011) compared with this Advice (dated 2019). In addition, the national listing may exclude some patches of the NSW-listed ecological community on the basis of condition thresholds (such as patch size, tree cover or native species richness).

The listing categories for Robertson Rainforest in the Sydney Basin Bioregion currently differ between Commonwealth and State jurisdictions. At the time of listing in NSW, the relevant legislation (*NSW Threatened Species Conservation Act 1995*) did not provide for listing of Critically Endangered ecological communities. Alignment of categories between jurisdictions is predicated on a re-assessment of the status of the community under the *NSW Biodiversity Conservation Act 2016*, which now provides for listing of Critically Endangered Communities.

Details of the NSW listed ecological community are available at:

<http://www.environment.nsw.gov.au/determinations/robertsonrainforest36a.htm>

### **3.5.3 Listed threatened flora and fauna species**

The ecological community provides habitat for a range of flora and fauna listed as threatened under state or national laws. NSW OEH (2018c) record 44 threatened species as being present within the Southern Warm Temperate Rainforests vegetation class that encompasses the ecological community. Sixteen of these are also listed as nationally threatened species. Between them, PCTs 1128 and 1129 (which correspond with the ecological community) are recorded by NSW OEH (2018a) as having 33 state and/or nationally listed threatened species, including most of the 44 recorded for the Southern Warm Temperate Rainforests vegetation class. These 33 species include four plants, three amphibians, one reptile, 11 birds and 14 mammals (10 bats and four marsupials).

A list of threatened species that are known to or may occur in the ecological community can be found in Table A3 at [Appendix A](#).

## **4 KEY THREATS**

The key threats to the ecological community are mainly associated with agriculture in the past and ongoing peri-urban and urban development in the Robertson and Southern Highlands region generally.

### **4.1 Clearing, degradation and fragmentation**

The ecological community has been extensively cleared for agriculture and development. About 400-870 ha or about 15-30% of its original extent is estimated to remain in an increasingly fragmented distribution, mostly on private land (NSW OEH 2017a; NSW

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Scientific Committee 2011; Tozer et al. 2010). Across the Illawarra and Southern Highlands region rainforests are estimated to have undergone a decrease of approximately 75%, from approximately 23,000 ha prior to European colonisation to about 7000 ha (Mills and Jakeman 1995). Continued rural and urban development is likely to result in further clearance, fragmentation, run-off and other impacts. For instance the ecological community may be impacted by pollution present in spray drift or run-off, as a result of urban and agricultural activities. Dumped rubbish from nearby residents and movement of people, vehicles and equipment through the ecological community can also spread weeds, smother understorey species and otherwise harm native flora and fauna. Pet animals can prey on fauna, damage flora and spread exotic species and disease.

Remnants with exposed edges are particularly susceptible to light, heat and wind intrusion which impacts on floristic composition due to the naturally closed nature of this ecological community.

‘Tidying up’ is a common activity in the increasingly park-like Southern Highlands, and generally involves the removal of dead trees, fallen logs and branches, rock and leaf litter from forest and woodland areas. It is an activity which is often mistakenly considered to be part of good land management (ANZECC, 2001) and is sometimes carried out for fire hazard reduction purposes. The collection of firewood may also be undertaken. The removal of these elements from an ecosystem significantly reduces habitat values for many animal species. These elements are also essential for maintaining nutrient cycling within rainforests since they provide the raw materials and habitat for the many organisms (insects, fungi and micro-organisms) which break down this material into soil. The equipment used for tidying and firewood collection also can spread weeds and diseases through spores and seeds in the machinery.

Bush rock collection is also a threat to this ecological community (NSW OEH 2017a) – the action of removing rocks can damage the understorey and soil and destroy valuable habitat for fauna that may use rocky outcrops for shelter.

### **4.2 Impacts from invasive species**

The ecological community is impacted by non-native environmental weeds, including Chinese Privet (*Ligustrum sinense*), English Ivy (*Hedera helix*), Japanese Honeysuckle (*Lonicera japonica*), European Holly (*Ilex aquifolium*), Kikuyu Grass (*Pennisetum clandestinum*) and Blackberry (*Rubus fruticosus* aggregate) (Table A4; NSW Scientific Committee 2011; NSW OEH 2017a; REPS 2019a). Weed incursion in the Southern Highlands region is associated with grazing and agricultural land uses as well as residential development (DoE 2015). In some native vegetation remnants in or adjoining residential areas in the Southern Highlands, residents introduce exotic species as an extension of their gardens, and remove native vegetation due to fear of fire or undesirable native animals such as snakes (Bray, cited in TSSC 2011). Species such as English Ivy and Japanese Honeysuckle can smother native vegetation, killing plants and suppressing regeneration. European Holly produces berries that are spread by birds, bats and/or foxes. Blackberry spreads easily from seeds, from arching canes taking root and from underground root runners (REPS 2019a).

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These plants can continually re-invade native bushland and may outcompete natives if left unmanaged (TSSC 2011), which typically leads to a decline in the diversity and regenerative capacity of a native ecosystem. This in turn impacts on habitat values for fauna by affecting the type and availability of resources such as food (e.g. nectar, seeds and fruit), shelter from predators or weather, and nesting sites (DoE 2015). Further, the use of herbicides and pesticides to control weeds and agricultural insect pests can kill native flora and fauna and disrupt natural food webs (DoE 2015).

There are many seasonal weeds where the seed is in the soil and therefore harder to eradicate. For example, Madagascan Fireweed (*Senecio madagascariensis*) is widespread, while Turnip Weed (*Rapistrum rugosum*) and Sheep's Sorrel (*Rumex acetosella*) are among numerous weeds that are a problem in the Robertson region during spring (REPS 2019a).

Barberry (*Berberis vulgaris*), Firethorn (*Pyracantha* spp.), Broom (*Genista* spp.), Bridal Creeper (*Asparagus asparagoides*), Chilean Needle Grass (*Nassella neesiana*), Serrated Tussock Grass (*Nassella trichotoma*), Gorse (*Ulex europaeus*) and Hawthorn (*Crataegus* spp.) are serious weeds also known to occur within the Southern Highlands region (TSSC 2011; DoE 2015). While some of these weeds may not yet have encroached into rainforest remnants, they are present near the rainforest and are known to have a serious invasive potential.

Myrtle rust (*Austropuccinia psidii*), an introduced fungal pathogen of plants, poses an increasing threat within the region. Among the characteristic species of the ecological community, *Syzygium smithii* (Lilly Pilly) is a known host, although it is regarded as relatively tolerant to moderately susceptible (Makinson 2018). Other myrtaceous species occurring in the ecological community include *Eucalyptus fastigata* (Brown Barrel), *E. smithii* (Gully Gum) and *Tristaniopsis collina* (Mountain Water Gum). However, these are not dominant species in the rainforest and their susceptibility to Myrtle Rust *in situ* is unknown at this time.

A range of feral animal species have been identified in the Southern Highlands region, notably rabbits (*Oryctolagus cuniculus*), pigs (*Sus scrofa*), goats (*Capra hircus*), cats (*Felis catus*), dogs (*Canis lupus familiaris*) and foxes (*Vulpes vulpes*) (Eco Logical Australia, cited in TSSC 2011). These feral animals are known to impact adversely upon native plant and/or animal species and it can be inferred that they are highly likely to impact upon the Robertson Rainforest ecological community. Rabbits, pigs and goats graze and degrade vegetation that provides food and shelter for them and other native species. REPS (2019a) report that rabbits are in plague proportions and do a lot of damage to the soil, seemingly in conjunction with wombats, which do the initial digging and land clearing, following which rabbits move in. REPS (2019a) also note that rabbit experts have indicated that the cool climate on the Robertson Plateau allows rabbits to develop an immunity to both myxomatosis and calicivirus. They can disturb the soil, promoting weed invasion and reducing regeneration. Dogs, foxes and cats affect native animal species via predation, competition for food and shelter, destroying habitat, and spreading disease (DEWHA 2010). Several aggressive bird species, including the introduced Indian Myna (*Acridotheres tristis*) and the native Sulphur-crested Cockatoo (*Cacatua galerita*), Magpie (*Cracticus tibicen*), Red Wattlebird

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(*Anthochaera carunculata*), Pied Currawong (*Strepera graculina*) and Noisy Miner (*Manorina melanocephala*), have spread throughout the largely cleared landscapes of south eastern New South Wales, including the Southern Highlands. These species can outcompete or aggressively exclude other native woodland bird species in areas of fragmented vegetation, further contributing to a decline in biodiversity (DoE 2015).

### **4.3 Grazing and trampling and ‘underscrubbing’**

Degradation of remnants by grazing stock and feral pigs, rabbits, goats and deer (*Cervus* spp.) is an ongoing threat that results in losses of plant species (simplification of the understorey and ground layer and suppression of overstorey), erosion and other soil changes including increased nutrient status (NSW OEH 2017a). Stock grazing can also selectively remove the more palatable species from the ecological community, which can then affect the suitability of the habitat for native fauna (Tozer et al. 2010). Grazing and trampling can impact on recovery by limiting plant regrowth and seedling establishment. The deliberate removal of the understory beneath the tree canopy (underscrubbing) to open areas up (e.g. to stock and/or enhance grazing, or to create lawns in per-urban areas), can also cause a lot of damage to the ecological community.

### **4.4 Altered fire regimes**

Destruction or degradation of remnants by wildfire is an ongoing threat to the ecological community (NSW OEH 2017a). The Robertson rainforest is sensitive to fire and can take many years if not decades to recover composition and structure, or show a range of transitional stages. The composition and overall structure of the ecological community is threatened by increasingly more fires, that can be more intense and at more times of the year in the Southern Highlands. Destruction or degradation of remnants related to the popularity of pile burning on peri-urban blocks is also an issue (NSW OEH 2017a) due to both ‘tidying up’ (as mentioned in Section 4.1) and fires getting out of control. Overall, fire impacts will be exacerbated by other threats such as urban development, weeds and climate change (as covered in Section 4.5). Fire exclusion and rapid detection and suppression of fires are essential to maintain the ecological and biological integrity of the community.

### **4.5 Climate change**

Climate change poses a serious long-term threat to terrestrial ecosystems with the potential to change the ecology of these environments through changes to species composition and community structure and function – including changes in timing and amount of precipitation and increased drying winds, and increased storm events (Dunlop et al. 2012; NSW OEH 2017a). Projections by the CSIRO and Bureau of Meteorology for climate change in Australia’s NRM regions (CSIRO & BOM 2015; Grose et al. 2015) indicate that for the Southern Slopes sub-cluster within which Robertson Rainforest occurs, there will be:

- continuing increase in average temperatures in all seasons
- more hot days and warm spells, with fewer frosts
- generally less rainfall in the cool season

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- increased intensity of extreme rainfall events
- harsher fire-weather climate in the future.

The fragmented nature of the ecological community greatly increases its vulnerability to the effects of a changing climate. For example, movement of native species is limited. In addition to threatening species that cannot adapt, climate change could also exacerbate existing threats such as habitat loss, altered fire regimes and the spread of invasive species and disease (DoE 2015). It is also likely to gradually change the composition of the Robertson Rainforest, with less of the cool temperate species (including complete loss of some species locally) and more warm temperate species. While the ecological community is likely to be negatively impacted by the effects of climate change, in a regional context it is likely to increasingly play an important role in supporting ecological adaptation by providing refuge for species displaced from their preferred habitat. Vegetation such as this ecological community is also important in mitigating extreme hot temperatures in local areas through shading, evaporative cooling and other attenuating processes (DoE 2015).

### **4.6 Key Threatening Processes**

National and State-listed Key Threatening Processes relevant to the Robertson Rainforest ecological community include:

<b>EPBC Act</b>	<b>NSW BC Act</b>
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners ( <i>Manorina melanocephala</i> )	Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners, <i>Manorina melanocephala</i> (Latham, 1802)
Competition and land degradation by rabbits	Competition and grazing by the feral European Rabbit, <i>Oryctolagus cuniculus</i> (L.)
Competition and land degradation by unmanaged goats	Competition and habitat degradation by Feral Goats, <i>Capra hircus</i> Linnaeus 1758
Land clearance	Clearing of native vegetation
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	Anthropogenic Climate Change
Novel biota and their impact on biodiversity e.g. Myrtle rust ( <i>Austropuccinia psidii</i> )	Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
Predation by European red fox	Predation by the European Red Fox <i>Vulpes vulpes</i> (Linnaeus, 1758)
Predation by feral cats	Predation by the Feral Cat <i>Felis catus</i> (Linnaeus, 1758)
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs	Predation, habitat degradation, competition and disease transmission by Feral Pigs, <i>Sus scrofa</i> Linnaeus 1758

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<b>EPBC Act</b>	<b>NSW BC Act</b>
	Bushrock removal
	Herbivory and environmental degradation caused by feral deer
	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
	Invasion and establishment of exotic vines and scramblers

## 5 DETAILED ASSESSMENT OF ELIGIBILITY FOR LISTING AGAINST THE EPBC ACT CRITERIA

This section presents an assessment of how the Robertson Rainforest ecological community meets each of the listing criteria, and forms the listing advice from the Threatened Species Scientific Committee to the Minister. The EPBC listing criteria are interpreted here with reference to the relevant guidelines for nationally threatened ecological communities (DoEE 2017).

Criterion 1. Decline in geographic distribution			
Category	Critically endangered	Endangered	Vulnerable
Its decline in geographic distribution is <b>either</b> :	very severe	severe	substantial
<b>a)</b> Decline relative to the longer-term (beyond 50 years ago e.g. since 1750); <b>or</b> ,	≥90%	≥70%	≥50%
<b>b)</b> Decline relative to the shorter-term (past 50 years).	≥80%	≥50%	≥30%
A past decrease sufficient to meet the criterion is considered to be a measurable change whereby: <ul style="list-style-type: none"> <li>the ecological community has contracted to less than some threshold proportion of its former range; or</li> <li>the total area occupied by the community is less than the threshold proportion of its former area; or</li> <li>less than the threshold proportion of the former area of the community is in patches of a size sufficiently large or well connected with other patches for them to be likely to persist beyond the <i>near future</i>.</li> </ul>			

### Eligible under Criterion 1 for listing as Endangered

#### Evidence:

The Robertson Rainforest ecological community was part of an extensive tract of rainforest that stretched between Wingecarribee Swamp and Macquarie Pass, at least, that was known as the Yarrawa Brush (REPS 1993; Mills 2018). This accounts for the main extent of the Robertson Rainforest, the main additional occurrences being in the Cambewarra Range to the south of Robertson.

The original extent of the Yarrawa Brush is estimated to have been around 2,500 ha (Mills 2018). The Yarrawa Brush was subject to extensive clearing after the Robertson Land Act was passed in 1861 and most of the clearing now evident had probably already been done by the early 1900s (REPS 1993; Fox et al. 1997). Comparisons with the earliest available aerial photographs taken over Robertson in 1949 show many remnants remained in the same state in the 1990s though some patches had become destroyed or were reduced in size. The rainforest had advanced in some places. The current extent for the Robertson Rainforest in the region of the Yarrawa Brush is estimated to be around 400-600 ha by the NSW Scientific Committee (2014) and 870 ha by Tozer et al. (2010). The available data indicate that the Robertson Rainforest has undergone an estimated reduction of 70 to 85% of its original pre-European extent.

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The ecological community has experienced at least a severe decline in its geographic extent, and is therefore **eligible** for listing as **Endangered** under this criterion.

<b>Criterion 2 - Limited geographic distribution coupled with demonstrable threat</b>			
Its geographic distribution is:	<b>Very restricted</b>	<b>Restricted</b>	<b>Limited</b>
2.1. Extent of occurrence (EOO)	< 100 km <sup>2</sup> = <10,000 ha	<1,000 km <sup>2</sup> = <100,000 ha	<10,000 km <sup>2</sup> = <1,000,000 ha
2.2. Area of occupancy (AOO)	< 10 km <sup>2</sup> = <1,000 ha	<100 km <sup>2</sup> = <10,000 ha	<1,000 km <sup>2</sup> = <100,000 ha
2.3. Average patch size	< 0.1 km <sup>2</sup> = <10 ha	< 1 km <sup>2</sup> = <100 ha	-
<b>AND</b> the nature of its distribution makes it likely that the action of a threatening process could cause it to be lost in:			
the Immediate future [within 10 years, or 3 generations of any long-lived or key species, whichever is the longer, up to a maximum of 60 years.]	<b>Critically endangered</b>	Endangered	Vulnerable
the Near future [within 20 years, or 5 generations of any long-lived or key species, whichever is the longer, up to a maximum of 100 years.]	Endangered	Endangered	Vulnerable
The Medium term future [within 50 years, or 10 generations of any long-lived or key species, whichever is the longer, up to a maximum of 100 years.]	Vulnerable	Vulnerable	Vulnerable

**Eligible under Criterion 2 for listing as Critically Endangered**

Criterion 2 aims to identify ecological communities that are geographically restricted to some extent. It is recognised that an ecological community with a distribution that is small and/or fragmented, either naturally or that has become so through landscape modification, has an inherently higher risk of extinction if it continues to be subject to ongoing threats that may cause it to be lost in the future. That there are demonstrable and ongoing threats to the Robertson Rainforest ecological community has been detailed in Section 4, above.

The indicative measures that apply to this criterion are:

- extent of occurrence, an estimate of the total geographic range over which the ecological community occurs;
- area of occupancy, an estimate of the area actually occupied by the ecological community, which generally equates with its present extent;
- patch size and distribution, an indicator of the vulnerability of small and/or isolated patches to particular threats; and
- an assessment of timeframes over which threats could result in further loss of the ecological community.

**Evidence:**

***Extent of occurrence.***

The Robertson Rainforest ecological community lies in the southern parts of the Sydney Basin bioregion, largely within the eastern part of the Moss Vale subregion, with a few patches extending into adjacent areas of the Illawarra subregion. The extent of occurrence for the Robertson Rainforest when measured as a minimum convex polygon is around 2000 km<sup>2</sup>, the threshold for a very restricted distribution under Criterion B1 of the IUCN Red List of Ecosystems (Bland et al 2017).

***Area of occupancy.***

The area of occupancy for the ecological community is estimated as up to 870 ha (Tozer et al., 2010) but could be slightly greater based on new mapping of Plant Community Types by the NSW Government. As this is either <1000 ha or close to the 1000 ha threshold, its geographic distribution can be considered **very restricted to restricted** on the basis of area of occupancy.

***Patch size distribution.***

The mean patch size for the Robertson Rainforest ecological community is 3.8 ha while the median patch size is only 0.5 ha. About 72% of extant patches are less than one hectare in size, while almost all (96%) are less than ten hectares (**Table 1**). There are only two extant patches larger than 100 ha remaining. The Robertson Rainforest ecological community therefore can be considered to have a **very restricted** geographic distribution on the basis of patch size statistics.

**Table 1. Number of patches by patch size range class for the Robertson Rainforest ecological community, and in relation to thresholds for fragmentation under Criterion 2.**

Thresholds		Size range (ha)	No. patches	% no. patches	Cumulative %	
Restricted	Very Restricted	0.1 - 1	293	72.0	95.6	99
		> 1 - 10	96	23.6		
		> 10-100	15	3.7	99.3	
		> 100	2	0.7	100	
		<b>Total</b>	<b>545</b>	<b>100</b>		

*Source:* Data supplied by the NSW OEH to the National Vegetation Information System plus unpublished data supplied by Kevin Mills.

The ecological community has been extensively cleared and modified, with most of the clearing undertaken in the distant past, during the late 1800s to early 1900s (REPS, 1993, Fox et al., 1997). There are no quantitative estimates to indicate the degree of recent clearing. However, the remaining stands are known to be small and severely fragmented and are threatened by ongoing threats, notably the spread of invasive species and damage from surrounding agricultural land practices and other activities. The capability of many patches to recover and extend their boundaries is likely to be very low under these circumstances. The nature of its geographic distribution makes it likely that the action of ongoing threatening processes could cause the ecological community to be lost in the ‘immediate’ future, unless

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more actions are taken to protect and restore the ecological community. Therefore, the ecological community is **eligible** for listing as **Critically Endangered** under this criterion.

<b>Criterion 3 - Loss or decline of functionally important species</b>			
<b>Category</b>	<b>Critically endangered</b>	<b>Endangered</b>	<b>Vulnerable</b>
For a population of a native species likely to play a major role in the community, there is a:	very severe decline	severe decline	substantial decline
3.1 Estimated decline over the last 10 years or three generations, whichever is longer of:	at least 80%	at least 50%	at least 20%
to the extent that restoration of the community is not likely to be possible in:	the immediate future	the near future	the medium-term future
3.2: <i>restoration</i> of the ecological community as a whole is <i>unlikely</i> in	10 years, or 3 generations of any long-lived or key species, whichever is the longer, up to a maximum of 60 years.	20 years, or 5 generations of any long-lived or key species, whichever is the longer, up to a maximum of 100 years.	50 years, or 10 generations of any long-lived or key species, whichever is the longer, up to a maximum of 100 years.

**Insufficient information for listing under Criterion 3**

Whilst there has been significant overall loss of area and degradation in the Robertson Rainforest ecological community, evidence for loss of particular functionally important species within remnants is not available at this stage of assessment. The dominant tree canopy species and lower stratum tree species that are key structural and functional elements of the ecological community are not considered to be threatened in their own right. The functions and importance of most other species in this ecological community are, at best, poorly understood and documented in the literature. Therefore, there is **insufficient information** to determine the eligibility of the ecological community for listing under this criterion.

<b>Criterion 4 - Reduction in community integrity</b>			
<b>Category</b>	<b>Critically endangered</b>	<b>Endangered</b>	<b>Vulnerable</b>
The reduction in its integrity across most of its geographic distribution is:	<b>very severe</b>	severe	substantial
as indicated by degradation of the community or its habitat, or disruption of important community processes, that is:			

Reference should also be made to the indicative restoration timeframes as outlined under Criterion 3, above.

## **Eligible under Criterion 4 for listing as Critically Endangered**

### **Evidence:**

The Robertson Rainforest ecological community has been extensively cleared and now exists in a severely fragmentary state. A majority of patches are now very small, under one hectare ([Table 1](#)) and many are in close proximity to land modified for pastures or other land uses (Fox et al., 1997). Cattle are particularly responsible for major disturbances to patches through destruction of understorey plants, opening up understorey vegetation, as vectors for weed seeds, and trampling impacts upon soil structure. Many small rainforest remnants remain on private land, often on steeper terrain less amenable to farming (REPS 1993; Dunstan and Fox 1996). Where these patches remain unfenced, domestic stock have access to enter the rainforest.

Despite this, the core areas of even small patches of Robertson Rainforest may remain relatively intact. The main impact of disturbances is through edge effects. Patches subject to major disturbances were marked by a wider edge zone and a more gradual, rather than abrupt, transition to core rainforest species (Fox et al., 1997). Rainforest remnant size also impacts on the ground-dwelling small mammal fauna (Dunstan and Fox 1996). Only three native small mammal species were detected in this study in Robertson Rainforest: *Rattus fuscipes* (Bush Rat), *Antechinus stuartii* (Brown Antechinus) and *Antechinus swainsonii* (Dusky Antechinus), with the first two species being abundant. The abundance of these two small mammals was greater within larger rainforest remnants and declined for patches subject to major disturbance. Furthermore, for the Bush Rat, the impact of disturbance on abundance markedly depended on remnant size such that abundance declined more sharply when smaller patches were subject to disturbance. These studies highlight that, while even small remnants of Robertson Rainforest may retain their biodiversity, their resilience to disturbance and functional integrity may be compromised.

Weeds and feral animals also impact upon remnants. The introduced Black Rat (*Rattus rattus*) also was abundant in the small mammal study by Dunstan and Fox (1996) but showed contrasting responses to the native mammal species. Black rats were more abundant in major disturbed sites and in small to medium sized rainforest remnants – i.e. they appear to prefer the less intact sites. In addition to introduced rats, rabbits also are prominent within remnants, where they damage the soil surface and structure (REPS 2019a). Feral dogs, foxes and cats also occur in rainforest remnants where they can impact on populations of native animals (REPS, 1993).

Many species of weeds occur in the rainforest remnants: Mills (2013) noted twenty introduced plant species in his survey of the large patch of rainforest at Robertson Nature Reserve, and Fox et al. (1997) identified 33 introduced species across the thirteen remnants of Robertson Rainforest they surveyed ([Table A4](#) in Appendix A). The kinds of weeds range from exotic trees (*Pinus radiata*) to herbs and grasses (e.g. thistles, Madagascan fireweed). Some of the species are serious transformer weeds with the capacity to be highly invasive and

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smothering within native ecosystems, notably blackberry (*Rubus fruticosus* spp. agg.) and kikuyu (*Cenchrus clandestinus*) (REPS 2019a).

The combination of extensive past clearing leading to severe fragmentation, impacts from immediately surrounding agricultural and other land uses, invasions by weeds and feral animals, plus other threats noted above (e.g. disturbances by domestic livestock), have affected the composition and functions of Robertson Rainforest, and their value as habitat for some native flora and fauna. This has resulted in a very severe reduction in integrity such that restoration is unlikely within the immediate future even with positive human intervention. Therefore, the ecological community is **eligible** for listing as **Critically Endangered** under this criterion.

Criterion 5 - Rate of continuing detrimental change			
Category	Critically endangered	Endangered	Vulnerable
Its rate of continuing detrimental change is:	very severe	severe	substantial
as indicated by a) degradation of the community or its habitat, or disruption of important community processes, that is:			
or b) intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:			
5.1 An observed, estimated, inferred or suspected <i>detrimental change</i> over the <i>immediate</i> <sup>#</sup> past or projected for the <i>immediate</i> future of at least:	80%	50%	30%

<sup>#</sup>The immediate timeframe refers to 10 years, or 3 generations of any long-lived or key species believed to play a major role in sustaining the community, whichever is the longer, up to a maximum of 60 years.

**Insufficient information for listing under Criterion 5**

No data on recent or reliably projected changes to the Robertson Rainforest ecological community are available. The available indicative information from REPS (1993) noted that comparisons with the earliest aerial photography of the region from 1949 showed remnants had generally remained in a similar state, though some patches had since been destroyed or reduced in area while the forest had advanced in some places. Consequently, there is **insufficient information** to determine the eligibility of the ecological community for listing under this criterion.

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Criterion 6 - Quantitative analysis showing probability of extinction			
Category	Critically endangered	Endangered	Vulnerable
A quantitative analysis shows that its probability of extinction, or extreme degradation over all of its geographic distribution, is:	at least 50% in the immediate future.	at least 20% in the near future.	at least 10% in the medium-term future.

**Insufficient data for listing under Criterion 6.**

There are no quantitative data available to assess this ecological community under this criterion. As such, there is **insufficient information** to determine the eligibility of the ecological community for listing under this criterion.

## **6 RECOMMENDATIONS BY THE THREATENED SPECIES SCIENTIFIC COMMITTEE**

### **6.1 Recommendation on eligibility for listing against the EPBC Act criteria.**

On the basis of an assessment of available scientific information, it is recommended that the *Robertson Rainforest in the Sydney Basin Bioregion* ecological community is **eligible** for listing as **Critically Endangered**. This was the highest conservation category triggered at the time of this assessment.

### **6.2 Recommendation on whether to have a recovery plan**

The Conservation Advice for the *Robertson Rainforest in the Sydney Basin Bioregion* ecological community outlines priority actions needed for the conservation and recovery of the ecological community, the main threats faced by the ecological community, and the criteria by which the ecological community is eligible for listing. The Committee is required to advise the Minister as to whether the ecological community should also have a Recovery Plan.

For the *Robertson Rainforest in the Sydney Basin Bioregion* ecological community the Committee advises that the Conservation Advice provides sufficient guidance on the recovery of the ecological community and that a decision to have a Recovery Plan is unlikely to lead to substantial additional conservation benefits given the resources required to develop a plan. Consequently, the Committee advises that a Recovery Plan is **not recommended** at this time.

## **7 PRIORITY RESEARCH AND CONSERVATION ACTIONS**

### **7.1 Conservation Objective**

The conservation objective (see section 1 above) provides the goal and rationale for the priority actions identified here. The objective is:

To prevent further loss and degradation of the **Robertson Rainforest in the Sydney Basin Bioregion** ecological community and help recover its biodiversity, function and extent, by protecting it from significant impacts as a Matter of National Environmental Significance under national environmental law and by guiding implementation of management and recovery, consistent with the recommended priority conservation and research actions set out in this advice.

### **7.2 Principles and standards**

In undertaking priority actions to meet the conservation objective, the overarching principle is that it is preferable to maintain existing areas of the ecological community that are relatively intact and of good quality. There are good, practical reasons to do so. It is typically more successful and cost-effective to retain an intact remnant than to allow degradation and then attempt to restore it or another area. The more disturbed and modified a patch of the ecological community, the greater the recovery effort that is required. Also, intact remnants are likely to retain a fuller suite of native plant and animal species, and ecological functions. Certain species may not be easy to recover in practice, if lost from a site.

This principle is highlighted in the National Standards for the Practice of Ecological Restoration in Australia (Standards Reference Group SERA, 2017):

**“Ecological restoration is not a substitute for sustainably managing and protecting ecosystems in the first instance.**

The promise of restoration cannot be invoked as a justification for destroying or damaging existing ecosystems because functional natural ecosystems are not transportable or easily rebuilt once damaged and the success of ecological restoration cannot be assured.”

*Standards Reference Group SERA (2017) – Appendix 2.*

The principle discourages ‘offsets’ where intact remnants are removed with an undertaking to set aside and/or restore other sites. The destruction of intact sites always results in a net loss of the functional ecological community because there is no guarantee all the species and ecological functions of the intact site can be replicated elsewhere.

Where restoration is to be undertaken, it should be planned and implemented with reference to the *National Standards for the Practice of Ecological Restoration in Australia*). These Standards guide how ecological restoration actions should be undertaken and are available online from the Standards Reference Group SERA (2017)<sup>10</sup>. They outline the principles that

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<sup>10</sup> Society for Ecological Restoration: <http://www.seraustralia.com/standards/home.html>

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convey the main ecological, biological, technical, social and ethical underpinnings of ecological restoration practice. More specific guidance regarding restoration of Robertson Rainforest, or information that is regionally specific, may also become available. As restoration ecology is continually developing, it is also important to reflect on the experience of others who have worked on restoring the ecological community, or other rainforests, as well as adapting restoration projects as site-level experience accumulates.

To achieve cost-effective investments in conservation management it is important to consider the likely interaction of the various management actions being undertaken at any one site, as these may be synergistic or antagonistic. There are also likely to be interactions between sites. Additionally, when allocating management resources it is important to consider what is the minimum investment required for success and the follow-up required to secure long-term recovery (for example, for how many years should weed management be repeated).

### **7.3 Priority actions**

Priority actions are recommended for the abatement of threats and supporting recovery of the ecological community. These recommended actions are designed to provide guidance for:

- planning, management and restoration of the ecological community by landholders, NRM and community groups and other land managers;
- determining conditions of approval for relevant controlled actions under national environment law; and
- prioritising activities in applications for Australian Government or other funding programs.

Detailed advice on actions may be available in other documents, such as management plans for weeds, fire or certain parks or regions. The most relevant are listed in section 7.4 below.

This conservation advice identifies priority conservation actions under the following key approaches:

- **PROTECT** the ecological community to prevent further losses;
- **RESTORE** the ecological community by active abatement of threats, appropriate management, restoration and other conservation initiatives;
- **COMMUNICATE, ENGAGE WITH AND SUPPORT** people to increase understanding of the value and function of the ecological community and encourage their efforts in its protection and recovery; and,
- **RESEARCH AND MONITORING** to improve our understanding of the ecological community and the best methods to aid its management and recovery.

These approaches overlap in practice; and form part of an iterative approach to management that includes research, planning, management, monitoring and review.

The actions below do not necessarily encompass all actions in detail that may benefit the Robertson Rainforest ecological community. They highlight general but key actions required to at least maintain survival of the ecological community at the time of preparing this

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Conservation Advice. Actions inconsistent with these actions and that are likely to significantly adversely affect the ecological community should be avoided.

### ***7.3.1 PROTECT the ecological community.***

This key approach includes priorities intended to protect the ecological community by preventing further losses to extent and integrity.

#### *Conserve remaining patches*

- Protect and conserve remaining areas of the ecological community, including protecting potential areas of natural or managed retreat.
- Avoid further clearance and destruction of the ecological community.
- Retain other native vegetation remnants, near patches of the ecological community, where they are important for connectivity, diversity of habitat and act as buffer zones between the ecological community and threats or development zones.
- Protect patches identified as the most intact wildlife refuges or of regional importance in formal conservation reserves. Consider other remnants for less formal conservation tenures, preferably ones that aim for protection over the long-term. This includes investigating formal conservation arrangements, management agreements and covenants to protect patches on private land. This is particularly important for larger patches or areas that link to other patches of native vegetation and are part of wildlife corridors or migration routes.
- Exclude fire from patches of the ecological community.
- Where regrowth is occurring, provide measures that will support the regrowth to mature (e.g. provide fencing to minimise the risk of damage).
- Construct wildlife friendly fences to exclude cattle and that incorporate a buffer to protect rainforest remnants and allowing for recruitment and enhanced connectivity.

#### *Plan strategically to minimise further clearing*

- Remnants should be properly taken into account during the early stages of zoning and development planning decisions, including strategic planning documents at state, regional and local levels.
- Liaise with local councils and State authorities to ensure that cumulative impacts on the ecological community are reduced as part of broader strategic planning or large projects (e.g. road works, developments).

#### *Manage actions to minimise impacts*

Apply the mitigation hierarchy to avoid, then mitigate, then offset potential impacts on the ecological community from development or other actions. The priority is to avoid further clearance and fragmentation of remnants with offsetting as the last resort.

- Plan projects to avoid the need to offset, by avoiding significant impacts to the ecological community.

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

### *Minimise indirect impacts*

- Minimise the risk of indirect impacts to the ecological community from actions outside but near to patches of the ecological community.
- Protect and apply appropriate buffers, particularly of other native vegetation, around patches of the ecological community to minimise off-site impacts; wider buffers may be required where there is larger scale landscape change, such as changes to catchment hydrology. Buffers also serve as important landscape connections, such as wildlife corridors.

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### *Prevent the introduction and spread of exotic species*

- Support strong border biosecurity and avoid importing or accidentally introducing invasive species and pathogens into Australia that may have a serious adverse impact on this ecological community.
- Identify potential new weed incursions early (particularly transformer species) and manage for local eradication, where possible.
- Prevent planting of known or potentially invasive species (particularly known transformer species) in gardens, developments and landscaping near the ecological community.
- Avoid planting highly invasive (e.g. bird dispersed) species in or near remnants.
- When conducting activities in or around the ecological community, practise good biosecurity hygiene to avoid spreading weeds or pathogens. For example, keep vehicles and machinery to dedicated roads and out of remnants wherever possible. If vehicles must be taken into remnants ensure vehicles are washed first to remove soil, potential fungal pathogens and weed seeds. Use plants from accredited nurseries (e.g. accredited through the Nursery and Garden Industry Australia's Nursery Industry Accreditation Scheme).
- Minimise unnecessary soil disturbance that may facilitate weed establishment.
- Prevent dumping of garden waste into bushland, especially in or near patches of the ecological community.
- If new incursions do occur, detect and control them early, as small infestations are more likely to be eradicated.
- Limit or prevent access of grazing animals to patches of the ecological community (e.g. construct fences) where practicable.
- Prevent further introduction of feral animals and, where possible, contain pets in nearby residential areas.

### ***7.3.2 RESTORE the ecological community***

This key approach includes priorities to restore the ecological community by active abatement of threats, appropriate management, restoration and other conservation initiatives.

- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Work with landholders to restore and reconnect patches of the ecological community and include buffers.

### *Manage weeds and pests*

- Implement effective integrated control and management techniques for weeds affecting the ecological community and manage sites to prevent the introduction of new, or further spread of, invasive weeds.
- Prioritise weed control in patches for which management is most urgent.

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- Target control of key weeds that threaten the ecological community using appropriate methods.
- Encourage appropriate use of local native species in developments in the region through local government and industry initiatives and best practice strategies.
- Ensure chemicals, or other mechanisms used to manage weeds and pathogens, do not have significant adverse, off-target impacts on the ecological community or adjacent waterbodies.
- Control introduced pest animals through coordinated landscape-scale control programs. For example, work with relevant authorities to suppress deer, goat and fox numbers, in line with regional pest management strategies.
- Control invasive species using best practice bush regeneration techniques by qualified bush regenerators.

### *Exclude trampling, browsing and grazing*

- Promote regeneration by removing grazing.
- Strategically manage total herbivore grazing (by native and domestic animals), for instance by fencing off regrowth and revegetation areas.

### *Undertake restoration*

- Undertake restoration, including bush regeneration and revegetation, of poorer and medium quality patches to restore them to high quality.
  - Plan and implement restoration with reference to the *National Standards for the Practice of Ecological Restoration in Australia* (Standards Reference Group SERA, 2016).
  - Use local native species in restoration/revegetation projects for the ecological community and restore understorey vegetation to a structure and diversity appropriate to the site.
  - In general, use locally collected seeds, where available, to revegetate native plant species. However, choosing sources of seed closer to the margins of their range may increase resilience to climate change.
  - Ensure commitment to follow up after planting, such as the care of newly planted vegetation by watering, mulching, weeding and use/removal of tree guards.
  - Consider the landscape context and other relevant species and communities when planning restoration works. For example, ensure adjacent ecological communities and threatened species are not adversely impacted by tree planting or other restoration activities.
- Seed collections should follow appropriate national guidelines and protocols with long-term storage of germplasm in an appropriate State facility.

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- Implement effective adaptive management regimes using information from available research and management guidelines, for example, see the National Standards for the Practice of Ecological Restoration in Australia, relevant research or advice from local authorities.

### ***7.3.3 COMMUNICATE, ENGAGE WITH AND SUPPORT***

This key approach includes priorities to promote the ecological community to build awareness and encourage people and groups to contribute to its recovery. This includes communicating, engaging with and supporting the public and key stakeholders to increase their understanding of the value and function of the ecological community and to encourage and assist their efforts in its protection and recovery. Key groups to communicate with include landholders, land managers, land use planners, researchers, community members and Indigenous communities, particularly Traditional Owner groups.

#### *Raise awareness*

- Educate landholders about the ecological values of and threats to Robertson Rainforest in the Sydney Basin Bioregion.
- Encourage landholders to protect patches through long term private land conservation mechanisms.
- Communicate with landholders/managers, relevant agencies and the public to emphasise the value of the ecological community, the key threats, its significance, and appropriate management. Encourage landholders to talk with local NRM organisations and other knowledgeable groups.
- Undertake effective community engagement and education to highlight the importance of minimising disturbance.
- Inform landholders about incentives, such as conservation agreements, stewardship projects, funding and government NRM programs etc. that may apply to help look after sites on private lands.

#### *Provide information*

- Develop education programs, information products and signage to help the public recognise the presence and importance of the ecological community, and their responsibilities under state and local regulations and national environmental law. This includes preparation of identification guidelines for the ecological community.
- Install signage to discourage damaging activities such as the removal of rocks and dead timber, dumping garden waste and other rubbish, creating informal paths and tracks, and the use of off-road vehicles in patches of the ecological community.
- Install significant vegetation markers along roads to designate areas of the ecological community to protect and prevent inappropriate road side maintenance from occurring.

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- Promote knowledge about local weeds and what garden plants to avoid planting. Recommend local native species for revegetation and landscaping or safe alternative garden plants.

### *Coordinate efforts*

- Encourage local participation in restoration and ‘landcare’ efforts through local conservation groups, creating ‘friends of’ groups, field days and planting projects, etc.
- Liaise with local fire management authorities and agencies and engage their support in removing the risk of fire to the ecological community. Ensure land managers are given information about how to manage fire risks to conserve any threatened species and ecological communities.
- Support opportunities for traditional owners or other members of the Indigenous community to manage the ecological community.

### **7.3.4 RESEARCH AND MONITORING**

This key approach includes priorities for research into the ecological community, and monitoring, to improve understanding of the ecological community and the best methods to aid its recovery through restoration and protection.

#### *Mapping*

- Collate existing vegetation mapping information and associated data for this ecological community and identify gaps in knowledge.
- Identify and map the fire interval status of surrounding fire-dependent vegetation.
- Undertake or support and enhance survey programs to:
  - Improve mapping of sites where the ecological community is known or likely to be present.
  - Conduct targeted field surveys and ground-truth to fill data gaps and clarify the presence and condition of remnants.

#### *Options for managing threats*

- Research into appropriate and integrated methods to manage weeds that affect the ecological community.
- Research into potential impacts of climate change on current distribution of the ecological community.

#### *Monitoring*

- Monitor for incursions by new weeds and pest animals.
- Monitor for myrtle rust and signs of new disease outbreaks and appropriate containment actions undertaken.

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- It is important that any monitoring is planned before management commences and considers what data are required to address research questions. Monitoring must also be resourced for management activities, especially for those using a novel approach, and applied during and following the management action.
- Monitor changes in the composition, structure and function of the ecological community, including response to all types of management actions and use this information to increase understanding of the ecological community and inform recommendations for future management.

### **7.4 Existing plans relevant to the ecological community**

A number of existing plans relate to management and/or recovery of the ecological community or its component species. These prescriptions were current at the time of publishing. Please refer to the relevant agency's website for any updated versions or new information that has been published.

Plans prepared for the management and/or recovery of the ecological community (or its component vegetation units and State-listed equivalent communities) include:

Eco Logical Australia Pty Ltd (2003) Wingecarribee Biodiversity Strategy – Phase 1.

Consultants report prepared by Eco Logical Australia Pty Ltd for the Wingecarribee our Future Environment Program.

Available on the Internet at:

<https://www.wsc.nsw.gov.au/services/environment/reports-and-resources/wingecarribee-biodiversity-strategy>

Accessed November 2018

Guymer K (2017) Private Land Biodiversity Strategic Plan 2014-2019 (Revision 1, August 2017), prepared for Wingecarribee Shire Council.

Available on the Internet at:

<https://www.wsc.nsw.gov.au/private-land-biodiversity-strategic-plan-20142019>

Accessed November 2018

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**Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)**  
**Threatened Ecological Communities**

**APPENDICES**

**APPENDIX A – SPECIES LISTS**

All species lists presented in this appendix are indicative rather than comprehensive lists of relevant species that comprise the ecological community. A particular patch may not include all species on the list or may include other species not listed. Scientific names are valid as at November 2018. Some local Indigenous names have also been provided.

**Table A1. Native plant species of the ecological community.**

Not all of these species need be present at any particular site, with species composition varying with factors such as the size of the site and its recent disturbance history.

**Bold font** – Key diagnostic species

# – Dominant canopy species

Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
<b>Trees and tall shrubs</b>			
<i>Acacia mearnsii</i>	Black Wattle		
<b><i>Acacia melanoxylon</i></b> #	<b>Blackwood</b>	✓	✓
<i>Acronychia oblongifolia</i>	Common Acronychia, Yellow Wood, White Aspen		✓
<i>Alectryon subcinereus</i>	Native Quince, Wild Quince, Bird's Eye, Smooth Rambutan	✓	✓
<b><i>Ceratopetalum apetalum</i></b>	<b>Coachwood, Scented Coachwood, Scented Satinwood, Tarwood</b>	✓	✓
<i>Citronella moorei</i>	Silky Beech, Soapbox, Churnwood, Corduroy		
<i>Cryptocarya glaucescens</i>	Jackwood, Silver Sycamore, Native Laurel, Bolly Laurel, Brown Laurel, Brown Beech		✓
<i>Cyathea australis</i>	Rough Tree-fern, Black Tree-fern, Pooeet (Koorie)		✓
<i>Cyathea leichhardtiana</i>	Prickly Tree-fern		✓
<i>Dendrocnide excelsa</i>	Giant Stinging Tree, Fibrewood		
<b><i>Dicksonia Antarctica</i></b>	<b>Soft Tree-fern, , Brown Tree-fern, Woolly Fern-tree, Common Tree-fern, Kombadik (Koorie)</b>	✓	✓
<i>Diospyros australis</i>	Black Plum, Grey Plum, Yellow Persimmon, Black Persimmon		✓
<b><i>Doryphora sassafras</i></b> #	<b>Sassafras</b>		✓
<i>Elaeocarpus holopetalus</i>	Black Olive Berry, Mountain Blueberry, Mountain Quandong		✓
<i>Eucalyptus fastigata</i>	Brown Barrel, Cut-tail	✓	✓
<i>Eucalyptus smithii</i>	Gully Gum		
<b><i>Eucryphia moorei</i></b>	<b>Eastern Leatherwood, Southern Leatherwood, Mainland Leatherwood, Pinkwood,</b>		✓

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

Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
	<b>Stinkwood, Plumwood, Yulbah, White Sally, Acacia Plum</b>		
<i>Ficus coronata</i>	Sandpaper Fig, Creek Sandpaper Fig, Creek Fig, Figwood		✓
<i>Hedycarya angustifolia</i>	<b>Austral Mulberry, Australian Mulberry, Native Mulberry, Djelwuck (Koorie)</b>	✓	✓
<i>Helicia glabriflora</i>	Smooth Helicia, Pale Helicia, Pale Oak, Leather Oak, Brown Oak		✓
<i>Livistona australis</i>	Cabbage Palm, Cabbage Tree Palm, Cabbage Fan Palm, Australian Fan Palm, Fan Palm, Daranggara (Cadigal)		✓
<i>Myrsine howittiana</i> (syn. <i>Rapanea howittiana</i> )	Brush Muttonwood	✓	✓
<i>Notelaea venosa</i>	Veined Mock-olive, Smooth Mock-olive, Large-leaved Mock-olive	✓	✓
<i>Olearia argophylla</i>	<b>Musk Daisy Bush, Native Musk, Silver Shrub, Silverleaf</b>		✓
<i>Olearia viscidula</i>	Brush Daisy-bush		
<i>Ozothamnus ferrugineus</i>	Tree Everlasting		✓
<i>Pennantia cunninghamii</i>	Brown Beech	✓	✓
<i>Pittosporum multiflorum</i> (syn. <i>Citriobatus multiflorus</i> )	Orange Thorn	✓	(✓ <sup>11</sup> )
<i>Pittosporum undulatum</i>	Native Daphne, Sweet Pittosporum, Snowdrop Tree (Lord Howe), Mock Orange, White Holly, Wave Leaved Pittosporum, Native Laurel, Engraver Wood	✓	✓
<i>Polyosma cunninghamii</i> #	<b>Featherwood</b>		✓
<i>Polyscias murrayi</i>	Pencil Cedar, Pencilwood, Umbrella Tree, White Basswood, Chinky Pine, Celerywood		✓
<i>Prostanthera lasianthos</i>	Christmas Bush, Victorian Christmas Bush, Mint Tree, Mint Bush, Mountain Lilac		✓
<i>Quintinia sieberi</i> #	<b>Possamwood</b>		✓
<i>Sambucus australasica</i>	Native Elder, Native Elderberry, Yellow Elderberry	✓	✓
<i>Sloanea australis</i>	Maiden's Blush		
<i>Stenocarpus salignus</i>	Scrub Beefwood, Killarney Beefwood, Red Silky Oak		✓

<sup>11</sup> The NSW Scientific Committee (2011) characteristic species list includes *Citriobatus pauciflorus*, which is a synonym of *Pittosporum spinescens*. Mills (2019a) noted that *Pittosporum spinescens* should be *Pittosporum multiflorum* as the former species is from the far north of NSW only.

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Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
<i>Symplocos thwaitesii</i>	Buff Hazelwood		✓
<i>Synoum glandulosum</i>	Scentless Rosewood, Bastard Rosewood, Red Sycamore		✓
<i>Syzygium smithii</i> (syn. <i>Acmena smithii</i> )	Lilly Pilly, Midjuburi (Cadigal)	✓	✓
<i>Tristaniopsis collina</i>	Mountain Water Gum, Hill Kanuka		✓
<b>Low to medium shrubs</b>			
<i>Coprosma quadrifida</i>	Prickly Currant Bush, Native Currant	✓	✓
<i>Melicytus dentatus</i> (syn. <i>Hymenanthera dentata</i> )	Tree Violet	✓	✓
<i>Tasmannia insipida</i>	Brush Pepperbush, Dorrigo Pepper, Pepper Tree		✓
<b>Vines, scramblers, lianas and epiphytes</b>			
<i>Amyema congener</i>	Mistletoe		
<i>Aphanopetalum resinum</i>	Gum Vine	✓	✓
<i>Asplenium australasicum</i>	Bird's Nest Fern, Crow's Nest Fern	✓	✓
<i>Celastrus australis</i>	Staff Climber	✓	✓
<i>Cissus hypoglauca</i>	Native Grapes, Jungle Grape, Five-leaved Grape, Water Vine, Giant Water Vine, Five-leaved Water Vine, White-leaved Water Vine, Jungle Vine, Billangai		✓
<i>Clematis aristata</i>	Old Man's Beard, Traveller's Joy		✓
<i>Clematis glycinoides</i>	Headache Vine, Guwalyari (D'harawal)		✓
<i>Dockrillia pugioniformis</i> (syn. <i>Dendrobium pugioniforme</i> )	Dagger Orchid		✓
<i>Eustrephus latifolius</i>	Wombat Berry, Orange Vine	✓	✓
<i>Fieldia australis</i>	Fieldia		✓
<i>Gynochthodes jasminoides</i> (syn. <i>Morinda jasminoides</i> )	Jasmine Morinda, Sweet Morinda		✓
<i>Hibbertia scandens</i>	Climbing Guinea Flower, Twining Guinea Flower, Golden Guinea Vine, Snake Vine	✓	✓
<i>Marsdenia rostrata</i>	Milk Vine	✓	✓
<i>Palmeria scandens</i>	Anchor Vine, Pomegranate Vine		✓
<i>Pandorea pandorana</i>	Wonga Wonga Vine, Wonga Vine, Spearwood, Lance Wood, Boat Vine	✓	✓

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

Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
<i>Parsonsia brownii</i>	Mountain Silkpod, Twining Silkpod	✓	✓
<i>Parsonsia straminea</i>	Common Silkpod, Monkey Rope	✓	✓
<i>Passiflora cinnabarina</i>	Red Passion-flower		
<i>Passiflora herbertiana</i>	Native Passionfruit		
<i>Ripogonum album</i>	White Supplejack		✓
<i>Rubus moluccanus</i> var. <i>trilobus</i>	Molucca Bramble		✓
<i>Rubus nebulosus</i>	Green-leaved Bramble	✓	✓
<i>Rubus rosifolius</i>	Rose-leaf Bramble, Native Raspberry		✓
<i>Sarcochilus falcatus</i>	Orange-blossom Orchid		✓
<i>Sarcopetalum harveyanum</i>	Pearl Vine, Big-leaf Vine	✓	✓
<i>Smilax australis</i>	Lawyer Vine, Wait-a-while, Barbwire Vine, Austral Sarsaparilla, Sweet Sarsaparilla	✓	✓
<b>Ferns, forbs and graminoids</b>			
<i>Arthropteris tenella</i>	Jointed Fern	✓	✓
<i>Asplenium flabellifolium</i>	Necklace Fern, Fan-leaved Fern, Fan-leaved Spleenwort, Butterfly Fern	✓	✓
<i>Asplenium flaccidum</i>	Weeping Spleenwort, Drooping Spleenwort		✓
<i>Australina pusilla</i>	Small Shade Nettle		✓
<i>Austrocynoglossum latifolium</i> (syn. <i>Hackelia latifolia</i> )	Forest Hound's Tongue, Forest Hound's Tooth		✓
<i>Blechnum neohollandicum</i> (syn. <i>Doodia aspera</i> )	Prickly Rasp Fern		✓
<i>Blechnum nudum</i>	Fishbone Waterfern, Wyebo Gaggawar (Koorie)		✓
<i>Blechnum patersonii</i>	Strap Waterfern		✓
<i>Blechnum watsii</i>	Hard Waterfern, Gaggawar (Koorie)		✓
<i>Carex appressa</i>	Tall Sedge, Southern Cutty Grass		✓
<i>Dennstaedtia davallioides</i>	Lacy Ground Fern		✓
<i>Dianella tasmanica</i>	Tasman Flax-lily		
<i>Dichondra repens</i>	Kidney Weed		
<i>Diplazium australe</i>	Austral Lady Fern		✓
<i>Einadia trigonos</i>	Fishweed		
<i>Elatostema reticulatum</i>	Rainforest Spinach		✓
<i>Entolasia marginata</i>	Bordered Panic		
<i>Galium leiocarpum</i>			
<i>Gastrodia sesamoides</i>	Cinnamon Bells		
<i>Geitonoplesium cymosum</i>	Scrambling Lily	✓	✓

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

Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
<i>Geranium homeanum</i>	Rainforest Crane's-bill		✓
<i>Gymnostachys anceps</i>	Settler's Flax, Settlers' Twine, Boorgay, Caterpillar Flower	✓	✓
<i>Histiopteris incisa</i>	Bat's Wing Fern, Oak Fern		✓
<i>Hydrocotyle acutiloba</i>	Pennywort		
<i>Hydrocotyle laxiflora</i>	Stinking Pennywort, Shitweed		✓
<i>Hymenophyllum cupressiforme</i>	Common Filmy Fern		✓
<i>Hymenophyllum flabellatum</i>	Shiny Filmy Fern, Fan-like Filmy Fern		✓
<i>Hypolepis glandulifera</i>	Downy Ground Fern		
<i>Lastreopsis acuminata</i> (syn. <i>Parapolystichum acuminatum</i> )	Shiny Shield Fern, Creeping Shield Fern, Glossy Shield Fern		✓
<i>Lastreopsis decomposita</i>	Trim Shield Fern		✓
<i>Lastreopsis microsora</i>	Creeping Shield Fern	✓	✓
<i>Libertia paniculata</i>	Branching Grass-flag		
<i>Microlaena stipoides</i>	Weeping Grass		
<i>Microsorium pustulatum</i> subsp. <i>pustulatum</i>	Kangaroo Fern, Hound's Tongue		✓
<i>Microsorium scandens</i>	Fragrant Fern	✓	✓
<i>Notogrammitis billardierei</i> (syn. <i>Grammitis billardierei</i> )	Finger Fern, Common Finger-fern		✓
<i>Oplismenus hirtellus</i> (syn. <i>Oplismenus imbecillis</i> )	Australian Basket-grass, Creeping Beard Grass		
<i>Pellaea falcata</i>	Sickle Fern, Australian Cliff Brake	✓	✓
<i>Pellaea nana</i>	Dwarf Sickle Fern		
<i>Plectorrhiza tridentata</i>	Tangle Orchid		✓
<i>Polyphlebium venosum</i>	Veined Bristle-fern		✓
<i>Polystichum proliferum</i>	Mother Shield Fern		✓
<i>Pseuderanthemum variabile</i>	Pastel Flower, Love Flower		
<i>Pteridium esculentum</i>	Bracken		
<i>Pteris umbrosa</i>	Jungle Brake		✓
<i>Pyrrosia rupestris</i>	Rock Felt Fern	✓	✓
<i>Ranunculus lappaceus</i>	Buttercup, Australian Buttercup, Common Buttercup, Yarrakalgamba (D'harawal)		✓
<i>Ranunculus plebeius</i>	Buttercup		✓
<i>Rumex brownii</i>	Swamp Dock		
<i>Senecio minimus</i>	Shrubby Fireweed		
<i>Senecio quadridentatus</i>	Cotton Fireweed		
<i>Sigesbeckia orientalis</i>	Indian Weed		

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

Scientific name	Common name	Tozer et al. 2010 positive diagnostic species	NSW Scientific Committee (2011) characteristic species list
<i>Solanum aviculare</i>	Kangaroo Apple		✓
<i>Solanum prinophyllum</i>	Forest Nightshade		
<i>Solanum pungetium</i>	Eastern Nightshade	✓	✓
<i>Stellaria flaccida</i>			✓
<i>Sticherus lobatus</i>	Spreading Shield Fern, Spreading Fan Fern		✓
<i>Tylophora barbata</i>	Bearded Tylophora	✓	✓
<i>Urtica incisa</i>	Stinging Nettle, Scrub Nettle, Tall Nettle	✓	✓
<i>Veronica plebeia</i>	Creeping Speedwell, Trailing Speedwell		✓
<i>Viola hederacea</i>	Ivy-leaved Violet, Ivy-leaf Violet, Ivy Violet, Native Creeping Violet, Australian Native Violet	✓	✓
<i>Wahlenbergia gracilis</i>	Australian Bluebell		

Sources: NSW Scientific Committee (2011); Mills (2013), NSW OEH (2017a); Mills (2018); NSW OEH (2018a & b); REPS (1993)

**Table A2. Native vertebrate animal species of the ecological community.**

Scientific name	Common name
<b>Amphibians</b>	
<i>Crinia signifera</i>	Common Eastern Froglet
<i>Limnodynastes peronii</i>	Striped Marsh Frog
<i>Litoria brevipalmata</i>	Green-thighed Frog
<i>Litoria dentata</i>	Bleating Tree Frog
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog; Heath Frog
<i>Litoria peronii</i>	Peron's Tree Frog
<i>Mixophyes balbus</i>	Stuttering Frog, Southern Barred Frog
<b>Birds</b>	
<i>Acanthiza lineata</i>	Striated Thornbill
<i>Acanthiza pusilla</i>	Brown Thornbill
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill
<i>Alisterus scapularis</i>	Australian King-Parrot
<i>Anthochaera carunculata</i>	Red Wattlebird
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow
<i>Cacatua galerita</i>	Sulphur-crested Cockatoo
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo
<i>Callocephalon fimbriatum</i>	Gang-Gang Cockatoo
<i>Chalcophaps indica</i>	Emerald Dove
<i>Colluricincla harmonica</i>	Grey Shrike-thrush
<i>Cormobates leucophaea</i>	White-throated Treecreeper
<i>Corvus coronoides</i>	Australian Raven
<i>Cracticus torquatus</i>	Grey Butcherbird
<i>Dacelo novaeguineae</i>	Laughing Kookaburra
<i>Daphoenositta chrysoptera</i>	Varied Sittella
<i>Dasyornis brachypterus</i>	Eastern Bristlebird
<i>Eopsaltria australis</i>	Eastern Yellow Robin
<i>Gerygone mouki</i>	Brown Gerygone
<i>Glossopsitta pusilla</i>	Little Lorikeet
<i>Gymnorhina tibicen</i>	Australian Magpie
<i>Hieraaetus morphnoides</i>	Little Eagle
<i>Leucosarcia melanoleuca</i>	Wonga Pigeon
<i>Macropygia amboinensis phasianella</i> (syn. <i>Macropygia phasianella</i> )	Brown Cuckoo-Dove
<i>Meliphaga lewinii</i>	Lewin's Honeyeater
<i>Menura novaehollandiae</i>	Superb Lyrebird
<i>Ninox strenua</i>	Powerful Owl
<i>Pachycephala olivacea</i>	Olive Whistler
<i>Pachycephala pectoralis</i>	Golden Whistler
<i>Pardalotus punctatus</i>	Spotted Pardalote
<i>Petroica rosea</i>	Rose Robin
<i>Platycercus elegans</i>	Crimson Rosella
<i>Psophodes olivaceus</i>	Eastern Whipbird
<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove
<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird
<i>Rhipidura fuliginosa</i>	Grey Fantail
<i>Rhipidura rufifrons</i>	Rufous Fantail
<i>Sericornis citreogularis</i>	Yellow-throated Scrubwren
<i>Sericornis frontalis</i>	White-browed Scrubwren
<i>Sericornis magnirostra</i>	Large-billed Scrubwren
<i>Strepera graculina</i>	Pied Currawong
<i>Streptopelia chinensis</i>	Spotted Dove

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Scientific name	Common name
<i>Tyto novaehollandiae</i>	Masked Owl
<i>Tyto tenebricosa</i>	Sooty Owl
<i>Calyptorhynchus funereus</i> (syn. <i>Zanda funerea</i> )	Yellow-tailed Black-Cockatoo
<i>Zoothera lunulata</i>	Bassian Thrush
<i>Zosterops lateralis</i>	Silvereye
<b>Mammals</b>	
<i>Antechinus stuartii</i>	Brown Antechinus
<i>Antechinus swainsonii</i>	Dusky Antechinus
<i>Cercartetus nanus</i>	Eastern Pygmy-possum
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat
<i>Dasyurus maculatus</i>	Spot-tailed Quoll
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle
<i>Isodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)
<i>Miniopterus australis</i>	Little Bent-wing Bat
<i>Miniopterus orianae oceanensis</i> (syn. <i>Miniopterus schreibersii oceanensis</i> )	Eastern Bent-wing Bat
<i>Micronomus norfolkensis</i> (syn. <i>Mormopterus norfolkensis</i> )	Eastern Freetail Bat
<i>Myotis macropus</i>	Southern Myotis
<i>Phoniscus papuensis</i>	Golden-tipped Bat
<i>Pseudocheirus peregrinus</i>	Common Ring-tailed Possum
<i>Rattus fuscipes</i>	Bush Rat
<i>Saccolaimus flaviventris</i>	Yellow-Bellied Sheath-tail Bat
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat
<i>Trichosurus cunninghami</i>	Mountain Brush-tailed Possum
<i>Trichosurus vulpecula</i>	Common Brush-tailed Possum
<i>Tachyglossus aculeatus</i>	Echidna
<i>Vombatus ursinus</i>	Bare-nosed or Common Wombat
<i>Wallabia bicolor</i>	Swamp Wallaby
<b>Reptiles</b>	
<i>Austrelaps superbus</i>	Copperhead
<i>Cacophis squamulosus</i>	Golden-crowned Snake
<i>Cryptophis nigrescens</i> (syn. <i>Rhinoplocephalus nigrescens</i> )	Eastern Small-eyed Snake
<i>Drysdalia coronoides</i>	White-lipped Snake
<i>Drysdalia rhodogaster</i>	Mustard-bellied Snake
<i>Eulamprus quoyii</i>	Eastern Water Skink
<i>Hemiaspis signata</i>	Marsh Snake
<i>Morelia spilota spilota</i>	Diamond Python
<i>Notechis scutatus</i>	Eastern Tiger Snake
<i>Phyllurus platurus</i>	Leaf-tailed Gecko
<i>Intellagama lesueurii</i> (syn. <i>Physignathus lesueurii</i> )	Eastern Water Dragon
<i>Saiphos equalis</i>	Three-toed Skink
<i>Saproscinus mustelina</i>	Weasel Skink

Sources: DoEE (2018); NSW OEH (2018a & b); REPS (2019b); Birdlife Southern Highlands (2019)

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

**Table A3. Threatened species that are known to occur or may occur in the ecological community (at the time of the national listing assessment).**

Scientific name	Common name	EPBC Act*	BC Act*
<b>Fauna</b>			
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow		V
<i>Callocephalon fimbriatum</i>	Gang-Gang Cockatoo		V
<i>Calyptorhynchus lathamii</i>	Glossy Black-cockatoo		V
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V
<i>Daphoenositta chrysoptera</i>	Varied Sittella		V
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E
<i>Dasyurus maculatus</i>	Spot-tailed Quoll	E	V
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle		V
<i>Glossopsitta pusilla</i>	Little Lorikeet		V
<i>Hieraaetus morphnoides</i>	Little Eagle		V
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	V	E
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot (eastern)	E	E
<i>Phoniscus papuensis</i> (syn. <i>Kerivoula papuensis</i> )	Golden-tipped Bat		V
<i>Litoria brevipalmata</i>	Green-thighed Frog		V
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	V	V
<i>Miniopterus australis</i>	Little Bent-wing Bat		V
<i>Miniopterus orianae oceanensis</i> (syn. <i>Miniopterus schreibersii oceanensis</i> )	Eastern Bent-wing Bat		V
<i>Mixophyes balbus</i>	Stuttering Frog, Southern Barred Frog	V	E
<i>Micronomus norfolkensis</i> (syn. <i>Mormopterus norfolkensis</i> )	Eastern Freetail Bat		V
<i>Myotis macropus</i>	Southern Myotis		V
<i>Ninox strenua</i>	Powerful Owl		V
<i>Pachycephala olivacea</i>	Olive Whistler		V
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V
<i>Ptilinopus regina</i>	Rose-crowned Fruit-dove		V
<i>Saccolaimus flaviventris</i>	Yellow-Bellied Sheath-tail Bat		V
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat		V
<i>Tyto novaehollandiae</i>	Masked Owl		V
<i>Tyto tenebricosa</i>	Sooty Owl		V
<b>Flora</b>			
<i>Arthropteris palisotii</i>			E
<i>Calomnion complanatum</i>			E
<i>Lastreopsis hispida</i>	Bristly Shield Fern		E
<i>Senna acclinis</i>			E

Sources: DoEE (2018); NSW OEH (2018a & c); NSW NPWS (2002)

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**Table A4. Introduced weed species known to occur in Robertson Rainforest (at the time of the national listing assessment).**

Scientific name	Common name
<i>Acetosella vulgaris</i>	Sheep Sorrel
<i>Berberis</i> sp.	Barberry
<i>Cenchrus clandestinus</i>	Kikuyu
<i>Cerastium fontanum</i>	Mouse-ear Chickweed
<i>Cestrum elegans</i>	Red Cestrum
<i>Cirsium vulgare</i>	Spear Thistle
<i>Crepis capillaris</i>	Smooth Hawksbeard
<i>Rumex hypogaeus</i> (syn. <i>Emex australis</i> )	Spiny Emex
<i>Galium</i> sp.	Bedstraw
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush
<i>Hedera helix</i>	English Ivy
<i>Holcus lanatus</i>	Yorkshire Fog
<i>Hypochaeris glabra</i>	Smooth Catsear
<i>Hypochaeris radicata</i>	Catsear
<i>Ilex aquifolium</i>	English Holly
<i>Ligustrum lucidum</i>	Large-leaved Privet
<i>Ligustrum sinense</i>	Small-leaved Privet
<i>Lonicera japonica</i>	Japanese Honeysuckle
<i>Lysimachia arvensis</i>	Scarlet Pimpernel
<i>Modiola caroliniana</i>	Red-flowered Mallow
<i>Phytolacca octandra</i>	Inkweed
<i>Pinus radiata</i>	Radiata Pine
<i>Plantago lanceolata</i>	Ribbed Plantain
<i>Plantago</i> sp.	Plantain
<i>Potentilla indica</i>	Indian Strawberry
<i>Potentilla indica</i>	Indian Strawberry
<i>Prunella vulgaris</i>	Self-heal
<i>Prunus laurocerasus</i>	Cherry Laurel
<i>Rapistrum rugosum</i>	Turnip Weed
<i>Rhaphiolepis indica</i>	Indian Hawthorn
<i>Rubus fruticosus</i> spp. agg.	Blackberry
<i>Rumex obtusifolius</i>	Broadleaf Dock
<i>Senecio madagascariensis</i>	Madagascan Fireweed
<i>Silybum marianum</i>	Variegated Thistle
<i>Solanum chenopodioides</i>	Velvety Nightshade
<i>Solanum nigrum</i>	Black Nightshade
<i>Stellaria media</i>	Chickweed
<i>Taraxacum khatoonae</i> (formerly <i>Taraxacum officinale</i> )	Dandelion
<i>Tradescantia fluminensis</i>	Wandering Jew
<i>Trifolium</i> spp.	Clover

Sources: Fox et al. (1997) for Robertson Rainforest remnants; and Mills (2013) for Robertson Nature Reserve. The list of weed species is likely to be greater across the entire extent of the ecological community; however, these are likely to be the main weeds encountered in rainforest patches.

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