Approved Conservation Advice for the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest

In effect under the *Environment Protection and Biodiversity Conservation Act 1999* from 5 October 2022.

This document combines the Conservation Advice and listing assessment for the threatened ecological community. It provides a foundation for conservation action and further planning.

Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest © Doug Beckers

The ecological community occurs within Country (the traditional lands) for the Kamilaroi / Gamilaroi / Gamilaraay / Gomeroi language nation and its peoples. We acknowledge their culture and continuing link to the ecological community and the Country it inhabits.

Conservation Status

The Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest is listed in the Critically Endangered category of the threatened ecological communities list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)(EPBC Act) effective from 5 October 2022.

The ecological community was assessed by the Threatened Species Scientific Committee to be eligible for listing as Critically Endangered under criteria 2 and 5. The Committee's assessment is at Section 6.

The main factors that make the threatened ecological community eligible for listing in the Critically Endangered category are its **very restricted** geographic distribution, and that the nature of this distribution makes it likely that the action of a threatening process could cause it to be lost in the **immediate future**, given the suite of interacting threats particularly severe fires and damaging weather events, in association with climate change; and its **very severe** rate of continuing decline as indicated by a **very severe** intensification in degradation or disruption of

important community processes across most of its geographic range that is observed over the immediate past.

Ecological communities can also be listed as threatened under state and territory legislation. At the time of this Conservation Advice, the ecological community includes the NSW-listed Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest. More information is at section 2.2.7.

Recovery Plan Decision

The Minister decided, in line with the Committee's recommendation, that a recovery plan is not required at this time. The Committee's recommendation is at section 6.3.

Approved Conservation Advice for the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest

About this document

This document describes the ecological community and where it can be found (section 1.2); outlines information to assist in identifying the ecological community and important occurrences of it (section 2); and describes its cultural significance (section 3).

In line with the requirements of section 266B of the EPBC Act, it sets out the grounds on which the ecological community is eligible to be listed as threatened (section 6); outlines the main factors that cause it to be eligible for listing (section 4); and provides information about what could appropriately be done to stop its decline and/or support its recovery (section 5).

CONTENTS

1 Ecological community name and description

1.1 Name

Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest (also referred to hereafter as 'the ecological community').

The ecological community was listed as an endangered Ecological Community in NSW in 1998 under the name 'Ben Halls Gap National Park Sphagnum Moss Cool Temperate Rainforest' (NSW Scientific Committee 1998). In 2016 the status of the protected area changed from National Park to Nature Reserve. This has resulted in the name of the listing being updated to 'Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest' (NSW Threatened Species Scientific Committee 2019). As the nationally-listed ecological community may also occur outside the Nature Reserve, the name has been simplified.

1.2 Description of the ecological community and the area it inhabits

The EPBC Act defines an ecological community as an assemblage of native species that inhabits a particular area in nature. This section describes the species assemblage and area in nature that comprises the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest.

The ecological community described in this conservation advice is the assemblage of plants, animals and other organisms associated with a type of cool temperate rainforest with a low dense tree canopy, usually associated with sheltered creek lines, occurring in the southern part of the New England tablelands. This rainforest is characterised by (typically contains or is in close proximity to) areas (e.g. watercourses) with a ground layer of the sphagnum moss *Sphagnum cristatum* (sometimes discontinuous), where conditions are suitable for development of a shallow but distinctive peat layer. The ground layer also typically includes a mixture of hydrophilic ferns, forbs and sedges.

Cool temperate rainforest vegetation types containing *Sphagnum* species represent communities that were likely to have been more widely distributed on the escarpment of northeastern New South Wales, but are now considered to be rare (NSW Scientific Committee 1998), particularly due to modern-day decline of Sphagnum moss linked to timber harvesting and the introduction of domestic livestock. The ecological community also occupies a westerly location which is biogeographically unusual as this may represent a remnant of a habitat previously more extensive during wetter (geological) periods (NSW Scientific Committee 1998).

This section primarily describes the range of natural states of the ecological community. More information to assist in identifying patches of the ecological community is provided in section 2. Because of past loss or degradation, not all current patches of the ecological community are in a completely intact state.

1.2.1 Location and physical environment

The known area remaining of the ecological community (at the time of listing) is comprised of patches within Ben Halls Gap Nature Reserve and the adjacent Ben Halls Gap State Forest. These patches occur on a small plateau on the Great Dividing Range where the Mount Royal Range meets the Liverpool Range (NPWS 2002).

This area occurs across the boundary of the New England Tablelands (NET03 Walcha Plateau subregion) and NSW North Coast (NNC14 Tomalla subregion) IBRA bioregions (Interim Biogeographic Regionalisation for Australia v. 7, DoE 2012) and across the boundary of the Tamworth Regional and Upper Hunter Local Government Areas. The ecological community is typically associated with sheltered creek lines. Other areas of rainforest within these biogeographical subregions could be part of this ecological community if they match the description.

The ecological community is known to occur within an altitudinal range of approximately 1050-1300 m above sea level. Areas of potential occurrences of the ecological community occur between approximately 1000-1600 m above sea level. The climate is cool and seasonally wet, with frequent dense fog and occasional snow (NPWS 2002). The soils are predominantly derived from the geological units called Liverpool Range basalt (based on PCT 3051 (DPIE 2021)) or basalts of the Mount Royal Volcanic complex (based on NSW Seamless Geology, Colquhoun et al. (2021)).

The plateau that contains the known patches of the ecological community forms the headwaters of several rivers including the Barnard and the Hunter, which are two of the major rivers in the region. Ben Halls, Brayshaws and Stockyard Creeks flow east into the Barnard River while Pages Creek flows south into Hunter River. The Peel River rises on the western side of the plateau and flows into the Namoi River (NPWS 2002). Small bogs are present where springs emerge on basalt benches on the mid-slopes of the plateau. The ecological community is often associated with these springs.

1.2.2 Description of the assemblage

1.2.2.1 VEGETATION STRUCTURE

The ecological community at maturity is multi-layered, occurring with or without tall emergent trees (usually in the outer parts or margins of patches, with occasional emergents in the interior of patches). There is typically a low and dense rainforest canopy, often forming a midstorey (or subcanopy) approximately four metres tall, comprising various species across the extent of the community. An understorey of shrubs, ferns and graminoids is also variable, often with extensive leaf litter. Where conditions are suitable for the formation of a shallow peat layer (recorded mean peat depth ranges from 5 – 43 cm[1]), *Sphagnum cristatum* is distinctive in the ground layer, forming large hummocks with a median size of 34.5 cm[1] (Whinam & Chilcott 2002), typically where gullies are wider and with a shallow gradient (relative to the surrounding area). Upstream and downstream from these areas the ecological community may also occur in narrower gullies where conditions are less conducive to peat and Sphagnum hummock development. *Sphagnum cristatum* in these areas of the ecological community is more likely to occur on rocks. The dense midstorey canopy plays a key role in shading and creating the micro-climate for the Sphagnum components that usually occur along rocky creeklines.

The community is distinct from other cool temperate rainforest remnants found at Barrington Tops and on the escarpment of the northeastern tablelands, as indicated by the common occurrence of distinctive *Sphagnum* moss hummocks scattered across the forest and the absence of *Nothofagus moorei* (Antarctic beech), which is often present in other cool temperate

[1] These figures are derived from relatively few sampling points, so peat depth and hummock size are not necessarily confined to these ranges.

rainforest of the region (Floyd 1990). The ecological community is also near the known northern limit of the *Atherosperma moschatum* (black sassafras) (NSW Scientific Committee 1998).

1.2.2.2 FLORA

The following are the most characteristic species of the ecological community, divided into general structural layers. Some species may occur in different layers depending on their growth form or stage of life cycle. A more comprehensive species list is in Appendix A – Native plant species list.

1.2.2.2.1 Canopy and midstorey species

With or without tall emergent trees, rainforest (mesophyllous) trees are common, typically forming a dense and low canopy. Although rainforest trees, including *A. moschatum* (black sassafras), *Elaeocarpus holopetalus* (black olive berry) and *Quintinia sieberi* (rough possumwood) typically dominate the dense canopy, the midstorey usually includes a combination of mesophyllous and sclerophyllous trees, with shorter individuals of the rainforest trees in combination with other tall shrubs such as *Banksia integrifolia* subsp. *monticola*, *Callistemon pallidus*[2] (lemon bottlebrush) and *Leptospermum polygalifolium* subsp. *montanum* (common teatree) (NSW Scientific Committee 1998; NSW DPIE 2021). Tall ferns including *Dicksonia antarctica* (soft tree-fern) and *Todea barbara* (king fern) may also be part of the midstorey, or the understorey if not at full potential growth height.

Where present, in association with the species above, emergent eucalypts and other tall canopy species include *Eucalyptus dalrympleana* subsp. *dalrympleana* (mountain gum), *E. laevopinea* (silver-top stringybark), *E. nobilis* (ribbon gum), *E. obliqua* (messmate), *E. pauciflora* (snow gum), *E. stellulata* (black sallee), *E. viminalis* (ribbon gum or manna gum) and *Acacia melanoxylon* (blackwood).

1.2.2.2.2 Understorey (including ground layer) species

Understorey and ground layer species include *Blechnum nudum*, *Bursaria spinosa* subsp. *spinosa, Corybas* sp. aff. *longitubus*[3]*, Deyeuxia gunniana*, *Isolepis habra*, *I. subtilissima*, *Juncus alexandri*, *J. laeviusculus* subsp. *laeviusculus*,), *Pterostylis* spp.[3] (greenhood orchids) and *Zealandia pustulata* subsp. *pustulata* (syn. *Microsorum pustulatum* subsp. *pustulatum*; kangaroo fern). Where conditions are suitable, a peat layer forms (typically shallow), and *S. cristatum* (sphagnum moss) is distinctive in the ground layer, particularly among rocky creeklines. In some areas, the ground layer can be dominated by large hummocks of *S. cristatum*.

1.2.2.3 FAUNA

Ben Halls Gap Nature Reserve, where most of the ecological community occurs, supports a wide variety of birds, mammals, frogs and invertebrates (NSW Scientific Committee 1998).

1.2.2.3.1 Mammals

Ben Halls Gap Nature Reserve supports a diversity of native mammal species, particularly arboreal mammals and these are likely to be found in the ecological community and may require tree hollows. Arboreal mammals include *Acrobates pygmaeus* (feathertail glider), *Petauroides*

[2] NSW Scientific Committee (1998) note the potential for the presence of an unidentified *Callistemon* species, yet no samples have been confirmed as a species other than *Callistemon pallidus* (at the time of writing).

[3] Further sampling is required to confirm the species (at the time of writing).

volans (greater glider), *Trichosurus vulpecula* (common brushtail possum), and nine species of bat including *Austronomus australis* (white-striped mastiff bat) and *Falsistrellus tasmaniensis* (eastern false pipistrelle) which is listed Vulnerable under the NSW *Biodiversity Conservation Act 2016* (NPWS 2002). Relatively common or characteristic ground dwelling species include *Antechinus stuartii* (brown antechinus), *Dasyurus maculatus maculatus* (spotted-tail quoll), *Isoodon macrourus* (northern brown bandicoot), *Notamacropus rufogriseus* (red-necked wallaby), *Rattus fuscipes* (bush rat), *Tachyglossus aculeatus* (short-beaked echidna), *Vombatus ursinus* (common or bare-nosed wombat), *Sminthopsis murina* (common dunnart), and *Wallabia bicolor* (swamp wallaby) (NPWS 2002).

Antechinus stuartii, *R. fuscipes*, *T. aculeatus* and *V. ursinus* were recorded by Benson & Andrew (1990) in areas of the ecological community.

1.2.2.3.2 Birds

A set of surveys, reported in Benson & Andrew (1990), recorded the following species in the ecological community: *Acanthiza lineata* (striated thornbill), *Acanthiza pusilla* (brown thornbill), *Acanthorhynchus tenuirostris* (eastern spinebill), *Alisterus scapularis* (king parrot), *Caligavis chrysops* (yellow-faced honeyeater), *Chalcites lucidus* (shining bronze cuckoo), *Colluricincla harmonica* (grey shrike-thrush), *Eopsaltria australis* (eastern yellow robin), *Falcunculus frontatus* (crested shrike-tit), *Malurus cyaneus* (superb fairy-wren), *Melithreptus lunatus* (white-naped honeyeater), *Menura novaehollandiae* (superb lyrebird), *Myiagra cyanoleuca* (satin flycatcher), *Neosericornis citreogularis* (yellow-throated scrubwren), *Ninox strenua* (powerful owl), *Pachycephala pectoralis* (golden whistler), *Pardalotus punctatus* (spotted pardalote), *Petroica rosea* (rose robin), *Platycercus elegans* (crimson rosella) and *Rhipidura albiscapa* (grey fantail).

Eighty-seven native bird species have been recorded more broadly in Ben Halls Gap Nature Reserve (NPWS 2002). Sixteen of these are tree-hollow nesting species and a number are largely dependent upon rainforest or tall open forest. Four of the bird species recorded; *Cacatua galerita* (sulphur-crested cockatoo), *Zanda funerea* (yellow-tailed black cockatoo), *Ninox novaeseelandiae* (southern boobook owl) and the state-threatened (NSW) *N. strenua* require large hollows in old trees for nesting. Such hollows may take up to 200 years to develop (Wormington & Lamb 1999). Other notable birds recorded include *Pachycephala olivacea* (olive whistler), *Falco peregrinus* (peregrine falcon), *Cinclosoma punctatum* (spotted quail-thrush), and *Climacteris erythrops* (red-browed tree-creeper). More common species include *Acanthiza nana* (yellow thornbill), *Ailuroedus melanotis* (green catbird), *Anthochaera carunculate* (red wattlebird), *Edolisoma tenuirostre* (cicadabird), *Lalage tricolor* (white-winged triller), *Melithreptus brevirostris* (brown-headed honeyeater), *Petroica phoenicea* (flame robin), *Scythrops novaehollandiae* (channel-billed cuckoo) and *Todiramphus sanctus* (sacred kingfisher), (NPWS 2002).

1.2.2.3.3 Amphibians

The following amphibian species have been recorded in Ben Halls Gap Nature Reserve: *Crinia signifera* (common eastern froglet), *Litoria booroolongensis* (booroolong frog), *L. daviesae*, *L. verreauxii* (Verreaux's tree frog), and *Pseudophryne* sp. (a toadlet)(NPWS 2002). *Litoria booroolongensis* and *L. daviesae* are examples of species closely tied to the hydrological conditions of the ecological community.

1.2.2.3.4 Reptiles

The following reptile species have been recorded in Ben Halls Gap Nature Reserve: *Eulamprus tympanum* (a water skink), *Lampropholis caligula* (montane sunskink), *Liopholis whitii* (White's skink), *Notechis scutatus* (tiger snake), *Pseudechis porphyriacus* (red-bellied black snake), *Pseudemoia entrecasteauxii* (southern grass skink), *Saiphos equalis* (a burrowing skink) and *Saproscincus mustelinus* (weasel skink) (NPWS 2002).

1.2.2.3.5 Invertebrates

An invertebrate survey of Ben Halls Gap Nature Reserve (Gunning 1995) found it to be very rich in insect species, with a particularly high diversity of butterflies, moths, beetles, bugs and wasps and of soil and ground dwelling insects associated with the large amount of organic matter on the forest floor. Two rare species were identified, *Eutanyderus* sp. (an alpine fly) and *Oreixenica kershawi* (Kershaw's brown butterfly), both of which were significant new distribution records as outliers from their main distribution further south. *Acripeza reticulata* (mountain katydid) was also found in the park. This is an alpine species and its finding in Ben Halls Gap was a significant range extension (NPWS 2002).

Euastacus spp. (spiny crayfish) likely occur in the ecological community. Crayfish burrows and exoskeletons were observed in the community during surveys in 2022 (NPWS *pers. comm.*).

1.2.3 Other relevant biology and ecology

1.2.3.1 FIRE ECOLOGY

Cool temperate rainforests rarely burn due to their moist microclimates, which render fuels in a state unable to support fire spread except in extended and severe droughts, or during extended heatwaves. Fires, even those with low flame heights, cause prolonged structural and functional transformation through top-kill of the thin-barked rainforest trees and through combustion or scorch death of *Sphagnum* hummocks. These changes may render the post-fire community unsuitable habitat for a range of rainforest-dependent flora and fauna for a prolonged period, with very long post-fire recovery times likely in these alpine environments. Loss of the sphagnum cover also renders the system vulnerable to weed incursion.

2 Identifying areas of the ecological community

Section 1.2 describes this ecological community and the area it inhabits. This section provides additional information to assist with the identification of the ecological community and important occurrences of it.

The Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest intergrades with other vegetation types and ecological communities (see section 2.2.6). Key diagnostic characteristics are used to identify an area of native vegetation as being the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest, and define the features that distinguish it from other communities, noting that additional information to assist with identification is provided in the other sections of this document, particularly the description (section 1.2).

2.1 Key diagnostic characteristics

The key diagnostic characteristics are designed to allow identification of the ecological community irrespective of the season.

Assemblages of species that do not meet the key diagnostics are not part of the nationally listed ecological community.

The ecological community is defined as the assemblage of species meeting the description in section 1.2 that meet the following key diagnostic characteristics:

- Overall, the ecological community is a forest characterised by the presence of cool temperate non-sclerophyll tree, shrub and fern species (see below, and Table 2), with the moss *S. cristatum* typically in the ground layer, and forming large distinctive hummocks across some parts of the forest. The *Sphagnum* hummocks are typically where gullies are wider and with a shallow gradient (relative to the surrounding area). Upstream and downstream from these areas the ecological community may occur in narrower gullies where conditions are less conducive to peat and *Sphagnum* hummock development. *Sphagnum cristatum* in these areas of the ecological community are more likely to occur on rocks.

- Areas of the ecological community are currently known to occur in or near Ben Halls Gap Nature Reserve and Ben Halls Gap State Forest, which occur across the boundary of the New England Tablelands (NET03 Walcha Plateau subregion) and NSW North Coast (NNC14 Tomalla subregion) IBRA bioregions (Interim Biogeographic Regionalisation for Australia v. 7, DoE 2012). It is typically associated with sheltered creek lines. Other areas of rainforest within these bioregional subregions could be part of this ecological community if they match the description.

- Areas of potential habitat of the ecological community occur between approximately 1000-1600 m above sea level.

- It typically appears as a forest with a low and dense canopy or midstorey dominated by rainforest species and ferns, and an understorey of shrubs, smaller ferns and mostly graminoids in the ground layer.

- Characteristic species in the canopy and/or midstorey (or subcanopy) include *Atherosperma moschatum* (black sassafras), *Banksia integrifolia* subsp. *monticola*, *Callistemon pallidus*[2] (lemon bottlebrush), *Elaeocarpus holopetalus* (black olive berry), *Leptospermum polygalifolium* subsp. *montanum* (common teatree) and *Quintinia sieberi* (rough possumwood) (NSW Scientific Committee 1998; NSW DPIE 2021). Tall ferns include *Dicksonia antarctica* (soft tree-fern) and *Todea barbara* (king fern). Unlike most other cool temperate rainforests in the region, *Nothofagus moorei* (Antarctic beech) is absent from this community.

- Other trees may or may not be present in association with the above species, typically as a tall emergent canopy layer, including *Eucalyptus dalrympleana* subsp. *dalrympleana* (mountain gum), *E. laevopinea* (silver-top stringybark), *E. nobilis* (ribbon gum), *E. obliqua* (messmate), *E. pauciflora* (snow gum), *E. stellulata* (black sallee), *E. viminalis* (ribbon gum) and *Acacia melanoxylon* (blackwood). These species usually occur in the outer parts or margins of patches, and occasionally in the interior of patches.

- Understorey and ground layer species include *Blechnum nudum*, *Bursaria spinosa* subsp. *spinosa, Corybas* sp. aff. *longitubus*[3], *Deyeuxia gunniana, Isolepis habra*, *I. subtilissima*, *Juncus alexandri*, *J. laeviusculus* subsp. *laeviusculus*, *Zealandia pustulata* subsp. *pustulata* (syn. *Microsorum pustulatum* subsp. *pustulatum*; kangaroo fern) and *Pterostylis* spp.[3]; and these layers can be dominated by large hummocks of *Sphagnum cristatum* (sphagnum moss), where conditions are suitable.

Note:

- Some species may grow across different structural layers depending on their growth form or stage of life cycle.
- The structure of the ecological community may be altered due to recent disturbances such as bushfire, heavy rain, heavy snowfall or strong winds and storms.

2.2 Additional information to assist in identifying the ecological community

The following information should also be taken into consideration when applying the key diagnostic characteristics to assess if a site may include the ecological community.

2.2.1 Identifying a patch

A patch is a discrete and mostly continuous area of the ecological community, as defined by the key diagnostics, but can include small-scale variations, gaps and disturbances within this area. The smallest patch size that can be identified is 0.1 ha, as the key diagnostics cannot reliably be identified for smaller areas than this. Where a larger area has been mapped or classified as a different vegetation type, localised areas of the ecological community greater than 0.1 ha may be present within this larger area.

2.2.2 Breaks in a patch

In defining a patch of the ecological community allowances are made for "breaks" up to 30 metres between areas that meet the key diagnostics. Such breaks may be the result of tracks, paths, roads, gaps made by exposed areas of soil, or leaf litter, and areas of localised variation in vegetation that do not meet the key diagnostics. For example, a single patch could include two areas of the ecological community that meet the key diagnostics, but which are separated by a track or road. Such breaks do not significantly alter the overall functionality of the ecological community and form a part of the patch. Gaps made by exposed areas of soil or leaf litter, and areas of localised variation in vegetation should be included in the calculation of the size of the patch and be taken into account when determining the overall condition of the patch. Tracks, paths, roads or other artificial surfaces should be excluded from the calculation of patch size and condition.

Where there is a break in the ecological community of 30 metres or more (e.g. due to permanent artificial structures, wide roads or other barriers, water bodies or a different type of vegetation) then the gap indicates that separate patches are present.

2.2.3 Variation within a patch

Patches of the ecological community may contain areas that vary in structural or biological characteristics. For example, one part of the midstorey of a patch may consist of mostly rainforest species, whereas another part of the midstorey in the same patch may be dominated

by tree-ferns; or one part of a patch may have been more recently burnt and therefore at a different stage of regeneration. Additionally, *Sphagnum cristatum* should occur in the ground layer across some parts of the patch but not necessarily the entire patch. Variation in vegetation across a patch should not be considered to be evidence of multiple patches, so long as it meets the key diagnostics.

2.2.4 Revegetation and regrowth

Revegetated or otherwise restored sites or areas of regrowth are not excluded from the listed ecological community so long as the patch meets the key diagnostic characteristics.

Where ecological restoration is planned, the aim should be for recovery of as many key biodiversity and ecosystem attributes as practical for a particular site, so that the ecological community is on a trajectory to recovery and is self-sustaining. This should be based on identifying appropriate reference site(s) for the ecological community following the *National Standards for the Practice of Ecological Restoration in Australia* (Standards Reference Group SERA 2021) (also see Section 5.4.2).

2.2.5 Survey requirements

Patches of the ecological community can vary markedly in their shape, size, condition and features. Thorough and representative on-ground surveys are essential to accurately assess the extent and condition of a patch. The Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain 2009), and New South Wales BioNet Vegetation Classification User Manual (NSW Office of Environment and Heritage 2018) may provide guidance.

The size, number and spatial distribution of plots or transects must be adequate to represent variation across the patch. Sampling should address likely variation in species composition and significant variation in the vegetation (including areas of different condition), landscape qualities and management history (where known) across the patch.

Recording the search effort (identifying the number of person hours spent per plot/transect 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.

Whilst identifying the ecological community and its condition is possible at most times of the year, consideration must be given to the role that season, rainfall and disturbance history may play in a survey/assessment. For example, after a fire one or more vegetation layers, or groups of species, may not be evident for a time. Timing of surveys should allow for a reasonable interval after a disturbance (natural or human-induced) to allow for regeneration of species to become evident, and be timed to enable diagnostic species to be identified. 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.

2.2.6 Mapping and vegetation classifications

There are a number of mapping and vegetation classification schemes in New South Wales. The primary scheme used by the NSW Government at this time is the Plant Community Type (PCT) system. Although no current classification system directly maps areas of this ecological community according to the key diagnostics, the ecological community is within the broader NSW Plant Community Type (PCT) 3051, Mount Royal Range Cool Temperate Rainforest (DPIE 2021).

Table 1 outlines how the ecological community can be distinguished from similar vegetation types.

Table 1: Key features distinguishing TEC from other vegetation types

Code / Number	Name	Key distinguishing features
PCT 3051	Mount Royal Range Cool Temperate Rainforest	• The ecological community is mapped as being within a broader unit PCT 3051 (at the time of writing), which is also found at Barrington Tops and on the northern tablelands. As described at a finer scale, the ecological community may be distinguished from other cool temperate rainforest remnants (that also may be within PCT 3051) by the absence of *Nothofagus moorei* (Antarctic beech) and the occurrence of distinctive *Sphagnum* moss hummocks across many areas of the ecological community (when undisturbed).

Source: NSW Scientific Committee (1998); DPIE (2021).

2.2.7 Other relevant listed ecological communities

The ecological community includes the endangered ecological community 'Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest' that is listed under the *NSW Biodiversity Conservation Act 2016.* At the time of writing the NSW-listed ecological community is restricted to occurrences within Ben Halls Gap Nature Reserve (NSW Scientific Committee 1998; NSW Threatened Species Scientific Committee 2019).

There is also another nationally-listed threatened rainforest that occurs to the east of the coastal escarpment within a lower altitude range:

- Lowland rainforest of subtropical Australia (critically endangered) – also listed in NSW as the Lowland Rainforest on Floodplain in the NSW North Coast bioregion (NSW TSSC 2019).

2.3 Condition classes and thresholds

No minimum condition threshold is prescribed for this ecological community. The ecological community has a very restricted extent, most within conservation tenure where the natural vegetation remains largely unmodified by development or agriculture. Fire, extreme storm events and invasive species are currently the key long term habitat modifiers in this landscape.

Condition classes are used to distinguish between patches of the ecological community of different qualities, to aid environmental management decisions.

A high-quality, or benchmark, *condition class* is specified to guide monitoring, management and restoration decisions for existing high-quality patches or to increase the quality of patches if they become degraded. Key to the ecological community's development is the presence of a closed canopy to maintain conditions suitable for understorey rainforest species, and in some areas, a ground layer of *Sphagnum cristatum*. Recent disturbance by fire is likely to result in the ecological community presenting in a temporarily altered state that may include reduced canopy cover, simplified vegetation structure, resprouting trees and shrubs and a lack of key ground layer species such as *S. cristatum*. Maintenance of suitable hydrological conditions is also important.

High-quality condition class:

- Canopy and/or midstorey combined cover of at least 70% projective foliage cover[4] of native species; AND
- A diversity of canopy, midstorey, understorey and ground layer plant species, with at least 10 'rainforest or hydrophilic species[5]' (from Table 2 below); AND
- Where applicable to some areas of a patch, a ground layer of *S. cristatum* is present, sometimes forming hummocks.

When assessing condition of a patch of the ecological community it is important to also consider *Additional information to assist in identifying the ecological community*, including patch definition information (section 2.2).

The broadest area that meets the key diagnostic characteristics of the ecological community should be used in determining patch condition. Where condition is variable and the condition of the total area falls below the minimum thresholds, the largest area or areas within the overall area that do meet the minimum condition thresholds should be identified. This may result in multiple patches of the ecological community being identified within the overall area first considered.

Table 2: Rainforest or hydrophilic plant species indicative of high-quality condition.

Atherosperma moschatum	*H. sibthorpioides*
Blechnum minus	*Hymenophyllum cupressiforme*
B. nudum	*Hypolepis glandulifera*
B. wattsii	*Isolepis habra*
Cardamine lilacina	*Juncus alexandri*
C. paucijuga	*J. laeviusculus* subsp. *laeviusculus*
Chiloglottis spp.	*Lobelia pedunculata*
Coprosma quadrifida	*Parsonsia brownii*
Corybas spp.	*Polystichum proliferum*
Deyeuxia gunniana	*Pteris tremula*
Dicksonia antarctica	*Pterostylis* spp.
Elaeocarpus holopetalus	*Quintinia sieberi*
Galium leiocarpum	*Smilax australis*
Galium spp.	*Todea barbara*
Gratiola peruviana	*Urtica incisa*
Hydrocotyle acutiloba	*Zealandia pustulata subsp. pustulata*

2.4 Habitat critical to the survival of the ecological community

The habitat or areas most critical to the survival of the ecological community includes all patches that meet the Key diagnostic characteristics (section 2.1) for the ecological community plus a buffer zone (particularly where the buffer includes native vegetation) (see section 5.4.1.3). It

[4] On average, across the patch. Canopy cover may be measured, for example, along a 50 m transect.
[5] Within a 20 x 20 m quadrat, with representative plots sampled across the patch.

also includes other natural areas within the local creeklines and catchments that influence patches of the ecological community, given that hydrological conditions (e.g. water availability and quality) are important requirements for development of the ecological community, particularly the peat layer with *Sphagnum cristatum*. The peat layer of this ecological community is shallow (compared to most other peatlands in Australia) so is susceptible to stochastic disturbance events.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat at this time. No occurrences of this ecological community are known to occur on Commonwealth land at this time.

2.5 Areas of high value - surrounding environment and landscape context

For natural resource management activities or actions that may have 'significant impacts' and require approval under the EPBC Act, it is important to consider the whole environment surrounding patches of the ecological community. Patches of the ecological community do not occur in isolation. The surrounding vegetation and other landscape considerations will also influence how important a patch is to the ecological community as a whole.

Patches that are larger and less disturbed are likely to provide greater biodiversity value. Patches that are spatially linked, whether ecologically through dispersal or gene flow, for instance, or by proximity, are particularly important as wildlife habitat and to the viability of those patches of the ecological community into the future.

The ecological community often occurs in association with other native vegetation types. Patches of the ecological community that remain connected with other native vegetation have a better chance of future survival and restoration success, because connected patches are buffered from disturbance by the surrounding native vegetation.

The following indicators of high-conservation value should be considered when assessing the impacts of proposed actions under the EPBC Act, or when determining priorities for protection, recovery, management and funding.

- Patches that meet, or are closest to the high-quality condition class for this ecological community. These may be based on on-site observations or known past management history.
- Patches with or in close proximity to an intact ground layer of *S. cristatum,* particularly large hummocks.
- Patches with a larger area to boundary ratio – such patches are more resilient to edge effect disturbances such as weed invasion and human impacts.
- Patches within or near to a larger native vegetation remnant and that contribute to a mosaic of vegetation types present at a site. Areas of mosaic native vegetation provide a wider range of habitats that benefit flora and fauna diversity. Other patches are important as linkages among remnants, acting as 'stepping stones' of native remnants in the landscape. Connectivity includes actual or potential connectivity to restoration works (e.g., native plantings).
- 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, particularly where

there is genetic distinction, or absence of some threats. These may include unique variants of the ecological community, e.g., with a unique flora and/or fauna composition, or a patch that contains flora or fauna that have largely declined across the broader ecological community or region.

- Patches that show evidence of recruitment of key native plant species or the presence of a range of age cohorts (including through successful assisted regeneration or management of sites).
- Patches with good faunal habitat as indicated by diversity of landscape, diversity of plant species and vegetation structure, diversity of age class, presence of movement corridors, mature trees (particularly those with hollows), logs, watercourses, etc.
- Patches containing nationally or state-listed threatened species.
- Patches with high species richness, as shown by the variety of native understorey plant species, or high number of native fauna species (vertebrates and/or invertebrates).
- Patches with relatively low levels of weeds and feral animals or areas where these can be managed efficiently.

3 Cultural significance

The ecological community occurs within Country (the traditional lands) for the Kamilaroi / Gamilaroi / Gamilaraay / Gomeroi language nation and its peoples. We acknowledge their culture and continuing link to the ecological community and the Country it inhabits.

The significance of the ecological community, particular species, spiritual, customary and other cultural values are diverse and varied for the Indigenous Australians that live in the vicinity and care for Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, all Indigenous Australians. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge and have the rights to decide how it is shared and used.

A wide variety of plant and animal resources from within the ecological community are traditionally used for food, medicine and materials.

NPWS (2002) describes that the area of the Nature Reserve was located in the lands of the Gumaroi[6] Aboriginal people. It is now in the area of the Nungaroo Local Aboriginal Land Council but Aboriginal people living in other land council areas may have an interest in the management of the reserve and the ecological community. Traditional knowledge held by Indigenous Australians today indicates that the Nature Reserve was significant (Tommy Taylor, pers. comm., cited in NPWS 2002). There is known to have been movement from the Nowendoc area into the Hunter Valley and it is probable that Ben Halls Gap was used as a travel route as it is a relatively low point in the ranges and permanent water is available. No Aboriginal sites have been located at this time in the Nature Reserve but sufficient surveys have not been undertaken. A scarred tree and open campsite have been recorded along Ben Halls Creek immediately east of the

[6] as termed in NPWS (2002)

Nature Reserve. Aboriginal sites known to occur in surrounding areas include campsites, axe-grinding grooves and a carved tree.

Ascertaining the cultural significance of this ecological community is a priority in 5.4 Priority conservation and research actions.

4 Threats

Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest is primarily threatened by fire and drought, storm damage, weed invasion and disturbance by humans and non-native animals.

4.1 Threat table

Table 3 outlines the key threats facing the ecological community, which represent the *main factors that cause it to be eligible for listing* as required by section 266B (2) (a) (ii) of the EPBC Act. This information supports the assessment against the criteria at section 6. Although presented as a list, in reality these threats often interact, rather than act independently. This table is supplemented by example images of the ecological community in Appendix B.

Table 3: Summary of threats facing the ecological community

Threat	Threat Status*	Threat Impacts
Fire regimes that cause declines in biodiversity	*Timing*: ongoing *Severity*: extreme *Scope*: whole	• The ecological community is highly vulnerable to the impacts of inappropriate and changing fire regimes including fire frequency, intensity, seasonality, and scale (NSW Scientific Committee 1998; NSW DPIE 2021). The key component species of the ecological community do not have protective anatomical features such as thick insulative bark and the cool temperate rainforest microclimate is particularly susceptible to disturbance from fire events (NPWS 1999). Increased sedimentation following fire may affect the organic content of the site and inhibit re-establishment of sphagnum moss (Whinam & Chilcott 2002). • Fires also have effects on biotic interactions, such as herbivore-plant interactions (e.g. altering resource availability), predator-prey interactions (e.g. facilitating easier access for feral predators to native fauna) and abiotic interactions, such as combined drought and fire, which may have compounding effects on rates of plant mortality and regenerative capacity (DAWE 2021). • Climate-change related changes to fire regimes may increase pressures on biodiversity, such as expansion of the fire season (e.g. potential for fires earlier and later than normal), changes to the dominant fire type (e.g. a shift from low severity understorey fires toward higher severity crown fires) and changes to the spatial patterns of fire in the landscape (DAWE 2021). • At least 50 % of the ecological community was burnt in December 2019 – January 2020 (Keith et al. 2022) with the remainder of the extent likely to have been affected (e.g., through increased sedimentation and solar radiation) by burning of adjacent and nearby vegetation communities (based on expert input and analysis of DAWE (2020) and PCT 3051 (DPIE 2021) in the Ben Halls Gap area). The ability of all components of the ecological community to recover is uncertain given increased exposure to light and solar radiation (e.g., moist rainforest components of the midstorey, understorey and ground layer). • Damage from fire also leaves the ecological community more susceptible to impacts from other threats such as invasion and rapid spread of weeds and pest animals, disease, disturbance due to heavy snowfall and storm events, and drought / a drying climate. • Further information about fire as a threat to biota is given in DAWE (2021).

Threat	Threat Status*	Threat Impacts
Disturbance due to heavy snowfall and storm events	*Timing*: ongoing *Severity*: major-extreme *Scope*: potentially whole	• Damage from heavy snowfalls, rain and high winds in 2021 has resulted in very severe canopy damage to approximately 80% of the extant ecological community (NPWS *pers. comm.*). It is evident that the disturbances due to these weather events have interacting impacts with previous (recent) fire damage. • Increased solar radiation, sedimentation and impacts on drainage patterns may have resulted from the loss of overstorey (i.e., fallen trees). This may influence resilience of the ecological community to any near-term extreme events (e.g., temperature rises, drought or extreme rainfall events). • Associated increased opportunities for invasive species is a significant risk post major disturbances to the canopy.
Disturbance to water quality and quantity	*Timing*: ongoing *Severity*: major *Scope*: whole	• The ecological community is vulnerable to sediment entering the streams due to soil disturbance, for example during track and road construction or grazing in the water catchment, especially when coupled with storm events. • Increased human visitation or pest species may impact on water quality in the area (NSW DPIE 2021). • Characteristic rainforest species, large ferns and sphagnum moss are very susceptible to changes in water availability. • Groundwater drawdown due to domestic, commercial, and mining activity is a potential threat.
Climate change	*Timing*: ongoing *Severity*: extreme *Scope*: whole	• Projections of future changes in climate for northern NSW generally include higher average temperatures, more intense rainfall, increased temperature extremes and higher evaporative demand (Hennessy 2011). Projections for the time range of 2060-79 for a 10 x 10 km grid cell encompassing Ben Halls Gap Nature Reserve indicate the following trends (relative to 2014) that are likely to have detrimental impacts on the ecological community or its component biota (NARCliM 1.0, A2 emissions scenario, NSW OEH 2014): – Annual temperature: +2.14% daily average. – Summer daily maximum temperature: +2.38%. – Rainfall: annual +3.09%; summer +7.28%; autumn +10.40%; winter -6.52%; spring -3.32%. – Hot days over 35°C: +3.65 days. – High fire danger days: +0.34 days. • Increasing temperatures and changed rainfall patterns will decrease water availability throughout periods of the year, and increase fire susceptibility. These factors are likely to result in degradation and contraction of the community. Whilst there is predicted to be increased rain in summer and autumn, higher intensity rainfall events are associated with increased runoff and potential damage to the ecological community (also see Disturbance due to heavy snowfall and storm events, below). • Characteristic rainforest species, large ferns and *Sphagnum* moss are very susceptible to drier, hotter weather, particularly when fires also damage the midstorey and/or canopy and exacerbate the impacts of solar radiation on higher evaporation rates. • Rainfall deficiency in the Ben Halls Gap region was in the 'Severe deficiency' or 'Lowest on record' rainfall percentile ranking categories in the two years prior to 30 November 2019 (BOM 2021a).
Invasive species - Pathogens	*Timing*: ongoing *Severity*: minor *Scope*: majority	• Plant pathogens such as *Phytophthora* and myrtle rust (*Austropuccinia psidii*) (NSW DPIE 2021) may cause disease in the ecological community • Infection by myrtle rust is potentially a threat to various trees and shrubs in the Myrtaceae family in the ecological community (Makinson 2018). • Chytrid fungus is a threat to the various frogs of the ecological community.

Threat	Threat Status*	Threat Impacts
Invasive species - Plants	*Timing*: ongoing *Severity*: major *Scope*: whole	• Introduced plants are present in the Nature Reserve and may outcompete native flora. The presence of these introduced plants may also provide habitat for introduced pest animals (NSW DPIE 2021). • Introduced species recorded in the ecological community include *Cirsium vulgare* (spear thistle), *Erigeron sumatrnesis* (syn. *Conyza sumatrensis*; tall fleabane), *Geranium molle* (cranesbill geranium), *Hypochaeris radicata* (catsear), *Prunella vulgaris* (self-heal), *Rubus fruticosus* aggregate (European blackberry), *Stellaria media* (common chickweed) and *Taraxacum officinal*e (dandelion). • Blackberry in particular forms dense thickets that exclude native species, leading to its complete dominance of the vegetation understorey and potentially the canopy. It also can contribute to fire fuel loads and alter fire regimes (NSW DPIE 2020). • Sphagnum moss is very susceptible to competition from weeds, particularly following disturbance such as fire and damage by pest animals (Whinam & Chilcott 2002).
Invasive species - Animals	*Timing*: ongoing *Severity*: major *Scope*: whole	• Impacts from feral animals occur through substrate disturbance, herbivory, and predation. • Feral herbivores like goats, deer and cattle are known to selectively graze along permanent water sources in the area, damaging plants, particularly sphagnum moss (NPWS 2002). • Pest animals that dig and wallow in watercourses and peat/sphagnum moss, such as pigs and deer, also cause habitat destruction through trampling, soil disturbance, eroding banks of watercourses and polluting the water, as well as promoting weed invasion and disease transmission. • Black rats (*Rattus rattus*) have been recorded in the ecological community (Benson & Andrew 1990). They have the potential to modify the composition of native plant species in a particular area, through seed removal, compete with native fauna species for resources and prey upon native fauna species (TSSC 2006, CABI 2019). • Feral horses do not currently occur in the area, but may invade from regional populations in the future, and would be an extreme additional threat to the sphagnum moss and riparian plants. • Pigs, foxes, cats and wild dogs prey on native fauna species in the ecological community within the Nature Reserve.
Disturbance by humans	*Timing*: ongoing *Severity*: minor *Scope*: minority	• The sphagnum moss-rainforest elements are vulnerable to visitor pressure which may disturb the community and destroy the sphagnum moss through trampling (NSW Scientific Committee 1998). • Illegal removal of sphagnum moss for commercial and domestic purposes is a significant potential risk for the ecological community (NSW Scientific Committee 1998). • Visitation may also result in further weed invasion and the spread of plant pathogens (NSW Scientific Committee 1998).

*__***Timing***__ – the threat occurs in the **past** (and unlikely to return), is **ongoing** (present/continuing), is likely to occur/return in the **future,** or timing is **unknown**

__***Severity***__ – the threat causes or has the potential to cause impacts that are **extreme** (leading to loss or transformation of affected patches/occurrences), **major** (leading to degradation of affected patches/occurrences), **minor** (impacting some components of affected patches/occurrences), **negligible** or **unknown**

__***Scope***__ – the threat is affecting the **whole** (>90%), a **majority** (>50%), a **minority** (<50%), a **negligible** amount, or **unknown** amount of the ecological community

4.1.1 Key threatening processes

The EPBC Act provides for the identification and listing of key threatening processes. A process is defined as a key threatening process if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

The following are EPBC-listed key threatening processes, current at the date of writing, that may be relevant to the ecological community or specific plants and animals that comprise it:

- Competition and land degradation by unmanaged goats
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
- Fire regimes that cause declines in biodiversity
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis
- Land clearance
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases
- Novel biota and their impact on biodiversity
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs
- Predation by European red fox
- Predation by feral cats.

Any approved threat abatement plans or advice associated with these items provides information to help landowners manage these threats and reduce their impacts to biodiversity. These can be found at http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl.

5 Conservation of the ecological community

5.1 Primary conservation objective

To prevent the extinction of the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest in the near future, and promote recovery of its biodiversity and function through protecting it from significant impacts as a Matter of National Environmental Significance under national environmental law, and by guiding management and recovery, consistent with the recommended priority conservation and research actions set out in this advice.

5.2 Existing protection and management plans

5.2.1 Existing protections

Almost all of the known extent is within Ben Halls Gap Nature Reserve. The threats to the ecological community operate regardless of land tenure. 'Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest' is listed as endangered under the NSW *Biodiversity Conservation Act* (2016) and included within the definition of the nationally-listed ecological community.

5.2.2 Existing management plans

- Department of Agriculture, Water and the Environment [DAWE] (2020) *Bushfire impacts and threatened ecological communities*. Commonwealth Department of Agriculture, Water and the Environment, Canberra.
  Available at: https://www.awe.gov.au/sites/default/files/env/pages/cae21f42-9328-45ee-b558-a79628aaf68f/files/tecs-data-release-factsheet.pdf
- NPWS (2002) Ben Halls Gap National Park Plan of Management. NSW National Parks and Wildlife Service. Available on the internet at:
  https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/ben-halls-gap-national-park-plan-of-management-020091.pdf
- Makinson (2018) Myrtle Rust in Australia – a draft Action Plan. Plant Biosecurity Cooperative Research Centre. www.anpc.asn.au/myrtle-rust/https://www.anpc.asn.au/myrtle-rust/

5.3 Principles and standards for conservation

To undertake priority actions to meet the conservation objective, the overarching principle is to maintain existing areas of the ecological community that are relatively intact and of high quality. There are good, practical reasons to do so. It is typically more 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, including fauna 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, 2021):

> *"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 (2021).

The principle discourages 'offsets' where intact remnants are removed with an undertaking to set aside and/or restore other, lesser quality, sites. The destruction of intact sites represents 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 (2021). They outline the principles that convey the main ecological, biological, technical, social and ethical underpinnings of ecological restoration practice.

5.4 Priority conservation and research actions

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

- planning, management and restoration of the ecological community by State agencies, landholders, Traditional custodians, NRM and community groups and other land managers;
- conditions of approval for relevant controlled actions under national environment law (the EPBC Act); and
- prioritising activities in applications for Australian Government funding programs.

Detailed advice on actions may be available in specific plans, such as management plans for weeds, fire or certain parks or regions. The most relevant at the time this conservation advice was developed are listed in section 5.2.2.

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 ecological community. They highlight general but key actions required to at least maintain survival of the ecological community at the time of preparing this Conservation Advice.

5.4.1 PROTECT the ecological community

This key approach includes priorities intended to protect the ecological community by preventing loss of geographic extent and integrity.

- Protecting the ecological community should be ensured 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 (including fire management).
- Undertake activities to mitigate future climate change and therefore reduce the impacts of climate stress on this ecological community.
- Ensure any use of planned fire avoids the ecological community entirely including the potential sources and watershed feeding the springs that support the community.

5.4.1.1 CONSERVE REMAINING PATCHES

There should be no clearance and damage to this ecological community because of its very restricted geographic distribution.

- Protect and conserve remaining areas of the ecological community, particularly areas that are habitat critical to survival.
- Given that this ecological community is very restricted in spatial extent, this means avoiding any further losses to any patches of the ecological community.
- Retain other native vegetation near patches of the ecological community, and consider inclusion of this in the conservation estate, as it is important for connectivity, diversity of habitat and act as buffer zones between the ecological community and threats. This includes investigating formal conservation arrangements, joint management agreements with Traditional custodians, and co-management agreements and covenants to protect nearby native vegetation on private land.
- Where regeneration is occurring, implement measures that will support the regeneration to maturity (e.g., provide fencing and avoid further fires to minimise damage risk).
- Protect mature and over-mature trees and stags, particularly those with hollows. Large and old trees typically have numerous hollows or fissures that provide shelter and support a diversity of animals.

5.4.1.2 MANAGE ACTIONS TO MINIMISE IMPACTS

When considering potential negative impacts on the ecological community from development or other actions in or nearby the ecological community, avoidance is the appropriate approach. The highest priority is to prevent direct disturbance of areas of the ecological community, but it is also important to avoid off-site impacts such as changes to hydrology or other ecological processes and damage to landscape function, particularly by preventing loss of nearby native vegetation and avoiding impacts in the catchment that may impact the ecological community. Where possible, facilitate the recovery of areas that are within the former range of the ecological community and retain suitable conditions for recovery such as appropriate soils and microclimate.

Land use and management in the vicinity of this ecological community should:

- Minimise the risk of indirect impacts to the ecological community from actions outside but near to patches of the ecological community. For example, prevent sediment entering the streams due to soil disturbance, for activities such as track and road construction in the water catchment.

- Avoid activities that are inconsistent with the fire regime considered appropriate for conservation of the ecological community (i.e., fire avoidance). Ensure that fire management activities (including creation of any new fire access tracks and asset protection zones) do not have detrimental impacts on the integrity of the ecological community. Avoid development that will limit future ecological management of fire.

- As this ecological community is highly restricted in extent and it is not possible or unknown how to reconstruct it, it is not appropriate to propose offsets for actions that may cause damage.

5.4.1.3 APPLY BUFFER ZONES

- Protect and apply appropriate buffers, particularly of other native vegetation, around patches of the ecological community to minimise off-site impacts. A buffer zone is a contiguous area adjacent to a patch that is important for protecting the integrity of the ecological community. As the risk of indirect damage to an ecological community is usually greater where actions occur close to a patch, the purpose of the buffer zone is to minimise this risk by guiding land managers to be aware that the ecological community is nearby and take extra care. For instance, the buffer zone will help protect the root zone of edge trees and other components of the ecological community from spray drift (fertiliser, pesticide or herbicide sprayed in adjacent land), weed invasion, polluted water runoff and other damage. The best buffer zones are typically comprised of other native vegetation. Fire breaks and other built asset protection zones do not typically provide a suitable buffer and should be additional to a vegetated buffer.

- The recommended minimum buffer zone is 50 m from the outer edge of the patch as this distance accounts for likely influences upon the root zone (potentially larger to protect sources of spring-fed water). A larger buffer zone should be applied, where practical, to protect patches that are of very high conservation value or depending on the threat. Judgement should be exercised to determine an appropriate buffer distance, depending on circumstances and how a patch may be detrimentally impacted.

5.4.1.4 PREVENT THE INTRODUCTION AND SPREAD OF EXOTIC SPECIES

- Implement strong biosecurity and avoid importing or accidentally introducing invasive species and pathogens that may have a serious adverse impact on this ecological community.
- Prevent planting of known or potentially invasive species in gardens, developments and landscaping near the ecological community.
- Prevent dumping of garden waste into bushland, especially in or near patches of the ecological community.
- Avoid the sale and planting of known invasive species in areas where the ecological community occurs. Review the planting schedule for new developments and landscaping near to the ecological community to ensure that potential weeds or other inappropriate plants (e.g. native plants likely to contaminate the local gene pool) are not included.
- Control runoff during nearby construction activities to prevent movement of weeds and pathogens into the ecological community or alteration to the spring-fed systems supporting the community.
- When conducting activities in or around the ecological community, practice good biosecurity hygiene to avoid spreading weeds or pathogens (see DoE, 2015).
- Minimise unnecessary soil disturbance that may facilitate weed establishment.
- If new invasive species (e.g., blackberry) or pathogen 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. Provide advice and support to landholders to assist with this.
- Limit or prevent access of vehicles to patches of the ecological community.
- Prevent further incursions of feral animals into the ecological community.

5.4.2 RESTORE and MANAGE the ecological community

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

- Implement management actions that mitigate against trampling, further weed encroachment, fire, drainage and sedimentation impacts.
- Liaise with landholders in surrounding areas and undertake and promote programs that ameliorate threats such as invasive plants and animals and disturbance from livestock.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.

5.4.2.1 MANAGE WEEDS, PESTS AND DISEASES

Implement effective integrated control and management techniques for weeds, pests and diseases affecting the ecological community and manage sites to prevent the introduction of new, or further spread of, invasive species.

- Identify potential new weed incursions early and manage for local eradication, where possible.
- Prioritise weeds and patches for which management is most urgent.
- Plan and budget for both initial weed management and for follow up treatment for as long as this is needed.
- Target control of key weeds that threaten the ecological community using appropriate methods that avoid impacts to non-target species.
- Encourage appropriate use of local native plant 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, do not have significant adverse, off-target impacts on the ecological community or adjacent native vegetation or waterbodies.
- Implement controls to prevent or reduce infection by fungal pathogens, especially myrtle rust (*Austropuccinia psidii*).
- Control introduced pest animals through coordinated landscape-scale control programs, with a particular focus on feral pigs, deer and goats.

5.4.2.2 MANAGE TRAMPLING, BROWSING AND GRAZING

- Any livestock grazing which may be occurring in the ecological community should cease and fencing may be required for exclusion of stock.
- Low level grazing, firewood cutting and other uses which may be acceptable in dry forests are not appropriate to maintain the integrity of this ecological community.

5.4.2.3 MANAGE INAPPROPRIATE BEHAVIOURS

- Avoid disturbance from visitors to sites containing the ecological community. Stay on established walking tracks when visiting national parks and nature reserves.
- Avoid/prohibit and monitor wood collection, such as for firewood or fencing, that leads to the loss and damage of trees, stags, logs or disturbs the natural litter layer.
- Avoid/prohibit and monitor destructive activities such as off-road trail bike or four-wheel-driving.
- Avoid/prohibit and monitor rubbish dumping.
- Avoid/prohibit and monitor native plant, wildflower, invertebrate and other fauna collection.
- Leave *Sphagnum* moss in its natural setting (do not collect) and obtain garden moss only from commercially authorised suppliers (or use an alternative to moss).

5.4.2.4 MANAGE APPROPRIATE FIRE REGIMES

Generally, fire should be excluded from the ecological community and nearby areas (NPWS 2002). Areas of this ecological community were recently affected by the fire occurring from December 2019 to January 2020. The following actions were identified for related ecological communities affected by the 2019-20 bushfires (Keith et al. 2020). For example, to reduce risks from fire-drought interactions and frequent fire, more specific actions may include:

- Avoid implementing fires including hazard reduction burns in all recently burnt habitat (including but not limited to habitat burnt in 2019/2020) and the watershed and spring-fed systems that support the community.
- Protect unburnt parts of the ecological community that function as refuges (i.e. avoid burning, clearing or logging in that habitat) .
- Develop and adapt fire management plans to ensure that any future wildfires that threaten to burn over recovering sites are rapidly extinguished and to avoid or minimise risks from hazard reduction burning in adjacent areas (i.e. by escaping containment lines).
- Monitor recovery of key components (e.g. *Sphagnum* moss) to determine the time required to re-establish habitat noting the need to undertake this monitoring following the 2019/2020 fires.
- Undertake post-fire on-ground surveys to quantify impacts, management needs and monitor recovery.
- Install targeted fencing if needed to exclude livestock, feral grazers, or overabundant native herbivores, and manage people and vehicle access to enable recovery.
- Control feral pigs and deer.
- Controlling feral predators such as foxes post-fire is not typically considered a high priority for this ecological community, but monitor for impacts on fauna after fire and undertake control measures as required.
- Manage structural components of sites and undertake habitat supplementation if required.
- Undertake weed surveys, treatment and removal.
- Undertake planning to accommodate co-dependency of management actions.
- Undertake strategic research to develop or assess management options. This may include investigating specific fire prevention and recovery interventions for this ecological community in future extreme fire conditions, such as installing perimeter watering points and watering key areas (e.g. where sphagnum is present) pre-fire and shading post-fire.

5.4.2.5 UNDERTAKE RESTORATION

- Undertake restoration, including facilitating regeneration, of degraded areas of the ecological community and surrounding native vegetation. Aim to restore patches to high

quality, including restoration of patches that do not currently meet the minimum condition thresholds for protection to a condition that does.

  - Restoration to improve the condition of degraded patches should aspire to the 5 Star Standard of the SERA Standards. Land managers should aim for the highest and best recovery of the ecological community to maximise biodiversity and ecological function based on appropriate metrics for each site (see Condition Thresholds in Section 2 and SERA (2021) for guidance on implementing appropriate standards). This is particularly the case for sites that are being restored or reconstructed from highly altered states.
  - Work with landholders to restore and reconnect patches of the ecological community and other adjacent or nearby native vegetation (including buffer areas).
  - Maintain stags, logs, large rocks, and mature and old-growth trees with hollows as they provide important habitat for fauna.
  - If necessary, supplement (but do not replace) habitat as part of restoration projects by placing hollow logs, large rocks or other habitat features (such as artificial hollows or various sized nest boxes) in or near to, the ecological community. This may be particularly important after disturbance such as a severe fire event.
  - 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. Take into account key plant species' growing seasons to successfully achieve seed set.
  - Ensure commitment to follow up after any planting, such as watering, mulching, weeding and use/removal of tree guards.
  - Close unnecessary roads and tracks, rehabilitate them back to their original vegetation, and otherwise control access to restored patches.

- 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* (Standards Reference Group SERA, 2021), relevant research or advice from local authorities.

5.4.3 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.

5.4.3.1 RAISE AWARENESS

- Communicate with relevant agencies, surrounding landholders/managers, Traditional custodians and the public to emphasise the value of the ecological community, the key threats, its significance, and appropriate management. Encourage surrounding landholders to talk with local NRM organisations, Indigenous Australians and other knowledgeable groups.

- Undertake effective community engagement and education to highlight the importance of minimising disturbance (e.g., during recreational activities) and of minimising pollution and littering (e.g., via signage).

- Inform landholders about incentives, such as conservation agreements, stewardship projects, funding and government NRM programs etc. that may apply to help look after native vegetation and waterways in the surrounding catchment.

5.4.3.2 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 environment law (the EPBC Act).

- Improve understanding of Traditional Ecological Knowledge and, where agreed by the knowledge-holders, identify and support culturally appropriate mechanisms to share and maintain this knowledge to protect and restore the ecological community.

- Install signage to discourage damaging activities such as the removal of 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.

- 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.

5.4.3.3 COORDINATE EFFORTS

- Liaise with local fire management authorities and agencies and engage their support in excluding fire from the ecological community. Ensure land managers in the catchment are given information about how to manage fire risks to conserve this and other threatened ecological communities and species.

- Develop coordinated incentive projects to encourage conservation and stewardship of the surrounding native vegetation on private land, and link with other programs and activities, especially those managed by regional Natural Resource Management groups.

- Support opportunities for Traditional Owners/Custodians or other members of the Indigenous community to manage the ecological community.

- Promote awareness and protection of the ecological community with relevant agencies and industries. For example with:

    - state and local government planning authorities, to ensure that planning takes the protection of remnants into account; infrastructure or development works involving substrate or vegetation disturbance in the surrounding areas do not

adversely impact the ecological community; maintenance activities (e.g. roads and roadsides) avoid the introduction or spread of weeds; with due regard to principles for long-term conservation;

- land owners and developers, to minimise threats associated with land conversion and development in surrounding areas;
- Natural Resource Management organisations, conservation organisations and groups volunteering time for restoration and ecological management.

5.4.4 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. Relevant and well-targeted research and other information gathering activities are important in informing the protection and management of the ecological community.

5.4.4.1 SURVEY AND MAPPING

- Collate existing vegetation mapping information and associated data for this ecological community and identify gaps in knowledge.
- Comprehensively survey and map the extent and condition of the ecological community:
  - support field survey and interpretation of other data such as aerial photographs and satellite images to more accurately document current extent, condition, threats, function, presence and use by regionally significant or threatened species.
  - support and enhance existing programs to model the pre-1750 extent across the entire range of the ecological community to inform restoration;
  - identify the most intact, high conservation value remnants and gain a better understanding of variation across the ecological community;
  - identify and map the fire interval status of the ecological community and surrounding fire-dependent and/or fire sensitive vegetation;
  - collate existing information on populations of fauna characteristic of the ecological community across its range.

5.4.4.2 OPTIONS FOR MANAGEMENT

- Investigate key ecological interactions, such as the role of fauna in pollination, seed dispersal and nutrient cycling.
- Research into appropriate and integrated methods to manage pests and weeds that affect the ecological community.
- Assess the vulnerability of the ecological community to climate change and investigate ways to improve resilience through other threat abatement and management actions.
- Conduct research leading to the development of effective landscape-scale restoration techniques for the ecological community. Investigate the interaction between

disturbance types, such as fire and invasion by weeds and feral animals, to determine how an integrated approach to threat management can be implemented.

5.4.4.3 MONITORING

- 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 the trajectory of recovery and condition after the 2019/20 fire event and subsequent heavy snowfalls, rain and high winds.
    - Monitor for signs of decline, and new incursions of invasive species and pathogens e.g., blackberry, *Phytophthora* dieback or myrtle rust.
    - Monitor changes in the condition, composition, structure and function of the ecological community, including response to climate change, fire, severe weather events and all types of management actions and use this information to increase understanding of the ecological community and inform recommendations for future management.

6 Listing assessment

This assessment outlines the *grounds on which the community is eligible to be listed* as required by section 266B (2) (a) (i) of the EPBC Act.

The Threatened Species Scientific Committee finalised this assessment on DATE.

6.1 Assessment process

6.1.1 Reason for assessment

This assessment follows prioritisation of a nomination from the Threatened Species Scientific Committee in response to the impacts of the 2019-2020 bushfires.

6.1.2 Public consultation

Notice of the proposed listing and a consultation document was made available for public comment for 35 business days between 14 December 2021 and 7 February 2022. Any comments received that were relevant to the assessment of the ecological community were considered by the Committee as part of the assessment process.

6.2 Eligibility for listing

An ecological community is eligible for listing under section 182 of the EPBC Act if it meets the prescribed criteria outlined in section 7.02 of the EPBC Regulations. This assessment uses the criteria set out in section 7.02 the EPBC Regulations and the TSSC Guidelines for nominating and assessing the eligibility for listing of threatened ecological communities (TSSC 2017), as in force at the time of the assessment.

6.2.1 Criterion 1 – decline in geographic distribution

Insufficient data to determine eligibility under Criterion 1

	Category		
	Critically Endangered	**Endangered**	**Vulnerable**
Its decline in geographic distribution is:	very severe	severe	substantial
decline relative to the longer-term/1750 timeframe	*≥90%*	*≥70%*	*≥50%*
decline relative to the past 50 years	*≥80%*	*≥50%*	*≥30%*

Source: TSSC 2017

Evidence:

The NSW Scientific Committee (1998) note that the prominence of *Sphagnum* in the ground layer beneath a mix of cool temperate rainforest species represents communities which were formerly widespread on the northern tablelands but are now considered to be rare, largely due to timber harvesting and the introduction of domestic livestock. The area surrounding Ben Halls Gap Nature Reserve is steep, partially cleared country used for grazing and some agriculture (NPWS 2002). Ben Halls Gap Nature Reserve was grazed in the past but not logged, however the area currently designated as Ben Halls Gap National Park (to the north of the Nature Reserve) did have some logging and was grazed until recently (2016). Therefore, the ecological community may have been considerably more extensive than it is now. However, the pre-1750 extent of the ecological community is unknown. In addition, the pre-1750 data for the related

Plant Community Type, PCT 3051 (DPIE 2021), is restricted to areas at Ben Halls Gap and Barrington Tops, so does not show any decline of this vegetation unit.

Following assessment of the available data the Committee has determined that there is insufficient information to assess the ecological community under Criterion 1.

6.2.2 Criterion 2 – limited geographic distribution coupled with demonstrable threat

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

	Category		
	Critically Endangered	**Endangered**	**Vulnerable**
Its geographic distribution is:	very restricted	restricted	limited
Extent of Occurrence (EoO)	*<100 km²*	*< 1,000 km²*	*< 10,000 km²*
Area of Occupancy (AoO)	*<10 km²*	*< 100 km²*	*< 1,000 km²*
Average patch size	*<0.1 km²*	*< 1 km²*	
AND 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	the near future	medium term future
timeframe	*10 years or 3 generations (up to a maximum of 60 years)*	*20 years or 5 generations (up to a maximum of 100 years)*	*50 years or 10 generations (up to a maximum of 100 years)*

Source: TSSC 2017

Evidence:

Geographic distribution

The ecological community's Extent of Occurrence is approximately 25 km^2, the Area of Occupancy is approximately 1 km^2 (100 ha). Both of these measures are indicative of a *very restricted* geographic distribution. Patch sizes were not evaluated because occurrences of this community within this current distribution have not been fragmented by clearing. Almost all occurrences are within a conservation tenure within a matrix of other forested land. In addition, the resolution of available spatial data may not be suitable for patch size analysis.

Timeframes and threats

The ecological community is subject to key threats that impact upon it over a variety of timeframes, as described in *Section 4 Threats* and Table 3. The ecological community is sensitive to disturbance in the catchment (e.g., changes in hydrology including water availability and quality/sedimentation) and locally (physical disturbance, weeds, feral animals). It is also particularly vulnerable to stochastic events, given its very restricted geographic distribution. This is also particularly relevant to the relatively shallow *Sphagnum* peat layer and other characteristic species requiring the cool temperate rainforest microclimate. That is, the ecological community is a rare, localised combination of biota that are highly sensitive to changes in climatic conditions and associated changing fire regimes and damaging weather events that could quickly transform them into a different or novel ecological community.

Estimates are that at least 50 % of the ecological community was directly burnt in December 2019 – January 2020 (based on expert input and analysis of DAWE (2020) and PCT 3051 (DPIE 2021) in the Ben Halls Gap area; Keith et al. 2022), with the remainder of the extent likely to have been affected (e.g., increased sedimentation and solar radiation) following burning of adjacent and

nearby vegetation communities. Recovery from this event is uncertain, particularly in conjunction with subsequent canopy damage from heavy rain, snow and high wind events. Increased sedimentation following fire may also affect the organic content of the site and inhibit re-establishment of *Sphagnum* moss (Whinam & Chilcott 2002). These fire events are likely to become more frequent in the future because the drying climate associated with climate change is likely to increase the duration, frequency and intensity of fires (BOM 2021b). Similarly, damaging weather events may become more frequent and/or severe.

Conclusion

The ecological community has a **very restricted** geographic distribution, and the nature of this distribution makes it likely that the action of a threatening process could cause it to be lost in the immediate future, given the suite of interacting threats particularly severe fires and damaging weather events. The Committee considers that the ecological community has met the relevant elements of Criterion 2 to make it eligible for listing at **Critically Endangered**.

6.2.3 Criterion 3 – decline of functionally important species

Insufficient data to determine eligibility under Criterion 3

	Category		
	Critically Endangered	**Endangered**	**Vulnerable**
For a population of a native species that is likely to play a major role in the community, there is a:	very severe decline	severe decline	substantial decline
Estimated decline over the last 10 years or three generations, whichever is longer	*80%*	*50%*	*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
timeframe	*10 years or 3 generations (up to a maximum of 60 years)*	*20 years or 5 generations (up to a maximum of 100 years)*	*50 years or 10 generations (up to a maximum of 100 years)*

Source: TSSC 2017

Evidence:

At this time, the Committee considers that there is insufficient information to determine the eligibility of the ecological community for listing in any category under Criterion 3.

6.2.4 Criterion 4 – reduction in community integrity

Insufficient data to determine eligibility under Criterion 4

	Category		
	Critically Endangered	**Endangered**	**Vulnerable**
The reduction in its integrity across most of its geographic distribution is:	very severe	severe	substantial
as indicated by degradation of the community or its habitat, or disruption of important community processes, that is:	very severe	severe	substantial
such that restoration is unlikely (even with positive human intervention) within	*the immediate future (10 years or 3 generations up to a maximum of 60 years)*	*the near future (**20 years** or 5 generations up to a maximum of 100 years)*	*the medium-term future (50 years or 10 generations up to a maximum of 100 years)*

Source: TSSC 2017

Evidence:

The ecological community has been subject to a past reduction in integrity due to substantial fire and storms, weeds, pests (hard hooved animals) and sediment. The ground layer and peat has also been exposed to solar radiation (heat/light) due to loss of canopy cover in the ecological community and surrounding vegetation (which is considered under Criterion 5).

However, as there is a lack of information on the recovery potential from the 2019-20 fires and subsequent canopy damage from storm conditions including snow and high winds, at this time the Committee considers that there is insufficient information to determine the eligibility of the ecological community for listing in any category under Criterion 4.

6.2.5 Criterion 5 – rate of continuing detrimental change

Eligible under Criterion 5 for listing as **Critically Endangered**.

	Category		
	Critically Endangered	**Endangered**	**Vulnerable**
Its rate of continuing detrimental change is: as indicated by:	**very severe**	severe	substantial
(a) rate of continuing decline in its geographic distribution, or a population of a native species that is believed to play a major role in the community, that is: OR	very severe	severe	serious
(b) intensification, across most of its geographic distribution, in degradation, or disruption of important community processes, that is:	**very severe**	severe	serious
an observed, estimated, inferred or suspected detrimental change over the immediate past, or projected for the immediate future (10 years or 3 generations, up to a maximum of 60 years), of at least:	***80%***	*50%*	*30%*

Source: TSSC 2017

Evidence:

It is estimated that at least half of the ecological community was directly burnt during the 2019-20 fires (based on expert input and analysis of DAWE (2020) and PCT 3051 (DPIE 2021) in the Ben Halls Gap area). The ecological community is particularly susceptible to the effects of fires,

including from fires in adjacent vegetation and more broadly in the catchment. Detrimental impacts include increased solar radiation due to loss of canopy shading effects, reducing conditions suitable for the cool temperate rainforest species and *Sphagnum cristatum*, and an influx of sediment along watercourses. Heavy rain, snow and high wind events in 2021 has also resulted in further canopy damage across most occurrences of the ecological community, estimated to have affected approximately 80% of the extant ecological community.

The impacts from the 2019-20 fires, as well as subsequent canopy damage, on the ecological community and surrounding vegetation represent a **very severe** rate of continuing detrimental change as indicated by a **very severe** intensification in degradation or disruption of important community processes across most of its geographic distribution that is observed over the immediate past. Following assessment, the Committee therefore considers that the ecological community has met the relevant elements of Criterion 5 to make it eligible for listing as **Critically Endangered**.

6.2.6 Criterion 6 – quantitative analysis showing probability of extinction

Insufficient data to determine eligibility under Criterion 6.

	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
timeframes	*10 years or 3 generations (up to a maximum of 60 years)*	*20 years or 5 generations (up to a maximum of 100 years)*	*50 years or 10 generations (up to a maximum of 100 years)*

Source: TSSC 2017

Evidence:

Quantitative analysis of the probability of extinction or extreme degradation over all its geographic distribution has not been undertaken. Therefore, there is insufficient information to determine the eligibility of the ecological community for listing in any category under this criterion.

6.3 Listing and Recovery Plan Recommendations

6.3.1 TSSC Recommendations

The Threatened Species Scientific Committee recommends:

(i) that the list referred to in section 181 of the EPBC Act be amended by **including** Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest in the list in the Critically Endangered category.

AND

(ii) that there not be a recovery plan for this ecological community at this time.

This recommendation is in accordance with the provisions of the EPBC Act and the Committee's conservation planning principles as follows:

- There are no significant complexities in conservation planning. The ecological community has a small distribution, primarily in one National Park in one bioregion within a single jurisdiction. The threats facing the ecological community are well-understood and the priority actions needed relate primarily to ongoing appropriate management of individual occurrences.
- There are no known occurrences on Commonwealth land.
- An approved conservation advice would be an effective, efficient and responsive document to guide the implementation of priority management actions, mitigate against key threats and support the recovery for this ecological community at the national level.
- Having regard to the above factors, a national recovery plan is not recommended as it would not provide a significant conservation planning benefit in addition to this Conservation Advice and other existing mechanisms.

References

- Benson J & Andrew D (1990) *Vegetation Community Mapping for Ben Halls Gap National Park*. State Government of NSW and Department of Planning, Industry and Environment 2012. Available at: https://datasets.seed.nsw.gov.au/dataset/ben-halls-gap-national-park-vegetation-1990-vis_id-909628c

- Bland L, Keith D, Miller R, Murray N and Rodriguez J (eds) (2017) *Guidelines for the application of IUCN Red List of Ecosystem Categories and Criteria*, *Version 1.1.* IUCN, Switzerland. Available at: https://www.iucn.org/es/content/guidelines-application-iucn-red-list-ecosystems-categories-and-criteria

- BOM (2021a) Rainfall deficiency maps for New South Wales/ACT, for the period up to 30/11/2019. Viewed 7/3/2022. Commonwealth of Australia, Bureau of Meteorology. Available at: http://www.bom.gov.au/climate/maps/rainfall

- BOM (2021b) State of the Climate. In Australia's Changing Climate. Commonwealth of Australia, Bureau of Meteorology.

- CABI (Centre of Agriculture and Biosciences International) (2019) Datasheet: *Rattus rattus* (black rat). In: *Invasive Species Compendium*. Wallingford, UK: CAB International. Available at: https://www.cabi.org/isc/datasheet/46831

- Colquhoun GP, Hughes KS, Deyssing L, Ballard JC, Folkes CB, Phillips G, Troedson AL & Fitzherbert JA (2021) New South Wales Seamless Geology dataset, single layer, version 2.1 [Digital Dataset]. Geological Survey of New South Wales, Department of Regional NSW, Maitland. Available at: https://data.nsw.gov.au/data/dataset/nsw-seamless-geology

- DAWE [Department of Agriculture, Water and the Environment] (2020) *National Indicative Aggregated Fire Extent Datasets (NIAFED)*. Australian Government Department of Agriculture, Water and the Environment, Canberra.

- DAWE (2021) *Fire regimes that cause biodiversity decline: amendments to the list of Key Threatening Processes. DRAFT version*. Department of Agriculture, Water and the Environment, Canberra.

- DoE [Department of the Environment] (2012) *Interim Biogeographic Regionalisation for Australia (Subregions - States and Territories) v. 7.*

- DoE [Department of the Environment] (2015) *Arrive Clean*, *Leave Clean. Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants*, *animals and ecosystems*. Commonwealth of Australia. Available at https://www.environment.gov.au/biodiversity/invasive-species/publications/arrive-clean-leave-clean

- Department of Planning Industry and Environment [DPIE] (2021) NSW State Vegetation Type Map (SVTM). Pre-Release v1.1.0 Eastern NSW Extant Plant Community Type. Full package available at https://datasets.seed.nsw.gov.au/dataset/nsw-state-vegetation-type-map

- Ellis R (1985) The relationships among eucalypt forest, grassland and rainforest in a highland area in north-eastern Tasmania. *Austral Ecology*, *10*, 297–314. https://doi.org/10.1111/j.1442-9993.1985.tb00891.x

- Fensham RJ, Fairfax RJ, Butler DW & Bowman DMJS (2003) Effects of Fire and Drought in a Tropical Eucalypt Savanna Colonized by Rain Forest, *Journal of Biogeography*, 30, 9 pp. 1405–1414.

- Floyd AG (1990) *Australian rainforests in New South Wales*. Surrey Beatty & Sons in association with National Parks and Wildlife Service of New South Wales.

- Gunning RV (1995) Insect Survey of Ben Halls Gap State Forest. *Proceedings of 26th AGM and Scientific Conference of the Australian Entomological Society*, *Tamworth NSW*.

- Harvest T, Davidson N & Close D (2008) Is decline in high altitude eucalypt forests related to rainforest understorey development and altered soil bacteria following the long absence of fire? *Austral Ecology*, 33, 880–890. https://doi.org/10.1111/j.1442-9993.2008.01859.x

- Hennessy K (2011) Climate change impacts. In Cleugh H, Stafford Smith M, Battaglia M & Graham P (Eds.), *Climate Change: science and solutions for Australia* (pp. 45–57) CSIRO Publishing.

- Keith DA, Auld TD, Barrett S, English V, Gallagher R, Gray R, van Leeuwen S, McIlwee A, Mitchell D, Tozer MG, Williams RJ, Yates CJ, Neldner J, Buchan A, White MD, Rogers D, West A, Seddon J, Simpson CC (in prep) Terrestrial Ecological Communities in Australia: initial assessment and management after the 2019-20 bushfires. Report to the Wildlife and Habitat Bushfire Expert Panel and the Australian Department of Agriculture, Water and the Environment. Centre for Ecosystem Science, University of NSW, Sydney. Available at: https://www.awe.gov.au/sites/default/files/env/pages/cae21f42-9328-45ee-b558-a79628aaf68f/files/tecs-threats-and-actions.pdf

- Keith DA, Allen SP, Gallagher RV, Mackenzie BDE, Auld TD, Barrett S, Buchan A, English V, Gosper C, Kelly D, McIllwee A, Melrose RT, Miller BJ, Neldner J, Tolsma AD, White MD, Rogers D, van Leeuwen S, Yates CJ & Tozer MG (2022) Fire-related threats and transformational change in Australian ecosystems. *Global Ecology and Biogeography*, in press. [doi: 10.1111/geb13500]

- Makinson RO (2018) *Myrtle Rust reviewed: the impacts of the invasive pathogen Austropuccinia psidii on the Australian environment*. Plant Biosecurity Cooperative Research Centre, Canberra. Available at: http://www.apbsf.org.au/wp-content/uploads/2018/11/Myrtle-Rust-reviewed-June-22-2018-web.pdf

- National Committee on Soil and Terrain (2009) *The Australian Soil and Land Survey Field Handbook*. CSIRO.

- NPWS (1999) *Vegetation Community Profiles of Ben Halls Gap National Park.* Adapted from Benson J & Andrew D (1990) The Flora, Fauna and Conservation Significance of Ben Halls Gap State Forest, Nundle, NSW. NSW NPWS, Hurstville.

- NPWS (2002) Ben Halls Gap National Park Plan of Management. NSW National Parks and Wildlife Service. Available at:

https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/ben-halls-gap-national-park-plan-of-management-020091.pdf

- NSW DPIE [Department of Planning, Industry and Environment] (2020) Exotic vines and scramblers: Blackberry. Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/pest-animals-and-weeds/weeds/widespread-weeds/exotic-vines/blackberry
- NSW DPIE (2021) Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest – profile. NSW Government. Available at: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10091
- NSW Office of Environment and Heritage (2018) New South Wales BioNet Vegetation Classification User Manual. State of NSW and Office of Environment and Heritage. Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/BioNet/bionet-vegetation-classification-user-manual-180423.pdf
- NSW Scientific Committee (1998) Ben Halls Gap National Park Sphagnum Moss Cool Temperate Rainforest Community - endangered ecological community listing. Final Determination. Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/nsw-threatened-species-scientific-committee/determinations/final-determinations/1996-1999/ben-halls-gap-sphagnum-moss-cool-temperate-rainforest-endangered-ecological-community-listing
- NSW Threatened Species Scientific Committee (2019) *Final Determination (2019-221) under the NSW Biodiversity Conservation Act 2016*. Available at: https://legislation.nsw.gov.au/view/pdf/asmade/sl-2019-221
- NSW OEH [Office of Environment and Heritage]. (2014) Climate projections map: 10 x 10 km grid cell over Ben Halls Gap Nature Reserve within the New England and North West region. NSW OEH, Sydney, NSW. Projection for 10 x 10 km grid cell at https://www.climatechange.environment.nsw.gov.au/projections-map?region=nsw&climateprojection=tasmaxmean&range=1
- Standards Reference Group SERA (2021) *National Standards for the Practice of Ecological Restoration in Australia.* Edition 2.2. Society for Ecological Restoration Australasia. Available at: http://www.seraustralasia.com/pages/standards.html
- Threatened Species Scientific Committee (TSSC) (2006) *Commonwealth Listing Advice on Predation by exotic rats on Australian offshore islands of less than 1000 km² (100,000 ha)*. Available at: https://www.awe.gov.au/environment/biodiversity/threatened/key-threatening-processes/predation-by-exotic-rats-on-australian-islands-less-than-100000-ha
- Whinam J & Chilcott N (2002) Floristic description and environmental relationship of Sphagnum communities in NSW and the ACT and their conservation management. *Cunninghamia* 7(3): 463–500.
- Wormington K & Lamb D (1999) Tree hollow development in wet and dry sclerophyll eucalypt forest in south-east Queensland, Australia. *Australian Forestry* 62(4): 336–345.

Appendix A – Native plant species list

This list is not exhaustive, other species may be present but not yet recorded. The species listed may be abundant, rare, or not necessarily be present in any given patch of the ecological community, and other native species not listed here may be present. Some species recorded during surveys in 2022 have be identified to genus level only at the time of writing.

Table 4: Native plant species recorded in the ecological community.

Family	Scientific Name	Common Name	Growth Form Group (as defined in BAM 2020)	Moss or liverwort
Apiaceae	*Centella asiatica*	Indian pennywort	Forb (FG)	
Apiaceae	*Hydrocotyle acutiloba*		Forb (FG)	
Apiaceae	*Hydrocotyle algida*	pennywort	Forb (FG)	
Apiaceae	*Hydrocotyle sibthorpioides*		Forb (FG)	
Apocynaceae	*Parsonsia brownii*	mountain silkpod	Other (OG)	
Aspleniaceae	*Asplenium flabellifolium*	necklace fern	Fern (EG)	
Asteraceae	*Euchiton involucratus*	star cudweed	Forb (FG)	
Asteraceae	*Euchiton japonicus*		Forb (FG)	
Asteraceae	*Euchiton* sp.	a cudweed	Forb (FG)	
Asteraceae	*Lagenophora* sp.		Forb (FG)	
Asteraceae	*Lagenophora stipitata*	common lagenophora	Forb (FG)	
Asteraceae	*Senecio biserratus*		Forb (FG)	
Asteraceae	*Senecio linearifolius* var. *arachnoideus*		Shrub (SG)	
Asteraceae	*Senecio minimus*		Forb (FG)	
Blechnaceae	*Blechnum minus*	soft water fern	Fern (EG)	
Blechnaceae	*Blechnum nudum*	fishbone water fern	Fern (EG)	
Blechnaceae	*Blechnum wattsii*	hard water fern	Fern (EG)	
Boraginaceae	*Hackelia latifolia*		Forb (FG)	
Brassicaceae	*Cardamine lilacina*		Forb (FG)	
Brassicaceae	*Cardamine paucijuga*		Forb (FG)	
Campanulaceae	*Lobelia pedunculata*	matted pratia, trailing pratia	Forb (FG)	
Campanulaceae	*Lobelia surrepens*		Forb (FG)	
Campanulaceae	*Wahlenbergia* sp.	bluebell	Forb (FG)	
Cyperaceae	*Carex gaudichaudiana*		Grass & grasslike (GG)	
Cyperaceae	*Carex inversa*	knob sedge	Grass & grasslike (GG)	
Cyperaceae	*Carex* sp.		Grass & grasslike (GG)	
Cyperaceae	*Cyperus gracilis*	slender flat-sedge	Grass & grasslike (GG)	

Family	Scientific Name	Common Name	Growth Form Group (as defined in BAM 2020)	Moss or liverwort
Cyperaceae	*Isolepis habra*		Grass & grasslike (GG)	
Cyperaceae	*Isolepis subtilissima*		Grass & grasslike (GG)	
Dennstaedtiaceae	*Hypolepis glandulifera*	downy ground fern	Fern (EG)	
Dennstaedtiaceae	*Pteridium esculentum*	bracken	Fern (EG)	
Dicksoniaceae	*Dicksonia antarctica*	soft treefern	Other (OG)	
Dicranaceae	*Dicranoloma* sp.	a moss		Moss
Dryopteridaceae	*Polystichum proliferum*	mother shield fern	Fern (EG)	
Elaeocarpaceae	*Elaeocarpus holopetalus*	black olive berry	Shrub (SG)	
Elatinaceae	*Elatine gratioloides*	waterwort	Forb (FG)	
Ericaceae	*Leucopogon affinis* (syn. *Leucopogon lanceolatus* var. *lanceolatus*)		Shrub (SG)	
Escalloniaceae	*Quintinia sieberi*	rough possumwood	Tree (TG)	
Fabaceae	*Acacia melanoxylon*	blackwood	Tree (TG)	
Frullaniaceae	*Frullania* sp.	a liverwort		Liverwort
Hemerocallidaceae	*Dianella* sp.		Forb (FG)	
Hymenophyllaceae	*Hymenophyllum cupressiforme*	common filmy fern	Fern (EG)	
Juncaceae	*Juncus alexandri*		Grass & grasslike (GG)	
Juncaceae	*Juncus laeviusculus* subsp. *laeviusculus*		Grass & grasslike (GG)	
Juncaceae	*Juncus planifolius*		Grass & grasslike (GG)	
Lamiaceae	Lamiaceae sp.		Forb (FG)	
Lauraceae	*Cryptocarya* sp.		Tree (TG)	
Lomandraceae	*Lomandra longifolia*	spiny-headed mat-rush	Grass & grasslike (GG)	
Meteoriaceae	*Papillaria* sp.	a moss		Moss
Monimiaceae	*Atherosperma moschatum*	black sassafras	Shrub (SG)	
Monimiaceae	*Hedycarya angustifolia*	native mulberry	Tree (TG)	
Myrtaceae	*Callistemon pallidus*	lemon bottlebrush	Shrub (SG)	
Myrtaceae	*Eucalyptus dalrympleana* subsp. *dalrympleana*	mountain gum	Tree (TG)	
Myrtaceae	*Eucalyptus laevopinea*	silver-top stringybark	Tree (TG)	
Myrtaceae	*Eucalyptus nobilis*	ribbon gum	Tree (TG)	
Myrtaceae	*Eucalyptus obliqua*	messmate	Tree (TG)	
Myrtaceae	*Eucalyptus pauciflora*	snow gum, white sally	Tree (TG)	
Myrtaceae	*Eucalyptus stellulata*	black sallee	Tree (TG)	

Family	Scientific Name	Common Name	Growth Form Group (as defined in BAM 2020)	Moss or liverwort
Myrtaceae	*Eucalyptus viminalis*	ribbon gum, manna gum	Tree (TG)	
Myrtaceae	*Leptospermum polygalifolium* subsp. *montanum*		Shrub (SG)	
Orchidaceae	*Acianthus* sp.	mosquito orchid	Forb (FG)	
Orchidaceae	*Chiloglottis* sp.		Forb (FG)	
Orchidaceae	*Corybas* sp.		Forb (FG)	
Orchidaceae	*Pterostylis* spp.	greenhood	Forb (FG)	
Osmundaceae	*Todea barbara*	king fern	Other (OG)	
Oxalidaceae	*Oxalis exilis*		Forb (FG)	
Oxalidaceae	*Oxalis* sp.		Forb (FG)	
Pittosporaceae	*Bursaria spinosa* subsp. *spinosa*	native blackthorn	Shrub (SG)	
Plantaginaceae	*Gratiola pedunculata*		Forb (FG)	
Plantaginaceae	*Gratiola peruviana*	Australian brooklime	Forb (FG)	
Pittosporaceae	*Pittosporum multiflorum*	orange thorn	Shrub (SG)	
Plantaginaceae	*Plantago debilis*	shade plantain	Forb (FG)	
Plantaginaceae	*Plantago* sp.	plantain	Forb (FG)	
Plantaginaceae	*Veronica* sp.		Forb (FG)	
Poaceae	*Deyeuxia gunniana*		Grass & grasslike (GG)	
Poaceae	*Microlaena stipoides* var. *stipoides*	weeping grass	Grass & grasslike (GG)	
Poaceae	*Poa sieberiana* var. *sieberiana*	snowgrass	Grass & grasslike (GG)	
Polypodiaceae	*Zealandia pustulata* subsp. *pustulata* (syn. *Microsorum pustulatum* subsp. *pustulatum*)		Fern (EG)	
Polypodiaceae	*Pyrrosia rupestris*	rock felt fern	Fern (EG)	
Proteaceae	*Banksia integrifolia* subsp. *monticola*		Tree (TG)	
Pteridaceae	*Pteris comans*	hairy bracken	Fern (EG)	
Pteridaceae	*Pteris tremula*	tender brake	Fern (EG)	
Ricciaceae	*Riccia* sp.			Liverwort
Rubiaceae	*Coprosma quadrifida*	prickly currant bush	Shrub (SG)	
Rubiaceae	*Galium leiocarpum*		Forb (FG)	
Rubiaceae	*Galium* sp.		Forb (FG)	
Sapindaceae	*Alectryon forsythii*		Shrub (SG)	
Smilacaceae	*Smilax australis*	lawyer vine	Other (OG)	
Solanaceae	*Solanum aviculare*	kangaroo apple	Shrub (SG)	
Sphagnaceae	*Sphagnum cristatum*	sphagnum moss		Moss

Family	Scientific Name	Common Name	Growth Form Group (as defined in BAM 2020)	Moss or liverwort
Urticaceae	*Urtica incisa*	stinging nettle	Forb (FG)	
Violaceae	*Melicytus dentatus*	tree violet	Shrub (SG)	
Violaceae	*Viola hederacea*	ivy-leaved violet	Forb (FG)	

Source: Growth forms, NSW Biodiversity Assessment Method (2020) Assessor resources: Resources for accredited assessors applying the Biodiversity Assessment Method. State of NSW and Department of Planning, Industry and Environment. Available at: https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity-offsets-scheme/accredited-assessors/assessor-resources

Appendix B – Example images of the ecological community

Examples of the ecological community prior to (a) and after (b-e) the 2019/20 bushfires and 2021 weather damage:

a) An example of reference condition (October 2013). © Doug Beckers

b) Severe canopy damage with almost complete loss of the ecological community's rainforest canopy and midstorey, surrounded by eucalypts of adjacent vegetation types (November 2021). © Ben Karlson

c) Severe canopy damage but retention of some of the midstorey, dominated by *Leptospermum polygalifolium* subsp. *montanum* (March 2022). © DCCEEW

d) Severe canopy damage with almost complete loss of the ecological community's rainforest canopy and midstorey, surrounded by eucalypts of adjacent vegetation types (March 2022). © DCCEEW

e) Fallen canopy tree with Sphagnum hummock in poor condition (March 2022). © DCCEEW

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Climate Change, Energy, the Environment and Water 2022, Approved *Conservation advice for* the Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest, Canberra.

This publication is available at the SPRAT profile for Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090, Canberra ACT 2601
Telephone 1800 803 772
Web dcceew.gov.au

Version history table

Document type	Title	Date [dd mm yyyy]
Consultation draft	Draft Conservation Advice for Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest	14 12 2021
Approved conservation advice	Approved conservation advice for Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest	5 10 2022