



Draft Conservation Advice for the Mount Kaputar Highland and Rainforest Snail and Slug Community

This draft document is being released for consultation on the description, listing eligibility and conservation actions of the ecological community.

The purpose of this consultation document is to elicit additional information to better understand the definition and status of the ecological community and help inform conservation actions. The draft assessment below should therefore be considered **tentative** at this stage, as it may change as a result of responses to this consultation process.

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

Images pending.

Mount Kaputar Highland and Rainforest Snail and Slug Community.

The Mount Kaputar highland and rainforest snail and slug community occurs within Country (the traditional lands) of the Kamilaroi people. We acknowledge their culture and continuing link to the ecological community and the country it inhabits.

Proposed Conservation Status

The Mount Kaputar highland and rainforest snail and slug community is proposed to be listed in the **Endangered** category of the threatened ecological communities list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act).

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About this document

This document describes the ecological community and where it can be found (section 1); outlines information to assist in identifying the ecological community and important occurrences of it (section 2); and describes Indigenous 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).

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1 Ecological community name and description

1.1 Name

The nominated ecological community is based on a NSW-listed community known as the *Mount Kaputar high elevation and dry rainforest land snail and slug community in the Nandewar and Brigalow Belt South Bioregions*. The name of the ecological community assessed here is the “Mount Kaputar highland and rainforest snail and slug community”, hereafter known as the “Kaputar snail and slug community”, or “the ecological community”. The name identifies it as a faunal assemblage of terrestrial gastropods that is limited to elevated areas of Mt Kaputar and surrounds.

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. For the purposes of the Kaputar Snail and Slug Community:

- The assemblage of native species comprises native terrestrial gastropods (land slugs and snails), many of which are endemic or largely confined to the area identified.
- The area in nature where this assemblage occurs is in and around Mount Kaputar in north-eastern New South Wales (NSW). The snail and slug assemblage occurs in a variety of environments that are often damp but not permanently inundated by water in this area.

This section describes the natural and largely undisturbed state of the ecological community and the environments in which it occurs. More information to assist in identifying occurrences of the ecological community is provided in [section 2](#). As a result of past loss, disturbances or degradation, not all occurrences of the ecological community may exist in a completely natural state. [Section 2](#) provides information to identify when sufficient conservation values remain to be considered a matter of national environmental significance.

1.2.1 Location and physical environment

The ecological community is located on and around Mount Kaputar in north-eastern NSW. Mt Kaputar and the distribution area for the ecological community corresponds largely with the Kaputar IBRA¹ subregion (NAN03), the westernmost part of the Nandewar bioregion that adjoins the Brigalow Belt South. The Kaputar subregion includes the high elevation environments (>1000 metres above sea level [ASL]) occupied by the Kaputar Snail and Slug Community. Occurrences of the ecological community below 1000 m ASL occur in pockets of mesic vegetation, notably dry rainforests and vine thickets in gullies and other protected sites. The ecological community is not found below 400 m ASL.

Some areas of highland and rainforest areas around Mt Kaputar extend into IBRA subregions immediately adjoining the Kaputar subregion: NAN04 Peel to the east; BBS21 Northern Basalts to the north and west; and BBS25 Liverpool Plains to the south and west. An area that extends outward for ten km around the edge of the Kaputar subregion captures pockets of highland and elevated (>400m ASL) dry rainforest environments, as well as areas of the national park and adjoining state forests, that lie outside the Kaputar subregion but in the vicinity of Mt Kaputar that allow for potential outlying occurrences of the ecological community.

The Nandewar Range was formed by successive volcanoes, much of which have since eroded into lower, undulating terrain (State of NSW and DPIE 2021a). Mount Kaputar remains as the ranges’

¹ IBRA refers to the Interim Biogeographical Regionalisation of Australia. IBRA regions are large geographically distinct areas of similar climate, geology and landform with corresponding similarities in their vegetation and animal communities. The version current at the time of this advice is IBRA v7 (DoE, 2013), which divides Australia into 89 bioregions and 419 subregions, including offshore islands.

highest and westernmost peak and the Kaputar subregion is more predominantly mountainous and volcanic compared to other adjacent subregions. The landforms and geology of Kaputar and surrounding subregions are summarised at [Table 1.1](#) and more detail on the geology and landforms of Kaputar is given by Hunter and Alexander (2015).

Table 1.1. Landforms and geology of the Kaputar and surrounding subregions.

Subregion	Landforms	Geology
NAN03 Kaputar	Rugged steep rocky hills and peaks, exposed volcanic plugs and dykes. Benched slopes mark different lava flows.	Remains of a Tertiary central volcano with a thick sequence of basaltic lavas.
NAN04 Peel	Low peaked hills with north-westerly alignment. Basalt caps of dissected flows, moderate slopes, and flat river valleys with alluvium. Karst landscapes in limestone.	Fine grained Silurian to Devonian sedimentary rocks. Strongly folded and faulted with marked northwest alignment. Areas of sub-horizontal Carboniferous shales and sandstones in the north. Limited areas of basalt cap from the Nandewar and Liverpool Ranges are included. Linear outcrops of serpentinite and scattered bodies of limestone.
BBS21 Northern Basalts	Undulating low stony hills, long slopes with sandy wash and heavy clays in the valley floors.	Tertiary basalts over Jurassic quartz sandstones and alluvial sediments derived from these.
BBS25 Liverpool Plains	Undulating hills and sloping plains with alluvial channels and floodplains.	Quaternary alluvial plains and outwash fans derived from Tertiary basalts. Permian and Triassic quartz sandstones with minor basalt caps.

Source: NSW National Parks and Wildlife Service (2003).

The unique position of Mt Kaputar has a highly significant influence on its local biota.

- It is the westernmost outlier of montane environments from the Great Dividing Range in northern NSW.
- Its altitude (1510m ASL) is considerably higher than other outlying ranges, such as the Warrumbungle Range (1206m ASL) or Liverpool Range (1300m ASL).
- The altitude, geological history and westward position means Mt Kaputar is isolated in the surrounding landscape, so has local evolutionary significance, particularly for slow-moving limited dispersal species such as land snails (Murphy and Shea 2015).
- Kaputar represents the most extensive area of native vegetation remaining in the Nandewar bioregion. The vegetation ranges from semi-arid woodlands on lower slopes and plains to rainforests and subalpine and shrubland communities at higher altitudes. The vegetation communities and species present indicate an intermingling of three different floristic regions (Hunter and Alexander 2015). The vegetation present in the subregion is discussed further in [Section 1.2.3](#) Environments and habitats for the ecological community.
- The Kaputar subregion supports several threatened species and is a distributional limit for at least some plant and bird species (State of NSW and DPIE 2021a). There are 21 terrestrial vertebrate animal and ten plant species listed as nationally threatened that occur on or in the vicinity of Mt Kaputar National Park ([Appendix A](#)). No threatened invertebrate species are currently listed from the immediate vicinity of Mt Kaputar.

Consultation Question:

- Do you agree with the proposed location and physical environment for the ecological community being assessed for listing under the EPBC Act, including the Kaputar subregion plus a 10km limit outwards from that into surrounding subregions and a minimum elevation of 400m ASL?
- If not please provide alternative options, your reasons and supporting evidence. As an example of an alternative definition of the location for where the ecological community inhabits, do you think the ecological community should be restricted to species occurring only on Mt Kaputar (not surrounding areas) and/or with no altitude limit (i.e. above 300m ASL)?

Climate

Mount Kaputar rises from around 300m ASL on the western plains to its summit at about 1500m ASL, hence there is a marked vertical gradation in local climate over a short distance (Hunter and Alexander 2015). The higher altitude areas are cool temperate to subalpine with many frosts and snow in winter, while the lower slopes are drier and warmer. Temperature variations of up to 12°C may occur between lower slopes and the summit and annual rainfall may vary from 800mm in the foothills to 1200mm in the highlands.

1.2.2 The biology of the Kaputar Snail and Slug Community

The Australian land mollusc fauna is characterised by a high degree of endemism, including many snail and slug species that are narrow-range endemics (Ponder 1997; Stanisic and Ponder 2004; Parkyn and Newell 2014). This is related to the uneven distribution of suitably moist habitat, such as rainforests, limestone outcrops and high-altitude sites, and the very limited dispersal capability of many terrestrial molluscs that confines them within particular areas of habitat.

This patchiness of rainforests and altitudinal stratification of land snail and slug species is very evident at Mt Kaputar, due to the mountain's unique and isolated position, as noted above. The Kaputar Snail and Slug Community is the assemblage of terrestrial native Australian gastropods found on Mt Kaputar and immediate surrounds. Three groupings of native gastropods in the Kaputar and surrounding subregions may be recognised, based on distribution, two of which are part of the ecological community ([Table 1.3](#)).

Endemic species – Limited to, or near endemic, for Kaputar. These snail and slug species are unique to the region and, together, characterise the assemblage. They include seven known species plus ~~about~~ at least seven taxa identified as distinct yet to be formally described. This element of the gastropod fauna represents six families. Most endemic members of the ecological community are small snail species living in leaf litter, typically at higher elevations of the Kaputar region. Two species are members of the carnivorous snail family Rhytididae that live in litter and under rocks and feed on other land snail species they encounter. The best known species, however, may be *Triboniophorus* sp. nov., the Kaputar pink slug which has become iconic as the public face of the NSW-listed snail community and one of Mt Kaputar's most distinctive animals. The Kaputar pink slug has a distribution limited to the higher altitudes of Mt Kaputar, above 1000m ASL (Murphy et al. 2019). It shelters under litter, debris and rocks during dry conditions, emerging during rain or moist nights to feed on films of algae, fungi and lichens on various surfaces. Slugs may crawl considerable heights on tree trunks, up to 20 metres, in their search for food. Even though slugs themselves may not be observed, they leave distinctive pink feeding trails indicating their presence and feeding activity at a location.

Restricted species – Not endemic but have a distribution generally restricted to northern NSW. These eight snail species are not endemic to Kaputar but occur in the area and more widely in the surrounding ranges to the coast, mostly within NSW. Some species may extend into the nearby regions of southern Queensland. These also are generally small snails often more common at lower elevations but not limited to those sites. For instance, *Elsothera funerea* (Grim Reaper pinwheel snail) and *Galadistes pustulosa* (Mt Kaputar woodland snail) are found at a range of elevations from below 500 m ASL to above 1300m ASL.

Table 1.3. Native snail and slug taxa that are components of the Mount Kaputar Highland and Rainforest Snail and Slug Community.

Scientific name	Common name	Family	ALA - Endemic to near endemic#			Distribution (Murphy & Shea)^
			Kaputar	Nandewar	NSW	
1. Species endemic or near-endemic to Kaputar and surrounds - A) named taxa.						
<i>Austrochloritis kaputarensis</i> *	Mt Kaputar bristle snail	Camaenidae	*	*	*	EK
<i>Austrorhytida nandewarensis</i>	Nandewar carnivorous snail	Rhytididae	*	*	*	EN
<i>Brevisentis kaputarensis</i>	Mt Kaputar glass-snail	Helicarionidae	*	*	*	EN
<i>Cralopa kaputarensis</i>	bronze rippled pinwheel snail	Charopidae	*	*	*	EK
<i>Kaputaresta nandewarensis</i>	Nandewar pinhead snail	Punctidae	*	*	*	EK
<i>Scelidoropa nandewar</i>	Nandewar Range pinwheel snail	Charopide	*	*	*	EK
<i>Vitellidelos kaputarensis</i>	Mt Kaputar carnivorous snail	Rhytididae	*	*	*	EK
B) taxa yet to be formally described.						
<i>Coenocharopa</i> 'Mt Kaputar'		Charopidae	-	-	-	(EK)
<i>Theristes</i> sp. nov. 'Kaputar' [NE27]	Kaputar keeled snail	Camaenidae	-	-	-	EK
<i>Triboniophorus</i> sp. nov. 'Kaputar' [aff. <i>graeffi</i>]	Kaputar pink slug	Athoracophoridae	-	-	-	EK
Charopidae NE2		Charopidae	-	-	-	EK
Charopidae NE6		Charopidae	-	-	-	EN
Charopidae NE11		Charopidae	-	-	-	EK
Charopidae NE19		Charopidae	-	-	-	EK
2. Species occurring at Mt Kaputar and restricted mostly to north-eastern NSW.						
<i>Annabellia bingara</i>	New England carnivorous snail	Rhytididae			*	W
<i>Austrochloritis niangala</i> *	Tamworth uplands bristle snail	Camaenidae			*	(W)
<i>Discocharopa stenomphala</i>	Off-white pinwheel snail	Charopidae			*	IP
<i>Elsothera funerea</i>	grim reaper pinwheel snail	Charopidae			*	W
<i>Galadistes pustulosa</i>	Mt Kaputar woodland snail	Camaenidae			*	W
<i>Iotula microcosmos</i>	miniscule pinhead snail	Punctidae			*	W
<i>Levidens ponderi</i>	coarse-grooved glass-snail	Helicarionidae			*	W
<i>Thersites novaehollandiae</i>	Dorrigo rainforest snail	Camaenidae			*	(W)

Source: NSW Scientific Committee (2013); Murphy and Shea (2015); Atlas of Living Australia (accessed September 2021).

The Atlas of Living Australia data collated all records for 'Gastropoda' within the Kaputar subregion between 1960 to 2021. ALA general filters were applied to the dataset. This identified 243 records for 22 native species named to species level. Individual species distributions were then examined to determine if each species was endemic or near endemic to the Kaputar subregion, Nandewar bioregion or NSW, or had a wider distribution. A '-' refers to no records for unnamed taxa evident in ALA. Blank cells indicate a wider distribution.

#Endemic refers to all known records (100%) within the defined area; near-endemic refers to 90% or more of known records within a defined area.

^ Legend to distribution by Murphy & Shea (2015) are: EK – Endemic to Mt Kaputar; EN – Endemic to Nandewar bioregion; IP – Isolated population at Mt Kaputar; W – Wider distribution beyond Nandewar bioregion. Brackets indicate taxa not observed by Murphy & Shea in their survey so distributions were based on other sources or ALA records.

*The species assemblage for the NSW listed community recognised two taxa of *Austrochloritis* as member species: *A. kaputarensis* and *A. niangala*. A taxonomic review by Shea and Kohler (2020) has concluded these are the same species with *A. niangala* given priority for the name.

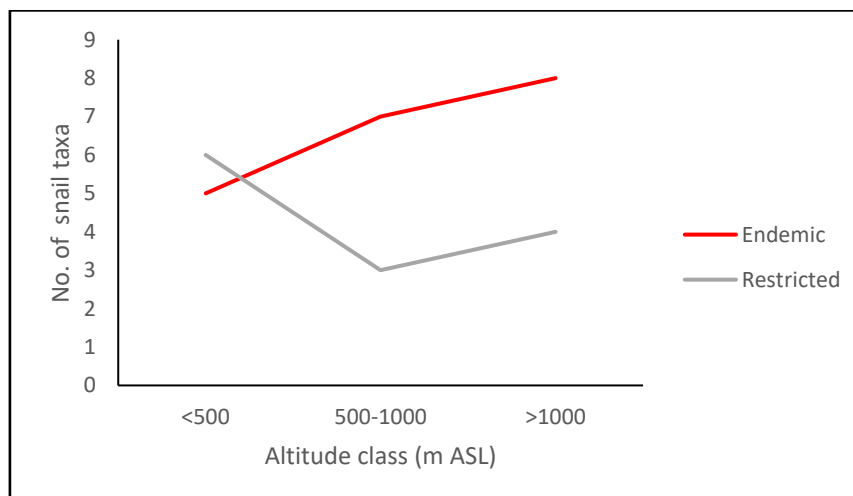
Other, more widespread species that occur in the Kaputar and surrounding subregions are listed in [Table A1](#) of [Appendix A](#). These are not part of the ecological community, but may be present, most likely at lower elevations.

Widespread species. There are snail and slug species that have been recorded within, or the vicinity of, the Kaputar subregion but are widespread across many bioregions and other States/Territories. These species are included in the full list of land gastropods at [Table A1](#) of [Appendix A](#). These species generally are limited to the lower slopes of Mount Kaputar (Murphy and Shea 2015). Due to their widespread distribution and association with a wide variety of environments they are not part of the ecological community described here. They are simply noted as additional related fauna that may be encountered in surveys within the extent of the ecological community. Widespread species also include introduced snail and slug species present in the subregion, such as *Deroceras reticulatum* (grey field slug).

Distribution of the snail assemblage.

Mount Kaputar rises to a summit of 1510m ASL, which is considerably higher than the surrounding landscape and other westerly outlying ranges in north-eastern NSW. The Kaputar Snail and Slug Community is generally limited to areas of higher moisture availability, these being high altitude sites above 1000m ASL and pockets of vegetation at lower elevation associated with dry rainforest and vine thickets, often in gullies and gorges. Altitudinal transect surveys of terrestrial snails and slugs on Mt Kaputar by Murphy and Shea (2015) showed the number of endemic native snail species increased with altitude ([Figure 1.1](#)). For taxa identified as present at Mt Kaputar but with a distribution restricted to northern NSW (as listed in [Table 1.3](#)), more species were observed at lower altitudes with some species persisting to higher altitudes. The highest sites surveyed, above 1400m ASL, comprised only of endemic snail and slug species (Murphy and Shea 2015). Some widespread snail and slug species that are not part of the ecological community were also observed but limited to low elevations below 500m ASL.

Figure 1.1. Average number of native snail and slug species from the ecological community observed during altitudinal surveys on Mt Kaputar.



Source: Murphy and Shea (2015), Table 1. Species categories are explained in [Table 1.3](#).

Consultation Question:

- Are there any snail species that you think should be removed, added or described differently to accurately represent the proposed ecological community? Please provide your reasons.
- Should the assemblage of species for the ecological community be broadened to include other ground-dwelling species that are not gastropods but are endemic or near-endemic to Mt Kaputar? For instance, any reptiles, velvet-worms, arthropods, etc?

1.2.3 Environments and habitats for the ecological community

Most Australian land snail species reside in the litter zone on moist forest floors, under rotting logs or in rock crevices. There is a distinct preference toward rainforest habitats as these are typically in wet, high nutrient areas, provide copious food such as rotting vegetation and fungal mycelia, and most importantly provide shelter from desiccation and predation (Ponder 1997; Stanasic and Ponder 2004). Up to 90% of the native land snail species of eastern Australia may be associated with rainforests, including dry rainforests. The Brigalow Belt bioregions of Queensland and northern NSW, that are adjacent to the Nandewar bioregion, are regarded as a hotspot of land snail diversity mainly due to the pockets of dry rainforests and vine thickets that effectively act as an archipelago of 'suitable habitat islands' scattered within a matrix of dry landscape unsuitable for native snails.

Environments suitable for the Kaputar Snail and Slug Community are linked to moisture availability for the gastropod species, most of which are small and desiccate easily. The key landscape attributes that define suitable moisture conditions for this community are altitude and vegetation.

Altitude. The distribution of the Kaputar Snail and Slug Community is closely related to altitude (Murphy and Shea 2015; Murphy et al 2019). There is a marked increase in rainfall, decline in evapotranspiration and higher number of endemic snail and slug species with rising altitude ([Table 1.2](#) and [Figure 1.1](#)). At least three taxa are only associated with highland areas on Mt Kaputar, these being the Kaputar pink slug, *Austrochloritis kaputarensis* (Mt Kaputar bristle snail) and *Vitellidelos kaputarensis* (Mt Kaputar carnivorous snail).

Vegetation. Mt Kaputar is characterised by highly dissected terrain with steep cliffs and ridges, valleys and gorges (Hunter and Alexander 2015). Topography influences microclimate and vegetation patterns that, in turn affect suitability of sites for the snail and slug fauna. For instance, the bottoms of valleys and gorges are where closed canopy vegetation types are more likely to develop that are more suitable for snail assemblages. However, the influence of topography on invertebrate fauna distributions is, as yet, relatively poorly studied for this region.

The Kaputar Snail and Slug Community is not limited to a single vegetation type. Its distribution on Mt Kaputar includes a core of high rainfall environments covering montane vegetation at altitudes above 1000m ASL, and an 'archipelago' of protected habitat islands that extend downslope in gullies and gorges with pockets of dry rainforest, vine thickets and wet sclerophyll forests. These vegetation types provide the most suitable environments in terms of shelter and food, where there are accumulated leaf litter, logs, and substrates on which biofilm and biological crusts grow.

The vegetation of Mt Kaputar has been surveyed and categorised, for example by Hunter and Alexander (2015). The NSW Bionet Vegetation Classification Database identified 125 Plant Community Types (PCTs) present within the Kaputar subregion (NSW Department of Planning, Industry and Environment 2021; Appendix B). These include various kinds of dry rainforest, vine thicket, montane heathland, grassy woodland and dry sclerophyll forest communities. [Table 1.4](#) identifies twenty PCTs most likely to represent key habitat for the Kaputar snail and slug community, based on comparisons of relevant vegetation identified in the habitat profile for the NSW-listed Mt Kaputar snail assemblage (NSW OEH 2021), and the complete list of PCTs present in the Kaputar subregion. They cover seven dry rainforest and vine thicket communities, eight montane bog, grassland and heath communities present at higher elevations and five eucalypt forest and woodland communities.

Consultation Question:

- How could the description of environment and habitat for the Kaputar Snail and Slug Community be improved?
- How could the list of relevant PCTs at Table 1.4 be improved?

Table 1.4. NSW Plant Community types relevant to the Kaputar Snail and Slug Community.

Formation	Class	Plant Community Type (PCT)	PCT ID
Dry sclerophyll forests (shrub/grass sub-formation)	New England Dry Sclerophyll Forests	Nandewar Box - Western New England Blackbutt - Red Stringybark open forest in the Kaputar area of the Nandewar Bioregion	530
Dry sclerophyll forests (shrub/grass sub-formation)	New England Dry Sclerophyll Forests	Silvertop Stringybark - Nandewar Box shrubby open forest in the Kaputar area of the Nandewar Bioregion	550
Dry sclerophyll forests (shrub/grass sub-formation)	New England Dry Sclerophyll Forests	Silvertop Stringybark - Bendemeer White Gum - Ribbon Gum open forest in the Kaputar area of the Nandewar Bioregion	572
Freshwater Wetlands	Montane Bogs and Fens	Sedgeland fens wetland of impeded drainage of the Nandewar Bioregion and New England Tableland Bioregion	582
Freshwater Wetlands	Montane Bogs and Fens	Carex sedgeland of the slopes and tablelands	766
Grasslands	Temperate Montane Grasslands	Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tableland Bioregion	586
Grassy woodlands	Tableland Clay Grassy Woodlands	Mountain Gum - Snow Gum grassy open forest at high altitudes in the Kaputar area of the Nandewar Bioregion	525
Heathlands	Northern Montane Heaths	Riparian tea tree - bottlebrush - pennywort forbland / shrubland / wetland of montane creeks in the Brigalow Belt South Bioregion	446
Heathlands	Northern Montane Heaths	Heathy outcrop shrublands on volcanic sediments of the Nandewar Bioregion and Brigalow Belt South Bioregion	520
Heathlands	Northern Montane Heaths	Mount Kaputar Kunzea - Five Star Heath - Spur-wing Wattle shrubland on siliceous outcrops mainly in the Nandewar Bioregion	521
Heathlands	Northern Montane Heaths	Tea-tree riparian shrubland / heathland wetland on drainage areas of Nandewar Bioregion and New England Tableland Bioregion	574
Heathlands	Northern Montane Heaths	Heathy shrubland on granitic outcrops of the central and western New England Tableland Bioregion	884
Rainforests	Dry Rainforests	Wild Quince - Mock Olive - Rusty Fig - lamboto - Sweet Pittosporum dry rainforest of rocky and scree areas of the Nandewar Bioregion and New England Tableland Bioregion	547
Rainforests	Dry Rainforests	Rusty Fig - Wild Quince - Native Olive dry rainforest of rocky areas of the Nandewar Bioregion	1124
Rainforests	Western Vine Thickets	Ooline closed forest (dry rainforest) on sandstone and conglomerate rises and hills in the Brigalow Belt South Bioregion	113
Rainforests	Western Vine Thickets	Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	147
Rainforests	Western Vine Thickets	Belah - Wilga +/- White Box dry viney scrub woodland the NSW Brigalow Belt South Bioregion	378
Rainforests	Western Vine Thickets	Brigalow viney scrub open forest on loamy soils in low hill landscapes in the northern Brigalow Belt South Bioregion	445
Rainforests	Western Vine Thickets	Mixed vine thicket low eucalypt woodland of the northern-western Brigalow Belt South Bioregion	452
Wet Sclerophyll Forests (grassy sub-formation)	Northern Tableland Wet Sclerophyll Forests	Silvertop Stringybark - Ribbon Gum ferny open forest in the Kaputar area of the Nandewar Bioregion	1166

Sources: NSW OEH (2021). Regional distribution and habitat profile for the NSW-listed Kaputar snail community. List of relevant vegetation types. Bionet Vegetation Classification Database. (accessed September 2021) List of PCTs for the Kaputar subregion.

Vegetation types listed in the habitat profile were included if they were identified as a PCT present in the Kaputar subregion. All PCTs that are part of rainforest and montane vegetation classes present in the Kaputar subregion were included, irrespective of whether they were identified in the habitat profile by NSW OEH (2021).

2 Identifying areas of the ecological community

Section 1 describes the Kaputar Snail and Slug Community and the area it inhabits. This section provides additional information to assist with identifying occurrences of the ecological community in the field.

The Kaputar Snail and Slug Community is isolated from other montane snail communities that may be present along the western edge of the Great Dividing Range, e.g., Warrumbungles or Liverpool Ranges, by the separation of Mt Kaputar from other distant and lower elevation peaks in north-eastern NSW. This isolation has contributed to the evolutionarily unique nature of the local gastropod fauna assemblage at Kaputar.

Key diagnostics are used to help define the features that distinguish the Kaputar Snail and Slug Community from other land gastropod assemblages.

2.1 Key diagnostics

The ecological community is defined as occurrences of gastropod taxa that meet the description in section 1, and that meet the key diagnostics specified below. Occurrences that do not meet the key diagnostics are not the nationally listed ecological community.

A three-step identification approach is applied to identify if the Kaputar Snail and Slug Community is likely to be present at a given site. The key pieces of information are:

1. The ecological community occurs on or around Mount Kaputar (section 1.2.1).
 - 'On Mt Kaputar' refers to the Kaputar (NAN03) subregion at elevations above 400m ASL;
 - 'Around' Mt Kaputar refers to an additional area of ten km extending out from the Kaputar subregional boundary, that captures the main outliers of suitable pockets of highland and rainforest and vine thicket habitats above 400m ASL.
2. The ecological community is associated with the following native vegetation habitats.
 - At high altitudes, above 1000 m ASL, the ecological community typically occurs in various native montane to subalpine habitats, generally forests, woodlands, bogs and heathlands.
 - At elevations below 1000m down to 400 m ASL, the ecological community has a limited occurrence in pockets of dry rainforest and vine thicket in protected gullies and gorges. About 95% of rainforest patches within the distribution of the community occur at elevations above 400 m ASL.
3. A minimum number of native snail and slug species from the assemblage are present.
 - A minimum number of three snail and slug taxa identified as part of the assemblage listed in Table 1.3 must be present at a site. The number of snail and slug taxa allows for any mix of endemic/near-endemic and restricted taxa to be present.
 - This minimum number of taxa applies to any elevation above 400m ASL within the area of interest defined under points 1 and 2, above.
 - Any other land snail and slug taxa observed at a site that are not listed in Table 1.3, for instance the other species also listed in Table A1 of Appendix A, are to be disregarded for the purposes of identifying if the Kaputar snail and slug community is present,

Consultation Questions on the key diagnostics

- Do you agree that these statements will clearly identify when the ecological community is present?
- Are the key diagnostic characteristics sufficient to differentiate the ecological community from other ecological communities? If not, how should they be modified?
- Is the elevation range in the Key Diagnostic Criteria of above 400 m ASL appropriate? Is it too broad or would there be occurrences below this?

2.2 Condition categories and thresholds

No condition categories and thresholds are prescribed for this ecological community. The Kaputar Snail and Slug Community has a restricted extent, much within conservation tenure and over rugged terrain where the natural vegetation remains largely unmodified by modern developments or agriculture. Fire and climate change are the key long term habitat modifiers in this landscape though their influence is likely to be potential or stochastic, to date. Any significant permanent modifications to natural vegetation are most likely at lower, flatter elevations, where environments are less suitable for the persistence of this ecological community. The Kaputar Snail and Slug Community remains relatively poorly known and studied with regard to the biology and ecology of component species and their inter-relationships.

Consultation questions

- Do you agree there should be no condition classes, categories and thresholds for the Kaputar Snail and Slug Community?
- If not, what condition classes, categories and thresholds could be used?

2.3 Additional information to assist in identifying the ecological community

2.3.1 *Surveys of the snail and slug assemblage.*

A combination of accessing available online records and undertaking surveys can help determine what native land snails and slugs may be present at or near to a site, and thus whether or not the ecological community is present.

Available site records may be accessed online through the Atlas of Living Australia website (<https://www.ala.org.au/>) or from records held by the Australian Museum in Sydney or the Queensland Museum in Brisbane². It is suggested that observations taken from the past 20 years and within a 20km radius be taken into account as being most relevant to a particular site. However, given the paucity of surveys and rugged nature of the terrain at high altitudes it is highly likely that sites away from frequented tracks and roads will not have been adequately surveyed in the past.

Advice from professional malacologists should be sought to assist with any surveys. It is strongly recommended that the results of any new surveys be contributed to public databases such as the Atlas of Living Australia or voucher specimens placed with relevant museums, to build on the limited public data available on this ecological community.

The surveys undertaken by Murphy and Shea (2015) were based on sites that were 0.04 to 1 ha in area, depending on whether the environment sampled was limited in size. Diurnal hand searches of leaf litter, loose rocks and fallen timber were undertaken for 30 to 60 minutes. Any live animals and dead shells were collected for later identification. Observations were also made for distinctive feeding trails, such as the pink trails made by the Kaputar pink slug on trunks and rocks (Murphy et al. 2019). These techniques are indicative of an appropriate approach to surveying for the ecological community. In these studies, bags of leaf litter were also collected at some sites for later sorting to extract any live or dead snail and slug specimens; however, this last approach can be ultimately destructive and should only be considered for confirmation purposes rather than as a standard approach.

Land snails and slugs have a high moisture requirement, and many species emerge at night or after rains, when they are most apparent. Surveys, therefore, should be timed to avoid the peak heat of daytime and ideally be timed during or soon after rainfall events.

² Note that these museums, along with other institutions, contribute records to the Atlas of Living Australia.

Some consideration should be given to the role that season, rainfall and disturbance history may play in an assessment. Vegetation can vary in its appearance through the year and between years, depending on climatic conditions, though the broad kind of natural vegetation present should remain evident. The detectability of the snail and slug assemblage however, varies with moisture availability, and these animals would be much less evident during longer-term dry seasons and years. Timing of habitat surveys should allow for a reasonable interval after a disturbance (natural or human-induced) to allow for initial regeneration of habitats to become evident, noting that some key features may take years to recover, or that recolonisation from adjacent undisturbed sites could also be slow (notably after severe fire impacts to vegetation, plant litter and fauna). At a minimum, it is important to note climate conditions and the type and timing of disturbance that may have occurred at a site.

2.3.2 *Consideration of environments and habitats.*

The following information should also be taken into consideration when applying the key diagnostics to assess if appropriate habitats for the Kaputar Snail and Slug Community are present. Disturbance history, notably wildfires, and land use, especially at lower elevations or along roads and tracks, may influence the state in which an occurrence of habitat is currently expressed.

At altitudes above 1000m ASL, a mosaic of various vegetation types and landscapes provide environments for the snail and slug assemblage, so the concept of patch is difficult to apply here. Areas that are sheltered from the sun, have layers of dense litter with fallen logs and rock outcrops with crevices are environments that harbour snails, slugs and other moisture-dependent animals and afford them protection from desiccation and predation.

2.3.3 *Revegetation, regrowth and reintroductions.*

Revegetated or replanted sites or areas of regrowth are included as environments for the ecological community, so long as these areas can support the snail and slug assemblage. Reintroductions and translocations of endemic and restricted species for the purposes of conservation are considered part of the Kaputar Snail and Slug Community.

2.3.4 *Other listed ecological communities in the area of interest*

Other nationally listed ecological communities occur in the vicinity of Mt Kaputar. The main ecological community that may be of some relevance to the Kaputar snail and slug community is the endangered *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions*. Patches of this ecological community are part of the vegetation grouped with dry rainforests, that may provides environments for the snail and slug assemblage at lower elevations, below 1000m ASL.

Nationally threatened species that may be present in the area where the Kaputar Snail and Slug Community occurs are listed in [Appendix A](#).

Consultation Question:

- How could the additional information to help identify the ecological community be improved?

2.4 **Habitat critical to the survival of the ecological community**

The habitat requirements for an ecological community include areas with the necessary physical, geological and climatic conditions, as well as the necessary biological conditions for the component species are present. 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.

The areas critical to the survival of the Kaputar Snail and Slug Community, as determined by the key diagnostics are:

- All areas of natural vegetation and landscapes above 1000m ASL within the prescribed extent of the ecological community; and
- Patches of dry rainforest and vine thickets below 1000m to 400m ASL within the prescribed extent of the ecological community.

- Sites where several members of the Kaputar Snail and Slug Community are known to occur together and can act as reservoirs or source populations to colonise other nearby areas, if subpopulations in the latter suffer impacts.

Consultation Question:

- How could the habitat critical to the survival description be improved?
- Does the EC occur within any areas of Commonwealth Land? If so, which of those areas should be considered for the Critical Habitat Register under section 207A of the EPBC Act upon listing this EC?

2.5 Areas of high value - surrounding environment and landscape context

The Kaputar Snail and Slug Community is an example of a unique, isolated invertebrate community because it is restricted to a single mountainous landscape. The most diverse assemblages occur above 1000m ASL with other occurrences downslope in mesic environments along gullies and gorges. Remnant natural vegetation covers much of the elevated landscapes and provides connectivity between the high altitude and downslope occurrences of the snail and slug species assemblage. The following indicators of high value should be considered when assessing the impacts of proposed actions under national law, or when determining priorities for protection, recovery, management and investment programs.

- Montane to subalpine environments that are wetter and have features suitable for sheltering snails and slugs, such as an abundance of rocks and fallen timber.
- High altitude (>1000m ASL) corridors that connect separate peaks in the Kaputar region and allow potential movement of the gastropod fauna among various sites.
- Gullies, gorges, areas of mesic vegetation with a strong development of litter, fallen logs and rocks that provide vertical connectivity between high altitude occurrences and populations at lower elevations.
- Areas most likely to provide refuges from key threats to the ecological community, for example:
 - suitable areas unburnt by the 2019-20 bushfires or any previous and subsequent serious fires on and around Mt Kaputar.
 - areas more protected from wildfire impacts due to their high moisture content and low flammability;
 - areas that may provide some protection from climate change impacts, such as cliff shelters and gorges less likely to dry out;
 - areas where invasive species, such as pigs or goats, are absent, uncommon or can be adequately managed.
- Areas that contain nationally or state-listed threatened species and natural or Indigenous cultural heritage sites. These may or may not be directly relevant to the Kaputar Snail and Slug Community but remain important for the protection of the wider biodiversity and cultural heritage of the region it inhabits.

Consultation Question:

How could the Areas of High Value description be improved?

3 Cultural significance

The significance of the ecological community, particular species, spiritual and other cultural values are diverse and varied for the Aboriginal peoples 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 people. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge.

Mount Kaputar occurs within country (the traditional lands) of the Kamilaroi³ people. We acknowledge their culture and continuing link to the ecological community and the Country it inhabits. The cultural significance of the Kaputar mountain peaks to Indigenous people and their occupation of the mountains is not well recorded in published information (State of NSW and DPIE 2021a). About 25 cultural sites have been recorded in the Mt Kaputar National Park, including campsites, artefact scatters, marked trees, axe grinding grooves and rock carvings. Comprehensive archaeological surveys, however, have not yet been undertaken. The Nandewar bioregion generally is known for its ornately carved trees, ceremonial bora grounds and art sites (NSW NPWS 2003), along with places that are campsites, middens, stone arrangements and axe grinding grooves (Hunter and Alexander 2015).

Despite little published information about the cultural value of Mount Kaputar to the Kamilaroi peoples, information about Indigenous cultural practices and uses of native plants and animals are known for the Terry Hie Hie Aboriginal area to the immediate north of Mt Kaputar National Park. A Terry Hie Hie Management Plan (State of NSW and DPIE 2021b) has been prepared for this significant area and it notes:

“The Terry Hie Hie Aboriginal area to the north of Mt Kaputar is of high cultural significance for the Kamilaroi people where several Aboriginal sites have been recorded and families maintain a strong connection to Country.

Stories and links to the Terry Hie Hie area provide the basis of spiritual and physical Aboriginal cultural sites, as well as the occupational sites and traditional areas which remain of significance to local and surrounding Aboriginal people.

The Terry Hie Hie district is known for its ceremonial significance, as shown by the presence of bora grounds, ritual designs carved on trees, rock engravings and art sites with paintings and stencils. These all indicate an intimate spiritual and physical attachment to this sacred landscape.

The area around the village of Terry Hie Hie is of great spiritual significance as it is part of the Great Ancestral Bora (*buurru*, *buurra*). This site was created by Baiame (*baayama*, *baayami*), one of the great ancestral beings of the Creation period whose journeys are recorded in song, dance, art, oral histories and Dreaming sites. Traditionally, Baiame is associated with all bora ceremonies across much of New South Wales, but most of the bora grounds are now gone, destroyed by cropping and other farming practices. The ceremonial bora ground at Terry Hie Hie is the largest in north-west NSW ... and is the most important to the Kamilaroi People.”

State of NSW and DPIE (2021b) pp7; 17-19

The last corroboree at Terry Hie Hie described in a written record was held in 1883; any later ceremonies would have been held in secret. Knowledge of the traditional uses of resources is part of the intellectual property of the Kamilaroi people, and the cultural use of bush tucker and medicines is essential to maintain Kamilaroi heritage and identity (State of NSW and DPIE 2021b).

³ There are various spellings of the name, for example ‘Gamilaroi’, ‘Gomerioi’, ‘Kamilaroi’ and ‘Gamilaraay’. The spelling used here is Kamilaroi, as given on the AIATSIS map of Indigenous culture and language.

There may not be any documented traditions specifically about Mt Kaputar but there are stories about mountains generally that show the importance of Country and nature such as that associated with this ecological community. For instance, the Kamilaroi have one story about the Pleiades star cluster that brings together mountains, water, seasons and the night sky. In this story the *Meamei* or *Mayi-mayi* are seven sisters with long hair and bodies of ice that represent the Pleiades:

“Before leaving Earth they travelled into the mountains causing springs to feed rivers so there would be water forever. A young hunter, *Karambal*, fell in love with one sister and carried her off. Other sisters sent cold, wintry weather to force him to release her, but later relented and made their way into the sky in search of the summer sun to melt snow and ice. Thus the Pleiades appear in the summer each year, bringing warm weather. Afterwards they travel west and winter returns as a reminder that it is wrong to carry off women who belong to a totem forbidden them. *Karambal* ascended with them and still pursues them as the star Aldebaran, which follows closely.”

Haynes via Selin and Sun (2000), cited by Fuller et al (2014).

A wide range of local plants and animals in the region surrounding the ecological community were used by the Kamilaroi people for a variety of purposes: as food, as medicines to help with healing, to make tools and shelter, for clothing and decoration, and for ceremonial purposes (McKemey & White 2011; State of NSW and DPIE 2021b). Totems and kinship rules meant Aboriginal people took only what they needed and left the rest for future times and generations. They had responsibility to care for their totems and the places and environments where they lived (McKemey and White 2011). The Kamilaroi people maintain strong connections to their traditional landscapes and nature, and these bonds are integral to Aboriginal spirituality and identity.

Some Traditional uses for common plants in the Terry Hie Hie area are listed in [Table 3.1](#). Some of these plant species extend onto at least the lower slopes of Mt Kaputar, for instance box eucalypts, river red gums and cypress pines. Animals such as kangaroos and possums were used for food, clothing and decoration, while stone and wooden tools, such as spears and boomerangs were used to hunt them (State of NSW and DPIE 2021b). Stone tools were made from local and traded stone, including greywacke and quartz.

Table 3.1. Native plants significant to the Kamilaroi People from the Terry Hie Hie region north of Mt Kaputar.

Common name	Scientific name	Kamilaroi name	Materials used
Belah	<i>Casuarina cristata</i>	Bilaarr	Wood (for spears)
Bimble box	<i>Eucalyptus populnea</i>	Buubaya/Bibil	Wood, bark
White box, other box eucalypts	<i>Eucalyptus</i> spp.	Bibil	Wood, bark, roots, leaves
Brigalow	<i>Acacia harpophylla</i>	Burrii	Wood, bark
Cypress pine – white and black	<i>Callitris glaucophylla</i> <i>Callitris endlicheri</i>	Gurraari	Sap, wood, seeds, leaves
Kangaroo apple	<i>Solanum</i> spp.	Gumi	Fruit
Kurrajong	<i>Brachychiton populneus</i>	Nhimin	Seeds, roots, sap, bark
Mistletoe	<i>Lysiana</i> spp.	Baan	Fruit, nectar, leaves
Native orange	<i>Capparis mitchellii</i>	Bambul	Leaves, fruit, seeds
River red gum	<i>Eucalyptus camaldulensis</i>	Yarraan	Leaves, bark, gum, wood
Rough-barked apple	<i>Angophora floribunda</i>	Bulamin	Nectar, wood, sap
Silver-leaved ironbark	<i>Eucalyptus melanophloia</i>	Thiinyaay	Wood, bark, sap
Weeping myall	<i>Acacia pendula</i>	Maayal/Maayaal/Mayal	Seeds, wood, bark

Source: State of NSW and DPIE 2021b.

Consultation Questions on the cultural significance

- Do you have any information you are willing to share about the cultural significance of the ecological community or the environments and country that support it?
- Do you know any other people or organisations we could contact in the Mt Kaputar region who may have information they are willing to share?
- Do you know of any books, articles or online resources about the Kamilaroi People's relationships with the snail and slug community and Mt Kaputar?

4 Threats

The Mt Kaputar Snail and Slug Community has been primarily impacted by wildfires and pest animals. The main underlying drivers of change at Mount Kaputar are climate change, weather extremes and, to a lesser extent, land uses related to tourism and recreation, given that much of the region is within conservation estate or rugged terrain unsuitable for agriculture and development (except for roads, telecommunications towers, and park infrastructures). These drivers exert pressure upon the ecological community through the threats outlined in [Table 4.1](#).

4.1 Threat table

The key threats faced by the ecological community are described to help explain why this ecological community merits listing as threatened and supports the assessment against the criteria at [section 6](#). Although presented as a list, in reality these threats often interact, rather than act independently.

Table 1.1. Summary of threats facing the ecological community

Threat factor	Threat Status*	Threat Impacts and Evidence Base
Climate change	<p><i>Timing:</i> ongoing / future</p> <p><i>Severity:</i> major / potentially extreme / unknown</p> <p><i>Scope:</i> whole</p>	<p>Anthropogenic climate change is a major potential threat to the Kaputar Snail and Slug Community. This is in line with the serious projected impacts of climate change established for other montane ecological communities. The key likely impacts to the Kaputar Snail and Slug Community are:</p> <ul style="list-style-type: none"> The climate projections for the region of north-west NSW where Mt Kaputar is situated are for: average temperatures to increase in all seasons with more hot days and fewer frosts; decreased rainfall in winter and spring but an increase in extreme rainfall events; and for fire weather to become harsher, with an increase in the number of severe fire days (NSW OEH 2014; Ekström et al. 2015). Maximum temperatures may increase by 1.9 to 2.7°C by 2070. For species already at the edge of their climatic and elevational range, any long-term changes that makes the climate drier and hotter leads to a reduction, if not entire loss, of suitable environment. Many of the snail and slug species are narrow-range endemics with poor dispersal ability that are limited to the highlands of Mt Kaputar. There is nowhere else these species could naturally move to when the climate gets too hot and dry (Murphy and Shea 2015). As an indication of potential decline in highland environments: if suitable environments shift in elevation by 100 metres from >1000m to >1100m then the extent of occurrence of the highland area is reduced by 55% from 107 km² to about 48 km² (Murphy and Shea 2015). Climate change can exacerbate other threats, especially invasive species and the risk of wildfires. Some pest animals and weeds currently at low abundance or mostly at lower altitudes could spread into higher altitudes and contribute to changes in environment quality for the native snail fauna. Increased risk of fires is likely to have a major impact to the native snail fauna, especially if fires become more frequent (Stanisic and Ponder 2004). Some subalpine vegetation communities on Mt Kaputar have already experienced fire frequencies beyond their ecological thresholds (Murphy and Shea 2015). The devastating impacts of fires is detailed further under the Fire regimes threat, below. There could also be a shift in the snail fauna toward more widespread snail and slug species that are presently more common at lower elevations. Changes in climate could allow other snail and slug species, notably introduced species, to colonise further upslope, thus leading to direct interspecific competition with undesirable species as environments change. This could lead to displacement of narrow-range endemic snail and slug species by other, more widespread species that have a broader tolerance of climatic conditions.

Threat factor	Threat Status*	Threat Impacts and Evidence Base
Inappropriate fire regimes (including fires which cause decline in biota)	<p><i>Timing:</i> ongoing</p> <p><i>Severity:</i> variable: often minor, occasionally major or extreme.</p> <p><i>Scope:</i> often minor (<5%), occasionally major, e.g., 40% in 2019-20</p>	<p>Most fires within Mt Kaputar National Park are started by lightning strikes that happen during summer thunderstorms (State of NSW and DPIE 2021a).</p> <p>During the 1980s and 1990s there was generally a low incidence of fires in the park: one fire and mostly less than 1000 ha burnt in most years (State of NSW and DPIE 2021a). However, four major fire events between 1970 to 2020 have exceeded 10,000 ha burnt on Mt Kaputar. These major fire events were in the 1974, 1986, 2006 and 2019 seasons. Most of these fires were of low to moderate intensity and burnt for several weeks before rain put them out. Given Mt Kaputar National Park covers about 51,300 ha, fires of 10,000 ha or more represent at least 20% of the extent being impacted. The extensive 2019–20 wildfires burnt almost 40% of the park and extended well into the highland areas above 1000m ASL (State of NSW and DPIE 2021a). These fires directly impacted primary environments for the Kaputar Snail and Slug Community.</p> <p>Extensive fires may impact on the Kaputar Snail and Slug Community in several ways. One immediate impact is that fire kills animals directly, especially so for very slow-moving, moisture-dependent invertebrates with limited dispersal abilities, such as land gastropods. Populations cannot escape fast-moving fires, as they sweep through environments. Fires hot enough to destroy accumulated leaf litter and logs deprive the snails of critical food and shelter, leaving them exposed to heat from the sun and to predators (Stanisic and Ponder 2004).</p> <p>The vegetation types favoured by the Kaputar Snail and Slug Community – dry rainforest, vine thickets and montane communities such as heathlands – are those in which high moisture levels, protected position in gullies and often rocky substrate can limit spread of fires, to a degree. However, very hot, intense fires can still engulf and destroy these sites. This happened to rainforests in other parts of Australia during the intense 2019-20 fire season. Drought and very dry conditions allowed severe fires to intrude into and destroy intact rainforest patches. Even where fires do not intrude into intact rainforests, the destruction of buffering native vegetation may affect the quality of environment for the land snail fauna by allowing edges to dry out, weeds to invade and preventing the rainforest patch from expanding its extent. (Stanisic and Ponder 2004)</p> <p>These vegetation types are also very fire sensitive. Hunter and Alexander (2015) recommended fire regimes for the ten broad vegetation communities they identified on the northern and central parts of Mt Kaputar National Park. They suggested no fires be applied to manage riparian, dry rainforest or outcrop shrubland communities. Rainforest and vine thicket communities can take a long time to fully recover from fire damage and restore their canopy, litter layers and other features essential for native land snails (Stanisic and Ponder 2004).</p> <p>Impacts from fires are compounded if the regime is too frequent. Repeated fires at too short intervals can prevent the natural recovery of a site and its features to their original state. Some patches of subalpine and rainforest communities on Mt Kaputar may have already been burnt at or beyond their ecological thresholds (Murphy and Shea, 2015).</p> <p>The recommended fire intervals for various dry sclerophyll woodlands and forests that occur on mid to lower slopes is 10-50 years, depending on the kind of vegetation (Hunter and Alexander 2015). The more frequent fires associated with various kinds of dry sclerophyll forests and <i>Acacia</i> scrub likely contributes to the poor diversity of their native snail fauna. This is additional to the inherent dryness of these environments. It explains why these habitats provide poor linkages for snail populations between suitably mesic environments on Mt Kaputar and other montane sites.</p> <p>Other impacts resulting from fire management include those from fire management operations such as the construction of trails, hand tool lines and water points. The application of inappropriate road track and path design can result in further barriers to the movement and dispersal of land snails.</p> <p>Further information about fire as a threat to biota is given in DAWE (2021c).</p>

Threat factor	Threat Status*	Threat Impacts and Evidence Base
Invasive species	<p><i>Timing</i>: ongoing</p> <p><i>Severity</i>: potentially major</p> <p><i>Scope</i>: whole</p>	<p>The main invasive species impacting on the Kaputar Snail and Slug Community are <i>Sus scrofa</i> (feral pigs), <i>Capra hircus</i> (feral goat) and <i>Rattus rattus</i> (black rat)) (NSW OEH 2021). Rats and pigs can directly feed on native snails and slugs (Murphy et al 2019; NSW OEH 2021). Feral pigs can seriously degrade land snail environments by removing vegetation, digging up soil, and turning over litter, logs and rocks (Murphy and Shea 2015). They are highly active and damaging in the subalpine areas of Mt Kaputar National Park (State of NSW and DPIE 2021a), that comprise major environments for the Kaputar Snail and Slug Community. Pigs and goats, along with foxes are high priority feral pests that are actively being controlled in the park through aerial baiting and shooting.</p> <p>Three introduced slug species: <i>Deroceras panormitanum</i> (brown field slug), <i>D. reticulatum</i> (grey field slug) and <i>Levidens nyctelia</i> (striped field slug) are noted to occur in the Kaputar subregion, but are generally restricted to low elevations where they are uncommon. These introduced pests are unlikely to move upslope into new environments as they are associated with disturbed areas and human occupation (Murphy and Shea 2015).</p>
<p>*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</p> <p>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</p> <p>Scope – the threat is affecting the whole (>90%), a majority (>50%), a minority (<50%), a negligible amount, or unknown amount of the ecological community</p>		

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.
- 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 fox.

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>.

Consultation Questions on the threats

- Do you agree with the information in the Threats table? In particular - are any of the listed threats more, or less, severe or of different timing or scope than currently proposed for this ecological community?
- Are any threats missing, including potential future threats (e.g. an invasive species not on Mt Kaputar yet, but spreading towards it), and if so please specify? Please provide additional examples of threat impacts, including potential threats.

5 Conservation of the ecological community

5.1 Primary conservation objectives

Prevent the Mount Kaputar Highland and Rainforest Snail and Slug Community and its component species from becoming extinct. This may be achieved by two key outcomes;

1. Protecting the community from significant impacts as a Matter of National Environmental Significance under national environmental law; and
2. Implementing management and recovery actions for the community, in line with guidance from the recommended priority conservation and research actions set out in this advice.

5.2 Existing protection and management plans

5.2.1 Existing protections

The Kaputar Snail and Slug Community equates with the *Mount Kaputar high elevation and dry rainforest land snail and slug community in the Nandewar and Brigalow Belt South Bioregions* which is listed as Endangered in NSW. A comparison of the national and NSW ecological communities is provided in [Table 5.1](#).

Table 5.1. Comparison between the national and NSW-listed Kaputar Snail and Slug communities.

Concept	NSW – Final determination	Proposed national (EPBC) listing
Name	Mount Kaputar high elevation and dry rainforest land snail and slug community in the Nandewar and Brigalow Belt South Bioregions	Mount Kaputar Highland and Rainforest Snail and Slug Community.
Conservation status	Endangered	Endangered
Extent	In & around Mt Kaputar in the Nandewar (NAN) and Brigalow Belt South (BBS) Bioregions.	In Kaputar = NAN03 Kaputar. Around Kaputar = 10 km area from the Kaputar subregion into adjoining NAN04, BBS21 & BBS25 subregions.
IBRA version 7	Nandewar & BBS	NAN03 (all); NAN04, BBS21, BBS25 (part).
Landscape	High elevations (>1000m ASL) Dry rainforest/Vine thickets (>400m ASL)	Native vegetation above 1000m ASL Rainforest/Vine thickets and other mesic vegetation patches > 400m ASL.
Key assemblage spp	<i>Austrochloritis kaputarensis</i> , <i>Coenocharopa</i> 'Mt Kaputar', <i>Cralopa kaputarensis</i> , <i>Discocharopa stenomphala</i> , <i>Kaputarenesta nandewarensis</i> , <i>Scelidoropa nandewar</i> , <i>Thersites</i> sp.1, <i>Triboniophorus</i> aff. <i>graeffei</i> , <i>Vitellidelos kaputarensis</i> + other more widespread, lower altitude snail spp. (e.g. <i>Diphyrora</i> 'Nandewar'; <i>Austrorhytida nandewarensis</i> ; <i>Brevisentis kaputarensis</i>) + other plants, animals, organisms in habitat.	Endemic and restricted species from Table 1.3 + associated native vegetation habitats.
Vegetation	Various eucalypt open forests to forests, Wet heath, Dry rainforest/SEVT.	Any high altitude vegetation. Dry rainforest/SEVT/other mesic vegetation on lower slopes.
Extent of Occurrence (EOO)	170,000-230,000 ha - Min convex polygon of likely landscapes	30,000-267,000 ha, maximum based on area of NAN03 Kaputar plus 10km
Area of Occupancy (AOO)	39,200 ha – 2x2 km grids with likely landscapes	AOO for 4 key species; area >1000m ASL + rainforest pockets.
Threats	Wildfires. Climate change shrinking montane habitats. Feral animals, notably pigs & rats.	Same

Source: NSW Scientific Committee (2013). The data on EOO and AOO are discussed in more detail, with sources, in the assessment against Criterion 2.

Consultation Question:

- Is the comparison with the NSW listing accurate?

Several National Parks occur within the area of interest (Kaputar subregion plus a ten km buffer around the boundary) (Table 5.2). The largest park is Mount Kaputar National Park. All National parks collectively account for about 21.8% of the area of interest. Most (81.0%) of highland areas above 1000m ASL occur within National Parks, all within Mt Kaputar National Park. However, only a relatively smaller proportion of low to mid elevation (>400m ASL) dry rainforest and vine thicket vegetation is protected within national parks, all within Mt Kaputar National Park: 807 ha or 11.4% of rainforest extent.

Table 5.2. National Parks within the area of interest: Kaputar subregion plus a 10 km buffer from the subregional boundary.

National Park	Area (ha)	Highlands >1000m ASL (ha)	Dry Rainforests >400m ASL (ha)
Mount Kaputar	51,304	8,919	807
Other smaller parks *	6,830	0	0
Total area of interest	266,863	11,004	7,065

Source: DAWE (2021b).

*National parks other than Mt Kaputar that are smaller and occur in the area of interest include: Bobbiwaa, Moema, Killarney, Couradda, Horton Falls and Bullawa Creek. None of these contain highland or rainforest habitats for the ecological community.

5.2.2 Existing management plans

The following list is not comprehensive but intended to help guide where some other information relevant to the management of the ecological community and the broader landscape in which it occurs may be found.

McDonald, WJF (2010). National recovery plan for the "Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" ecological community. Report to Department of the Environment, Water, Heritage and the Arts, Canberra. Queensland Department of Environment and Resource Management, Brisbane. Available at: <https://www.awe.gov.au/environment/biodiversity/threatened/recovery-plans/semi-evergreen-vine-thickets-brigalow-belt-north-and-south-2010>

Murphy MJ, Murphy JK, Faris CJ, Mulholland MJ (2019). Marooned on an extinct volcano: the conservation status of four endemic land snails (Gastropoda: Pulmonata) at Mount Kaputar, New South Wales. *Proceedings of the Linnean Society of New South Wales* 141: S33-S44.

NSW Office of Environment and Heritage (2021) Mount Kaputar high elevation and dry rainforest land snail and slug community in the Nandewar and Brigalow Belt South Bioregions – profile. Website. Available at: <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20275>

State of NSW and NSW DPIE [Department of Planning, Industry and Environment] (2021a) Mount Kaputar National Park. Plan of Management. Available at: <https://www.environment.nsw.gov.au/research-and-publications/publications-search/mount-kaputar-national-park-plan-of-management>

State of NSW and NSW DPIE (2021b) Terry Hie Hie Aboriginal Area. Plan of Management. Available at: <https://www.environment.nsw.gov.au/research-and-publications/publications-search/terry-hie-hie-aboriginal-area-plan-of-management>

5.3 Principles and standards for conservation

To undertake priority actions to meet the conservation objective, the overarching principle is that it is preferable to maintain existing environments for the Kaputar Snail and Slug Community that are relatively intact and remain in medium to 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 the ecological community and its environments are, the greater the recovery effort that is required. Also, intact habitat remnants are likely to retain a fuller suite of snails, viability and ecological functions. Given the highly endemic nature of this ecological community, most species are not easy to recover in practice, if lost from a site, nor are key features, such as logs or a deep litter layer, quick 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) – Appendix 2.

The principle discourages ‘offsets’ where intact habitats 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 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 5.2.4](#).

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 further loss and degradation of occurrences. Of the known environments for the Kaputar Snail and Slug Community, most of the highlands (81% of extent >1000 m ASL) but little of the dry rainforests (11% of the extent above 400m ASL) occurs within National Parks. Designation as a National Park or other conservation tenure helps to protect the landscape and ecological communities therein, but does not, in itself, eliminate all threats. For instance, wildfires and feral animals can affect landscapes regardless of their tenure.

- Ensure key threats to the ecological community are identified and effectively managed:
 - continue to monitor and control feral pig, goat and fox populations;
 - minimise the risk of wildfires or other damage for habitats where fire avoidance is the recommended fire regime, such as subalpine areas and rainforest patches. Minimise fire risk to any areas of natural vegetation that serve to connect or buffer these primary habitats.
 - identify and maintain areas that could serve as refugia under climate change scenarios, for instance around rock outcrops, valleys and gorges (Reside et al. 2011).
- Ensure that environments for the ecological community outside of conservation tenure are included in effective management programs, where possible.
- Engage the co-operation of landholders and managers responsible for these sites to effectively manage threats. Most of the threats also cause damage to lands used for production and other human uses.
- Liaise with local councils and State agencies to ensure that potential impacts to the ecological community are included as part of broader strategic planning or large projects (e.g. road works and other infrastructure, fire management).
- Promote the need for large and small scale changes in the human activities that are contributing to global climate change.

5.4.1.1 *CONSERVE REMAINING PATCHES*

The Kaputar Snail and Slug Community has a restricted geographic distribution limited to one subregion and includes many species endemic to that subregion. Avoiding any damage is the appropriate approach to its conservation

- Avoid clearance, infrastructure development and degradation of known and likely environments for the ecological community.
- Avoid any indirect impacts, such as changes to hydrology or nearby areas of native vegetation that are outside of known habitats but buffer them from any direct damage.
- Where regeneration is occurring, for instance after fire or other damage, provide measures that will support regeneration that restores long-term habitat features, e.g. developed litter layers, fallen logs. For instance, temporary fencing to minimise damage to regenerating plants from pest animals.

- Limit or prevent access of vehicles in the vicinity of environments where the ecological community occurs and in line with the vehicle access policy of the Mt Kaputar Management Plan (State of NSW and DPIE 2021a).
- Avoid disturbance from visitors to sites containing the ecological community. Stay on established walking tracks when visiting national parks.

5.4.2 *RESTORE and MANAGE the ecological community*

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

- Liaise with landholders in surrounding areas and undertake and promote programs that ameliorate threats such as weeds, feral animals, disturbance from livestock and fire risk.
- 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, pest animals and diseases affecting the ecological community and manage sites to prevent the introduction of new, or further spread of, invasive species.

- Control introduced pest animals through coordinated landscape-scale control programs.
- Incorporate feral animal, especially pig, control in appropriate environments (subalpine, dry rainforest and valleys and gorges) into the Mt Kaputar National Park and Regional pest control strategies.
- Encourage effective fencing of boundaries with neighbouring properties to prevent domestic stock from entering the park, and provide fencing assistance where possible and appropriate.
- Treat known occurrences of noxious weeds in national parks and any environments outside of conservation areas. Identify specific annual priorities for control programs in regional Pest Management Strategies.
- Design weed and feral animal control programs to avoid impacts on non-target native species.
- Prevent dumping of garden waste into bushland, especially in or near likely occurrences of the ecological community such as lower elevation rainforests and other vegetation in gorges, valleys and riparian areas.
- If new invasive species incursions do occur or spread into new areas, detect and control them early, as small infestations are more likely to be eradicated.

5.4.2.2 *MANAGE APPROPRIATE FIRE REGIMES*

Fire should be excluded from the ecological community and nearby areas; however large parts of the extent for this ecological community were affected by the fire of October-November 2019. 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 areas burnt in 2019/2020).
- Protect unburnt parts of the range that function as refuges (i.e. avoid burning, clearing or logging in those areas) in order to avoid putting all the species at risk at once.
- Develop or implement 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 of the ecological community to determine the time required to re-establish habitat and populations.
- Undertake post-fire on-ground surveys to quantify impacts, management needs and monitor recovery.
- Protect unburnt fire refuges from future fires.
- Protect burnt areas from future fires.
- Install targeted fencing to exclude livestock, feral grazers, or overabundant native herbivores.
- Increase control of feral pigs and goats in burnt areas.
- Increase control of feral predators, notably foxes, in burnt areas.
- Manage access to enable recovery.
- Undertake strategic translocations to restore functional components, where this is known or feasible.
- Manage structural components of sites and undertake habitat supplementation.
- Undertake weed surveys, treatment and removal.
- Undertake planning to accommodate co-dependency of management actions.
- Undertake strategic research to develop or assess management options.

5.4.2.3 UNDERTAKE RESTORATION

- Undertake restoration of degraded habitats for the ecological community and surrounding native vegetation.
 - Work with park managers and other adjoining landholders to restore and reconnect areas for the ecological community and other adjacent or nearby native vegetation that provide protection and connectivity.
 - Maintain pockets of deep leaf litter, fallen logs and rocky outcrops as they provide important features for members of the snail and slug fauna. If necessary, supplement these features from other, intact areas outside of the ecological community, as part of habitat restoration projects. This may be particularly important after disturbance, such as a severe fire event, has locally removed these features.
 - If replanting is necessary to supplement natural recovery, 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.
 - Ensure commitment to follow up after planting, such as weeding.
- 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 protection and 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. 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 landholders/managers, relevant agencies, and the public to emphasise the value of the ecological community, the key threats, its significance, and appropriate management. Encourage landholders to talk with local NRM organisations, National Parks staff 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 catchment.
- 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 the EPBC Act.

5.4.3.2 COORDINATE EFFORTS

- Liaise with local fire management authorities and agencies and engage their support in fire management of the ecological community. Ensure land managers 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 potential environments that may be present 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 contribute to the management of suitable environments.
 - Improve understanding of Traditional Ecological Knowledge relevant to the region, habitats and ecological community and identify and support culturally appropriate mechanisms to implement this knowledge, with the support and participation of local Indigenous peoples, to protect and restore 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 occurrences into account, with due regard to principles for long-term conservation.

5.4.4 RESEARCH and monitoring

There is limited knowledge about the Kaputar snail and slug community. In particular, more information is needed about their distributions, barriers to dispersal, habitat requirements, the ecological interactions among community species and with other ground-dwelling fauna at Mt Kaputar, the impacts of various threats on member species, and their ability to recover from various threats and their associated impacts. This lack of knowledge applies not just to molluscs but to many invertebrate species and species assemblages (Stanisic and Ponder 2004). The research and monitoring activities outlined here for the ecological community seek to redress some of these limitations.

5.4.4.1 MAPPING

- Collate existing information about land snail and slug records and undertake new surveys to refine knowledge about the distributions of member species of the assemblage.
 - Undertake studies that collect and incorporate information on habitat features with locational data to better understand the habitat requirements of member species.

- Identify the habitat and environmental characteristics that support a higher diversity of land snails and slugs from the ecological community. This can be used to identify priority areas to protect from threats such as fire and climate change.
- Using guidance from conceptual papers, such as Reside et al (2011), identify likely refugia sites most likely to harbour members of the ecological community during period of stress, and prioritise these areas for protection from threats.
- Comprehensively record the condition of major areas of the ecological community across its range.
- Research into potential impacts of climate change on the current distribution and future habitat suitability of endemic snail and slug species.

5.4.4.2 OPTIONS FOR MANAGEMENT

- Research into integrated methods to effectively manage pests that impact directly on members of the snail and slug assemblage, and indirectly on the habitats for the ecological community.
- Research into the feasibility of captive breeding populations of endemic snail and slug species, with a view to establishing potential translocation populations to aid reintroductions after severe threats.
 - Undertake research into the genetics of endemic species to understand the degree of genetic isolation of geographically separate populations and subpopulations and potential genetic barriers to breeding.
- Research the mechanisms that help individuals and populations persist at sites after fires, feral animals impacts and in light of climate change.
- 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 and its habitats, incorporating Indigenous knowledge.
- Research into the feasibility of directly watering key spots (where known) during drought or fire to help the snail assemblage persist under adverse conditions.

5.4.4.3 MONITORING

It is important that any monitoring is planned before management commences and considers what data are required to address management outcomes and research questions. Monitoring must be resourced for management activities, especially for those using a novel approach, and applied during and following management actions. Monitoring should also reflect on whether outcomes are tracking effectively against the conservation objectives for this advice.

- Build teams to design, implement and sustain long-term monitoring of snail and slug assemblages by researchers, Traditional custodians, citizen scientists and volunteers, and incorporate new survey and observational data into databases, such as Atlas of Living Australia and museum record sites.
 - Use the information on trends in species abundance coupled with observations on the status of habitat features to inform recommendations for future management.
- Monitor the impacts of fires on the abundance and recovery (or decline) of snail species, especially in severe fire seasons. Community involvement in recovery is particularly beneficial where it contributes to long-term monitoring.
 - Note the impacts of fires of different severity and history (e.g. burnt once or multiple times) at each site.
- Monitor total herbivore numbers across the landscape to inform actions.

- A particular focus should be given to feral pests that are management priorities for Mt Kaputar National Park and that impact on the ecological community, notably feral pigs and goats.
- Monitor for new incursions or spread of weeds and pest animals, to inform on appropriate management actions.

Consultation Questions on the priority conservation and research actions

- Do you agree with the proposed actions?
- How can the descriptions for the proposed actions be improved?
- Are any priority actions missing, and if so please specify?
- Please provide additional examples of existing relevant management plans.

6 Listing assessment and recovery plan recommendation

The Threatened Species Scientific Committee finalised this assessment on **DATE**.

6.1 Reason for assessment

This assessment follows prioritisation of a nomination from the Threatened Species Scientific Committee in light of the 2019-20 bushfires

6.2 Eligibility for listing

This assessment uses the criteria set out in the [EPBC Regulations](#) and TSSC [Guidelines for Nominating and Assessing Threatened Ecological Communities](#), as in force at the time of the assessment. Information on listing eligibility under the IUCN Red List for Ecosystems criteria (Bland et al 2017) is included for information only.

6.2.1 Criterion 1 – decline in geographic distribution

Not eligible under Criterion 1

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

Source: TSSC (2017)

Evidence:

Mount Kaputar is part of the remnant from a large shield volcano covering the Nandewar Range that was active 17 to 20 million years ago (Hunter and Alexander 2015; State of NSW and DPIE 2021a). The rugged and inaccessible terrain on and around Mt Kaputar precluded any use for agriculture or major infrastructure developments. The landscapes were progressively added to conservation tenure from 1925 onward, such that the Mt Kaputar region now represents the largest remnant of intact natural vegetation in the Nandewar and Brigalow Belt South bioregions.

The original extent of the Kaputar Snail and Slug Community is not known for certain. The estimated pre1750 and current vegetation extent, which are valid broad-scale surrogates for habitat, does not indicate any substantial permanent loss of natural vegetative habitats.

Following assessment of the data the Committee has determined that the ecological community is not eligible for listing in any category under Criterion 1.

6.2.2 Criterion 2 – limited geographic distribution coupled with demonstrable threat

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

	Category		
	Critically Endangered	Endangered	Vulnerable
Its geographic distribution is:	very restricted	restricted	limited
Extent of Occurrence (EoO)	<100 km ² <10,000 ha	< 1,000 km ² <100,000 ha	< 10,000 km ² <1,000,000 ha
Area of Occupancy (AoO)	<10 km ² <1,000 ha	< 100 km ² <10,000 ha	< 1,000 km ² 100,000 ha
Average patch size	<0.1 km ² <10 ha	< 1 km ² 100 ha	
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:

Criterion 2 aims to identify ecological communities that are geographically restricted to some extent or where the nature of the distribution makes them more susceptible to threats. It is recognised that an ecological community with a distribution that is small and/or fragmented, either naturally or that has become so through landscape modification and other threats, has an inherently higher risk of extinction if it continues to be subject to ongoing threats that may cause it to be lost in the future.

The indicative measures that apply to this criterion are:

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

Estimates of Extent of Occurrence (EOO) and Area of Occupancy (AOO)

The geographic distribution for the Kaputar Snail and Slug Community may be determined from a number of measures (Table 6.1) based on extent of known environments and records of the snail and slug fauna. The Kaputar Snail and Slug Community has a restricted geographic distribution based largely on EOO estimates in the range 30,000 to 80,000ha for the Kaputar subregion and distribution of key endemic snail and slug species. Estimates for AOO are more indicative of a limited geographic distribution with most estimates being over the threshold of 10,000 ha.

Table 6.1. Estimates of geographic distribution for the Kaputar Snail and Slug Community.

Measure	Source	EOO (ha)	AOO (ha)	Eligible category
Habitats - Kaputar subregion	DoE (2013)	78,307		Restricted (EOO)
Habitats - Area over 1000m AHD + dry rainforest remnants >500m	Murphy & Shea (2015)		10 800	Restricted (AOO)
NSW TEC - Convex polygon with areas >1000m ASL + >500m in & around Mt Kaputar	NSW Scientific Committee (2013)	170,000 – 230,000		Limited (EOO)
NSW TEC - 2x2 km grids over known habitats	"		39 200	Limited (AOO)
Species records - Kaputar pink slug	Murphy et al (2019)	54 500	28 000	Restricted (EOO)
Species records - Bronze rippled pinwheel snail	"	30 900	13 600	Restricted (EOO)
Species records - Kaputar carnivorous snail	"	55 200	28 800	Restricted (EOO)
Species records - Kaputar keeled snail	"	34 800	19 600	Restricted (EOO)
Habitats - Kaputar subregion + 10km buffer		266,900		Limited (EOO)
Habitats - Area over 1000m ASL in Kaputar + 10km			11,000	Restricted (AOO)
Habitats - Dry rainforest + vine thickets 500-1000m ASL			2,259	

Sources: as cited. EOO refers to Extent of Occupancy; AOO refers to Area of Occupancy, both measures defined above.

The distribution polygons derived from records for the four gastropod species assessed overlap substantially or occur in proximity; the larger estimates of the four species records are likely to be most representative of the Kaputar Snail and Slug Community.

The AOO based on habitats >1000m plus dry rainforest patches by Murphy and Shea (2015) is rated as restricted, given it is just over the 10,000 ha threshold. Similarly, the AOO estimates for this assessment are rated as Restricted because the habitat features for highlands and rainforests slightly exceed but remain close to the threshold for Restricted, even when summed together.

Patch size distribution.

This measure is difficult to apply to the Kaputar Snail and Slug Community. The scale of the patch thresholds is not appropriate for a community of small invertebrates that have very limited mobility and dispersal capabilities. The collective area of rainforest pockets on Mt Kaputar is minor, about 2,260ha, and little is known about the connectivity between rainforest sites in terms of snail dispersal. The more diverse and abundant expression of the ecological community occurs at higher elevations, above 1000m ASL, where a near continuous mosaic of natural vegetation and habitats exist.

Timeframes and threats.

The ecological community is subject to key threats that impact upon it over a variety of timeframes, as described in [Table 4.1](#).

- The key threat of climate change is projected to have significant detrimental impacts but will develop over the medium-term future, and beyond.
- Wildfire is a stochastic but also immediate threat. The stochastic threat element is that fire history indicates there have been four extensive fires covering 10,000 ha or more (or at least 12% of the Kaputar subregion) in the fifty years between 1970 to 2020 (State of NSW and DPIE 2021a). This represents an average recurrence of large fire events somewhere within Mt Kaputar National Park of about 12.5 years. These large fire events may not overlap to burn the same areas, but still indicates that substantial areas of the National Park are impacted relatively often. This is especially important for fire sensitive vegetation that comprise habitat for the ecological community, where the recommendation is to completely avoid fires (Hunter and Alexander 2015). The immediate threat element is the severe and extensive impacts on Mt Kaputar from the 2019-20 fire season. Almost 26,000ha on and around the slopes of Mt Kaputar (or about 33% of the Kaputar subregion) were burnt, including large parts of the highland area

that are important for the ecological community (Murphy and Shea 2015). These are fire sensitive environments (Hunter and Alexander 2015) that are slow to recover. Furthermore, the 2019-20 fires followed the Paleroo Creek fire in 2006 that is estimated to have burnt about 15,000 ha in and around Mt Kaputar National Park (Narrabriweather.net 2006). The slow recovery of important habitats plus the stochastic element of another large fire recurring within 10 to 20 years suggest a timeframe of loss over the near future is appropriate.

- The damaging impacts of invasive species such as feral pigs and goats are ongoing and likely to exacerbate the damaging impacts from threats such as fire. Access to sites by feral animals that recolonise from nearby unburnt areas is easier after fire. The regrowth of shoots and seedlings for many native plants are also more prone to browsing and trampling damage. Such threats are moderated by current measures to control populations of feral pigs, goats and foxes as the most damaging pest animals at Mt Kaputar National Park. However, control efforts are especially crucial after fires when the environment is more sensitive to additional damage that only impedes recovery.

Draft Conclusion

The Kaputar Snail and Slug community is a group of mostly narrow-range endemic species confined to a single montane environment. The geographic distribution for this assemblage is restricted and the nature of its distribution makes it likely that the action of interacting threatening processes could cause it to be lost in the near future. The Committee therefore considers that the ecological community has met the relevant elements of Criterion 2 to make it eligible for listing as 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
<i>Estimated decline over the last 10 years or three generations, whichever is longer</i>	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
<i>timeframe</i>	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:

There are a number of ways to consider functional importance. One is to consider the known biology of the component species and their interactions, as a way to infer functional importance. For instance, can we determine, from the known biology, if losing any of the component species will, in itself, lead to declines in the remaining species?

A second approach is to consider function in terms of the diversity of functional traits within a species assemblage. For instance, Suarez-Castro et al (2020) define:

“.... functional diversity as the variation and dispersion in the distribution of functional traits in a species assemblage. A subgroup of functional traits that is important to consider separately when using functional diversity to understand ecosystem function are “effect traits”. Effect traits determine the effect of species on ecosystem functions such as nutrient cycling, seed dispersal and primary productivity, and thus effect trait diversity plays a key role linking biodiversity and ecosystem functioning For example, effect traits such as tongue length and bill morphology [in bird assemblages] “affect” ecosystem function by influencing pollination effectiveness and the handling of fruits [An]other important subgroup of traits to consider when studying functional diversity and its link to ecosystem function are “response traits”; traits that determine species vulnerability to environmental change. Body size and dispersal capacity are examples of response traits as they are involved in the way that species respond to changes in habitat patch size, patch isolation and matrix permeability Importantly, individual functional traits can be both effect and response traits depending on the context.”

Unfortunately, there is little to no information regarding either of these approaches in regard to the Kaputar Snail and Slug Community. In the absence of detailed food web, competition and similar studies, the range of interactions are too poorly known to properly assess an individual species’ functional importance. Several species would have some unique trait while many other traits would be redundant across several species. The importance of these to overall functionality remains little known, such that the loss of any one trait or single species would not necessarily be known to lead to collapse of the entire ecosystem.

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

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

	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
<i>such that restoration is unlikely (even with positive human intervention) within</i>	<i>the <u>immediate</u> future (10 years or 3 generations up to a maximum of 60 years)</i>	<i>the <u>near</u> future (20 years or 5 generations up to a maximum of 100 years)</i>	<i>the <u>medium-term</u> future (50 years or 10 generations up to a maximum of 100 years)</i>

Source: TSSC (2017)

Evidence:

This criterion considers whether there has been a loss of integrity for the Kaputar Snail and Slug Community across its restricted geographic range. It is noted that this criterion includes evidence that is qualitative as well as quantitative, where such data are available. Reduction in integrity can be a consequence of various threatening processes that do not necessarily lead to outright loss but to declines in the quality of habitats and the functionality of the species assemblage. The threats considered most relevant and influential on the ecological community, and for which some data are available are: fire regimes, interactions with pest animals, and projections of climate change. While these threats are considered separately here, they do not operate independently but interact in complex, cumulative, ways in how they affect the Kaputar snail and slug community.

Fire.

Fire has the capacity for short-term and long-term, potentially permanent, impacts to the ecological community. Short-term impacts are evident after fires that affect only a small area of habitat or local population of the species assemblage; or if extensive fires occur at long intervals that allow reasonable recovery of habitats and populations between fire events. Most of the fires reported for Mt Kaputar are <1000 ha in extent (State of NSW and DPIE 2021a). Longer-term impacts are from fires that cover extensive areas of suitable habitat and/or cause damage to species that are fire sensitive; are high intensity; or are fires that recur in an area and have successive impacts.

Table 6.2. Impacts of the 2019-20 Mt Kaputar fires on the landscapes and habitats for the Kaputar Snail and Slug Community.

Landscape feature	Extent (ha)	Area burnt (ha)	Area burnt (%)
Area of interest (Kaputar subregion + 10 km buffer)	266,900	25,791	9.7
Kaputar subregion	78,307	25,791	32.9
Mt Kaputar National Park	51,304	18,835	36.7
Highlands >1000m ASL	11,004	6,374	57.9
Dry rainforest + vine thickets 500-1000 ASL	2,259	162	7.2
Dry rainforest + vine thickets <1000m in Mt Kaputar NP	805	102	12.7

Source: DAWE (2021b) Analysis of fire, vegetation and elevation data.

The most recent extensive fire was the 2019-20 wildfires that burnt large areas of Mt Kaputar, including key habitats for the Kaputar Snail and Slug Community ([Table 6.2](#)). Almost 25,800ha were burnt, covering about a third of the Kaputar (NAN03) subregion and of Mt Kaputar National Park. Of the primary habitats for the Kaputar Snail and Slug Community, highland areas >1000m ASL were mostly impacted by fires with almost 58% of such sites burnt. Occurrences of dry rainforest and vine thickets at lower elevations (500-1000m ASL) were relatively less impacted by fires, with about 7 to 13% of patches on the lower slopes around Mt Kaputar being burnt. Most dry rainforest and vine thickets in the vicinity of Kaputar occur as small pockets situated at low elevations (<500m ASL) and outside for formal conservation tenures.

The key impacts of the 2019-20 Mt Kaputar fires on the Kaputar Snail and Slug Community are:

1. A larger proportion of highland habitats (>1000m ASL) were burnt.

Almost 60% of the limited highland area was burnt in the 2019-20 wildfires ([Tables 6.2; 6.3](#)). The most extensive major vegetation subgroups present at high elevations in the Kaputar region are Eucalypt woodlands with a shrubby understorey, Eucalypt woodlands with a ferny and wet graminoid understorey, and Heathlands ([Appendix B](#)). Each of these key vegetation types were substantially impacted by fire ([Table 6.3](#)): over two-thirds of the highland extent of Eucalypt woodlands with a shrubby understorey and over 40% of Heathlands were burnt.

Highland areas are habitat for the Kaputar Snail and Slug Community because of the higher rainfall with altitude, the well-developed litter layer under the vegetation, and fallen logs and rock outcrops that all provide food and shelter for the snail and slug fauna. Fires that extend substantially into highland areas can remove these key habitat features. Any snail and slug species that are not directly killed by fires are left exposed to desiccation and predation in the bare post-fire landscape. The loss of well over half this extent of primary habitat reduces the area available as refuges from which populations may recover. Several members of the Kaputar Snail and Slug Community are extreme narrow-range endemics, limited not just to the Kaputar region, but specific to its highland areas, for instance the iconic Kaputar Pink Slug. There were concerns that the fires may have caused the Kaputar Pink Slug to become extinct but individuals were observed to emerge once it rained after the fires (ABC News 2020). They likely escaped the heat and fires by sheltering under large logs or in rock crevices and emerged following suitable moisture with rainfall. However, it's not yet clear how significantly other smaller, more cryptic endemic land snails that typically reside in leaf litter were impacted. For the extreme narrow-range endemic species, the highland fires likely reduced their area of occupancy, potentially by up to 60%. For species that are not narrow-range endemic to the Kaputar highlands and extend onto the lower slopes, the fires substantially reduced the availability of suitable habitats, if not their areas of occupancy.

In brief, the highland fires resulted in a severe loss of vegetation community integrity and assumed snail community integrity, notably of high-altitude sites after the 2019-20 wildfires.

Table 6.3. Impact of 2019-20 wildfires on Major Vegetation Subgroups on Mt Kaputar. Data stratified by elevation (highland >1000m ASL vs lowland (<1000m ASL) and by fire intensity (low to moderate intensity vs high to very high intensity).

Major Vegetation Subgroup / Elevation	Total area (ha)	Area burnt (ha)		% of total area burnt in all fires
		Low to moderate fires	High to very high fires	
Callitris forests and woodlands	34,634	1,567	48	4.66
Above 1000m	14	2	0	14.29
Below 1000m	34,620	1,565	48	4.66
Casuarina and Allocasuarina forests and woodlands	7,621	669	8	8.88
Above 1000m	198	196	1	99.49
Below 1000m	7,423	473	7	6.47
Dry rainforest or vine thickets	10,470	165	3	1.60
Above 1000m	6	5	0	83.33
Below 1000m	10,464	160	3	1.56
Eucalyptus woodlands with a shrubby understorey	24,538	10,376	625	44.83
Above 1000m	8,206	5,322	313	68.67
Below 1000m	16,332	5,054	312	32.86
Eucalyptus woodlands with ferns, herbs, sedges, rushes or wet tussock grassland	68,398	10,686	550	16.43
Above 1000m	1,432	252	15	18.65
Below 1000m	66,966	10,434	535	16.38
Heathlands	2,505	367	92	18.32
Above 1000m	569	187	51	41.83
Below 1000m	1,936	180	41	11.42
Temperate tussock grasslands	6,550	54	0	0.82
Above 1000m	0	0	0	0.00
Below 1000m	6,550	54	0	0.82
Regrowth or modified forests and woodlands	27,499	554	15	2.07
Above 1000m	580	31	1	5.52
Below 1000m	26,919	523	14	1.99
Cleared, non-native vegetation, buildings	50,401	15	0	0.03
Above 1000m	0	0	0	0.00
Below 1000m	50,401	15	0	0.03
TOTAL	232,616	24,453	1,341	11.09
TOTAL Above 1000m	11,005	5,995	381	57.94
TOTAL Below 1000m	221,611	18,458	960	8.76
- Rainforest	10,464	160	3	1.56
- Non-rainforest	211,147	18,298	957	9.12

Source: DAWE (2021b) Analysis of vegetation, elevation and fire data.

2. Most of the areas burnt were at lower elevations (75% of the fire was below 1000m ASL).

The main habitats for the ecological community at lower elevations are dry rainforests and vine thickets. These habitats were not extensively impacted by the fires, in the order of 7 to 13% of their extent. This may be due to the patchy and rare nature of dry rainforest pockets, and that low to moderate fires are less likely to transmit far into damp and fire-retardant vegetation types. Hunter and Alexander (2015) noted Riparian Forests and Dry Rainforest are limited to protected depressions and incised gorges, and generally remain in good condition though weeds are an issue at some sites ([Table B4, Appendix B](#)). Given dry rainforest and vine thickets are fire sensitive vegetation types ([Table B4](#)), all patches of dry rainforest affected by fire of any severity could have been damaged, to some degree, though the most serious damage would have been where fires were more intense. Only three ha of dry rainforest were impacted by fires of high to very high severity.

Other low elevation vegetation extensively impacted by low to moderate fires included eucalypt woodlands with an understorey of ferns, herbs and wet graminoids and eucalypt woodlands with a shrubby understorey ([Table 6.3](#)). About 16,000 ha or 20% of the lower elevation (<1000m ASL) occurrences of these woodlands were burnt. Some of these woodlands occupy less protected depressions and creeks ([Table B4](#)), so may serve as appropriately moist connecting habitats for the snail fauna that link patches of dry rainforest patches and highland sites, especially in wetter seasons. If these are the vegetation types that typically surround and buffer dry rainforest patches then their loss from these positions may leave rainforest patches further exposed to harsher weather, at least until surrounding vegetation regenerates.

In brief, the extensive lower elevation fires did not result in the loss of a large proportion of dry rainforests and vine thicket habitats but did damage considerable other habitat that afforded linkages among primary habitats and some protective buffer to sites. In this way it led to loss of community integrity for the snail fauna.

3. Most of the area burnt was affected by low to moderate intensity fires (95% of total area burnt).

Low to moderate fires most affect species and habitats that are fire sensitive. Land snails are slow-moving, soft-bodied, non-burrowing species with a high moisture requirement (Stanisic and Ponder 2004). Consequently, they are very sensitive to the heat and desiccation that comes with fire, even cool fires like those associated with prescribed burns.

The species of land snail in the region reside and shelter in the litter layer, under logs and rocks, or in rock crevices; some are also arboreal, crawling up tree trunks (Murphy et al. 2019). Marsh et al. (2021) investigated the impacts of the 2019-20 wildfires on invertebrate populations and rated microhabitats for their susceptibility to fires. Some favoured land snail microhabitats, such as logs and rock crevices, can provide protection, especially during low to moderate intensity burns ([Table 6.4](#)). Microhabitats that are more open, however, such as litter and open ground confer little protection, even from low to moderate fires. Extensive fires at these sites can potentially wipe out entire local snail populations and assemblages. Even low to moderate fires can potentially eliminate half to three-quarters of exposed local snail populations ([Table 6.4](#)).

Table 6.4. Invertebrate microhabitats scored for their likely susceptibility of species to fires.

A) Scores rated from 1 = low mortality risk to 4 = high mortality risk

Microhabitat / shelter site	Low to moderate severity fires	High severity fires
In leaf litter (on ground)	3	4
In elevated leaf litter	3	4
On vegetation	2	4
No shelter	2	4
Ground living	2	3
Shallow burrow in ground (<10cm)	1	3
In/under bark	1	3
In/under logs	1	3
Arboreal – large trees/shrubs	1	3
Under rock	1	2
In standing wood	1	2
Creekline/water	1	2
Deep burrow in ground (>30cm)	1	1
In soil	1	1
Troglofauna / stygofauna	1	1

B) Scores re-scaled as estimates of site-level proportion of the population killed in fires with the lower and upper bounds in parentheses. 1 = total population loss.

Microhabitat / shelter site	Low to moderate severity fires	High severity fires
In leaf litter (on ground)	0.75 (0.625-0.875)	1 (0.875-1)
In elevated leaf litter	0.75 (0.625-0.875)	1 (0.875-1)
On vegetation	0.5 (0.375-0.625)	1 (0.875-1)
No shelter	0.5 (0.375-0.625)	1 (0.875-1)
Ground living	0.5 (0.375-0.625)	0.75 (0.625-0.875)
Shallow burrow in ground (<10cm)	0.25 (0.125-0.375)	0.75 (0.625-0.875)
In/under bark	0.25 (0.125-0.375)	0.75 (0.625-0.875)
In/under logs	0.25 (0.125-0.375)	0.5 (0.375-0.625)
Arboreal on trees / large shrubs	0.25 (0.125-0.375)	0.5 (0.375-0.625)
Under rock	0.25 (0.125-0.375)	0.5 (0.375-0.625)
In standing wood	0.25 (0.125-0.375)	0.5 (0.375-0.625)
Creekline or water	0.25 (0.375-0.625)	0.5 (0.125-0.375)
Deep burrow in ground (>30cm)	0.25 (0.125-0.375)	0.25 (0.125-0.375)
In soil	0.25 (0.125-0.375)	0.25 (0.125-0.375)
Troglofauna / stygofauna	0.25 (0.125-0.375)	0.25 (0.125-0.375)

Source: Marsh et al (2021). **Bolded** entries are microhabitats favoured by land snails.

It may seem contrary for wildfires to extend substantially into the damper highland areas of Mt Kaputar and strongly influence the fauna and habitats there. However, the fire season of 2019-20 was accompanied by extremely low rainfall that made many damp areas susceptible to fire impacts. The rainfall recorded at the nearby Mt Lindsay rainfall weather station – the nearest station at higher elevation with long-term records - recorded its lowest annual rainfall since 1900 during 2019: only 316 mm (BoM 2021). This followed the pattern across south-eastern Australia of severe drought, hot days and very dry fuel loads in the litter layer for that season. Consequently, it is presumed that even low to moderate fires had the capacity to remove much of the litter layer in highland areas. A near complete loss of the litter layer would have extinguished key habitat and shelter for the snail assemblage and left them exposed and vulnerable to further desiccation long after the fires had passed. *Kaputartesta nandewarensis* (Nandewar pinhead snail), for instance, is among 22 known invertebrate species expected to decline to a population size of less than ten percent of its post-fire population in the longer term after fire (2-20 years) (Marsh et al. 2021).

In short, the sensitivities of the snail assemblage and microhabitats to even low to moderate fires can result in the severe loss of community integrity, evident through destruction of microhabitats. The consequent decline in snail and slug populations is considered in Criterion 5.

4. The extensive 2019-20 wildfire was not an isolated event.

The last large-scale wildfire on Mt Kaputar occurred in 2006, when about 15,000 ha of the park was burnt (Narrabriweather.net 2006). Other extensive fires that burnt over 10,000 ha of Mt Kaputar National Park since 1970 occurred in 1974 and 1986 (State of NSW and DPIE 2021a). All extensive fires since 1970 are considered to have been mostly low to moderate intensity fires but, as noted above, even mild fires can be severely detrimental to the Kaputar Snail and Slug Community.

Frequency of fires, however may be a more important factor than fire severity on how sensitive invertebrate groups cope with fire. Habitats and vegetation types that are sensitive to burning require time to recover, more so if they are severely burnt. For instance, vegetation needs to regrow so that litter layers and fallen logs can be replaced to restore the microhabitats and shelters required by the Kaputar Snail and Slug Community. Fires that frequently recur in an area prevent these microhabitats from being fully restored and keeps them in a state of disturbance. If the litter layer is poorly developed and protective logs and rock crevices are lost from sites, then there is less protection to the snail fauna when subsequent fires recur. Even if later fires do not overlap into previously burnt areas, they impact on neighbouring habitats so that the overall impacts of multiple fires are additive. Stanisic and Ponder (2004) considered that land snail populations are more likely to recolonise from unburnt refuges within burnt areas than from areas outside the fire due to the limited ability of species to disperse. Any cumulative impacts of fires on refuge or habitat recovery can compromise the capacity for snail populations to recolonise disturbed areas.

Large fires (>10,000 ha) on Mount Kaputar have recurred about every 12.5 years between 1970 to 2020 (State of NSW and DPIE 2021a), noting they have occurred over different parts of this large national park. Seven of the ten vegetation communities identified by Hunter and Alexander (2015) have recommended fire intervals of 30 years or more. It's not yet known if all four fire events severely impacted highland and/or dry rainforest areas as did the 2019 fire. Murphy et al. (2019) noted, however, that subalpine vegetation on Mt Kaputar have experienced fire frequencies above their ecological tolerances; this implies multiple past fire events have impacted highland areas. That was before the 2019-20 fire season that burnt 60% of highland areas. So, this extensive fire event was impacting upon an already stressed ecosystem.

Fires do not act in isolation – their impacts can be additive to other stressors. A key stressor is low rainfall and drought. In the lead up to a fire event, drought can make sites more flammable. Low rainfall post-drought can affect the ability of vegetation and native animal populations to recover from fire damage. Other stressors include increased feral animal activity and spread of weeds, and longer-term climate change trends. These may increase the risk of more frequent fires and damage from individual fire events.

In brief, the ecological integrity of habitats for the Kaputar Snail and Slug Community has been severely impacted by multiple fire events. The 2019 fires were only the most recent of several extensive fire events in the region.

Climate change

The projections for climate change in the region are outlined in the Threats table ([Table 4.1](#)), above and include lower rainfall, hotter days and more days of high fire risk. The degree of change depends on the scenario for ongoing carbon emissions. Montane systems such as Mt Kaputar are considered highly susceptible to climate change impacts, and snail assemblages all the more so, given their reliance on moisture and sensitivities to fire and desiccation (Murphy and Shea 2015; Murphy et al. 2019).

If warming temperatures shift suitable highland habitats by 100 metres in elevation, from 1000 m to 1100m ASL, then the area of habitats available to the Kaputar Snail and Slug community declines considerably, by about 55 percent (Murphy et al 2019). This would be additional to any losses as a result of fires or feral animal activity. The constraint on elevated habitats potentially imposed by climate change would magnify the impacts of any severe fire events that reach the highlands: their lesser extent means smaller fires may still damage a considerable proportion of total habitat.

- Temperature records for the Central Slopes NRM cluster, which has Mt Kaputar in the centre of the region, shows mean temperature has risen by about 0.8°C between 1910 and 2013, based on a linear trend (Ekström et al 2015).
- The projected warming to 2030 is in the range 0.6 to 1.5°C, relative to 1995 temperatures, with only minor variations among models tested.

Weather station data on and in the vicinity of Mt Kaputar were examined to look for trends in climate over recent decades. The weather station on Mt Kaputar only has records available for solar exposure (since 1990) and rainfall (since 2001 with gaps). Other weather stations in the vicinity of Mt Kaputar have longer-term records, e.g. Barraba (Mt Lindsay) has rainfall records since 1886. The available data show the following trends.

- There was only minor variation in mean annual solar exposure on Mt Kaputar between 1990 to 2020, from 16.4 to 19.3 MJm⁻², with a slight but not significant declining trend ($R^2 = 0.137$) over the period, that indicates increasing cloud cover (Figure 6.1A). Solar exposure also varies seasonally, with a peak in December-January and lowest levels in June-July.
- Annual rainfall was averaged over ten weather stations located around Mt Kaputar that had an elevation of 499 to 880 m (see Appendix B for details of stations), and records dating back at least the past fifty years. There was no evident trend in average rainfall over the period 1900 to 2020.
- There was, however, a pattern for events involving very wet (>1,000mm rainfall) and very dry (<500mm rainfall) years. Very wet years occurred on ten occasions, mostly before 1960: in 1916, 1921, 1931, 1947, 1950, 1955, 1956, 1978, 1983, and 1996. Very dry years occurred on eight occasions, mostly after 1960: in 1902, 1919, 1957, 1965, 1980, 2002, 2018 and 2019. The two lowest average rainfall years since 1900 were after 2000, in 2002 and in 2019, the season of the last extensive fire at Mt Kaputar (Figure 6.1B). This suggests that events likely to cause most stress upon the Kaputar Snail and Slug Community, such as droughts, may have become more frequent from the middle of the 20th century. This is in line with regional forecasts of likely climate change impacts.

Impacts from pest animals

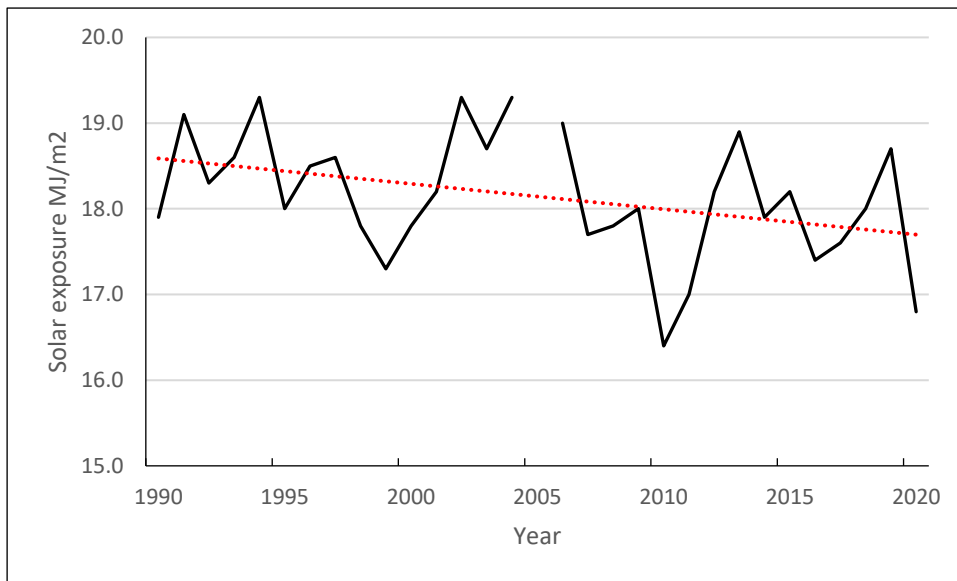
Several feral animal species affect the Kaputar Snail and Slug Community either by directly feeding on individual snails and slugs, or destroying their habitats. The main pest animals involved are *Capra hircus* (feral goats), *Rattus rattus* (black rat) and *Sus scrofa* (feral pig). Of these, feral pigs are the most damaging pest to the snail assemblage and to habitats throughout Mt Kaputar National Park (Murphy et al. 2019; State of NSW and DPIE 2021a). Feral pigs, along with goats and foxes, are the subject of active control programs in the National Park to manage their populations and impacts. Feral pigs are active throughout the park, including highland areas. No data are available to indicate the likely population of feral pigs in and around Mt Kaputar National Park or the extent to which they are causing damage to the natural vegetation, especially in highland areas of the park.

However, there have been studies of pig impacts to other, related systems that point to the serious nature of the damage that pigs may cause.

- Fencing exclusion studies show that digging by pigs can affect seedling survival, litter biomass and the density of ground invertebrates in tropical rainforests of Queensland. In a short-term study over two years, Mitchell et al (2007) observed a decline in seedling numbers in rainforest areas with pig diggings but no significant influence of pig diggings on either litter biomass or earthworm biomass in the soils. Litter biomass was consistent across sites exposed to pig diggings and where they were excluded.

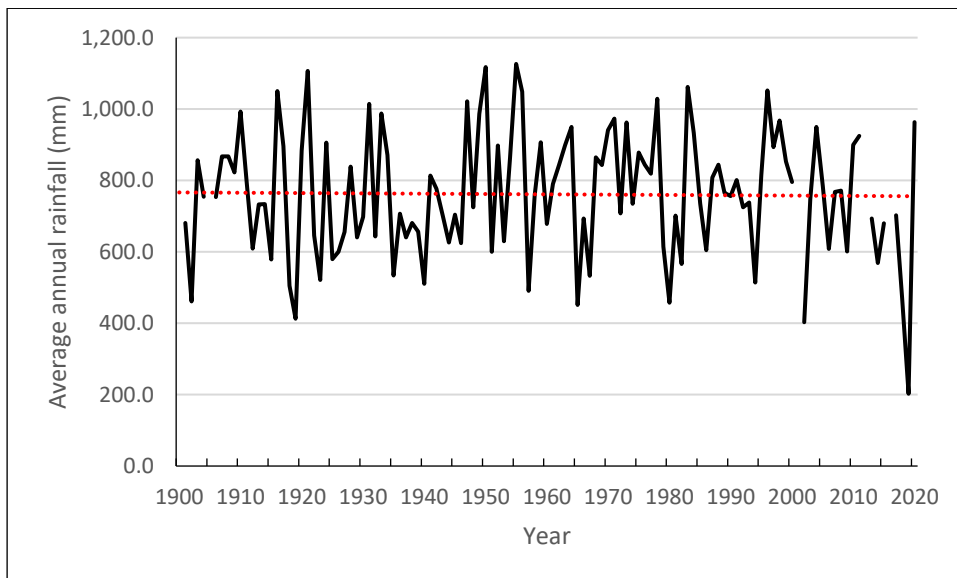
Figure 6.1. Trends in key weather variables from weather stations in the vicinity of Mt Kaputar.

A) Solar exposure (MJm^{-2}) from records at the Mt Kaputar weather station, 1990-2020.



Black solid line = solar exposure. **Red dashed line** = linear trend ($R^2 = 0.137$)

B) Annual rainfall averaged for ten weather stations in the vicinity of Mt Kaputar for the period 1900 to 2020.



Black solid line = annual rainfall (mm/year). **Red dashed line** = linear trend ($R^2 = 0.003$).

Source: Bureau of Meteorology, weather station data downloaded October 2021. Details of weather stations and data analysis provided in Appendix B.

- Taylor et al (2001) studied the effect of longer-term pig exclusion in sites that had been fenced for 12 years. Their study found significant declines due to pig activities in seedling density, soil macroinvertebrate density and leaf litter cover after 12 years. The damage caused by pigs to macroinvertebrate density before the exclusion treatments appears to have caused a long-term suppression that did not recover after 12 years. However, the diversity of vegetation, soil invertebrates and fallen log cover did not vary among exposed and excluded sites, indicating some measures may have recovered over the 12 year period. The reduction in leaf litter cover and soil macroinvertebrate density may be linked, given litter is crucial microhabitat for many ground invertebrates.
- Ground diggings by feral pigs in Namadgi National Park is most frequent at higher elevations, especially in drainage lines and flatter slopes (Hone 2001). The extent of pig diggings may be

related to their search for particular food items such as tuberous plants, e.g. *Bulbine* spp (Bulbine lilies), *Arthropodium* spp (Vanilla and Chocolate lilies) and orchids, and possibly earthworms that are eaten by pigs (Mitchell et al 2007). Diggings may therefore cause certain plant species to decline but also may promote the abundance of other species such as *Leptospermum* spp (Tea-trees).

- Globally, feral pigs dig up a substantial area of soil per year, with the largest area in Oceania (O'Bryan et al 2021). Oceania - Australia, New Zealand, New Guinea, Indonesia and Pacific islands – collectively have a median area of 22,000 km² of soil dug up by pigs. In doing so, feral pigs contribute to a substantial release of soil carbon dioxide into the atmosphere, a median of almost 3 metric tonnes of CO₂ per year from Oceania alone, and almost 5 million metric tonnes of CO₂ per year globally. In this regard, feral pig activities have a much broader impact from local habitat damage to global by contributing, in an insidious manner, to longer-term climate change impacts.

These studies on feral pig may be relevant to the Kaputar Snail and Slug Community. The control mechanisms applied to feral pigs are aerial baiting and shooting, and fence enclosures are not a practical solution. Digging and soil disturbance activities from feral pigs in the highland regions of Kaputar remains an ongoing and long-term problem. As shown in rainforest studies this contributes to local declines in litter layer development and densities of macroinvertebrates. It can be reasonably concluded that the snail fauna would be detrimentally affected by loss of the litter layer and soil disturbances, at least. The more open nature of burnt sites may increase access of pigs through highland areas, as they search for food in the post-fire landscape. Their digging and feeding activities may prevent the re-establishment of certain vegetation components and further contributes to slowing the recovery of habitats for the Kaputar Snail and Slug Community. Rainforest studies and the recent soil carbon modelling indicates that some pig activities have long-term impacts.

Draft Conclusion

This combined and known impacts from recent fire and feral animals plus projections from climate change modelling represents a **severe** reduction in integrity across most of its geographic distribution, as indicated by a **severe** degradation of the community of its habitat. The Committee therefore considers that the ecological community has met the relevant elements of Criterion 4 to make it eligible for listing as **Endangered**.

6.2.5 Criterion 5 – rate of continuing detrimental change

Eligible under Criterion 5 for listing as **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
<i>an observed, estimated, inferred or suspected detrimental change over the immediate past, or projected for the immediate future (10 years or 3 generations), of at least:</i>	<i>80%</i>	<i>50%</i>	<i>30%</i>

Source: TSSC (2017)

Evidence:

There are two lines of evidence that indicate the rate of continuing detrimental change over the immediate past.

1. Decline in suitable habitats due to the severe 2019-20 wildfires.

This is summarised in the data on fire impacts in [Tables 6.2 and 6.3](#), above. Considering the total area of highlands above 1000m ASL plus the extent of dry rainforest and vine thickets below this contour down to 500m ASL, the extent of primary habitat for the Kaputar snail and Slug Community is about 13,263 ha. The 2019-20 fires burnt 6,536 ha or 49.3% of primary habitat.

The severity of the impact was greater for the highlands component, with almost 60% burnt, than for the dry rainforest component. This is significant because several of the endemic species of the ecological community are limited to the highlands, notably the Kaputar Pink Slug. Another factor to consider is that the 2019-20 fires were additional to the extensive 2006 fires that only 13 years earlier burnt 15,000 ha of Kaputar National Park. It is not yet known how much of the area was burnt twice by these successive fires and how much total area was burnt by both fire events.

To be completed. We can access records for the fire events since 1970 to determine the area and habitats burnt. The same data in Table 6.2 for 2019 can be presented for some earlier fires.

In effect, about half the extent of habitats for the ecological community were impacted by the 2019-20 fires.

2. Estimated direct impacts of wildfires to endemic snail species from the ecological community.

Marsh et al. (2021) included data on six members of the Kaputar Snail and Slug Community in their analysis of distributional overlaps with the 2019-20 wildfires ([Table 6.5](#)). All six species are snails considered to be endemic to the Kaputar region and the ecological community, at the time of the study. The distributional overlap of all fires of any intensity was in the range 25 to 100%, with median and mean values of 44 to 47%. Given severe fires were less extensive in this fire event on Mt Kaputar, the overlap with severe fires is low, in the range 1 to 50% with median and mean values of 9 to 13%. While there is some variation among snail taxa, the analysis indicates that just under half the key endemic snail populations and the ecological community overlapped with the extent of the fire. This accords with the estimate of primary habitats impacted by fire in point 1, above.

Table 6.5. Distributional overlap with the 2019-20 fires for selected snail species that are endemic members of the Kaputar Snail and Slug Community, and included as part of the Assessment of the 2019-20 wildfires on invertebrate species.

Species name	Common name	No. filtered records	Distributional overlap (%) - ALL fire	Distributional overlap (%) - SEVERE fire
<i>Austrochloritis kaputarensis</i> *	Mount Kaputar Bristle Snail	14	39.43	0.65
<i>Austrochloritis nandewarensis</i>	Nandewar Carnivorous Snail	28	25.43	3.80
<i>Brevisentis kaputarensis</i>	Mount Kaputar Glass-snail	38	26.34	1.59
<i>Kaputarensis nandewarensis</i>	Nandewar Pinhead Snail	2	100.00	50.00
<i>Scelidoropa nandewar</i>	Nandewar Range Pinwheel Snail	7	47.59	11.93
<i>Vitellidelos kaputarensis</i>	Mount Kaputar Carnivorous Snail	17	43.78	9.36
Average overlap			47.10	12.89
Median overlap			43.78	9.36

Source: Marsh et al (2021) Appendix 3 Table of the distributional overlap with fire for the 191 invertebrate species listed as provisional priority species in April 2020.

Note that SEVERE fire comprises GEEBAM 4 and 5 classes; mild fire comprises the average overlap of GEEBAM 3 class and GEEBAM 2 and 3 classes; and ALL fire is the sum of overlaps with severe and mild fires.

*Shea and Kohler (2020) determined *Austrochloritis kaputarensis* to conspecific with *Austrochloritis niangala* and that the name *A. niangala* has priority for this taxon. The information is presented here as cited by Marsh et al (2021).

This impacts from the 2019-20 fires on key habitats and endemic snail population represents at least a **severe** rate of continuing detrimental change as indicated by a **severe** intensification in degradation across most of its geographic distribution. The Committee therefore considers that the ecological community has met the relevant elements of Criterion 5 to make it eligible for listing as **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.

No quantitative IUCN analysis was available to assess the risk of collapse to the ecological community. Under Criterion E, the status of the ecological community was concluded to be Data Deficient (DD).

6.3 Public consultation

Notice of the proposed listing and consultation documents were made available for public comment for a minimum of 30 business days between DATE1 and DATE2. Any comments received that were relevant to the assessment of the ecological community were considered by the Committee as part of the assessment process.

Appendix A - Species lists

This Appendix lists various native species that are relevant to the ecological community and gives context for the species assemblage. [Table 1.3](#), above, lists the land snail and slug species present in the ecological community and the Kaputar subregion. [Table A1](#) provides context, listing the land snail and slug species present in the broader vicinity in and around the Kaputar subregion. The vegetation communities of Kaputar are discussed in [Appendix B](#). The habitats for the ecological community also include animals, fungi, cryptogamic plants and other species; however, these are not listed and, except for the vertebrate animals, are relatively poorly documented.

The gastropod species listed may be abundant, rare, or not necessarily be present in any given occurrence of the ecological community. Other native gastropod species not listed here may be present. Given

Species presence and relative abundance varies naturally across the range of the ecological community based on factors such as historical biogeography, exposure to heat and desiccation, moisture content, topography, depth of leaf litter, presence of fallen logs and rock crevices for shelter, and climate. They also change over time, for example, in response to disturbance by fire, or to the climate and weather (e.g. seasons, floods, drought and extreme heat or cold). The species recorded at a particular site can also be affected by sampling scale, season, effort and expertise. In general, the number of species recorded is likely to increase with the size of the site and with survey effort and methods.

Scientific names used in this Appendix are nationally accepted names as per the Atlas of Living Australia, as at the time of writing.

Table A1. Land snail species present in the Kaputar (NAN03) and adjoining IBRA subregions. Undescribed but informally recognised taxa are not included in this list (except for the iconic Kaputar pink slug), noting that such taxa are included in the assemblage for the ecological community presented in [Table 1.3](#).

Scientific name	Common name	Family	Subregional presence			
			Kaputar NAN03	Peel NAN04	Northern Basalts BBS21	Liverpool Plains BBS25
Member species of the Kaputar snail and slug community						
<i>Annabellia bingara</i>	New England carnivorous snail	Rhytididae	X	X		
<i>Austrochloritis kaputarensis</i> *	Mount Kaputar bristle snail	Camaenidae	X			
<i>Austrochloritis niangala</i> *	Tamworth uplands bristle snail	Camaenidae	X	X		
<i>Austrochloritida nandewarensis</i>	Nandewar carnivorous snail	Rhytididae	X	X		
<i>Brevisentis kaputarensis</i>	Mount Kaputar glass-snail	Helicarionidae	X	X	X	
<i>Cralopa kaputarensis</i>	bronze rippled pinwheel snail	Charopidae	X			
<i>Discocharopa stenomphala</i>	off-white pinwheel snail	Charopidae	X	X		
<i>Elsothera funerea</i>	Grim Reaper pinwheel snail	Charopidae	X	X	X	X
<i>Galadistes pustulosa</i>	Mount Kaputar woodland snail	Camaenidae	X	X	X	X
<i>lotula microcosmos</i>	minuscule pinhead snail	Punctidae	X	X		
<i>Kaputaresta nandewarensis</i>	Nandewar pinhead snail	Punctidae	X			
<i>Levidens ponderi</i>	coarse-grooved glass-snail	Helicarionidae	X	X		
<i>Scelidoropa nandewar</i>	Nandewar Range pinwheel snail	Charopidae	X			
<i>Thersites novaehollandiae</i>	Dorrigo rainforest snail	Camaenidae	X			
<i>Triboniophorus</i> sp. nov. 'Kaputar'	Kaputar pink slug	Anthoracophoridae	X			

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Scientific name	Common name	Family	Subregional presence			
			Kaputar NAN03	Peel NAN04	Northern Basalts BBS21	Liverpool Plains BBS25
<i>Vitellidelos kaputarensis</i>	Mount Kaputar carnivorous snail	Rhytididae	X	X		
Other native snail and slug species present in, or the vicinity of, the Kaputar subregion						
<i>Acheronopa attunga</i>	Attunga pinwheel snail	Charopidae		X		
<i>Arion ater</i>		Arionidae		X		
<i>Austrochloritis liverpoolensis</i>	Liverpool Range bristle snail	Camaenidae		X		
<i>Austrochloritis nundinalis</i>	Nundle bristle snail	Camaenidae		X		
<i>Austrochloritis timorensis</i>	Timor Caves bristle snail	Camaenidae		X		
<i>Austrosuccinea</i> sp.		Succineidae		X	X	
<i>Bradybaena similis</i>		Camaenidae		X		X
<i>Brevisentis atratus</i>	black jewel glass- snail	Helicarionidae		X		
<i>Cylindrovertilla hedleyi</i>	Hedley's amber pupasnailed	Pupillidae				X
<i>Decoriopea lirata</i>	beautiful pinwheel snail	Charopidae		X		
<i>Discocharopa aperta</i>	miniscule white pinwheel snail	Charopidae	X	X		
<i>Euconulus fulvus</i>	brown beehive snail	Euconulidae		X		
<i>Fastosarion freycineti</i>	crimson foot semi- slug	Helicarionidae		X		
<i>Galadistes allenii</i>	Dubbo woodland snail	Camaenidae				X
<i>Galadistes interveniens</i>	Collarenebri woodland snail	Camaenidae		X	X	X
<i>Galadistes liverpoolensis</i>	Liverpool Range woodland snail	Camaenidae		X		X
<i>Galadistes pilligaensis</i>	Pilliga Scrub woodland snail	Camaenidae				X
<i>Galadistes</i> sp.		Camaenidae		X		
<i>Gastrocopta hedleyi</i>	Brigalow pupasnailed	Pupillidae		X	X	X
<i>Gastrocopta pedicula</i>	weakly toothed pupasnailed	Pupillidae		X	X	X
<i>Gastrocopta strangei</i>	Strange's pupasnailed	Pupillidae		X		X
<i>Glacidorbis hedleyi</i>		Glacidorbidae	X			
<i>Glyptopupoides egregia</i>	ribbed pupasnailed	Pupillidae		X		
<i>Gouldiropa carlessi</i>	Yarramanbully pinwheel snail	Charopidae		X		
<i>Jimbouria chrisalleni</i>	Boggabri black soil snail	Camaenidae				X
<i>Macrophallikioropa belli</i>	Bell's pinwheel snail	Charopidae		X		
<i>Neveritis aridorum</i>	nomadic velvet snail	Camaenidae		X	X	X
<i>Nitor</i> sp.		Helicarionidae	X			
<i>Omegapilla australis</i>	bronze pupasnailed	Pupillidae		X		
<i>Paralaoma caputspinulae</i>	prickle pinhead snail	Punctidae	X	X	X	X
<i>Plotiopsis balonnensis</i>		Thiaridae		X	X	X
<i>Ponderconcha gilberti</i>	Darling Downs woodland snail	Camaenidae			X	
<i>Ponderconcha ianthostoma</i>	Granite Belt woodland snail	Camaenidae			X	
<i>Posticobia brazieri</i>		Tateidae				X
<i>Pseudiotula euryiana</i>	Timor Caves pinhead snail	Punctidae		X		
<i>Pumilicopta bifurcata</i>	many-toothed pupasnailed	Pupillidae		X		
<i>Pupisoma porti</i>	tall toothless pupasnailed	Pupillidae		X		
<i>Pupisoma</i> sp.		Pupillidae		X		
<i>Pupoides pacificus</i>	single-toothed pupasnailed	Pupillidae		X	X	X
<i>Scelidoropa sarahjaneae</i>	wide-ranging pinwheel snail	Charopidae		X		

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Scientific name	Common name	Family	Subregional presence			
			Kaputar NAN03	Peel NAN04	Northern Basalts BBS21	Liverpool Plains BBS25
<i>Stanisiccia macintyrensis</i>	Ashford woodland snail	Camaenidae			X	
<i>Strangesta</i> sp.		Rhytidae		X		
<i>Thersites</i> sp.		Camaenidae	X			
<i>Thiara</i> sp.		Thjiaridae		X		
<i>Triboniophorus graeffei</i>	red-triangle slug	Anthoracophoridae		X		
<i>Vitellidelos costata</i>	strong-ribbed carnivorous snail	Rhytididae		X		
<i>Zonitoides arboreus</i>	orchid snail	Gastrodontidae		X		
Introduced snail and slug species present in, or the vicinity of, the Kaputar subregion						
<i>Cornu aspersum</i>	common garden snail	Helicidae		X		
<i>Deroceras panormitanum</i>	brown field slug	Agriolimacidae		X		
<i>Deroceras reticulatum</i>	grey field slug	Agriolimacidae	X	X		
<i>Deroceras</i> sp.		Agriolimacidae		X		
<i>Lehmannia nyctelia</i>	striped field slug	Limacidae	X	X		
<i>Lehmannia</i> sp.		Limacidae		X		
<i>Limax maximus</i>	leopard slug	Limacidae		X		

Source: Atlas of Living Australia records for land gastropods present within the Kaputar subregion and immediately adjacent subregions. Data downloaded October 2021. Names were checked and aligned with the Australian Faunal Directory (ABRS 2021).

*Shea and Kohler (2020) determined *Austrochloritis kaputarensis* to conspecific with *Austrochloritis niangala* and that the name *A. niangala* has priority for this taxon.

Table A2. Nationally listed threatened species that are known to, likely to, or may occur within and around Mt Kaputar National Park.

Scientific name	Common name	EPBC status
Plants		
<i>Androcalva procumbens</i>		Vulnerable
<i>Cadellia pentastylis</i>	Ooline	Vulnerable
<i>Callistemon pungens</i>	a bottlebrush	Vulnerable
<i>Dichanthium setosum</i>	a bluegrass	Vulnerable
<i>Euphrasia arguta</i>		Critically Endangered
<i>Homopholis belsonii</i>	Belson's Panic	Vulnerable
<i>Lepidium monoplacoides</i>	Winged Pepper-cress	Endangered
<i>Prasophyllum</i> sp. Wybong (C.Phelps ORG 5269)	a leek-orchid	Critically Endangered
<i>Thesium australe</i>	Austral Toadflax, Toadflax	Vulnerable
<i>Tylophora linearis</i>		Endangered
Reptiles		
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink, Long-legged Worm-skink	Vulnerable
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard, Pink-tailed Legless Lizard	Vulnerable
<i>Uvidicolus sphyrurus</i>	Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko	Vulnerable
Birds		
<i>Anthochaera phrygia</i>	Regent Honeyeater	Critically Endangered
<i>Calidris ferruginea</i>	Curlew Sandpiper	Critically Endangered
<i>Erythrorhynchus radiatus</i>	Red Goshawk	Vulnerable
<i>Falco hypoleucos</i>	Grey Falcon	Vulnerable
<i>Geophaps scripta</i>	Squatter Pigeon (southern)	Vulnerable
<i>Grantiella picta</i>	Painted Honeyeater	Vulnerable
<i>Hirundapus caudacutus</i>	White-throated Needletail	Vulnerable
<i>Lathamus discolor</i>	Swift Parrot	Critically Endangered
<i>Leipoa ocellata</i>	Malleefowl	Vulnerable
<i>Polytelis swainsonii</i>	Superb Parrot	Vulnerable
<i>Rostratula australis</i>	Australian Painted Snipe	Endangered
Mammals		
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	Vulnerable
<i>Dasyurus maculatus</i> (SE mainland population)	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat, South-eastern Long-eared Bat	Vulnerable
<i>Petauroides volans</i>	Greater Glider	Vulnerable
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Vulnerable
<i>Phascogale cinereus</i> (Queensland, NSW, ACT)	Koala (populations of Queensland, NSW, ACT)	Vulnerable
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Vulnerable

Source: DAWE (2021a) Species Profile and Threats database. EPBC status refers to species listed under the EPBC Act at the time this document was prepared.

Note that these taxa may not necessarily directly interact or overlap with the Kaputar snail and slug community or its habitats. However, they represent other Matters of National Environmental Significance to take into consideration for any activities in the area of interest.

Appendix B – Additional information relevant to the ecological community.

B1. Relationship to other vegetation classification and mapping systems

Ecological communities are complex to classify. States and Territories apply their own systems to classify vegetation communities. Reference to vegetation and mapping units as equivalent to the ecological community, at the time of listing, should be taken as indicative rather than definitive. A unit that is generally equivalent may include elements that do not meet the key diagnostics and minimum condition thresholds. Conversely, areas mapped or described as other units may sometimes meet the key diagnostics for the ecological community. Judgement of whether the ecological community is present at a particular site should focus on how the site meets the description ([section 1.2](#)), the key diagnostic characteristics ([section Error! Reference source not found.](#)) and minimum condition thresholds ([section 0Error! Reference source not found.](#)).

State vegetation mapping units are not the ecological community being listed. However, for many sites (but not all) certain vegetation map units will correspond sufficiently to provide indicative mapping for the national ecological community, where the description matches.

On-ground assessment is vital to finally determine if any patch is part of the ecological community.

Table B1. Major vegetation subgroups present within the area of interest (Kaputar subregion (NAN03 plus 10 km buffer around the subregion. Comparisons are made for the extent above and below the 1000m ASL contour line.

Major Vegetation Subgroup (MVS)	Lower elevation <1000m ASL (ha)	Higher elevation 1000m+ ASL (ha)
Callitris forests and woodlands	34,620	14
Casuarina and Allocasuarina forests and woodlands	7,423	198
Dry rainforest or vine thickets	10,464	6
Eucalyptus open forests with a grassy understorey	300	-
Eucalyptus open forests with a shrubby understorey	382	8,206
Eucalyptus open woodlands with a grassy understorey	1,827	-
Eucalyptus open woodlands with shrubby understorey	2	-
Eucalyptus woodlands with a shrubby understorey	16,332	-
Eucalyptus woodlands with a tussock grass understorey	48	-
Eucalyptus woodlands with ferns, herbs, sedges, rushes or wet tussock grassland	66,966	1,432
Heathlands	1,936	569
Mallee with an open shrubby understorey	117	-
Mallee with hummock grass	1,855	-
Other Acacia tall open shrublands and shrublands	95	-
Other tussock grasslands	273	-
Temperate tussock grasslands	6,550	-
Wet tussock grassland with herbs, sedges or rushes, herblands or ferns	6	-
Salt lakes and lagoons	19	-
Unclassified/Unknown/No data	29,325	-
Cleared, non-native vegetation, buildings	50,401	-
Regrowth or modified forests and woodlands	26,919	580
Grand Total	255,875	11,004

Source: DAWE (2021b)

Table B2. NSW vegetation formations, classes and Plant Community Types (by identification number) present in the Kaputar subregion (NAN03).

Vegetation Formation	Vegetation Class	Plant Community Type ID
Dry Sclerophyll Forests (Shrub/grass sub-formation)	New England Dry Sclerophyll Forests	530, 542, 550, 568, 572, 1396
	North-west Slopes Dry Sclerophyll Woodlands	228, 413, 418, 429, 432, 435, 506, 543, 549, 562, 563, 587, 588, 591, 594, 597, 598, 1165, 1306, 1308, 1317, 1387
	Pilliga Outwash Dry Sclerophyll Forests	141
Dry Sclerophyll Forests (Shrubby sub-formation)	Northern Tableland Dry Sclerophyll Forests	538, 551, 558, 578, 675, 1116, 1341, 1382
	Southern Tableland Dry Sclerophyll Forests	701
	Western Slopes Dry Sclerophyll Forests	179, 398, 409, 420, 430, 431, 531, 576, 581, 592, 610, 671, 676, 940, 1307, 1313, 1314, 1316, 1381
	Yetman Dry Sclerophyll Forests	422, 791, 1380
Forested Wetlands	Eastern Riverine Forests	84, 1270
	Inland Riverine Forests	78, 112
Freshwater Wetlands	Inland Floodplain Swamps	53, 361, 447
	Montane Bogs and Fens	582, 766
Grasslands	Semi-arid Floodplain Grasslands	52
	Temperate Montane Grasslands	586
	Western Slopes Grasslands	460, 619, 710, 1076
Grassy Woodlands	Floodplain Transition Woodlands	81, 244
	New England Grassy Woodlands	501, 510, 571, 704, 1118, 1171
	Tableland Clay Grassy Woodlands	525, 921, 1099
	Western Slopes Grassy Woodlands	202, 281, 421, 434, 436, 437, 444, 451, 511, 516, 544, 589, 590, 593, 599, 711, 1315, 1329, 1383
Heathlands	Northern Montane Heaths	446, 520, 521, 574, 884
Rainforests	Dry Rainforests	547, 1124
	Western Vine Thickets	113, 147, 378, 445, 452
Semi-arid Woodlands (Grassy sub-formation)	Brigalow Clay Plain Woodlands	101
	North-west Floodplain Woodlands	55
	Riverine Plain Woodlands	27
Semi-arid Woodlands (Shrubby sub-formation)	Inland Rocky Hill Woodlands	427, 439
	North-west Alluvial Sand Woodlands	428
	Western Peneplain Woodlands	145
Wet Sclerophyll Forests (Grassy sub-formation)	Northern Tableland Wet Sclerophyll Forests	1166

Source: NSW DPIE (2021) Bionet Vegetation Classification database accessed 24 Sept 2021.

Table B3: Recommended broad fire regimes for each of the ten plant communities identified by Hunter and Alexander (2015).

Community	Suggested Fire Regimes
1 River Oak Riparian Forests & 'Dry Rainforest' Found exclusively in protected open depressions at lower altitudes, often associated with deeply incised gorges. Generally, very good condition though many sites do have significant weed infestations.	No requirement for fire. Fires will be detrimental to this community, as River Oak, River Red Gum and 'Dry Rainforest' taxa are all excluded by fire.
2 White Box – Rough Barked Apple Woodlands Found along less protected creeks at lower altitudes but occasionally above creeks on flatter topography. Generally, in relatively good condition, being in inaccessible locations.	No fires within a 10 yr. period. Fires generally within a 10 to 30 yr. period and a maximum of 50 yrs. However, where <i>Callitris</i> is present generally a 30 to 100 yr. fire interval to maintain the mixed nature of the dominants.
3 White Box – Cypress Pine Woodlands More common on slopes throughout the reserve except at higher altitudes. Variable condition - some areas highly intact while other areas show significant previous impacts, especially secondary grasslands and shrublands.	No two fires within a 15 yr. period. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr. period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches and only followed by feral animal control. Generally, a 30 to 100 yr. fire interval to maintain the mixed nature of the dominants.
4 Narrow-leaved Ironbark – Cypress Woodlands Usually on slopes, upper or lower, rarely on crests or open depressions. Generally in very good condition.	
5 New England Blackbutt – Stringybark Open Forests Found throughout the upper altitudes particularly in the central portion. Usually on crests, upper slopes or mid slopes but rare on lower slopes. Generally, in very good condition.	No two fires within a 30 yr. period. Fires to be within a 50 to 200 yr. cycle. Small low intensity fires may occur of higher frequency but only in small patches and only followed by feral animal control.
6 Stringybark – New England Blackbutt Open Forests Found throughout the reserve at higher altitudes, mainly upper slopes or mid slopes and rarely crests. Generally, in good condition.	
7 Mountain Gum – Ribbon Gum Open Forests Only in the south eastern portion of the study area, usually on lower slopes or open depressions. In reasonable condition. Some areas have been previously cleared for grazing. Pigs are rutting in some localities.	No two fires within a 50 yr. period. Fires to be within a 50 to 200 yr. cycle. Small low intensity fires may occur of higher frequency but only in small patches and only followed by feral animal control.
8 Stringybark – Fern Open Forests Restricted to the southern and central sections of the study area, mainly open depressions but also mid slopes. In good condition.	
9 Lowland Outcrop Shrublands Restricted to crests and upper slopes on rock outcrops. Very good condition, intact. Goats can pose a threat and were noted in this community.	No requirement for fire. Fire intervals of larger intervals probably preferred. No two fires within a 20 yr. period and fires generally 50 yrs.+ to indefinite.
10 Highland Outcrop Shrublands Restricted to the central and southern portions of the study region, on rock outcrops on mid or lower slopes. Very good condition, very intact. Goats can pose a threat.	

Source: Hunter & Alexander (2015) Table 5 Suggested fire recommendations for communities.

B2. Weather record data downloaded and used in analyses

Table B4. Weather station data for which weather records were downloaded for various analysis.

Station no.	Station name	Elevation (m ASL)	Year open	Records examined
054151	Narrabri (Mt Kaputar NP)	1,450	1981	Monthly Mean Daily Global Solar Exposure (MJ/m ²) [since 1990] Monthly Rainfall (mm) [since 2000]
054105	Bundarra (Granite Heights)	880	1965	Monthly Rainfall (mm)
054021	Barraba (Mount Lindsay)	869	1886	Monthly Mean Daily Global Solar Exposure (MJ/m ²) [since 1990] Monthly Rainfall (mm)
055082	Orabah (Manilla (Warrabah))	853	1959	Monthly Rainfall (mm)
054000	Bundarra (Araluen)	740	1926	Monthly Rainfall (mm)
056180	Bundarra (South Winscombe)	715	1965	Monthly Rainfall (mm)
056006	Bundarra Post Office	654	1883	Monthly Rainfall (mm)
054117	Cobbadah (Rocky Glen)	646	1965	Monthly Rainfall (mm)
054102	Barraba (Rosevale)	620	1964	Monthly Rainfall (mm)
054023	Barraba (Neranghi)	563	1908	Monthly Rainfall (mm)
054003	Barraba (Clifton Lane)	499	1900	Monthly Rainfall (mm)
054153	Caroda (Paleroo)	488	1954	Monthly Rainfall (mm)
054125	Caroda (Roseberry Park)	462	1967	Monthly Rainfall (mm)
054138	Upper Horton (Dunbeacon)	392	1974	Monthly Rainfall (mm)
055076	Boggabri (Kanownda)	320	1899	Monthly Rainfall (mm)

Source: Bureau of Meteorology (2021). Data downloaded during October 2021.

Note that rainfall records from several weather stations around Kaputar contain gaps, particularly so for the years since 2000 to 2020. Similarly, with regard to maximum temperature records, there are surprisingly few stations in the vicinity of Mt Kaputar that are at altitude and have collected long-term (>50 years) datasets.

Patterns of annual rainfall focussed on data from 1960 to 2020 from ten stations at elevations of 499 to 880m ASL, and collated data for years in which at least three weather stations had records.

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Consultation draft	Draft Conservation Advice for the Mount Kaputar Highland and Rainforest Snail and Slug Community	13 Dec 2021
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