Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Plant assemblages of the Billeranga System as originally described in Beard (1976)
Other names:	Billeranga System
Description:	The community occurs in the Billeranga Hills in the north-eastern Wheatbelt of Western Australia. It comprises: *Melaleuca filifolia — Allocasuarina campestris* thicket on clay sands over laterite on slopes and ridges; open mallee over mixed scrub on yellow sand over gravel on western slopes; *Eucalyptus loxophleba* (York gum) woodland over sandy clay loam or rocky clay on lower slopes and creeklines; and mixed scrub or scrub dominated by *Dodonaea inaequifolia* over red brown loamy soils on the slopes and ridges. The community was originally described in Beard J.S. (1976) "The vegetation of the Perenjori area, Western Australia: Map and explanatory memoir" (1:250,000 series, Vegmap Publications, Perth, Western Australia).
Nomination for:	Listing under BC Act ☒ Change of status ☐ Delisting ☐

1. *Is the ecological community currently on any conservation list, either in a State or Territory, Australia or Internationally?* 2. *Is it present in an Australian jurisdiction, but not listed?*	*Provide details of the occurrence and listing status for each jurisdiction in the following table*

Jurisdiction	**List or Act name**	**Date listed or assessed (or N/A)**	**Listing category eg. critically endangered (or none)**	**Listing criteria eg. B1ab(iii)+2ab(iii) (or none)**
National	EPBC Act	N/A	none	none
Western Australia	Current ranking under WA Minister ESA list in policy	24/11/1999	Vulnerable	A), B)
	Priority list	N/A	1 ☐ 2 ☐ 3 ☐ 4 ☐	
Other State/Territory		N/A	none	none

Nominated conservation status: category and criteria (include recommended status for deleted ecological communities)				
Critically endangered (CR) ☒	Endangered (EN) ☐	Vulnerable (VU) ☐	Collapsed (CO) ☐	
Priority 1 ☐	Priority 2 ☐	Priority 3 ☐	Priority 4 ☐	None ☐

What criteria support the conservation status category for listing as a threatened ecological community or collapsed ecological community? *Refer to Section 32 of the Biodiversity Act 2016 for definition of 'Collapsed', and Appendix 6 table 'IUCN Red List Criteria for ecosystems version 2.2'.*		**CR** B1a(iii),b; B2a(iii),b
Eligibility against the criteria		
*Provide justification for the nominated conservation status; is the ecological community eligible or ineligible for listing against the five criteria. For **delisting**, provide details for why the ecological community no longer meets the requirements of the current conservation status.*		
A.	Reduction in geographic distribution *(evidence of decline)*	☐ **A1** ☐ **A2a** ☐ **A2b** ☐ **A3**
	Justification of assessment under Criterion A.	For criterion A, the ecosystem is assumed collapsed when the mapped distribution declines to zero. • A: It is estimated that the original area of the Billeranga system was 3250 ha (DEC 2000) of which 2461 ha remain. This represents a loss of 24% (mostly from the lower lying areas) of the area of a plant community that was originally restricted in distribution. All locations occur on private land and are adjacent to grazed farmlands. • No available evidence supports an inference that a minimum 30% reduction in geographic distribution has or will occur over any 50-year period, or a 50% reduction since 1750 (ie. the minimum thresholds to meet the category VU under criterion A). • **Based on available evidence, does not meet criterion A.**
B.	Restricted geographic distribution *(EOO and AOO, number of locations and evidence of decline)*	☒ **B1** (specify at least one of the following): ☐ **a)(i)** ☐ **a)(ii)** ☒ **a)(iii)** ☒ **b)** ☐ **c);** ☒ **B2** (specify at least one of the following): ☐ **a)(i)** ☐ **a)(ii)** ☒ **a)(iii)** ☒ **b)** ☐ **c);** ☐ **B3 (only for Vulnerable Listing)**
	Justification of assessment under Criterion B.	For criteria B, the ecosystem is assumed collapsed when the mapped distribution declines to zero. • B1: EOO is 93 km^2 (≤ 2,000 km^2, which is the threshold for CR). • B2: AOO occupies two 10x10 km^2 grid cells (threshold for CR is a maximum of two grid cells). • a) (iii): A spatial imagery NDVI analysis between 1989 and 2019 revealed that there has been a measure of continuing decline in the canopy cover and quality of the vegetation for this community (Robertson 2019 - see Appendix 3). • b): It is inferred that ongoing grazing and weed invasion will cause continuing declines in environmental quality and biotic interactions including decline in vegetation cover and

		increased weed invasion within the next 20 years (see Appendices 1, 3 for details). • c): The community occurs at six threat-defined locations (threshold for EN is five and for VU is ten threat-defined locations). • B3: The community is known from more than 5 threat-defined locations. Does not meet B3. • **Meets criteria for Critically Endangered B1aiii,b; B2aiii,b. Meets VU under B1c, B2c.**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	Damage to the substrate and soil loss, particularly as a consequence of grazing, represent a change to an abiotic variable that is a significant threat to the community. Collapse in this context is loss of the surface soils across the extent of the community. The assumption is that complete loss of soil will result in loss of the characteristic vegetation of the assemblage and replacement with weeds or native species that can tolerate rock substrate. The extent and severity of soil loss has not been measured and requires investigation. Quantitative data that would link loss of substrate with decline of the community are also not available. There are inadequate quantitative data in relation to soil loss to indicate if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50 year period, or decline of (≥50%) or proportional severity of degradation (≥50%) since 1750 to meet VU**.**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☐ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	Loss of vegetation cover as a consequence of grazing in particular, is a significant biotic variable affecting the community. The severity of vegetation loss associated with collapse is uncertain, but it is assumed conservatively that the community reaches a collapsed state when there is a total loss of vegetation cover. Landsat satellite imagery was utilised to assess the change in vegetation cover between 1989 and 2019 (see Appendix 3: Robertson 2019). A vegetation cover change image within the community is shown in Appendix 3, Figure 1 and an area summary is provided in the associated table.

		Inadequate evidence to determine if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of the biotic variable (≥30%) in any 50 year period or threshold for proportion of the extent (≥50%) or proportional severity of disruption of the biotic variable (≥50%) since 1750 to meet VU. **Inadequate information to indicate if the community meets criterion D.**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse. • **Unable to assess criterion E.**

Reasons for change of status
Genuine change ☐ New knowledge ☐ Previous mistake ☐ Review/Other ☒
Provide details: The community was initially ranked as Vulnerable using ranking criteria developed in WA that do not match those in the IUCN Red List Criteria for Ecosystems (version 2.2).

Summary of assessment information *(provide detailed information in the relevant sections of the nomination form)*

EOO	93 km^2	AOO	two 10 x 10 km grid cells
No. occurrences	6	Severely fragmented (justification below)	Yes ☒ No ☐ Unknown ☐
Justification of whether fragmented	The community has historically been heavily cleared and grazed for farmland. Occurrences are surrounded and separated by cleared farmland (See Appendix 2).		
Current known area			2460.91 ha
Pre-industrialisation extent or its former known extent (if known)			3250 ha (DEC 2000)
Estimated percentage decline			24.28%

Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Does not meet criterion A.
A2a	-	• Does not meet criterion A.
A2b	-	• Does not meet criterion A.
A3	-	• Does not meet criterion A.
B1a	CR	• EOO is ≤2,000km^2. • NDVI analysis shows continuing decline in vegetation cover. • Meets criterion for CR.
B1b	CR	• EOO is ≤2,000km^2. • Inferred that ongoing grazing and weed invasion will cause continuing decline within the next 20 years. • Meets criterion for CR.
B1c	VU	• EOO is ≤2,000km^2. • Ecosystem exists at 6 threat-defined locations. • Meets criterion for VU.
B2a	CR	• AOO is 2 grid cells. • NDVI analysis shows continuing decline in vegetation cover. • Meets criterion for CR.
B2b	CR	• AOO is 2 grid cells. • Inferred that ongoing grazing and weed invasion will cause continuing decline within the next 20 years. • Meets criterion for CR.
B2c	VU	• AOO is 2 grid cells. • Ecosystem exists at 6 threat-defined location. • Meets criterion for VU.
B3	-	• Does not meet criterion.
C1	-	• Inadequate evidence to indicate if the community meets criterion
C2	-	• Inadequate evidence to indicate if the community meets criterion
C3	-	• Inadequate evidence to indicate if the community meets criterion
D1	-	• Inadequate evidence to indicate if the community meets criterion.
D2	-	• Inadequate evidence to indicate if the community meets criterion.
D3	-	• Inadequate evidence to indicate if the community meets criterion.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Meets CR B1a,b; B2a,b. Meets VU under B1c, B2c. *The highest risk category obtained by any of the assessed criteria will be the overall risk status of the ecosystem'* (IUCN RLE Guidelines V1.1 page 42). **Meets CR B1aiii,b; B2aiii,b.**

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Summary of location (occurrence) information *(provide detailed information in the relevant sections of the nomination form)*						
Occurrence	Land tenure	Survey information: date of survey	Condition	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
Occurrence 1 (Campbell1)	Private land, Crown Reserve	13/05/99 20/09/99 15/07/08 02/09/08	90% Excellent 10% Very good 60% Excellent 40% Very good 100% Very good -	614.31	Grazing (past) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy, control weeds, maintain fencing
Occurrence 2 (Oxley)	Private land	13/05/99 15/07/08 05/09/08	14% Excellent 20% Very Good 66% Degraded - 80% Very Good 20% Good	44.80	Grazing (past) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy; control weeds control; maintain fencing

Occurrence 3 (Hill3)	Private land	13/05/99 15/07/08 03/09/08	5% Excellent 73% Very good 22% Degraded - 100% Excellent	234.73	Grazing (past, present, future) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy, control weeds control, install fencing
Occurrence 4 (M1A)	Private land	20/09/99 14/07/08 04/09/08	40% Excellent 20% Very good 40% Good - 80% Very good 20% Good	696.76	Grazing (past) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy, control weeds, maintain fencing
Occurrence 5 (M2A)	Private land	13/05/99 20/09/99 14/07/08	95% Excellent 5% Good 30% Excellent 40% Very good 30% Good -	842.33	Grazing (past, present, future) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy, control weeds, install fencing

		01/09/08	10% Excellent 80% Very good 10% Good			
Occurrence 6 (RCM_Transect07_end)	Private land	20/09/99 14/07/08 04/09/08	40% Excellent 20% Very good 40% Good - 80% Very good 20% Good	27.98	Grazing (past) Weed invasion (past, present, future) Too frequent fire (past, present, future)	Develop fire management strategy; control weeds; maintain fencing

*For the purposes of relating condition to IUCN Criteria, condition categories from (Keighery (1994) Vegetation Condition Scale (Government of WA 2000)) are defined below:

Good ('Pristine', 'Excellent', 'Very Good' using Bush Forever (Government of WA 2000) scale): This includes vegetation ranging from 'Pristine' - with no obvious signs of disturbance, to 'Excellent' - Vegetation structure intact, with disturbance only affecting individual species, weeds are non-aggressive species and 'Very Good' - Vegetation structure altered, obvious signs of disturbance eg: from repeated fires, dieback, logging, grazing.

Medium ('Good' using Bush Forever (Government of WA 2000) scale): This includes vegetation categorised as 'Good' - Vegetation structure altered but retains basic vegetation structure or ability to regenerate it, obvious signs of disturbance are present, from activities including partial clearing, dieback and grazing.

Poor ('Degraded' using Bush Forever (Government of WA 2000) scale): This includes vegetation ranging from 'Degraded' Basic vegetation structure severely impacted by disturbance, the vegetation requires intensive management, and disturbance such as partial clearing, dieback, logging and grazing, to 'Completely Degraded' where vegetation structure is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native shrubs and trees.

Beyond recovery ('Completely degraded' using Bush Forever (Government of WA 2000) scale): Vegetation structure is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native shrubs and trees.

Table 1. Known condition of occurrences of the Plant assemblages of the Billeranga System as originally described in Beard (1976).

Condition Ranking (Keighery 1994) from Government of Western Australia 2000	**Hectares**	**IUCN Criteria condition ranking**	**Hectares**
Pristine	0	**Good**	2222.77
Excellent	318.96		
Very Good	1903.81		
Good	238.14	**Medium**	238.14
Degraded	0	**Poor**	0
Completely degraded	0	**Beyond recovery**	0
Total	2460.91	**Total**	2460.91

REFERENCES

Beard, J. S. (1976). Vegetation Survey of Western Australia. The Vegetation of the Perenjori Area, Western Australia. 1:250,000 series. Vegmap Publications, Perth.

Department of Conservation and Land Management (2000). Plant assemblages of the Billeranga System. Interim Recovery Plan No. 71. Department of Conservation and Land Management, Perth.

Government of Western Australia (1997). Memorandum of Understanding between the Commissioner of Soil and Land Conservation, Environmental Protection Authority, Department of Environmental Protection, Agriculture Western Australia, Department of Conservation and Land Management, Water and Rivers Commission for the protection of remnant vegetation on private land in the agricultural region of Western Australia. Western Australian Department of Agriculture, Perth.

Hobbs, R. J. and Mooney, H. A. (1993). Restoration ecology and invasions. In Nature Conservation 3: Reconstruction of Fragmented Ecosystems. pp 127-133, Saunders, D. A., Hobbs, R. J. and Ehrlich, P. R. (eds). Surrey Beatty and Sons: NSW.

Keighery, B. J. (1994). Bushland Plant Survey. A Guide to Plant Community Survey for the Community. Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.

Robertson, P. L. (2019). Vegetation cover assessment for "Plant assemblages of the Billeranga System as described by Beard (1976)" using satellite imagery. Unpublished internal report for the Department of Biodiversity, Conservation and Attractions, Kensington.

Sudmeyer, R., Edward, A., Fazakerley, V., Simpkin, L. and Foster, I. (2016). Climate change: impacts and adaptation for agriculture in Western Australia. Bulletin 4870, Department of Agriculture and Food, Western Australia, Perth.

APPENDIX 1 THREATS

Clearing

The most recent major clearing of the Billeranga System was mostly on the lower-lying areas and occurred approximately 50 years ago (DEC 2000). New proposals for clearing would be subject to various legislative controls.

Grazing

Grazing by sheep and other introduced herbivores has caused alterations to the species composition of much of the occurrences by the selective grazing of edible species, the introduction of weeds and nutrients, trampling and general disturbance. Overstorey was in good condition, with understorey grazed in the late 1990s/early 2000s. Occurrences 1, 2, 4 and 6 were fenced 10 years ago but it is uncertain if the occurrences are still fenced as there has been a lack of any recent survey for this community.

Weed invasion

Weeds can have significant impacts through competition with native species, preventing regeneration and altering fire regimes (Hobbs and Mooney 1993). Disturbances such as fires and grazing can predispose areas to weed invasion if weed propagules are present. All of the occurrences of this community are close to agricultural areas that act as weed sources and are vulnerable to weed invasion following any disturbance. Records from over 15 years ago state that weed invasion was high in most occurrences (DEC 2000).

Altered fire regimes

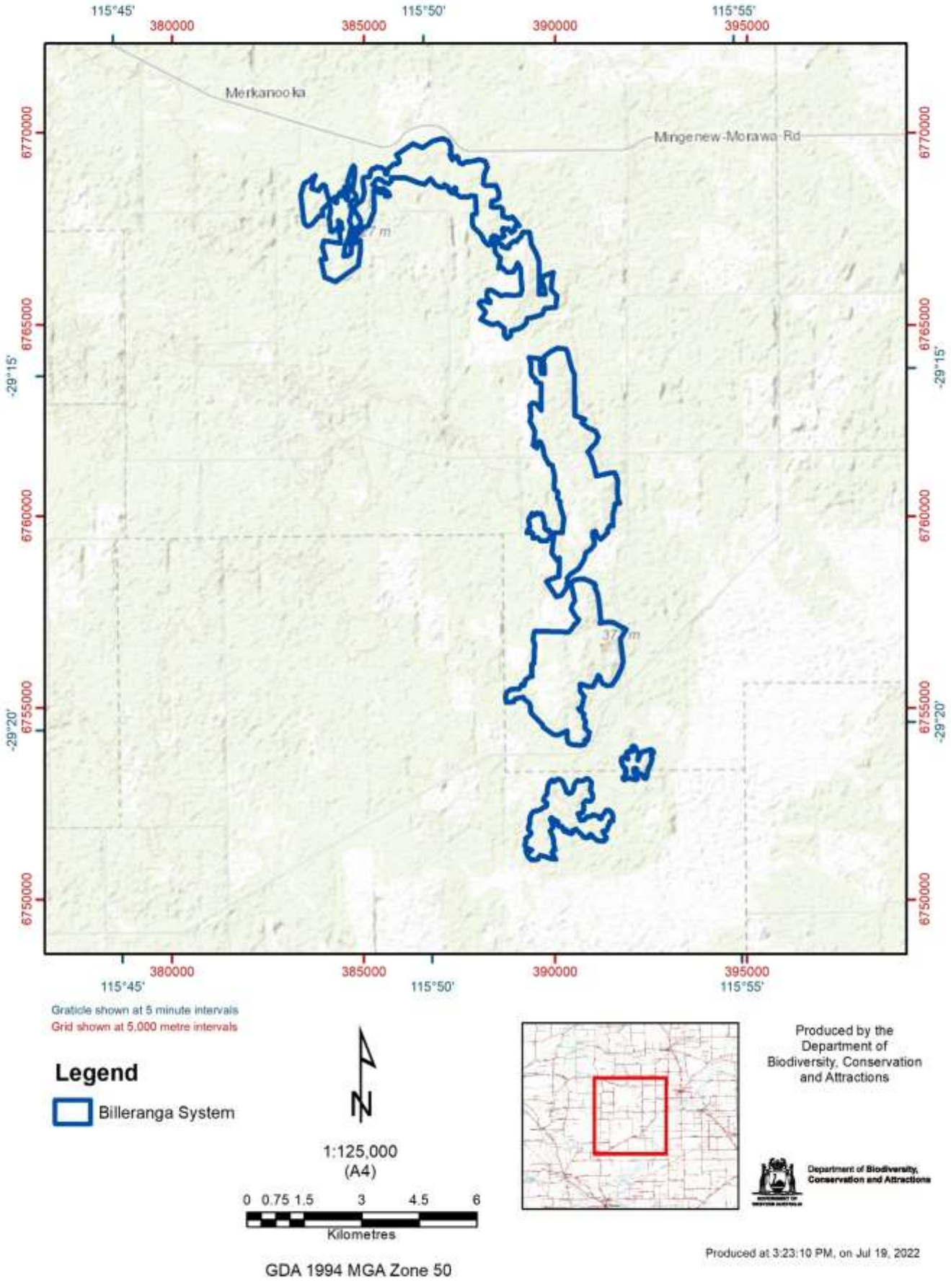
Fire can cause alterations to the species composition by increasing the number of weeds. Altered fire regimes can prevent species from completing growth and reproductive cycles. The risk of fire is increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the original native species in the understorey.

Warming and drying climate

The community is at risk from a drying and warming climate resulting from a decline in rainfall and increased temperatures in the south west of the state. The tolerance of particular species to changes that may occur in association with climate change, including changes in rainfall and temperatures, is generally unknown. According Sudmeyer (2016), climate change predictions for the south west of WA are as follows:

- By 2030, mean annual temperature is projected to increase by 0.5–1.2°C.
- Reduction in rainfall by 2030 by 2-14%, the southwest is predicted to experience some of the largest reductions in rainfall in all of Australia.
- Reduction in runoff by 10-42% (median 24%) by 2030.
- Decline in groundwater levels by 2030 (extractive yields may decrease by a third to a half in some areas).
- Increase in the intensity and frequency of bushfires.

APPENDIX 2: Distribution map



APPENDIX 3: NDVI ANALYSIS

Vegetation cover assessment for "Plant assemblages of the Billeranga System as described by Beard (1976)" using satellite imagery.

[redacted] Department of Biodiversity, Conservation and Attractions
[redacted]

Introduction

The plant assemblages of the Billeranga System (Beard 1976) cover the outcrop of Proterozoic rocks located in the Billeranga Hills. There are ongoing impacts of clearing, grazing, weed invasion and altered fire regimes. The community is present in 6 occurrences that cover a total of 2460 ha.

In the past 50 years there has been significant technological advances in the usage of satellites for gathering remote sensing data. The development of specialised multispectral cameras has been instrumental in gathering critical data regarding our environment on a global scale. One of the most widespread applications of this technology has been the use of remote sensing data for vegetation mapping and monitoring. Healthy plant absorbs a lot of visible light and reflects a large portion of near-infrared light, whereas unhealthy or sparse vegetation absorbs more visible light and reflects less near-infrared light. The most common method for visualising vegetation is through the use of Normalised Difference Vegetation Index (NDVI).

The objective of this study was to perform a vegetation cover analysis of the Billeranga community using NDVI datasets from satellite imagery in order to provide an estimate of vegetation cover density changes from 1989 to 2019.

Methods

Study Area
The study area comprised the six occurrences of the Billeranga community located on the Billeranga Hills situated in the state of Western Australia. This area represents a total of 2460 ha.

Datasets
The exact location of the Billeranga threatened ecological community (TEC) was sourced from the Department of Biodiversity, Conservation and Communities TEC database.

The satellite imagery was sourced from the Landsat 5 and Landsat 8 satellites which are archived and freely available from the U.S Geological Survey website. We only selected imagery from March and April as they represent the southern hemisphere autumn, which is the harshest season for vegetation in Western Australia and will therefore show the maximum extent of vegetation degradation. The specific dates we used were the 17/03/1989 and the 05/04/2019. The imagery was processed to take into account atmospheric disturbance and cloud cover.

Data analysis
The satellite imagery data was analysed within ArcMap version 10.6.1 and QGIS version 2.18.16. NDVI rasters were created with the ArcMap Image Analysis function and bands 3 and 4 from the Landsat imagery which represent the red band and infra-red bands respectively. The symbology was then classified into 6 distinct classes of increasing vegetation density ranging from -0.1 to 0.5 NDVI.

The NDVI data was then imported in QGIS and the raster statistics from the distinct classes were exported with the Semi-Automatic Classification plugin into a CSV table to be summarised.

Results

Our NDVI analysis over 30 years indicated that there has been a significant degradation of vegetation density and health between 1989 and 2019. The most notable changes were for the densely vegetated 0.3 to 0.4 NDVI class which experienced a 55% decline in area and the very densely vegetated 0.4 to 0.5 NDVI class which experienced a 93% decline in area (Table 1). This decline is mainly concentrated in the four southern occurrences. Overall the vegetation of this area has transitioned from relatively large and dense patches of vegetation to small fragmented areas of healthy vegetation (Fig. 1)

Table 1. NDVI satellite imagery classification and area.

		1989 Landsat imagery		2019 Landsat Imagery	
NDVI	Vegetation Density	Area (ha)	Percentage	Area (ha)	Percentage
-0.1 – 0.0	Bare soil	0	0 %	0.63	0.03 %
0.0 – 0.1	Bare soil	29.88	1.21 %	2.79	0.11 %
0.1 – 0.2	Very low	377.91	15.35 %	355.05	14.42 %
0.2 – 0.3	Low	967.86	39.32 %	1631.79	66.29 %
0.3 – 0.4	Medium	1017.72	41.34 %	466.47	18.95 %
0.4 – 0.5	High	68.31	2.77 %	5.04	0.20 %

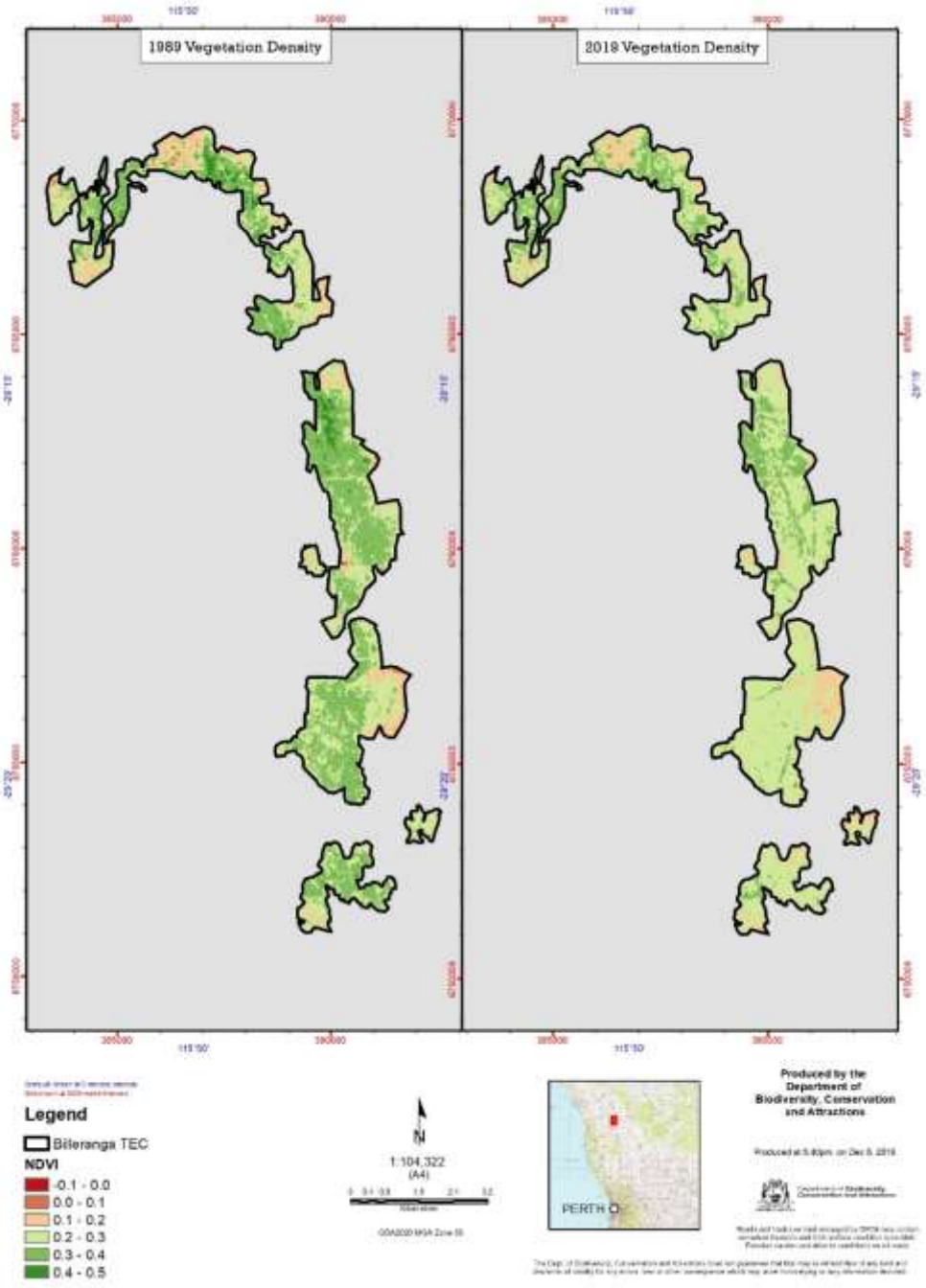
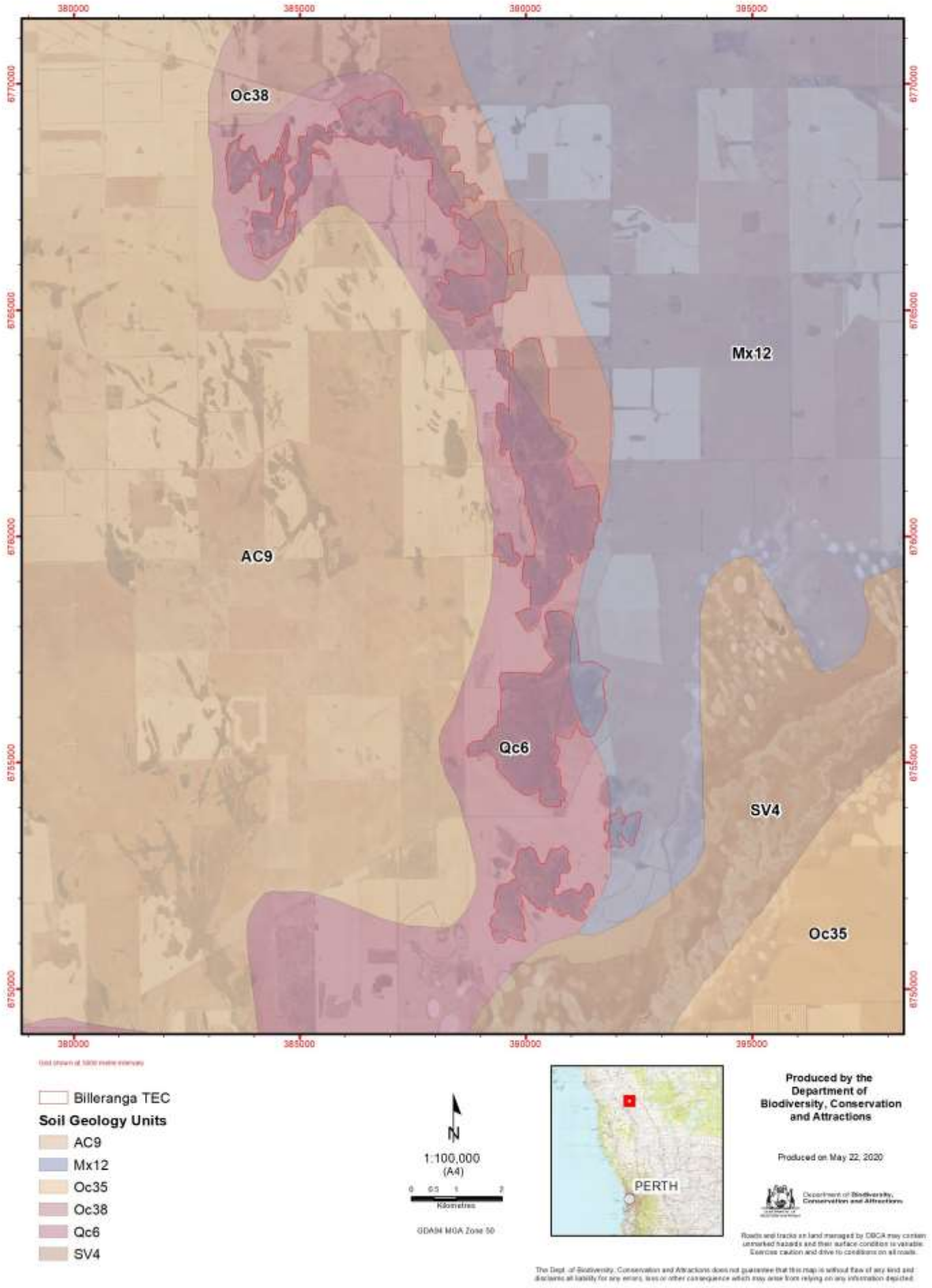


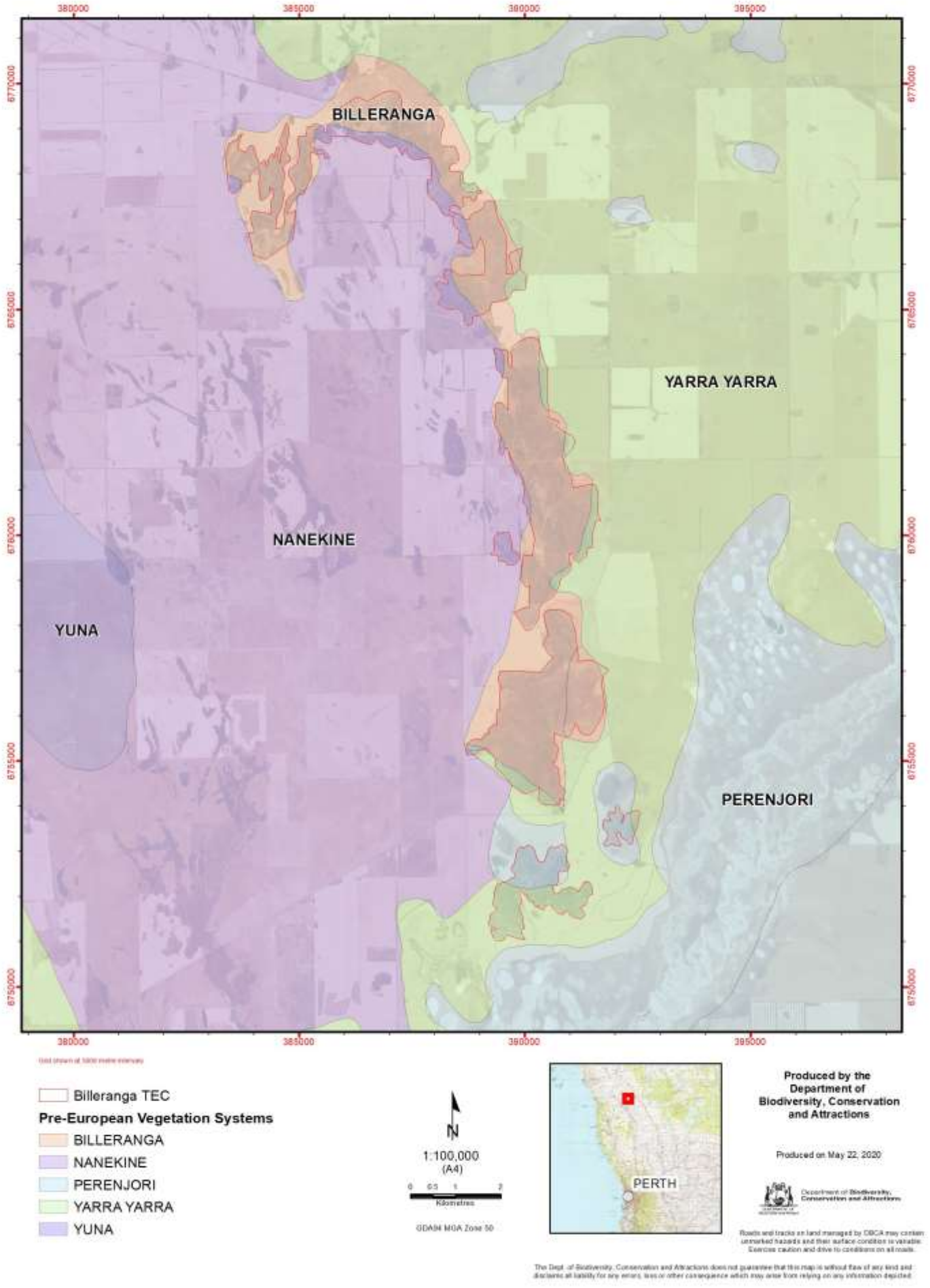
Fig. 1 – NDVI map of the Billeranga System TEC in 1989 and 2019. High NDVI values indicate denser and healthier vegetation (illustrated here in increasing shades of green).

NDVI	INTERPRETATION
0 – 0-1	Bare soil
0.1 – 0.2	Almost absent canopy cover
0.2 – 0.3	Very low canopy cover
0.3 – 0.4	Low canopy cover, low vigour or very low canopy cover, high vigour
0.4 – 0.5	Mid-low canopy cover, low vigour or low canopy cover, high vigour
0.5 – 0.6	Average canopy cover, low vigour or mid-low canopy cover, high vigour
0.6 – 0.7	Mid-high canopy cover, low vigour or average canopy cover, high vigour
0.7 – 0.8	High canopy cover, high vigour
0.8 – 0.9	Very high canopy cover, very high vigour
0.9 – 1	Total canopy cover, very high vigour

APPENDIX 4: Soil Geology Map



APPENDIX 5: Beard Vegetation Map



APPENDIX 6 IUCN Red List Criteria for ecosystems (version 2.2) (IUCN 2017)

A. Reduction in geographic distribution over ANY of the following time periods:

		CR	EN	VU
A1	Present (over the past 50 years).	≥ 80%	≥ 50%	≥ 30%
A2a	Future (over the next 50 years).	≥ 80%	≥ 50%	≥ 30%
A2b	Future (over any 50 year period including the present and future).	≥ 80%	≥ 50%	≥ 30%
A3	Historic (since 1750).	≥ 90%	≥ 70%	≥ 50%

B. Restricted geographic distribution indicated by EITHER B1, B2 or B3:

		CR	EN	VU
B1	Extent of a minimum convex polygon enclosing all occurrences (Extent of Occurrence)	≤ 2,000 km²	≤ 20,000 km²	≤ 50,000 km²
	AND at least one of the following (a-c):			
	(a) An observed or inferred continuing decline in **EITHER**:			
	i. a measure of spatial extent appropriate to the ecosystem; **OR**			
	ii. a measure of environmental quality appropriate to characteristic biota of the ecosystem; **OR**			
	iii. a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem.			
	(b) Observed or inferred threatening processes that are likely to cause continuing declines in geographic distribution, environmental quality or biotic interactions within the next 20 years.			
	(c) Ecosystem exists at …	1 location	≤ 5 locations	≤ 10 locations
B2	The number of 10 × 10 km grid cells occupied (Area of Occupancy)	≤ 2	≤ 20	≤ 50
	AND at least one of a-c above (same sub-criteria as for B1).			
B3	A very small number of locations (generally fewer than 5) **AND** prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus capable of collapse or becoming Critically Endangered within a very short time period (B3 can only lead to a listing as VU).			VU

C. Environmental degradation over ANY of the following time periods:

C1 The past 50 years based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

C2 The next 50 years, or any 50-year period including the present and future, based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

	≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

C3 Since 1750 based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

	≥ 90	≥ 70	≥ 50
≥ 90	CR	EN	VU
≥ 70	EN	VU	
≥ 50	VU		

D. Disruption of biotic processes or interactions over ANY of the following time periods:

D1 The past 50 years based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

D2

	≥ 80	≥ 50	≥ 30

	(D2a) The next 50 years, or (D2b) any 50-year period including the present and future, based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table: OR	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
D3	Since 1750, based on a change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 90	CR	EN	VU
		≥ 70	EN	VU	
		≥ 50	VU		
E. Quantitative analysis					
			CR	EN	VU
	… that estimates the probability of ecosystem collapse to be:		≥ 50% within 50 years	≥ 20% within 50 years	≥ 10% within 100 years