GOVERNMENT OF WESTERN AUSTRALIA

Department of Biodiversity, Conservation and Attractions

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Koolanooka System as originally described by Beard (1976)
Other names:	Koolanooka Hills
Description:	This community is known from the Koolanooka Hills, its footslopes and the Perenjori Hills. It comprises: *Eucalyptus ebbanoensis* subsp. *ebbanoensis* mallee and *Acacia* sp. scrub with scattered *Allocasuarina huegeliana* (rock sheoak) over red loam and ironstone on the upper slopes and summits; *Allocasuarina campestris* scrub over red loam on hill slopes, shrubs and emergent mallees on shallow red loam over massive ironstone on steep rocky slopes; *Eucalyptus loxophleba* (York gum) woodland over scrub on the footslopes; and mixed *Acacia* sp. scrub on granite. 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 ☐ 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			
Western Australia	Threatened list	29/10/1999	Vulnerable	A) B)
	Priority list		1 ☐ 2 ☐	3 ☐ 4 ☐
Other State/Territory				

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 ☐

<table>
<tr><td colspan="3">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 4 table 'IUCN Red List Criteria for ecosystems version 2.2'.</td><td>B1b</td></tr>
<tr><td colspan="4">Eligibility against the criteria</td></tr>
<tr><td colspan="4">Provide justification for the nominated conservation status; is the ecological community eligible or ineligible for listing against the five criteria. For <u>delisting</u>, provide details for why the ecological community no longer meets the requirements of the current conservation status.</td></tr>
<tr><td>A.</td><td>Reduction in geographic distribution
(evidence of decline)</td><td colspan="2">☐ A1
☐ A2a
☐ A2b
☐ A3</td></tr>
<tr><td></td><td>Justification of assessment under Criterion A.</td><td colspan="2">For criteria A and B, the ecosystem was assumed to collapse when the mapped distribution declines to zero.

• A1: A maximum 0.27% reduction in geographic distribution (assuming >80% loss of vegetation correlates to areas that are mostly cleared (Van Dongen 2019: Appendix 3)) has occurred in the past 31 years. Available data therefore indicate the community does not meet the 30% minimum threshold of reduction in geographic distribution to meet criterion A1.
• A2: The presence of mineral extraction and exploration leases over the majority of the occurrences, as well as active exploration drilling occurring, support an inference of a reduction in geographic distribution over a 50-year period in the future. It is not possible to reliably predict the proportional reduction over any future 50 year time period (the minimum threshold to meet VU under criterion A2a is 30% decline).
• A3: A maximum 0.27% reduction in geographic distribution has occurred in the last 31 years, and loss since 1750 has not been determined. Historical clearing of the community for mineral extraction or cropping prior to 1988 (ie. the initial time point for measurement of vegetation decline in Van Dongen 2019: see Appendix 3) is unknown. Available data do not indicate the community meets the 50% minimum threshold of decline to meet criterion A3 (50% historic decline since 1750 is the minimum threshold to meet A3).
• Does not meet criterion A</td></tr>
<tr><td>B.</td><td>Restricted geographic distribution
(EOO and AOO, number of locations and evidence of decline)</td><td colspan="2">☒ B1 (specify at least one of the following): CR
☐ 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)</td></tr>
</table>

	Justification of assessment under Criterion B.	- B1: EOO is 270km² (≤2,000km²). This meets the threshold for CR. - B2: AOO is six 10x10 km grid cells (≥2, ≤20). This meets the threshold for EN. - a): i) Clearing for mineral exploration, mining, and cropping are significant threats to the community and reduce the ability of the community to sustain its characteristic native biota. Clearing and cropping have resulted in an observed maximum 0.27% decline in spatial extent (measured as total area) over the last 31 years. Although the potential impact of currently known proposals is considered 'trivial' in magnitude, in terms of observed or inferred continuing decline, the number of active mineral exploration proposals indicates clearing has the potential to become 'non-trivial' in the future. - b): There has been a continuing decline in condition of the community observed from grazing and weed invasion; and future decline in geographic distribution from clearing for mineral extraction is inferred (see Appendix 1 for further information on threats). **Meets CR under B1b.** - c): Ecosystem exists at two threat-defined locations as the occurrences are mainly threatened by clearing for mineral extraction and impacts associated with grazing and cropping. Occurrences are separated by a distance of approximately 7 km and have been subject to separate proposals for mining in the past (threshold for CR is one and for EN is five threat-defined locations). **Meets EN under B2c**. - B3: Known from two threat-defined locations which are prone to impacts of clearing, weed invasion, grazing, drying climate and changes in hydrology. Community is considered prone to effects of human activities or stochastic events within a very short time period in an uncertain future and thus capable of collapse or becoming CR within a very short time period. **Meets VU under B3**. - Plausible rank VU to CR under criterion B. '*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 criteria for critically endangered B1b.**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	For criterion C, collapse of the community is defined as 100% loss of substrate that sustains the community. C1, C2: A significant abiotic variable affecting the community is removal of substrate for mining that will reduce the ability of the community to sustain its characteristic native biota. This has resulted in a maximum 0.27% decline in spatial extent in the last 31 years (this is correlated with a minimum

D.		>80% loss of vegetation cover, as reported in Van Dongen 2019). Although the potential impact of currently known proposals is considered 'trivial' in magnitude, in terms of observed or inferred continuing decline, the number of active mineral exploration proposals indicates clearing has the potential to become 'non-trivial' in the future. There is no evidence to indicate the community meets the minimum thresholds for minimum proportion of the extent (30%) or proportional severity of disruption of abiotic processes (30%) over any 50-year period, to meet VU under this criterion. • C3: With a maximum 0.27% measurable decline from removal of substrate, the community does not meet the minimum thresholds for proportion of the extent (50%) or proportional severity of disruption of abiotic processes (50%) since ~1750, to meet VU under this criterion. • **Does not meet criterion C**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☐ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	For criterion D, collapse of this community is defined as 100% loss of vegetation cover. • D1, D2, D3: Grazing is a significant biotic variable affecting the community. The assumption is made that impacts of grazing are measured by changes in vegetation condition. 70-80% of the community was considered in 'good' condition when last surveyed in 1999 to 2000, but these values are very approximate and based only on very broad assessments of condition. • Quantitative analysis by Van Dongen (2019; see Appendix 3) shows decline in vegetation canopy cover with 6.9% of the community experiencing greater than 30% loss; 2.0% experiencing greater than 50% loss, and 0.27% experiencing greater than 80% loss in vegetation cover between 1988 to 2019. 93% of the community experienced minimal loss in vegetation cover between 1988 to 2019. • No available evidence indicates the community meets the minimum proportion of the extent (30%) or proportional severity of disruption of biotic processes (30%) over any 50-year period, or since ~1750 (50% disruption of biotic processes / 50% of the extent) to meet VU under this criterion. • **Does not meet criterion D**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse have been completed. • **Not assessed**

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 differ to those in the IUCN Red List Criteria for Ecosystems (version 2.2). The difference in the assessed rank between the original WA criteria and the IUCN criteria is because the community's extent is small and is exposed to non-trivial and ongoing threats.			
Summary of assessment information *(provide detailed information in the relevant sections of the nomination form)*			
EOO	270 km^2	AOO	Six 10x10 km grid cells
No. occurrences	2	Severely fragmented	Yes ☒ No ☐ Unknown ☐
Justification	The community was naturally fragmented as it is restricted to the banded ironstone formations of the Koolanooka and Perenjori Hills. The vegetation between the hills has been cleared, and this has increased their isolation.		
Current known area			6,936 ha
Pre-industrialisation extent or its former known extent (if known)			Not determined
Estimated percentage decline			A maximum 0.27% of the total extent is estimated to have been cleared for mineral extraction and cropping in the last 31 years (van Dongen 2019, see Appendix 3, Table 2 below).

Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Available data do not indicate community meets criterion
A2a	-	• Available data do not indicate community meets criterion
A2b	-	• Available data do not indicate community meets criterion
A3	-	• Available data do not indicate community meets criterion
B1a	-	• EOO is ≤2,000km^2 • An observed 9% decline in spatial extent has occurred (measured as total area) due to clearing. Threat of clearing may become 'non-trivial' in the future. • Does not currently meet criterion
B1b	CR	• EOO is ≤2,000km^2 • Observed and inferred continuing decline from grazing and weeds; and inferred future decline in geographic distribution due to clearing. • Meets criterion for CR
B1c	EN	• EOO is ≤2,000km^2 • Ecosystem exists at two threat-defined locations • Meets criterion for EN
B2a	EN	• AOO is six grid cells • An observed decline in spatial extent has occurred (measured as total area) due to clearing. • Meets criterion for EN
B2b	EN	• AOO is six grid cells • Observed and inferred continuing decline from grazing and weeds; and inferred future decline in geographical distribution from clearing • Meets criterion for EN
B2c	EN	• AOO is six grid cells • Ecosystem exists at two threat defined locations • Meets criterion for EN
B3	VU	• Known from two threat-defined locations • Prone to the effects resulting from grazing, weeds and clearing • Meets criterion for VU
C1	-	• Inadequate evidence to indicate the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over past 50 years to meet VU.
C2	-	• Inadequate evidence to indicate the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50-year period to meet VU.
C3	-	• Does not meet the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since ~1750 to meet VU.
D1	-	• Inadequate evidence to indicate the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over past 50 years to meet VU.
D2	-	• Inadequate evidence to indicate the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over any 50-year period to meet VU.
D3	-	• Does not meet the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of biotic processes (≥50%) since ~1750 to meet VU.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Plausible range VU-CR. *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 under B1b.**

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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
GL38 GL39 KOOL1	Freehold, recreation reserves, road reserves, unallocated Crown land, railway reserve	1999	50% excellent 20% very good 30% completely degraded	4,801 ha	Clearing, grazing, weed invasion (*past, present, future*) Drying climate (*future*)	Install fencing, control weeds, remove introduced fauna, secure community through reservation, monitoring
PEREN1	Freehold, road reserves, crown reserve	2000	80% excellent 20% completely degraded	2,134 ha	Clearing, grazing, weeds (*past, present, future*) Drying climate (*future*)	Install fencing, control weeds, remove introduced fauna, secure community through reservation, monitoring

*Estimates of condition areas are based on very brief limited surveys and are very approximate. Van Dongen (2019) data in Appendix 3 provide more reliable quantitative analysis of changes in vegetation extent and condition.

APPENDIX 1 THREATS

Clearing

The proportion of the vegetation of the Koolanooka System that has been cleared since pre-European settlement for mineral extraction and cropping has not been determined. Clearing of a further 7.74ha of the community for exploration drilling has been proposed more recently (MS 1011, 811). None of the community occurs in a conservation reserve (Hamilton-Brown 2000).

Grazing

The majority of the community is unfenced with grazing by sheep, cattle and goats widespread. Much of the remaining footslopes have been heavily grazed and trampled by sheep and cattle, which has caused alterations to the species composition of both occurrences by the selective grazing of edible species, the introduction of weeds and nutrients, trampling and general disturbance. A small area within the northern portion of the Perenjori Hills occurrence has been fenced, however as at 2000 the landholders still allowed their sheep access to graze the vegetation for at least a fortnight a year (Hamilton-Brown 2000).

Weeds

Combined disturbances such as grazing can predispose areas to weed invasion if weed propagules are present. The community occurs adjacent a mine pit (GE38; GE39; KOOL1) and agricultural areas (both occurrences) that act as weed sources and is vulnerable to weed invasion following any disturbance (Hamilton-Brown 2000).

Drying climate

The Koolanooka System is at risk from a drying climate resulting from a decline in rainfall in the south west of the state. The tolerance of particular species to changes that may occur in association with a drying climate, including changes in rainfall and temperatures, is generally unknown. Climate change predictions for the south west of WA are as follows (from ***NCCARF*** website: https://www.nccarf.edu.au/sites/default/files/attached_files_publications/PDF%20Report%20Card%20Low%20Res.pdf); accessed 2019):

- Reduction in rainfall by 2030 by 2-14% (median 8%). Southwest predicted to experience some of the largest reductions in rainfall in all of Australia;
- Reduction in runoff by 10-42% (median 25%) by 2030;
- Decline in groundwater levels by 2030 (extractive yields may decrease by a third to a half in some areas).

References

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).

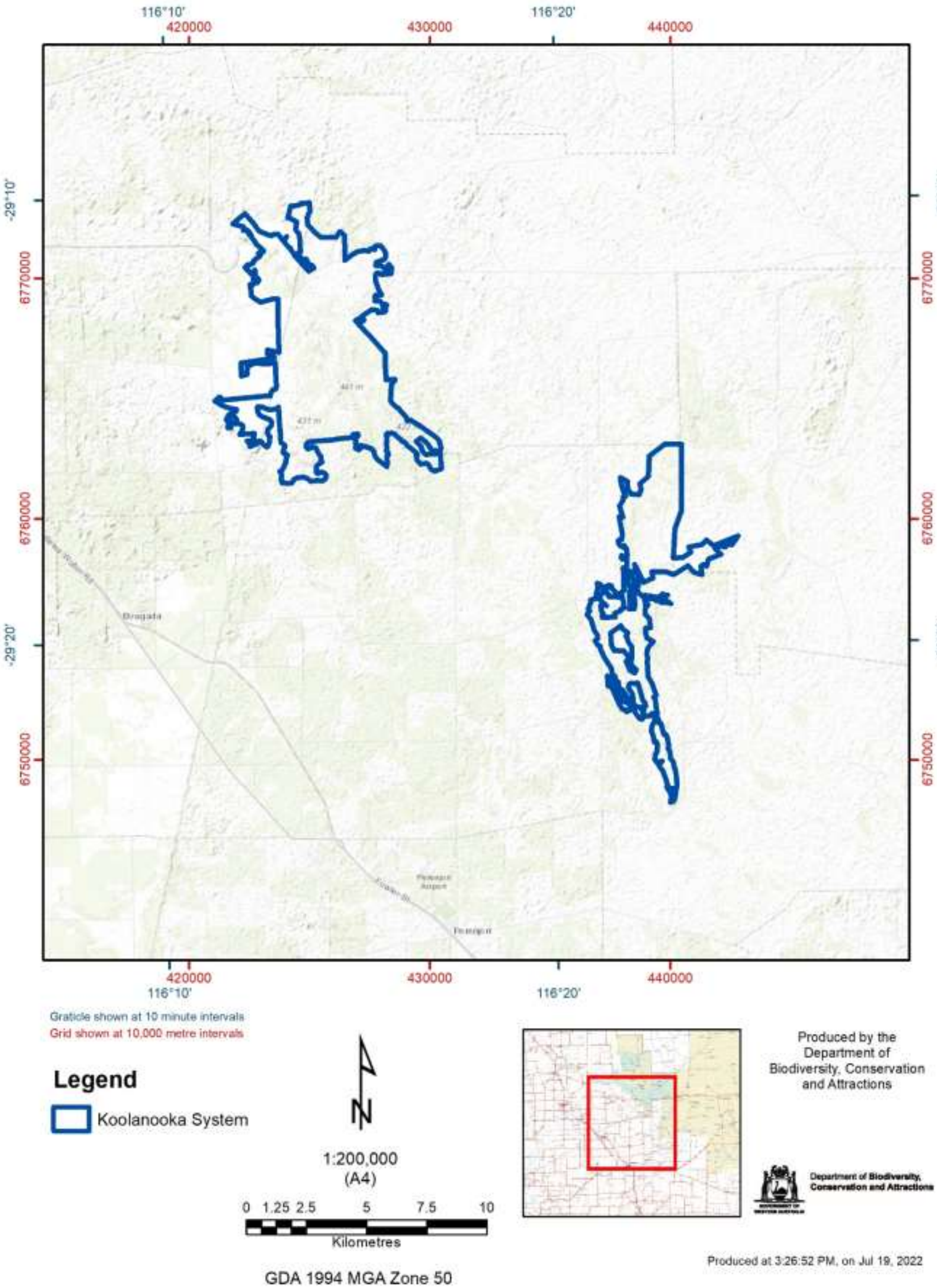
Borger, J. (2018) Vegetation and flora survey of proposed drill sites and access tracks in Koolanooka Hills in mining tenement M70/1164. For Westralia Iron Pty Ltd. Jenny Borger Botanical Consulting, Kalamunda.

Government of Western Australia (2000) Bush Forever. Department of Environmental Protection, Perth.

Hamilton-Brown, S. (2000) Plant assemblages of the Koolanooka System Interim Recovery Plan #73, 2000-2003. Department of Conservation and Land Management, Western Australia.

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.

APPENDIX 2 Koolanooka System as originally described by Beard (1976) (green)



The Dept. of Biodiversity, Conservation and Attractions does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Roads and tracks on land managed by DBCA may contain unmarked hazards and their surface condition is variable. Exercise caution and drive to conditions on all roads.

APPENDIX 3 Vegetation cover assessment for “Koolanooka Hills System” using satellite imagery.

[redacted][1], 30/8/2019

Datasets

Landsat satellite imagery was used to assess the change in vegetation cover between 1988 and 2019. Images used in the analysis to map cover change were captured 11/2/1988 and 16/2/2019.

Canopy cover calibration

To calibrate imagery index values with vegetation cover in the “Koolanooka Hills System” community, 90 by 90 m polygons (n = 29), were digitised in areas of dense and sparse vegetation cover. The percentage cover within these polygons was calculated from aerial photography. Pixel values from the rgb bands in the aerial photography were summed and those with values less than 70 were classified as vegetation. Examples of the classifications are shown in Figure 2. Vegetation cover is delineated in red.

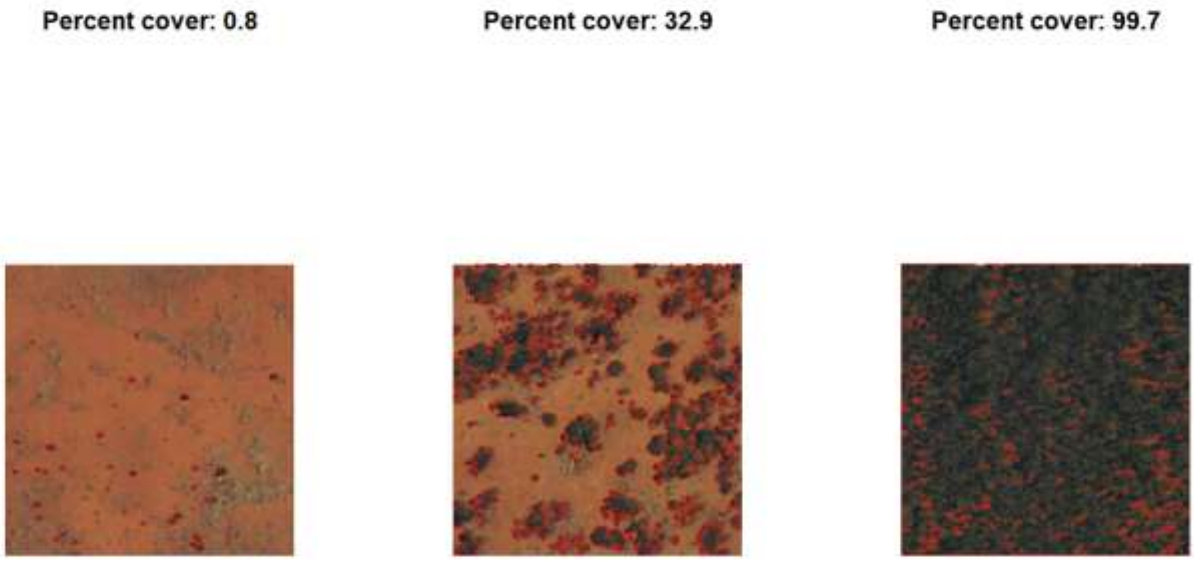


Figure 2. Examples of vegetation classification from aerial photography. Vegetation cover is outlined in red.

[1] Remote sensing officer, DBCA

Table 1. Indices derived from Landsat imagery regressed against canopy cover.

index	mod	r.squared	p.value
i35	quadratic	0.920	0.000
satvi	quadratic	0.914	0.000
i35	linear	0.892	0.000
satvi	linear	0.892	0.000
stvi	quadratic	0.694	0.000
stvi	linear	0.592	0.000
ndvi	quadratic	0.257	0.021
ndvi	linear	0.251	0.006
ndmi	quadratic	0.132	0.160
ndmi	linear	0.131	0.054

Regression plot of the i35 index is shown below (Figure 3).

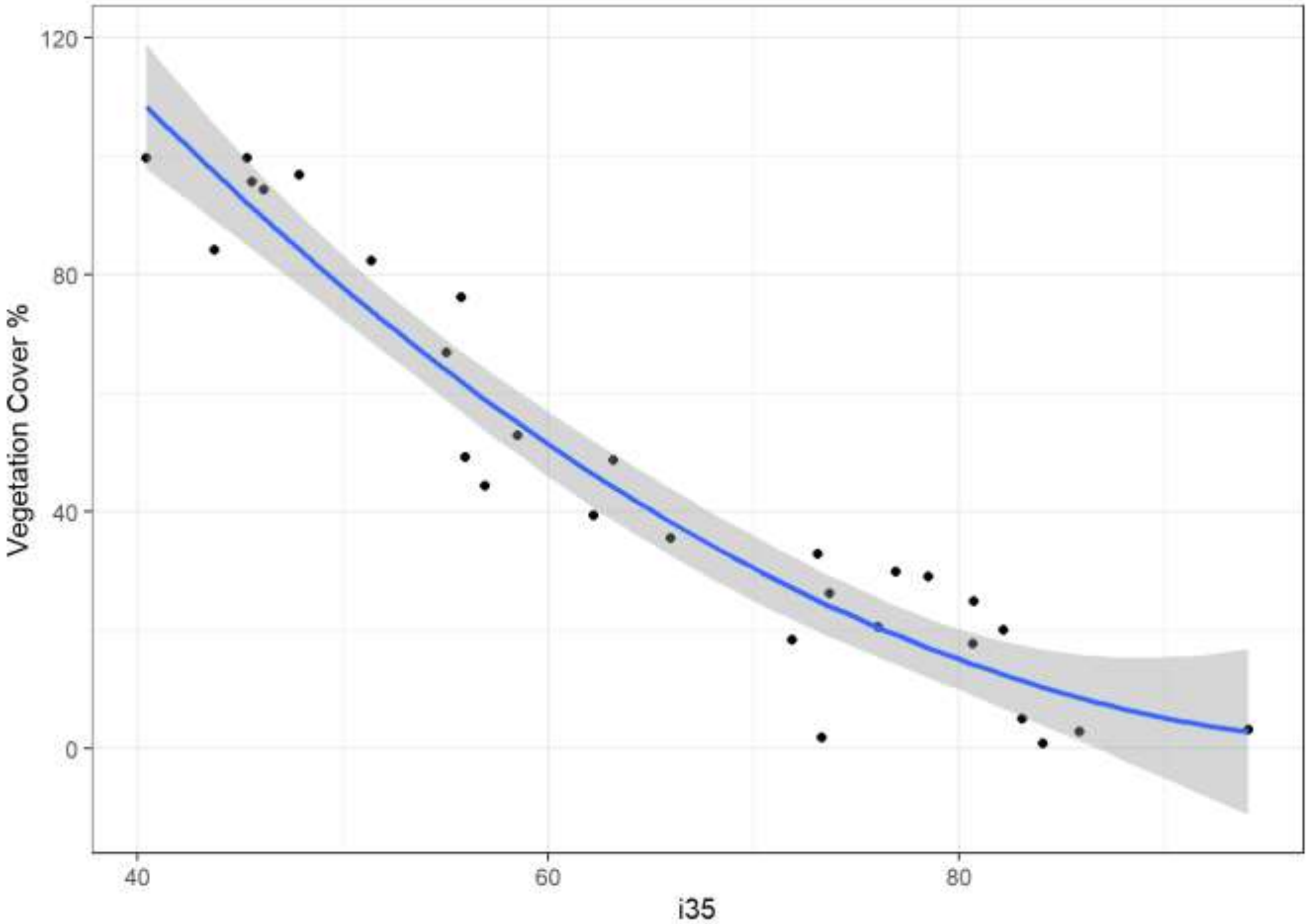


Figure 3. Regression of the i35 index from Landsat imagery and canopy cover from aerial photography (r.squared = 0.92, n = 29).

Change image and statistics

Coefficients from the regression were applied to imagery from 11/02/1988 and 16/02/2019. This produced two vegetation cover images. The percentage difference of cover values between these two images can then be calculated. A vegetation cover change image within the “Koolanooka Hills System” community is shown in Figure 4 and an area summary is provided in Table 2. For further interrogation the change image can be acquired and viewed in standard GIS software.

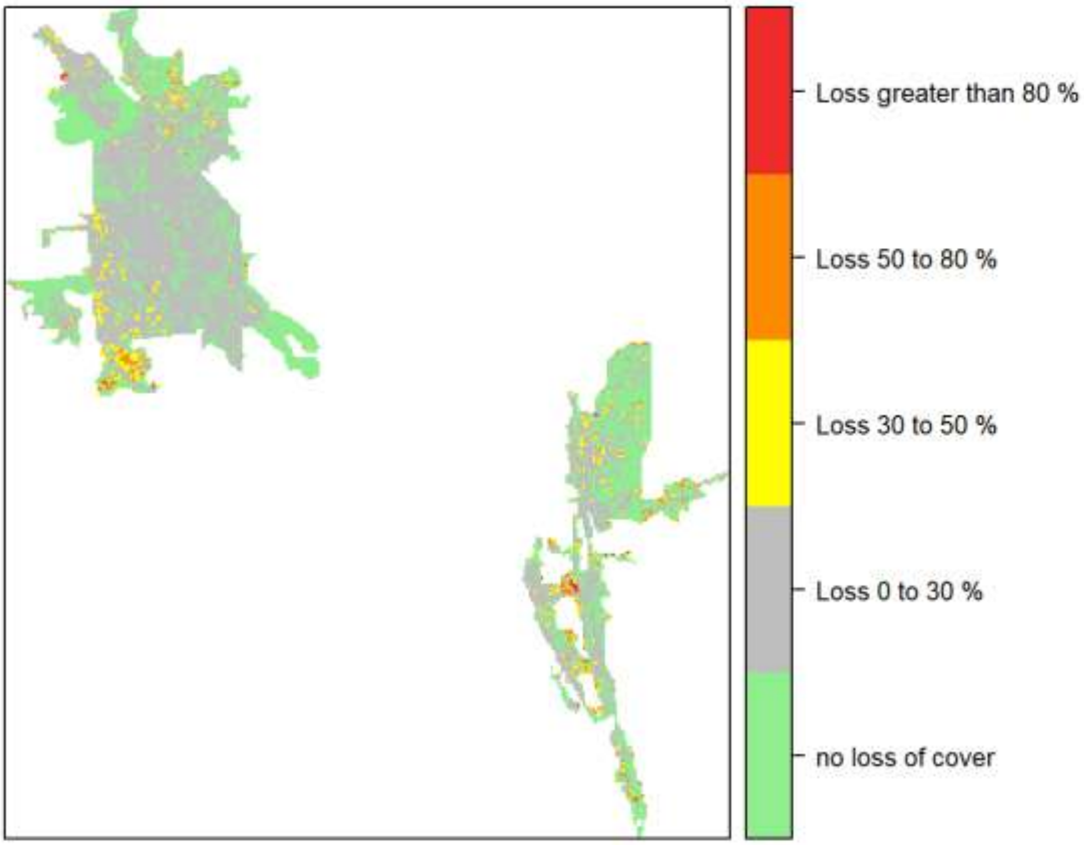


Figure 4. Vegetation cover change within the Koolanooka Hills System community (1988 to 2019).

Table 2. Percent of the community within each loss class (1988 to 2019).

Description	Percent of community
Loss less than 30 %	93.08
Loss greater than 30 %	6.92
Loss greater than 50 %	1.98
Loss greater than 80 %	0.27

Fire impact

No fires were recorded in the DBCA fire history occur within the Koolanooka Hills System community since 1988.

Satellite imagery over all areas of loss greater than 2 ha was inspected and no fire impacts were identified since 1988.

APPENDIX 4 IUCN Red List Criteria for ecosystems (version 2.2) (IUCN 2017)

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

		Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
C1	The past 50 years based on change in an <u>abiotic</u> variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
C2	The next 50 years, or any 50-year period including the present and future, based on change in an <u>abiotic</u> variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
C3	Since 1750 based on change in an <u>abiotic</u> 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		

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

		Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
D1	The past 50 years based on change in a <u>biotic</u> variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	

		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
D2	(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