Section 1 – Eligibility for Listing		
1. Name of the ecological community		
Themeda grasslands on cracking clays (Hamersley Station, Pilbara)		
2. Listing Category for which the ecological community is nominated		
	Current ranking under WA Minister ESA list in policy	EPBC Act
Current listing category (Please check box)	☐ Critically endangered ☐ Endangered ☒ Vulnerable ☐ Priority 1-5 ☐ Data Deficient ☐ None – not listed	Name: Themeda grasslands on cracking clays (Hamersley Station, Pilbara) ☐ Critically endangered ☐ Endangered ☐ Vulnerable ☒ None – not listed
	Recommended ranking under BC Act IUCN assessment	
Proposed listing category (Please check box)	☐ Collapsed ☒ CR: Critically endangered ☐ EN: Endangered ☐ VU: Vulnerable ☐ Data Deficient	
Select one or more of the following criteria under which the community is to be nominated for BC Act listing. (Please check box). For further details on these criteria please refer to the Attachment to this form. The information you provide in Section 3 should support the criteria you select here.	☐ Criterion A – Reduction in geographic distribution ☒ Criterion B – Restricted geographic distribution ☐ Criterion C – Environmental degradation based on change in an abiotic variable ☐ Criterion D – Disruption of biotic processes or interactions based on change in a biotic variable ☐ Criterion E – Quantitative analysis that estimates the probability of ecosystem collapse	

Section 2 – Description, Condition, Threats & Recovery
Please answer all the questions, providing references where applicable. If no or insufficient information exists to answer a question, you must indicate this instead of leaving the question blank. The answers may be provided within this form or as attachments, ensuring that responses clearly indicate which question number they refer to.
Classification
3. What is the name of the ecological community?
Note any other names that have been used recently, including where different names apply within different jurisdictions. For example, is it known by separate names in different States or regions?
Themeda grasslands on cracking clays (Hamersley Station, Pilbara). Also commonly referred to as Themeda grasslands community.
4. What authorities/surveys/studies support or use the name?

The community was originally identified as being restricted to a particular land system (Brockman land system) within the Hamersley Station by Shaw and Mitchell (1994) and was considered to be of high conservation value. Van Vreeswyk *et al*. (2004) completed more detailed mapping of the community on the Brockman land system on Hamersley Station. The community type was recognised and was endorsed as a vulnerable community by the WA Minister for Environment in 2001, but was ranked as VU using ranking criteria developed in WA, that differ from those used for the IUCN RLE. The community is not currently nominated or listed under the EPBC Act.

5. How does the nominated ecological community relate to other ecological communities that occur nearby or that may be similar to it?

Does it intergrade with any other ecological communities and, if so, what are they and how wide are the intergradation zones?
Describe how you might distinguish the ecological community in areas where there is overlap (also see Description section below).

The Themeda grasslands community is associated with and occurs on the cracking clay soils of the Brockman land system. The 'Brockman Iron cracking clay' community also occurs on the Brockman land system and is listed as a Priority 1 ecological community (PEC).

Description

6. List the main features that distinguish this ecological community from all other ecological communities.

Characteristic (or diagnostic) features can be biological (e.g. taxa or taxonomic groups of plants and animals characteristic to the community; a type of vegetation or other biotic structure), or associated non-biological landscape characteristics (e.g. soil type or substrate, habitat feature, hydrological feature). Please limit your answer to those features that are specific to the ecological community and can be used to distinguish it from other ecological communities.

The Pilbara Bioregion is significant for its diverse grassland communities and geomorphological structures. Within the Hamersley Station flats, that occur within the valleys of the Hamersley Plateau, particular tussock and hummock grasslands occur on gilgai alluvial plains with cracking clay soils. The hydrology of these soils is characterised by a mostly internally draining catchment that exhibits a cyclic wet-dry process and the soils can become temporarily inundated when high rainfall occurs.

Generally moderately widespread in the Fortescue Botanical District, *Themeda* sp. Hamersley Station (Trudgen 11,431) or kangaroo grass usually only occurs as scattered plants or very small stands (Ecologia 1988). However, early surveys by Beard (1975) noted *Themeda australis*, later to be re-determined as *Themeda* sp. Hamersley Station (Trudgen 11,431), dominated one area sampled within the Hamersley Homestead Plain. Other surveys (Shaw and Mitchell 1994; Trudgen and Casson 1998) further noted the *Themeda* grasslands were restricted to only the Brockman land system within the Hamersley Station, and were therefore considered to be of high conservation value.

7. Give a description of the biological components of the ecological community.

For instance, what species of plants and animals commonly occur in the community; what is the typical vegetation structure (if relevant).

The community is known from Hamersley Station in the Pilbara. It comprises an open to closed tussock grassland on cracking clays and is dominated by the Priority 3 perennial *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) that grows to approximately 1.8 m high. A suite of other grasses and herbs also occur. In some areas there is scattered open overstorey of low trees present including *Hakea lorea* subsp. *lorea* (witinti) and *Eucalyptus victrix* (smooth barked coolabah).

8. Give a description of the associated non-biological landscape characteristics or components of the ecological community.

For instance, what is the typical landscape in which the community occurs? Note if it is associated with a particular soil type or substrate; what major climatic variables drive the distribution of the ecological community (e.g. rainfall). Note particular altitudes, latitudes or geographic coordinates.

The mapping of the Themeda grasslands community was based on earlier land system mapping by the Department of Agriculture and Food (van Vreeswyk *et al*. 2004), which also coincided with the distribution of the Brockman land system mapped for the Hamersley subregion. The Brockman land system was described by van

Vreeswyk *et al*. as 'level alluvial plains with cracking clay soils and gilgai microrelief, supporting tussock grasslands (land type 14)' and comprised six land units. Of these land units, the gilgai plains were associated with the tussock grassland vegetation types. The soils are classified by van Vreeswyk *et al*. (2004) as 'self-mulching cracking clays (soil group 602)' and 'red/brown non-cracking clays (soil group 622)'. The term 'self-mulching' describes the way heavy clay soils (35%+ clay) form a loose granular mulch of fine aggregates at the soil surface, after wetting and drying, which falls to the bottom of the profile and increases its volume (Grant and Blackmore 1991). These soils have shrink-swell properties that exhibit strong cracking at depth when dry hence, 'cracking' soils (CSIRO 2016). Van Vreeswyk *et al*. (2004) describe the profile of cracking soils as generally deep (>100cm) with thin to medium (10 to 30cm) light, silty or medium clay topsoils, sometimes with a thin (1 to 10 cm) layer of clay loam. The uppermost soil layer exhibits large surface cracks or has crumbly (self-mulching) surfaces when dry, and when wet heave, often showing rough mounded (gilgai) surfaces forming a network of gilgai plains. The soil colour is mainly dark reddish brown to red, the red colour resulting from hot oxidising conditions producing free iron oxides in the soil (Payne *et al*. 1988). The soil surface is generally non-saline, to partially saline in deep sub soils. Cracking soils may form gullies where they are found on undulating plains (van Vreeswyk *et al*. 2004).

The Themeda grasslands community that occurs within the Hamersley subregion has a semi-arid tropical climate, with hot, wet summers and mild, mostly dry winters. Rainfall for the area is highly variable, ranging from 69mm (1944) in a dry year to 1089.8mm (2006) in a wet year, averaging 384.5mm per year (1912 to 2015) (Bureau of Meteorology (BOM) data from Hamersley Station). The mean monthly temperature (recorded at the nearest station in Wittenoom) varies in the winter from approximately 24 degrees (June/July) to 37 degrees in summer (October to April). Most of the rainfall (approximately 70%) occurs between December and March and is derived from summer cyclonic or thunderstorm events. These events cause a large degree of variability in total annual rainfall.

9. Provide information on the ecological processes by which the biological and non-biological components interact (where known).

The Themeda grasslands community is dependent on inundation with fresh water from sporadic rainfall events and run-on rainfall from surface flows. Groundwater storage is mostly small but may be large locally in solution voids. Recharge is episodic and affected by direct infiltration of rainfall over areas where the rocks are fractured, jointed and weathered. Recharge occurs by leakage from surface flows into basement rocks, or indirectly through superficial sediments which overlie basement rocks (van Vreeswyk *et al*. 2004; McKenzie *et al*. 2009).

10. Does the ecological community show any consistent regional or other variation across its extent, such as characteristic differences in species composition or structure?

If so, please describe these.

The floristic units described by Biota (2012) are all dominated by *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) but vary in composition with the addition of scattered tall shrubs, woodlands and shrublands. The composition varies between sites depending on soil depth and probably chemistry, local hydrology, fire history, and possibly other factors such as land use.

11. Does the ecological community provide habitat for any listed threatened species and/or endemic species?

If so, please note the species and whether the species is listed on State and/or national lists and the nature of their dependence on the ecological community.

The Themeda grasslands community provides foraging habitat for the following fauna species (from FMG 2019):

- Peregrine Falcon (*Falco peregrinus*- listed under Schedule 6 of the BC Act as fauna that is of special conservation need as conservation dependent fauna)
- Grey Falcon (*Falco hypoleucos*- listed as Vulnerable under BC Act)
- Northern short-tailed mouse (*Leggadina lakedownensis*- priority 4)

The community also provides habitat for a number of possibly threatened or data deficient flora species (see table below).

Table 1. Priority flora that occur within the buffer of the Themeda grasslands community (records from Threatened Priority Flora database and Florabase)

Species name	Conservation status (WA)	Conservation status (EPBC Act 1999)
Euphorbia inappendiculata var. *queenslandica*	P1	-
Euphorbia australis var. *glabra*	P2	-
Glycine falcata	P3	-
Iotasperma sessilifolium	P3	-
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	-
Rostellularia adscendens var. *latifolia*	P3	-
Stackhousia clementii	P3	-
Swainsona thompsoniana	P3	-
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	-

12. Identify major studies on the ecological community (authors, dates, title and publishing details where relevant).

Beard, J.S. (1975) Pilbara Explanatory Notes to Sheet 5 1:1,000,000 Series Vegetation Survey of Western Australia. UWA Press, Nedlands.

Biota Environmental Sciences (2012) *Themeda Grasslands Threatened Ecological Community – Seasonal Botanical Survey*. Report prepared for Rio Tinto Iron Ore Pty Ltd.

Ecologia (1998) West Angelas Iron Ore Project Environmental Review and Management Program. Report to Robe River Mining Co. Pty. Ltd. Perth.

Ecoscape (2011) 'Themeda Grasslands on Cracking Clay' TEC Assessment. Report prepared for Fortescue Metals Group Limited.

Grant, C.D. and Blackmore, A.V. (1991) Self-mulching behaviour in clay soils: Its definition and measurement. *Australian Journal of Soil Research* 29: 155−173.

Shaw, J.F.D. and Mitchell, A.A. (1994) A Resource Inventory and Condition Survey with Proposals for Sustainable Management on Hamersley Station. Hamersley Iron Pty Ltd., Perth.

Trudgen, M. E. and Casson, N. (1998) Flora and Vegetation Surveys of Orebody A and Orebody B in the West Angela Hill area, an area surrounding them, and of rail route options considered to link them to the existing Robe River Iron Associates rail line. Unpublished Report Prepared for Robe River Iron Associates.

Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Department of Agriculture and Food, Western Australia, Perth. *Technical Bulletin 92*.

Distribution

13. Describe the distribution across WA and nationally.

State the appropriate bioregions where the ecological community occurs. Attach or provide any maps showing its distribution with details of the source of the maps, or explain how they were created and the datasets used.

The Themeda grasslands community is known from 90 occurrences that occur in two distinct locations, one located 40km north and one 72km north-west of Tom Price within the Pilbara bioregion, extending east to west over a range of approximately 65km. The majority of occurrences occur within Hamersley Station (LPL N050438), an active pastoral leasehold for agricultural activities. Three occurrences also occur on unallocated Crown Land to the north of Hamersley Station. The community occupies approximately 5,087 hectares in total and varies in size from less than one hectare to nearly 1,900 hectares.

14. What is the area of distribution of the ecological community?

For answers to parts a, b, c & d: please identify whether any values represent extent of occurrence or area of occupancy (as described in the Attachment); provide details of the source(s) for the estimates and explain how they were calculated and the datasets used.

14 a. What is the current distribution (in ha)? 5,087ha

14 b. What is the pre-industrialisation extent or its former known extent (in ha)?

Not known. It is likely there has been some reduction in extent due to clearing for exploration, roads and fences, however, this has not been quantified.

14 c. What is the estimated percentage decline of the ecological community?

Estimated percentage decline has not been determined.

14 d. What data are there to indicate that future changes in distribution may occur?

Ongoing pastoral activities such as grazing and the construction of associated infrastructure (fences, tracks, etc) will continue to occur.

Mineral exploration occurs within the region and requires the temporary clearing of native vegetation. The current total area of the mapped *Themeda* grassland community is overlayed by mining tenements. As a consequence of mineral exploration and associated activities the loss of vegetation and changes to substrate are likely to occur. The total area that has been cleared or is permitted to be cleared within the clearing permit areas is yet to be quantified (by DBCA).

In the future, clearing of the *Themeda* grasslands community for agricultural developments, such as irrigated fodder and horticulture, to the Hamersley Station area is also likely (DPIRD 2017).

There is anecdotal evidence that the community takes upwards of five years to regenerate to a similar pre-clearing condition once post exploration rehabilitation has occurred.

A rail proposal is likely to result in an additional 40 hectares of clearing and disturbance to the community. The EPA has formally assessed the proposal under Part IV, and the Minister has provided his approval of the project.

The introduction of weeds from land uses including pastoral, intensive agriculture (irrigated agriculture) and mineral exploration present an ongoing risk to the community. Weeds of concern include *Chloris gayana* (grown nearby in irrigated agriculture) and others identified as being rapidly invasive or of high ecological impact.

Patch size

15. What is the typical size (in ha) for a patch of the ecological community (if known)?

Explain how it was calculated and the datasets that are used. Relevant data includes the average patch size, the proportion of patches that are certain sizes, particularly proportions below 10 ha and below 100 ha, (but also below 1 ha and above 100 ha, for example).

Themeda grasslands community was mapped using ArcGIS© and a range of data sources including quadrat and survey data; soil mapping, sampling and analysis; and on ground survey (Biota 2012). Minimum patch size is 0.04 ha and maximum patch size is 1,900 ha. The mean patch size is 56.5ha (see table below for patch size proportions).

Table 2. Proportion of occurrences with a certain patch size.

Patch size (hectares)	Number of occurrences
<1	33 (36.7%)
<10	71 (79%)
<100	80 (88.9%)
>100	10 (11.1%)

16. Quantify the smallest percentage or area required for a patch of the ecological community to be considered viable.

This refers to the minimum size of a remnant that can remain viable without active management. It may be determined through the requirements for dominant native species, level of species diversity, or the nature of invasive weeds.

All areas of the community that are in good condition (or better) have been mapped. The community has a mosaic distribution, and there is no minimum area specified for a patch that could remain viable without active management. Patches vary in size and in the absence of causative threatening processes, those that are considered in good condition do not require active management.

Functionality

17. Is the present distribution of the ecological community severely fragmented?

If so, what are likely causes of fragmentation?
If fragmentation is a natural or positive characteristic of this ecological community, please explain this and state the reason.
Severely fragmented refers to the situation in which increased extinction risk to the ecological community results from most remnants being found in small and relatively isolated patches.

The Themeda grasslands community is naturally fragmented as it occurs on a specific soil type that is highly restricted within the Pilbara Region. Native vegetation clearing as a result of mineral exploration, roads and fences has not been quantified (by DBCA) but is not considered to have resulted in severe fragmentation of the community.

18. Has there been a loss or decline of functionally important species?

This refers to native species that are critically important in the processes that sustain or play a major role in the ecological community and whose removal has the potential to precipitate change in community structure or function sufficient to undermine the overall viability of the community.

Themeda sp. Hamersley Station (M.E. Trudgen 11431) is dominant in the community and is therefore significant in that it is a major part of characterising and differentiating the community. Continuous grazing of the Themeda grasslands alters the botanical composition by selectively removing edible species, as well as causing physical damage to the vegetation through grazing and trampling. In areas which have been extensively grazed, grass clumps have been severely reduced in size with considerable erosion occurring around the base of the tussocks.

18 a. If yes, which species are affected?

Themeda sp. Hamersley Station (M.E. Trudgen 11431) which is a dominant species in the community.

18 b. How are the species functionally important and to what extent have they declined?

The Themeda grassland community occurs almost exclusively within Hamersley Station, an active pastoral lease that is grazed extensively, with 98.2% of the community exposed to grazing. The grass clumps are severely reduced in size with considerable erosion occurring around the base of the tussocks and in some cases a change in floristic composition has occurred, including the introduction of weeds.

Mineral exploration occurs within the region and requires the temporary clearing of native vegetation. The current total area of the mapped *Themeda* grassland community is overlayed by mining tenements. As a consequence of mineral exploration and associated activities the loss of vegetation and changes to substrate are likely to occur. The total area that has been cleared or is permitted to be cleared within the clearing permit areas is yet to be quantified (by DBCA).

Reduction in community integrity

19. Please describe any processes that have resulted in a reduction in integrity and the consequences of these processes, e.g. loss of understorey in a woodland. Include any available information on the rate of these changes.

This recognises that an ecological community can be threatened with extinction through on-going modifications that do not necessarily lead to total destruction of all elements of the community. Changes in integrity can be measured by comparison with a benchmark state that reflects as closely as possible the natural condition of the community with respect to the composition and arrangement of its abiotic and biotic elements and the processes that sustain them. Please provide a description of the benchmark state where available. For further information please refer to the Guidelines.

Extensive changes in the composition of the grasslands community through grazing.

Local extirpation of species, such as *Themeda* sp. Hamersley Station (M.E. Trudgen 11431), can occur in specific locations as a consequence of grazing.

Occurrences in excellent condition are characterised by the following:

- Few weed taxa and low weed cover
- All previously recorded natural strata of the vegetation present
- Connectivity with other intact vegetation and other occurrences of the community.

Survey and Monitoring

20. Has the ecological community been reasonably well surveyed?

Provide an overview of surveys to date and the likelihood of the ecological community's current known distribution and/or patch size being its actual distribution (consider area of occupancy and area of extent, including any data on number and size of patches).

A number of flora and vegetation surveys were undertaken from 1975 to 2012:

- Beard, J.S. (1975) Vegetation Survey of Western Australia.
- Biota Environmental Sciences Consultants 2010, 2011 and 2012 for Rio Tinto Iron Ore.
- Trudgen and Casson in 1997 for Robe River Iron Associates.
- Van Vreeswyk *et al*. 2004 an inventory and condition survey of the Pilbara region for Department of Agriculture and Food.

21. Where possible, please indicate areas that haven't been surveyed but may add to the information required in determining the community's overall viability and quality.

NA

22. Is there an ongoing monitoring program? If so, please describe the extent and length of the program.

Biota Environmental Sciences consultants installed quadrats for flora and vegetation surveys in 2010 to 2012. Species composition and vegetation condition were recorded in 50 x 50m plots from May to June.
Permanent quadrats are installed at occurrence 27 and monitoring should be undertaken every five to ten years to examine long-term broad scale compositional and structural change.
Clearing permits usually require that proponents undertaking mineral exploration are usually required to report on the success of rehabilitation and subsequent regeneration of the community.

Condition Classes and Thresholds

23. Do you think condition classes/thresholds apply to this ecological community? If not, give reasons.

The Committee recognises that ecological communities can exist in various condition states. In reaching its decision the Committee uses condition classes and/or thresholds to determine the patches that are included or excluded from the listed ecological community (see the Guidelines for details of the process of determining condition classes).

The minimum viable condition for this community to be considered viable is Good Condition. This refers to a patch in which "Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance, e.g. from grazing, partial clearing. Presence of very aggressive weeds" (Keighery (1994) Vegetation Condition Scale (Government of WA 2000)). No minimum patch size is specified, as future viability will depend on management. Very small areas are known to be able to maintain their condition if they are subject to very minimal disturbance.

Table 3. Condition and extent of occurrences (2006 condition data *pers obs*. [redacted][1])

Occ. #	Site ID	Date: Condition (using Bush Forever scale)	Estimated area (ha)	Condition when last surveyed
1	HAMERSL01a-c	2006: Excellent (1.2%)-very good (98.8%)	4.82±0.4	
2	HAMERSL07	2009: Very good (100%)	203±20.2	Some signs of cattle, no sign of fire
7	HAMERSL12a-c	2006: Excellent (1.2%)-very good (98.8%)	11.19±0.1	
8	HAMERSL13	2006: Excellent (1.2%)-very good (98.8%)	0.2±0.02	
9	HAMERSL14	2006: Excellent (1.2%)-very good (98.8%)	1.0±0.1	
10	HAMERSL15	2006: Excellent (1.2%)-very good (98.8%)	1.92±0.2	
11	HAMERSL16	2006: Good (100%)	163.3±16.3	
12	HAMERSL17a,b	2006: Good (100%)	19.41±1.9	Signs of cattle; cattle pad through quadrat
13	HAMERSL18	2006: Excellent (1.2%)-very good (98.8%)	0.12±0.01	
14	HAMERSL19	2006: Excellent (1.2%)-very good (98.8%)	0.07±0	
15	HAMERSL20	2006: Excellent (1.2%)-very good (98.8%)	0.16±0.01	
16	HAMERSL21	2006: Excellent (1.2%)-very good (98.8%)	94.52±9.4	
17	HAMERSL22	2006: Excellent (1.2%)-very good (98.8%)	0.27±0.02	
18	HAMERSL23	2011: Very good (100%)	2.68±0.2	Occasional weeds; horse scats
19	HAMERSL24a-c	2011: Very good (100%)	319.42±31.9	Occasional weeds; no obvious signs of grazing but cattle in locality
20	HAMERSL25	2006: Excellent (1.2%)-very good (98.8%)	0.2±0.02	

[1] [redacted], Former Assistant Director Science, DBCA

21	HAMERSL26	2006: Excellent (1.2%)-very good (98.8%)	0.67±0.07	
22	HAMERSL27	2006: Excellent (1.2%)-very good (98.8%)	0.37±0.03	
23	HAMERSL28	2006: Excellent (1.2%)-very good (98.8%)	0.22±0.02	
24	HAMERSL29	2006: Excellent (1.2%)-very good(98.8%)	0.27±0.02	
25	HAMERSL30	2006: Excellent (1.2%)-very good (98.8%)	0.27±0.02	
26	HAMERSL31	2006: Excellent (1.2%)-very good (98.8%)	0.11±0.01	
27	HAMERSL32	2016: Very good (100%)	287.94±28.7	Pads, cattle scats present
28	HAMERSL33a-l	2006: Excellent (1.2%)-very good (98.8%)	3.24±0.3	
29	HAMERSL34	2006: Excellent (1.2%)-very good (98.8%)	12.85±1.2	
32	HAMERSL37	2006: Excellent (1.2%)-very good (98.8%)	8.66±0.8	
33	HAMERSL38	2006: Excellent (1.2%)-very good (98.8%)	0.29±0.02	
34	HAMERSL39	2006: Excellent (1.2%)-very good (98.8%)	2.02±0.2	
35	HAMERSL40	2006: Excellent (1.2%)-very good (98.8%)	0.51±0.05	
36	HAMERSL41	2006: Excellent (1.2%)-very good (98.8%)	0.79±0.07	
37	HAMERSL42	2011: Very good (100%)	506.57±50.6	Cattle scats present, no obvious signs of grazing; 2x **Malvastrum* plants and occasional **Vachellia*
38	HAMERSL43	2006: Excellent (1.2%)-very good (98.8%)	0.57±0.05	
39	HAMERSL44	2006: Excellent (1.2%)-very good (98.8%)	1.24±0.1	
40	HAMERSL45	2011: Very good (100%)	205.24±20.5	Presence of some weeds and cattle scats
41	HAMERSL46	2006: Excellent (1.2%)-very good (98.8%)	7.3±0.7	
42	HAMERSL47	2006: Excellent (1.2%)-very good (98.8%)	1.82±0.1	
43	HAMERSL48	2011: Very good (100%)	28.72±2.8	Occasional weeds; signs of stock but no obvious grazing
44	HAMERSL49	2006: Excellent (1.2%)-very good (98.8%)	0.53±0.05	
45	HAMERSL50a, b	2011: Very good (100%)	493.18±49.3	Cattle scats present; some weeds
46	HAMERSL51	2006: Excellent (1.2%)-very good (98.8%)	1.65±0.16	
47	HAMERSL52	2006: Excellent (1.2%)-very good (98.8%)	0.69±0.06	
48	HAMERSL53	2011: Very good (100%)	30.3±3	Occasional weeds; signs of cattle
49	HAMERSL54	2006: Excellent (1.2%)-very good (98.8%)	2.86±0.2	
50	HAMERSL55	2006: Excellent (1.2%)-very good (98.8%)	10.43±1.0	
51	HAMERSL56	2006: Excellent (1.2%)-very good (98.8%)	2.77±0.2	
52	HAMERSL57	2006: Excellent (1.2%)-very good (98.8%)	2.12±0.2	
53	HAMERSL58	2006: Excellent (1.2%)-very good (98.8%)	7.16±0.7	
54	HAMERSL59	2006: Excellent (1.2%)-very good (98.8%)	1.42±0.1	
55	HAMERSL60	2006: Excellent (1.2%)-very good (98.8%)	4.6±0.4	
56	HAMERSL61	2006: Excellent (1.2%)-very good (98.8%)	3.36±0.3	
57	HAMERSL62	2006: Excellent (1.2%)-very good (98.8%)	0.17±0.01	
58	HAMERSL63	2006: Excellent (1.2%)-very good (98.8%)	1.31±0.1	
59	HAMERSL64	2006: Excellent (1.2%)-very good (98.8%)	1.97±0.19	
60	HAMERSL65	2006: Excellent (1.2%)-very good (98.8%)	0.48±0.04	
61	HAMERSL66	2006: Excellent (1.2%)-very good (98.8%)	0.45±0.04	
62	HAMERSL67	2006: Excellent (1.2%)-very good (98.8%)	1.9±0.2	
63	HAMERSL68	2006: Excellent (1.2%)-very good (98.8%)	1.8±0.1	
64	HAMERSL69	2006: Excellent (1.2%)-very good (98.8%)	1.24±0.1	
65	HAMERSL70	2006: Excellent (1.2%)-very good (98.8%)	0.45±0.04	
66	HAMERSL71	2006: Excellent (1.2%)-very good (98.8%)	11.75±1.1	
67	HAMERSL72	2006: Excellent (1.2%)-very good (98.8%)	1.62±0.1	
68	HAMERSL73	2006: Excellent (1.2%)-very good (98.8%)	1.44±0.1	
69	HAMERSL74	2006: Excellent (1.2%)-very good (98.8%)	3.3±0.3	
70	HAMERSL75	2006: Excellent (1.2%)-very good (98.8%)	3.92±0.3	
71	HAMERSL77a-c	2013: Very good (100%)	1899.63±189.9	Weeds- *Vachellia farnesiana*, Bardi bush
72	HAMERSL78	2006: Excellent (1.2%)-very good (98.8%)	6.38±0.6	
73	HAMERSL83	2006: Excellent (1.2%)-very good (98.8%)	1.78±0.1	
74	HAMERSL84	2006: Excellent (1.2%)-very good (98.8%)	3.64±0.3	
75	HAMERSL85	2006: Excellent (1.2%)-very good (98.8%)	319.42±31.9	
76	HAMERSL86a-d	2006: Excellent (1.2%)-very good (98.8%)	319.42±31.9	
77	HAMERSL87	2006: Excellent (1.2%)-very good (98.8%)	6.38±0.6	
78	HAMERSL90	2006: Excellent (1.2%)-very good (98.8%)	6.38±0.6	
79	HAMERSL91	2006: Excellent (1.2%)-very good (98.8%)	6.38±0.6	
80	HAMERSL92	2006: Excellent (1.2%)-very good (98.8%)	20.2±0.2	
81	HAMERSL93	2006: Excellent (1.2%)-very good (98.8%)	1.88±0.18	

82	HAMERSL94	2006: Excellent (1.2%)-very good (98.8%)	1.57±0.15	
83	HAMERSL95	2006: Excellent (1.2%)-very good (98.8%)	0.25±0.02	
84	HAMERSL96	2006: Excellent (1.2%)-very good (98.8%)	0.55±0.05	
85	HAMERSL97	2006: Excellent (1.2%)-very good (98.8%)	0.4±0.04	
86	HAMERSL98	2006: Excellent (1.2%)-very good (98.8%)	1.71±0.17	
87	HAMERSL99	2006: Excellent (1.2%)-very good (98.8%)	0.13±0.01	
88	HAMERSL100	2006: Excellent (1.2%)-very good (98.8%)	1.66±0.16	
89	HAMERSL101	2006: Excellent (1.2%)-very good (98.8%)	0.95±0.09	
90	HAMERSL102	2003: Excellent (1.2%)-very good (98.8%)	1.87±0.18	

24. If so, how much of the community would you describe as in relatively <u>good condition</u>, i.e. likely to persist into the long-term with minimal management?

For the purposes of relating condition to IUCN Criteria, WA condition categories 'Very Good to Pristine' as below (see ^below in Table 4) are considered to be in good condition, so therefore 4905ha or 96% of known occurrences are considered to be in good condition. They contain a high diversity of native plant species, maintain integrity of vegetation structure, and have minimal weed/introduced species cover.

Table 4: Vegetation condition of occurrences of Themeda grasslands

Occurrence number (for portion of occurrence estimated as percentage see table 3)	**Total area (ha)**	**Condition when last surveyed**
0	0	^^^^Beyond recovery ('completely degraded using Bush Forever (2000) scale)
0	0	^^^Poor ('degraded' using Bush Forever (2000) scale)
16, 17	183	^^Medium ('good' using Bush Forever (2000) scale)
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91	4905	^Good ('pristine', 'excellent', 'very good' using Bush Forever (2000) scale)

25. What features or variables do you consider to be most valuable for identifying a patch of the ecological community in relatively <u>good condition</u>?

Variables for establishing the highest condition class may include: patch size; connectivity; native plant species composition; diversity and cover (for example in overstorey; mid-shrub and/or understorey layers); recognised faunal values; and cover of weeds or other invasive species.

See Section 24 above.

^This includes vegetation ranging from Bush Forever (2000) condition scales of 'Pristine' - with no obvious signs of disturbance and native plant species diversity fully retained or almost so, zero or almost so weed cover/abundance, to 'Excellent' - Vegetation structure intact, with disturbance only affecting individual species, weeds are non-aggressive species, and the area contains high native plant species diversity, with less than 10% weed cover, and 'Very Good' - Vegetation structure altered, obvious signs of disturbance eg: from repeated fires, grazing, aggressive weeds are present, with moderate native plant species diversity, and typical weed cover is less than 20% (5 – 20%).

26. How much of the community would you describe as in relatively <u>medium condition</u>, i.e. likely to persist into the long-term future with management?

For the purposes of relating condition to IUCN Criteria, medium condition relates to WA condition categories 'Very Good to Good' as below (see ^ below and Table 4 above), so therefore 183ha of known occurrences are considered to be in medium condition, and contain medium plant species diversity, reduced of vegetation structure, and a medium level of weed/introduced species cover.

^^This includes vegetation ranging from 'Very Good-Good' and '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, grazing, and very aggressive weeds are present, with low native plant diversity (5 – 50%).

27. Please describe how you would identify areas in <u>medium condition</u> using one or a combination of indicators such as species diversity, structure, remnant size, cover of weeds or other invasive species, etc.

See section 26 above.

28. How much of the community would you describe as in relatively <u>poor condition</u>, i.e. unlikely to be recoverable with active management?

For the purposes of relating condition to IUCN Criteria, poor condition in this instance relates to WA condition categories 'Degraded' and 'completely degraded' (see ^^^ and ^^^^ below and Table 4 above), so 0ha of known occurrences are considered to be in poor condition, with vegetation containing minimal native flora, presence of aggressive weeds, and evidence of much disturbance.

^^^Basic vegetation structure is severely impacted by disturbance such as partial clearing, dieback, logging and grazing. Scope for regeneration but not to a state approaching good condition without intensive management. Very aggressive weeds are present at high density, and very low native plant species diversity is observed (20 – 70%).

^^^^A collapsed state (Beyond recovery under IUCN condition ranking) is considered 'Completely Degraded' where vegetation structure is no longer intact and the area is completely or almost completely without native flora, referred to also as 'Parkland Cleared', with very low to no native species diversity (weed species greater than 70%).

29. Please describe how you would identify area in <u>poor condition</u> using one or a combination of indicators such as species diversity, structure, remnant size, cover of weeds or other invasive species, etc.

See section 28 above.

Threats

Note: If you plan to identify <u>climate change</u> as a threat to the ecological community, please refer to the IUCN Red List of Ecosystem Guidelines for information on how this should be addressed.

30. Identify <u>PAST</u> threats to the ecological community indicating whether they are *actual* or *potential*.

Cattle grazing has been the predominant threat to the Themeda grasslands community with the majority of occurrences occurring on an active pastoral station. Is an <u>actual</u> threat.

Mineral exploration occurs across the community with clearing permits having been issued. Is an <u>actual</u> threat.

Weeds from land uses including agriculture, intensive agriculture and native vegetation clearing. Is an <u>actual</u> threat.

31. Identify <u>CURRENT</u> threats to the ecological community indicating whether they are *actual* or *potential*.

The Themeda grasslands community is subject to recent and ongoing disturbance from grazing, mineral exploration, hydrological changes, weeds and feral animals.

32. Identify FUTURE threats to the ecological community indicating whether they are *actual* or *potential*.

It is predicted that in the future the Themeda grasslands community will be threatened by grazing, mineral exploration, hydrological changes, mining, weeds and feral animals.

For <u>each</u> threat describe:

32 a. How the threat has impacted on this ecological community in the past.

Total grazing pressure

The majority of occurrences of the Themeda grasslands community occurs on Hamersley Station, an active pastoral lease for cattle. The grasslands contain native pastures that have high to moderate value for stock production, producing large quantities of good quality fodder after rain which can support lactating cows. The nutritional value declines as the grasslands dry off, eventually supplying only a maintenance diet (Clunies-Ross and Mitchell 2014; Shaw and Mitchell 1994).

Hamersley Station has been grazed extensively over 100 years, firstly by sheep and then cattle (pers comm. Stephen Van Leeuwen), with 98.2% of the community exposed to grazing. Continuous grazing of the grasslands alters the floristic composition by selectively removing edible species, as well as causing physical damage to the vegetation through grazing and trampling. In areas that have been extensively grazed, grass clumps are severely reduced in size with considerable erosion occurring around the base of the tussocks. The self-mulching cracking clay soils on which the grasslands occur tend to lose structure after major, long-term vegetation depletion with some areas no longer supporting the perennial grasses. Significant vegetation loss as a result of overgrazing will eventually lead to erosion (van Vreeswyk *et al*. 2004). In addition to physical disturbance, faeces of stock can introduce or increase weed invasion. Fencing has served to reduce the impact to the grasslands from cattle but only a small portion of the community (~200 hectares) is fenced.

Hydrological changes (change in surface water flows)

The Hamersley and Robe River railway bisects occurrences of the Themeda grasslands and Brockman cracking clay communities and has resulted in changes to overland hydrological flows. As the community is maintained by surface runoff, these changes are detrimental to the wet/dry cycles characteristic of cracking clays, resulting in the permanent alteration of the community's composition. Development planned that will alter the surface flow of water within the catchment adjacent the community also have the potential to impact on hydrology through a shadowing effect.

Vegetation clearing

Vegetation clearing for mineral extraction and other developments have impacted the community. The Hamersley and Robe River railway construction resulted in the clearing of approximately 23 hectares of the community. Although this equates to <1% of the community, the railway line bisects the community resulting in fragmentation as well as changes to surface water flows. A new mine has been approved and includes a rail and infrastructure corridor that will impact two occurrences of the community through loss of vegetation, changes in vegetation structure and species composition, fragmentation and likely increased weed invasion, dust and hydrological change. The rail proposal is likely to result in the loss of 40 hectares of the community (0.84%) and is also likely to impact on surface water flows for the adjacent occurrences.

Weed invasion

Currently weeds levels are not high within the Themeda grasslands, with nine species of introduced flora recorded by Biota (2012) including bipinnate beggartick (*Bidens bipinnata*), *Lepidium didymum*, pie melon (*Citrullus amarus*), sunnhemp (*Crotalaria juncea*), mimosa bush (*Vachellia farnesiana*), spiked malvastrum (*Malvastrum americanum*), buffel grass (*Cenchrus ciliaris*), birdwood grass (*Cenchrus setiger*) and awnless barnyard grass (*Echinochloa colona*). Only *Vachellia farnesiana* was widespread with most other species, such as *Cenchrus ciliaris*, concentrated around stock watering points where heavy grazing and trampling occurred (Biota 2012).

Weeds change the natural diversity and balance of ecological communities and are a threat to the Themeda grasslands. They displace native plants, particularly following disturbances such as too frequent fire, grazing or partial clearing, and compete with them for light, nutrients and water. Weeds can also prevent recruitment, cause changes to soil nutrients, and affect abundance of native fauna. They can also impact on other conservation values by harboring pests and diseases and increasing the fire risk.

Feral animals

Feral animals, including foxes (*Vulpes vulpes*), cats (*Felix catus*), European rabbits (*Oryctolagus cuniculus*), brumbies (*Equus caballus*), camels and donkeys (*Equus asinus*), are present throughout the area but are actively managed by the pastoral station. As with cattle, feral animals cause damage to the vegetation through trampling and grazing,

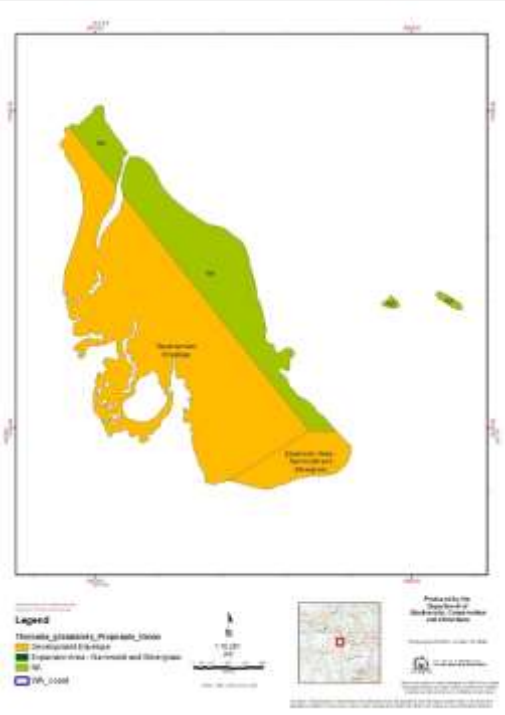
compaction and erosion of the soil, and nutrient enrichment of the water. Foxes and cats predate on native species. Larger feral animals such as donkeys and camels also damage fences (McKenzie *et al*. 2009).

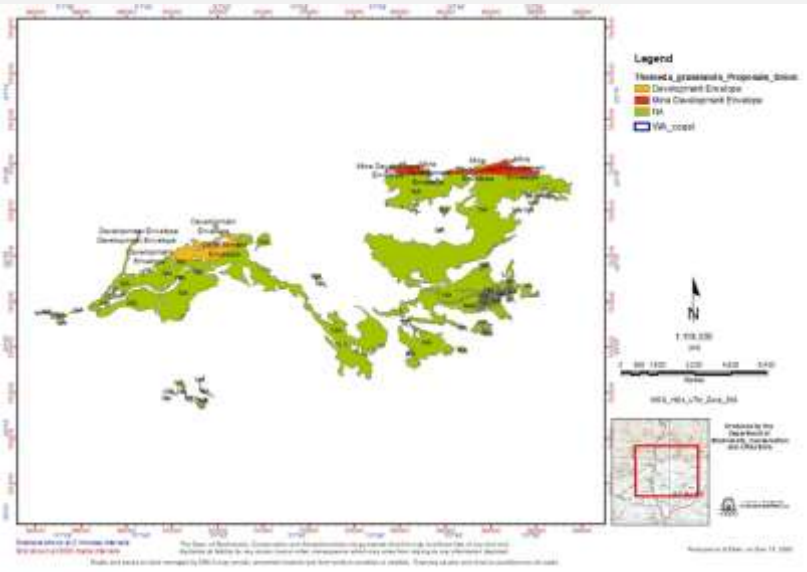
32 b. What its expected effects are in the future. Include or reference supporting research or information.

Significant vegetation loss as a result of overgrazing will result in decline in condition of the community including changes to the community structure and potentially erosion (van Vreeswyk *et al*. 2004).

Weed invasion will continue to increase resulting from the increase in nutrients levels from cattle and is expected to result in changes in species composition and subsequent increase in fire risk.

The current total area of the mapped *Themeda* grassland community is overlayed by mining tenements and exploration leases. Clearing for mineral exploration will result in the temporary loss of the community with regeneration (of varying success) expecting at least five years after rehabilitation. The rail proposal is likely to result in the loss of 40 hectares of vegetation (0.84%) as well as impact on surface water flows. The development envelopes provide a good indication of the current potential extent to which the community could be impacted. Overall 596.44 ha (12.5%) of the Themeda Grasslands community could potentially be directly/indirectly impacted from mining related activities or at threat (e.g. cattle grazing), over the life of the proposals (pers comm. [redacted][2]). This estimate of impact areas is not comprehensive and is underestimated. For example, impacts of rail lines, roads, previous exploration, and from additional mining companies were not included. The two figures below were produced based on spatial data for future mining impacts provided by Department of Water and Environmental Regulation.





In the future, clearing of the *Themeda* grasslands community for agricultural developments, such as irrigated fodder and horticulture in the Hamersley Station area is also likely (DPIRD 2017).

32 c. Identify whether the threat only affects certain portions or occurrences. Give Details.

A proposal for the construction of an access road and railway will directly impact ~40 hectares of the community.

The remaining threats listed above have impacted on the entire community, including the floristic composition and the substrate.

[2] GIS Analysist, Department of Water and Environmental Regulation

33. Identify any natural catastrophic event/s

Explain its likely impact and indicate the likelihood of it occurring (e.g. a drought/fire in the area every 100 years). Catastrophic events are those with a low predictability that are likely to severely affect the ecological community.

Increased droughts will reduce surface water runoff, thereby resulting in a loss of vegetation, as well as more extreme fire behavior, the result of higher temperatures and a greater number of severe fire danger days.

Major fires can occur any time and have potential for major impacts to the vegetation, leading to a decline in projective cover of perennial tussock grasslands and reduction in aboveground biomass and grassland productivity.

34. Additional biological characteristics

Identify and explain any additional biological characteristics particular to the community or species within it that are threatening to its survival (e.g. low genetic diversity). Identify and explain any models addressing survival or particular features.

34 a. How does it respond to disturbance?

Physical disturbance, such as from cattle and feral animals grazing and trampling, can alter the floristic composition of the community by selectively removing edible species, as well as causing physical damage. Grass clumps may be severely reduced in size with considerable erosion occurring around the base of the tussocks. The self-mulching cracking clay soils on which the grasslands occur tend to lose structure after major, long-term vegetation depletion with some areas no longer supporting the perennial grasses.

34 b. How long does it take to regenerate and/or recover?

During flooding periods in the Pilbara, the pastures are poorly accessible by cattle and may provide a reprieve from grazing (Clunies-Ross and Mitchell 2014; Shaw and Mitchell 1994).

Threat Abatement and Recovery

35. Identify key management documentation available for the ecological community, e.g. recovery plans, biodiversity management programmes, or site specific management plans (e.g. for a reserve).

Department of Biodiversity, Conservation and Attractions (2019) Draft Interim Recovery Plan 2019-2024 for Themeda grasslands on cracking clays (Hamersley Station, Pilbara) and Brockman Iron cracking clay communities. Department of Biodiversity, Conservation and Attractions, Western Australia.

36. Give an overview of how threats are being/potentially abated and other recovery actions underway and/or proposed. Identify who is undertaking these activities and how successful the activities have been to date.

Regulations that govern land clearing under the WA *Environmental Protection Act 1986* have limited the impact from land clearing from developments.

Other key measures required to mitigate risks to the ecological community include informing station owners of the significance of the Themeda grasslands community; fencing occurrences in good condition to prevent impacts from cattle; controlling weeds.

37. What portion of the current extent of the ecological community is protected in a reserve set aside for conservation purposes, and what proportions are private land, or other tenure?

The majority of the Themeda grasslands community occurs within Hamersley Station (LPL N050438), an active pastoral leasehold for cattle. Three occurrences also occur on unallocated Crown land.

Table 5. Tenure and extent of occurrences

Number	Occurrence	Area (ha)	Tenure	Comments
1, 7, 5-90	HAMERSL01;07; 10-91	4982.73	Hamersley pastoral lease	Not conservation tenure
2	HAMERSL07	103	UCL	Not conservation tenure
3	HAMERSL08	0.52	UCL	Not conservation tenure
4	HAMERSL09	0.75	UCL	Not conservation tenure

38 a. Which of the reserves are actively managed?

The occurrences of the Themeda grasslands community are actively managed by a mining company.

38 b. Give details of any other forms of protection, such as conservation covenants, and whether the protection mechanisms are permanent.

None

38 c. Indigenous interests
Is the nominated ecological community or parts thereof known to occur on any culturally significant sites? If so comment on any issues with respect to aboriginal interests, in particular with regard to management of the ecological community.

Aboriginal people have lived in the Pilbara since ancient time practising a hunter-gatherer and fire-stick farming lifestyle, moving in cycles throughout their land depending on the availability of food and water (Wangka Maya). The native titles rights of the Eastern Gumura People have been determined and granted over the majority of Hamersley Station.

An Aboriginal Sites Register, kept by the Department of Planning, Lands and Heritage (DPLH), lists three sites of Aboriginal significance occurring within a number of occurrences of the Themeda grasslands community (see table 6).

Table 6: Registered Aboriginal sites (from DPLH) occurring within the boundary of Themeda grasslands on cracking clays community.

Site name	Site Identification	Occurrence Site ID	Restrictions	Site type
HS02-01 Artefact Scatter	19035	HAMERSL45	No gender restrictions	Artefacts/scatter
RTC 03-01 Artefact Scatter	21059	HAMERSL77a-c	No gender restrictions	Artefacts/scatter
Narraminju (Caves Creek)	37670	Many	No gender restrictions	Mythological

Aboriginal cultural heritage practices may include access for traditional hunting, use of significant sites and cultural activities, and the involvement of traditional owners in the management of the site. Under traditional law, traditional owners have a binding responsibility to care for country and keep their culture strong and being on country is the best place for engaging with their culture and passing on the knowledge of country (Parks and Wildlife 2016).

38 d. Native Title
Do Native Title or Indigenous Protected Areas apply to any parts of the community? If so comment on any issues with respect to exclusive possession and rights to plants and animals, in particular with regard to management of the ecological community.

Native Title has been determined over the Hamersley Station area. The claim covering the entire station was registered in 2007 by the Wintawari Guruma Aboriginal Corporation RNTBC (WAD 6208/1998) and covers 6,006.9km^2. The determination granted native title rights to the Eastern Gumura People.

Two registered Indigenous land use agreements (ILUAs) cover the Hamersley Station area including: ILUA (WI2007/001) registered in June 2008, named 'Pilbara Iron – Eastern Guruma Body Corporation', represented by Yamatji Marlpa Aboriginal Corporation, and covering 6,008.5km^2; ILUA (W12001/001) registered in March 2004, named 'Hamersley Iron Pty Ltd – Eastern Guruma', also represented by Yamatji Marlpa Aboriginal Corporation, and covering 6,757.3km^2.

39. Give details of recovery actions that are or could be carried out at the local and regional level, e.g. develop and implement management plan for the control of specific weed species (regional), undertake weeding of known sites (local).

Refer to draft recovery plan. Key measures required to mitigate risks to the ecological community include managing the impact of developments, informing station owners of the significance of the Themeda grasslands community, fencing occurrences in good condition to prevent impacts from cattle, and controlling weeds.

40. Is there an existing support network for the ecological community that facilitates recovery? e.g. an active Landcare group, Conservation Management Network.

A mining company holds the lease for Hamersley Station.

41. Describe methods for identifying the ecological community including when to conduct surveys,

For example, season, time of day, weather conditions; length, intensity and pattern of search effort; and limitations and expert acceptance; recommended methods; survey-effort guide. Include references.
Permanent quadrats are installed and monitoring should be undertaken every five to ten years to examine long-term broad scale compositional and structural change.
42. Are there other any aspects relating to the survival of this ecological community that you would like to address?
No

Section 3 - Justification for this nomination

In order for the nomination to be considered further, one or preferably more of the following criteria need to be fulfilled and substantiated. A clear case for why the ecological community is eligible for listing under the criteria is required, including evidence as to how it meets the requirements for listing under a particular listing category, e.g. ' David *et al*. (1999) finding of 95% decline in geographic distribution suggests it should be listed as critically endangered'. The type of data available will determine which criteria will be used to justify the application of a listing category.
At least one criterion must trigger the thresholds of a listing category as indicated in the Attachment. Criteria may be of different levels of listing category e.g. Criterion 1 = CR and Criterion 3 = VU.

43. Provide data that demonstrates why the ecological community meets at least one of the following criteria for the nominated listing category.

Please use data provided in previous sections to demonstrate how it specifically meets at least one of the following criteria. Advice on how to interpret the listing criteria is in Attachment A. Provide a response for every sub-criterion.

Criterion A: Reduction in geographic distribution.

Criterion A	
☐ CR ☐ EN ☐ VU ☒ not eligible	☐ **A1** ☐ **A2a** ☐ **A2b** ☐ **A3**

Full explanation for Criterion A:

For criterion A, the ecosystem was assumed to collapse when the mapped distribution declines to zero.

Remnant vegetation clearing for mineral exploration and mining activities has resulted in the loss of approximately 23 hectares of the community. Approval to clear a further 40 hectares (0.84%) has also recently been granted. The development envelopes could provide a good indication of the current potential extent to which the TEC could be impacted. There is the potential for 596.44 ha (12.5%) of Themeda Grasslands community to be directly/indirectly impacted from mining related activities or at threat (e.g. cattle grazing), over the life of the proposals. S&C to add images of Themeda TEC areas proposed for impact to nomination form, noting that the areas are not comprehensive and are underestimated (rail and roads, previous exploration, other company's impacts such as Rio Tinto were not included).

This planned clearing and other limited areas of known historical clearing are unlikely to meet the minimum ≥30% decline threshold in proportional reduction over any future 50-year time period to meet vulnerable under Criterion A.

Criterion B: Restricted geographic distribution.

Criterion B	
☒ CR ☐ EN ☐ VU ☐ not eligible	☒ **B1** (specify at least one of the following) ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☒ **b)** ☐ **c); OR** ☐ **B2** (specify at least one of the following) ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☐ **b)** ☐ **c); OR** ☐ **B3** (only for Vulnerable Listing)

Full explanation for Criterion B:

For criterion B, the ecosystem was assumed to collapse when the mapped distribution declines to zero.

B1: The extent of a minimum convex polygon enclosing the Themeda grasslands community is 440km^2 (≤2,000km^2, which is the less than the threshold for CR).
B2: The Themeda grasslands community is estimated to occupy six 10 × 10km square grid cells (threshold for EN is 20 and for CR is two grid cells). As for criterion B1, there is also evidence of continuing decline in the community from grazing and trampling by cattle; temporary clearing, as a result of mineral exploration; and inferred from changes to the hydrological regime and increase in weeds. The rank under criterion B2 is Endangered.
a): Few appropriate data are available to measure decline in spatial extent, environmental quality or disruption to biotic interactions appropriate to the characteristic biota of the ecosystem.
b): Decline observed from the impacts of continuing decline in the community from grazing and trampling by cattle; temporary clearing leading to changes to vegetation structure and species composition, as a result of mineral exploration; clearing for mine infrastructure, and inferred from changes to the hydrologic regime and increase in weeds. Meets criteria for Critically Endangered B1b.
c) Ecosystem exists at three threat-defined locations based on the very limited distance between the groups of eastern and western occurrences and presence of intact vegetation between them (threshold for CR is one and for EN is five threat-defined locations).

B3: The Themeda grassland community is dependent on certain biotic and abiotic conditions. The effects of human activities or stochastic events may cause the ecosystem to collapse within a very short period of time, given its highly restricted distribution, ongoing threats from cattle grazing, and clearing for exploration and mine infrastructure. The ecosystem therefore meets vulnerable status under criterion B3.

Community meets criteria for critically endangered under B1b.

Criterion C: Environmental degradation based on change in an abiotic variable.

Criterion C	
☐ CR ☐ EN ☐ VU ☐ not eligible	☐ **C1 OR** ☐ **C2 OR** ☐ **C3**

Full explanation for Criterion C: -

C1, C2, C3: Hydrological change from infrastructure development is a significant abiotic variable affecting the community. Collapse under criterion C is conservatively defined as complete cessation of surface flows such that the community no longer receives the cross-ground flows that support the community.

One railway line bisects occurrences of the community and have resulted in changes to overland surface water flows. As the community is fed by surface runoff, these changes are detrimental to the wet/dry cycles characteristic of cracking clays, resulting in the permanent alteration of the composition of the community.

At least 40 hectares (0.84%) of the community will be impacted in the near future. The proportional severity in relation to the collapse state that the current and planned railways and other infrastructure have on the community and the extent of impact of the current rail line and other infrastructure on the hydrology and composition of the community has not been determined. Based on available data, the community is unlikely to meet the minimum thresholds for minimum proportion of the extent (≥30%) over any 50-year period, or since 1750 to meet VU under criterion C.

There are inadequate data to determine if the current infrastructure has resulted in the minimum proportional severity of disruption of abiotic processes (≥30%), and inadequate evidence to indicate if the minimum threshold for extent of impact is met for criterion C (≥30%).

Available data does not indicate the community meets criterion C.

Criterion D: Disruption of biotic processes or interactions based on change in a biotic variable.

Criterion D ☐ CR ☐ EN ☐ VU ☐ not eligible	☐ **D1 OR** ☐ **D2 OR** ☐ **D3**

Full explanation for Criterion D:

D1, D2, D3: Weed invasion is a significant biotic variable affecting the community.

For criterion D, collapse of this community is conservatively defined as decline of vegetation condition such that 90% of species in the community are weeds.

Continuous grazing has resulted in changes to floristic composition such that weed levels are high in the community. Some data on weed presence has been recorded by Biota (2012) however, there are inadequate data available to quantify the level of degradation to the Themeda grasslands community to determine if it meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over any 50-year period, or since 1750 to meet VU under criterion D.

Inadequate data to indicate the community meets criterion D.

Criterion E: Quantitative analysis that estimates the probability of ecosystem collapse.

Criterion E ☐ CR ☐ EN ☐ VU ☐ not eligible	

Full explanation for Criterion E:

The ecosystem has not been assessed under Criterion E as no quantitative estimates of the risk of ecosystem collapse were completed.

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 • No available data indicate decline in spatial extent, environmental quality or disruption to biotic interactions that would meet lowest thresholds of the criterion (VU) • Does not meet criterion
B1b	CR	• EOO is ≤2,000km^2 • Impacts observed from grazing and trampling by cattle; clearing as a result of mineral exploration and railway construction; weed invasion; and inferred from changes to the hydrological regime are considered 'non-trivial'. • Meets CR B1b
B1c	EN	• EOO is ≤2,000km^2 • Ecosystem exists at three threat-defined locations • Meets criterion for EN B1c
B2a	-	• AOO is six grid cells • No available data indicate decline in spatial extent, environmental quality or disruption to biotic interactions that would meet minimum thresholds of the criterion (VU) • Does not meet criterion
B2b	EN	• AOO is six grid cells • Impacts observed from grazing and trampling by cattle; clearing as a result of mineral exploration and railway construction; weeds; and inferred from changes to the hydrological regime • Meets criterion for EN B2b
B2c	EN	• AOO is six grid cells • Ecosystem exists at three threat-defined locations • Meets criterion for EN B2c
B3	VU	• Known from three threat-defined locations • Prone to the effects resulting from cattle, clearing and hydrological change • Meets criterion for VU B3
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 past 50 years to meet VU.
C3	-	• Inadequate evidence to indicate community meets 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	-	• Inadequate evidence available to indicate the community meets 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 completed.
		Meets CR under B1b

Section 4 – References/Standard of Scientific Evidence/Critical habitat

Note: The opinion of appropriate scientific experts may be cited (with their approval) in support of a nomination. If this is done the names of the experts, their qualifications and full contact details must also be provided in the reference list below. Harvard style of referencing is preferred.

44. Please provide copies of key documentation/references used in the nomination.

Beard, J.S. (1975) Pilbara Explanatory Notes to Sheet 5 1:1,000,000 Series Vegetation Survey of Western Australia. UWA Press, Nedlands.

Biota Environmental Sciences (2012) *Themeda Grasslands Threatened Ecological Community – Seasonal Botanical Survey*. Report prepared for Rio Tinto Iron Ore Pty Ltd.

Biota Environmental Sciences (2012) *Themeda Grasslands Threatened Ecological Community – Seasonal Botanical Survey*. Report prepared for Rio Tinto Iron Ore Pty Ltd.

Clunies-Ross, M. and Mitchell, A. (2014) Pasture Identification: A field guide for the Pilbara. Greening Australia, WA.

CSIRO (2016) The Australian Soil Classification. Second Edition. CSIRO Publishing, Australia.

CSIRO and Bureau of Meteorology (2015) Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia.

Department of Biodiversity, Conservation and Attractions (2019) Draft Interim Recovery Plan 2019-2024 for Themeda grasslands on cracking clays (Hamersley Station, Pilbara) and Brockman Iron cracking clay communities. Interim Recovery Plan. Department of Biodiversity, Conservation and Attractions, Western Australia.

Department of Parks and Wildlife (2017) Pilbara Conservation Strategy. Government of Western Australia.

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Ecologia (1998) West Angelas Iron Ore Project Environmental Review and Management Program. Report to Robe River Mining Co. Pty. Ltd. Perth.

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

Grant, C.D. and Blackmore, A.V. (1991) Self-mulching behaviour in clay soils: Its definition and measurement. *Australian Journal of Soil Research* 29: 155−173.

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.

McKenzie, N.L., van Leeuwen, S. and Pinder, A.M. (2009) Introduction to the Pilbara Biodiversity Survey, 2002–2007. In: George, A.S., McKenzie, N.L. and Doughty, P. (2009) A Biodiversity Survey of the Pilbara Region of Western Australia, 2002–2007. *Records of the Western Australian Museum*, Supplement 78: 3–89.

Rangeland NRM Western Australia (2011) The Kimberley Project Group 2009−2011. Caring for Our Country.

Shaw, J.F.D. and Mitchell, A.A. (1994) A Resource Inventory and Condition Survey with Proposals for Sustainable Management on Hamersley Station. Hamersley Iron Pty Ltd., Perth.

Trudgen, M. E. and Casson, N. (1998) Flora and Vegetation Surveys of Orebody A and Orebody B in the West Angela Hill area, an area surrounding them, and of rail route options considered to link them to the existing Robe River Iron Associates rail line. Unpublished Report Prepared for Robe River Iron Associates.

Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Department of Agriculture and Food, Western Australia, Perth. *Technical Bulletin 92*.

Wangka Maya (date unknown) Pilbara Aboriginal History, Cultures and Languages. Brochure for Wangka Maya, Pilbara Aboriginal Language Centre.

45. Statement on the Standard of Scientific Evidence

Published data on the Themeda grasslands community were sufficient to apply some of the Red List of Ecosystem criteria and based on these criteria, the outcomes are considered robust. There are inadequate data to support the application of some criteria with any confidence. In particular, there are inadequate monitoring data to link changes in surface flows to changes in composition of the community, or to link the impacts of grazing and levels of weed invasion.

46. Has this document been reviewed and/or have relevant experts been consulted?
If so, indicate by whom and provide their contact details.

The document was reviewed by the following people:
Kirsten Marmion, Conservation Officer (Developments Manager), DBCA Pilbara Region; Parks and Wildlife Service; Lot 3 Anderson Road, (PO Box 835), Karratha WA 6714; P: (08) 9182 2034 M: 0428187672;
Email: kristen.marmion@dbca.wa.gov.au

Jill Pryde, Ecologist, DBCA Species and Communities Program, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983; p: (08) 9219 9941; Email: jill.pryde@dbca.wa.gov.au.

47. Do you wish to propose any areas of habitat for consideration as Critical Habitat for the nominated community?
If so, indicate location/s including a map, and attached shapefiles.

Section 5 - Nominator Details & Declaration

48. Contact Details

Note: Nominator details are subject to the provision of the *Privacy Act 1988*

Title/Full Name	Robyn Luu
Organisation or Company name	Department of Biodiversity, Conservation and Attractions
Postal address	17 Dick Perry Avenue, Kensington Post: Locked Bag 104, Bentley Delivery Centre, WA 6983.
Email	robyn.luu@dbca.wa.gov.au
Phone	9219 9356
Fax	

49. Declaration

Signature (Or insert electronic signature)	***I declare that the information in this nomination form and any attachments is true and correct to the best of my knowledge.***
Date signed	

Section 6 – Completed nomination form checklist

Please check all items on this list have been completed or are included with your nomination.

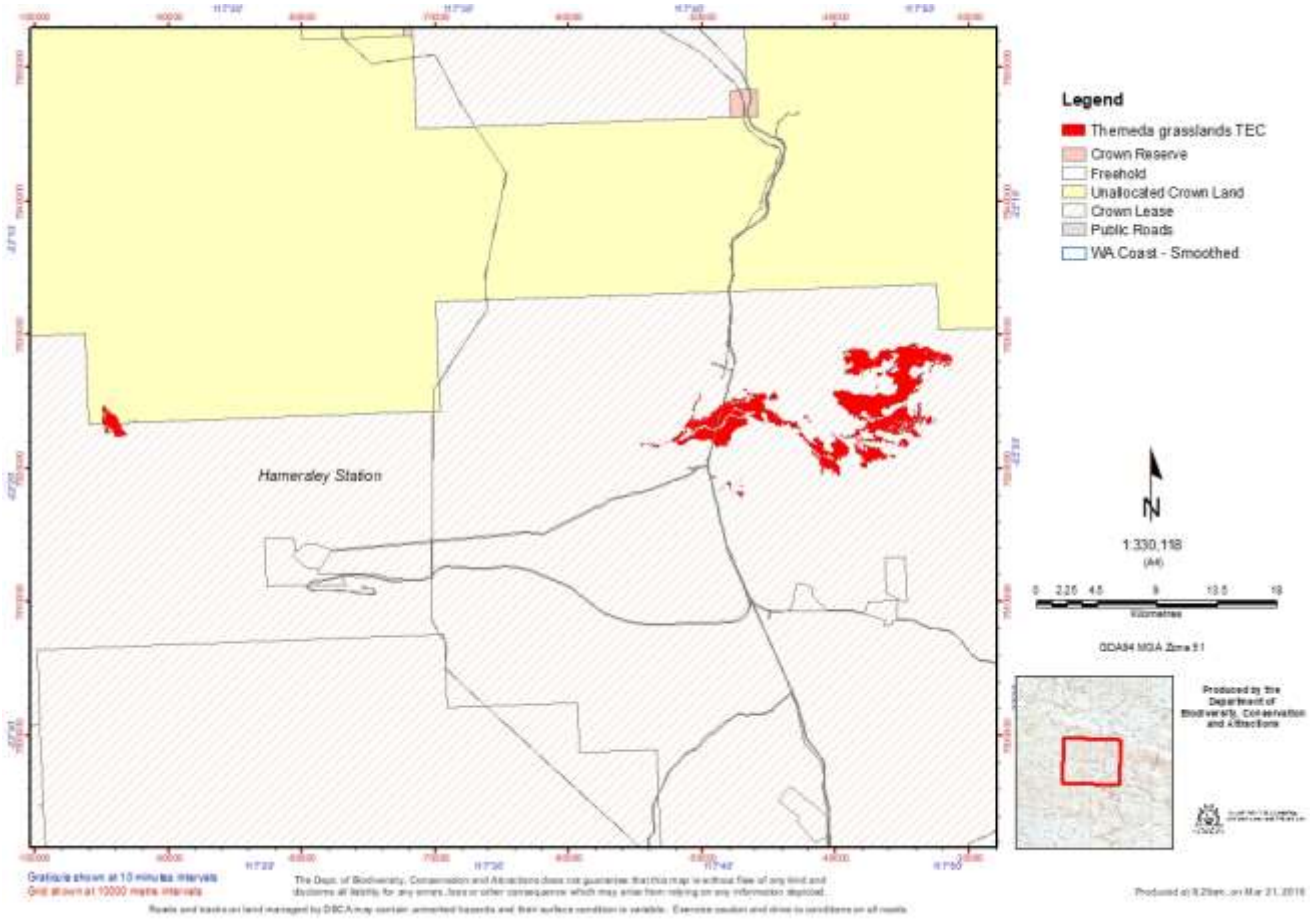
- ☐ I have read and applied the further information and guidelines for completing this nomination form in Attachment A
- ☐ Nominator details including name, address contact phone number included
- ☐ Name of the EC
- ☐ Any other names it is known by
- ☐ Map included or attached
- ☐ References cited
- ☐ If questions are left unanswered, a statement indicating that insufficient information is available

A description of:

- ☐ Biological components of the ecological community
- ☐ Non biological components of the ecological community
- ☐ Key interactions and functional processes
- ☐ Characters distinguishing it from other ecological communities
- ☐ Key species (dominant, characteristic or diagnostic, threatened etc)
- ☐ Known or estimated current extent of the ecological community
- ☐ Past/current/future threats including actual/potential, how/ where, how being/how could be abated
- ☐ Which listing category/categories it should be listed under and why

How to lodge your nomination

Appendix 1. Themeda grasslands on cracking clays (



Hamersley Station, Pilbara) community (red)