Department of Biodiversity, Conservation and Attractions

GOVERNMENT OF WESTERN AUSTRALIA

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Herbaceous plant assemblages on Bentonite Lakes as originally described by Griffin and Associates (1991)
Other names:	
Description:	The community occurs on the lake margins of bentonite lakes in the Watheroo-Marchagee region as originally described by Griffin, E.A. and Associates (1991). Flora and Vegetation of Watheroo Bentonitic Lakes. Unpublished report prepared for Bentonite Australia Pty Ltd. The community comprises herbaceous plant assemblages dominated by a combination of *Triglochin mucronata, Trichanthodium exilis*, *Asteridea athrixioides* and *Puccinellia stricta* (marsh grass) on the lake beds, and a combination of *Siemssenia capillaris* (wiry podolepis), *Angianthus tomentosus* (camel-grass) and *Pogonolepis stricta* (stiff angianthus). These herbaceous plant assemblages are characterised by a dependence on a bentonite (saponite) substrate — naturally restricted to the lake beds and margins of perched, ephemeral freshwater playa lakes and claypans of the Watheroo-Marchagee region. While most lakes comprise only herbaceous species, there are a number with varying densities of *Casuarina obesa* trees, and shrubs of *Melaleuca lateriflora* (gorada) and *Acacia ligustrina*.
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; under WA Minister ESA list in policy	8/5/2002	Endangered	EN B) iii) (under previous ranking criteria developed in WA)
	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 ☐

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 3 table 'IUCN Red List Criteria for ecosystems version 2.2'.*		VU B3
Eligibility against the criteria		
*Provide justification for the nominated conservation status; is the ecological community eligible or ineligible for listing against the five criteria. For **delisting**, provide details for why the ecological community no longer meets the requirements of the current conservation status.*		
A.	Reduction in geographic distribution *(evidence of decline)*	☐ **A1** ☐ **A2a** ☐ **A2b** ☐ **A3**
	Justification of assessment under Criterion A.	For criteria A and B, the ecosystem was assumed to collapse when the mapped distribution declines to zero. • The assemblage is dependent on bentonite (saponite) substrate that is naturally restricted to the lake beds and margins of perched, ephemeral freshwater playa lakes and claypans of the Watheroo-Marchagee region. The bentonite substrate occurs in other lakes in the Marchagee region, but these areas lack the characteristic herbaceous flora assemblage. From examination of aerial photographs of surrounding lakes likely to have bentonite substrate, it is inferred the characteristic bentonite assemblage may have once existed at these locations but that it has been cleared and possibly mined. Based on aerial photo interpretation, and soil surveys by T. Griffin and J. Wagnon (Department of Agriculture and Food, 2001), a 44% decline in extent is estimated for this community. • The timing of the clearing is not known but may have occurred in the last 50 years. The clearing is conservatively assumed to have occurred since 1750. Based on available evidence, the community does not meet criterion A as the distribution decline of 44% does not meet a minimum 50% threshold decline in extent historically (since ~1750 - the date specified in IUCN RLE). As the timing of clearing is not clear, there is insufficient evidence to support an inference that a minimum 30% reduction in geographic distribution has or will occur over any particular 50-year period (ie. the minimum thresholds to meet the category VU under criterion A1, A2). • **Available data do not indicate community meets criterion A**

B.	Restricted geographic distribution *(EOO and AOO, number of locations and evidence of decline)*	☐ **B1** (specify at least one of the following): ☐ **a)(i)** ☐**a)(ii)** ☐**a)(iii)** ☐**b)** ☐**c);** CR ☐ **B2** (specify at least one of the following): ☐ **a)(i)** ☐**a)(ii)** ☐**a)(iii)** ☐**b)** ☐**c);** EN ☒ **B3 (only for Vulnerable Listing)** VU
	Justification of assessment under Criterion B.	• B1: EOO is 232km^2 • The community's EEO is less that the 2,000km2 threshold for rank CR. Community meets threshold for rank CR under criterion B1. • B1a): Inadequate 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. • B1 b): Main threatening processes are land clearing, salinisation, increased inundation and waterlogging, nutrient enrichment, weed invasion and a drying climate, however, there is no substantial evidence of these threats being non-trivial and causing a continuing decline (see Appendix 1 for details on threats). Does not meet criterion. • B1 c) There is insufficient evidence to indicate that current threats are non-trivial. Does not meet criterion. • B2: AOO- the community covers 6 grid cells (threshold for CR is ≤2 and for EN it is ≤20 grid cells). There is no available evidence that indicates current threats being are non-trivial and causing a continuing decline. Does not meet criterion. • B3: community is considered to occur at 3 threat defined locations under B3. Salinisation is notably increasing near the northern occurrences but the southern occurrences currently may be less affected. A northern, southern and separate eastern group of occurrences is therefore considered to represent 3 locations. Community occurs at less than 5 threat-defined locations that are prone to effects of stochastic events within a very short time period – including salinisation and vegetation clearing, and is thus capable of collapse or becoming CR within a short time period. • **Meets VU under B3**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	• Salinisation is an abiotic variable that may be a significant threat to the community. • For criterion C, the assessment of decline in abiotic processes focussed on salinisation using data on the

		electrical conductivity (mS/m). In 1996, the occurrence Bent41 was observed to be complete degraded (collapsed) and this was attributed to hydrological change - salinisation. The earliest salinity recording of this occurrence was in 2007, with a salinity level of 3530 mS/m. There are inadequate systematic monitoring data to extrapolate the salinity threshold at which this occurrence collapsed, however, it is inferred that the 2007 salinity level represents this threshold. This is also comparable to the trigger level that indicates the requirement for 'close monitoring'. Currently, salinity monitoring data is only available for Bent41, an occurrence that has collapsed. It is expected that other occurrences in close proximity to Bent41 are also affected by salinisation. The extent of impact of salinisation cannot be determined based on current data and requires further investigation. • There is inadequate evidence to indicate the community meets the thresholds for minimum proportion of the extent (30%) or proportional severity of degradation (30%) over any 50-year period to meet VU under these criteria. • **Inadequate evidence to indicate the community meets the criterion**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☐ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	• Weed invasion is a significant biotic threat to the community. Weeds can have significant impacts on the assemblage through competition with the native species. Disturbances such as salinisation and waterlogging can predispose areas to weed invasion if weed propagules are present. Some lake beds are already dominated by highly salt tolerant weeds that are more aggressive than the native species that can tolerate saline conditions. Increased nutrient enrichment also promotes the growth of weeds. • The severity of weed invasion associated with collapse is uncertain, but it is assumed conservatively that the community reaches a collapsed state when only 10% (plausible range 0–20%) of its plant species are native. • Currently, there are inadequate systematically collected monitoring data about weed levels to support assessment of the community against criterion D. • **Insufficient evidence to indicate the community meets criterion D.**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse have been completed • **Does not meet criterion**

Reasons for change of status			
Genuine change ☐ New knowledge ☐ Previous mistake ☐ Review/Other ☒			
Provide details: The community was initially ranked as EN B) iii) using ranking criteria developed in WA that differ to those in the IUCN Red List Criteria for Ecosystems (version 2.2).			
Summary of assessment information *(provide detailed information in the relevant sections of the nomination form)*			
EOO	232km^2	AOO	600 km^2 (10x10km grid method).
No. occurrences	34	Severely fragmented (justification below)	Yes ☒ No ☐ Unknown ☐
Justification of whether fragmented	The community is confined to specific habitats in Bentonite lakes that are naturally highly fragmented. It is restricted to clay playas in the Watheroo-Marchagee area.		
Current known area			145.6ha
Pre-industrialisation extent or its former known extent (if known)			Community estimated to have originally covered 260ha (ie. 145.6x100/56).
Estimated percentage decline			44% (see explanation under criterion A above).

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	-	• Community does not meet criterion A as the distribution decline of 44% does not meet a minimum threshold of 50% since 1750 (VU) • Available data do not indicate community meets criterion
B1a	-	• EOO is <2,000km^2 • Inadequate data to indicate decline in spatial extent, environmental quality and disruption to biotic interactions that would meet lowest thresholds for the criterion (VU) • Does not meet criterion
B1b	-	• EOO is <2,000km^2 • Insufficient evidence to indicate current threats are non-trivial. • Does not meet criterion
B1c	-	• EOO is <2,000km^2 • There is insufficient evidence to indicate that current threats are non-trivial and therefore the number of threat-defined locations cannot be determined to meet this sub criteria • Does not meet criterion
B2a	-	• AOO is 6 grid cells • Inadequate data available to indicate decline in spatial extent, environmental quality or disruption to biotic interactions that would meet lowest thresholds for the criterion (VU) • Does not meet criterion

B2b	-	• AOO is 6 grid cells • No evidence to indicate current threats are non-trivial. Does not meet criterion
B2c	-	• AOO is 6 grid cells • There is insufficient evidence to indicate that current threats are non-trivial and therefore the number of threat-defined locations cannot be estimated to meet this sub criteria • Does not meet criterion
B3	VU	• Known from 3 threat-defined locations • Prone to the effects of salinization within a short time period in uncertain future • 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 the 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	-	• Inadequate evidence to indicate the 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	-	• 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.
		Meets VU under B3.

Department of **Biodiversity, Conservation and Attractions**

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Summary of location (occurrence) information *(provide detailed information in the relevant sections of the nomination form)*						
Occurrence ID (Occurrence No.)	Land tenure	Survey information: date of survey	Condition	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
Bent16 (1)	DBCA (Pinjarrega Nature Reserve 25210)	1996 and 2009	100% Very good	2.8	Resource extraction, hydrological change, grazing by native or introduced species, weed invasion (past, present, future)	Long term hydrological monitoring, manage water quality, feral animal control and weed control
Bent18Q6 (2)	DBCA (Pinjarrega Nature Reserve 25210)	1991, 1996, 2000, 2009 (condition survey) and 2012	100% Very good	7.5	Resource extraction, hydrological change, grazing by native or introduced species, weed invasion (past, present, future)	As above
Bent19 (3)	DBCA (Pinjarrega Nature Reserve 25210)	1996 and 2000	100% Excellent	3.2	Resource extraction and recreational activities, weed invasion (past, present, future)	As above
Bent20 (4)	DBCA (Pinjarrega Nature Reserve 25210)	1996, 2008 and 2009	100% Very good	1.6	Resource extraction, hydrological change, grazing by native or introduced species, weed invasion (past, present, future)	As above

Bent21 (5)	DBCA (Pinjarrega Nature Reserve 25210)	1991, 1996, 2009 (condition survey) and 2012	85% Good and 15% Very good	6	Resource extraction, hydrological change, weed invasion (past, present, future)	As above
Bent22 (6)	DBCA (Pinjarrega Nature Reserve 25210)	1996	100% Excellent	3.2	Resource extraction and hydrological change, weed invasion (past, present, future)	As above
Bent23 (7)	DBCA (Pinjarrega Nature Reserve 25210)	1996	100% Excellent	2.9	Resource extraction, hydrological change, weed invasion (past, present, future)	As above
Bent24 (8)	DBCA (Pinjarrega Nature Reserve 25210)	1996	100% Excellent	0.9	Resource extraction, recreational activities, hydrological change, weed invasion (past, present, future)	As above
Bent25 (9)	DBCA (Pinjarrega Nature Reserve 25210)	1996	80% Excellent 20% Very good	4.6	Resource extraction, weed invasion (past, present, future)	As above
Bent26 (10)	DBCA (Pinjarrega Nature Reserve 25210)	1991,1996, 2009 (condition survey) and 2012	80% Very good 20% Excellent	4.1	Resource extraction, hydrological change, grazing by native or introduced species, weed invasion (past, present, future)	As above
Bent27 (11)	DBCA (Pinjarrega Nature Reserve 25210)	1996, 2000 and 2009	100% Good	1.4	Resource extraction, hydrological change, weed invasion and grazing by native or	As above

					introduced species (past, present, future)	
Bent28 (12)	DBCA (Pinjarrega Nature Reserve 25210)	1996	100% Excellent	1.1	Resource extraction, recreational activities, weed invasion and hydrological change (past, present, future)	As above
Bent29 (13)	UCL	1996 and 1998	100% Excellent	3.3	Resource extraction, weed invasion (past, present, future)	Long term hydrological monitoring, manage water quality, seek conservation vesting, feral animal control, weed control
Bent30 (14)	UCL	1996 and 1998	100% Excellent	2.5	Resource extraction, weed invasion	As above
Bent31 (15)	UCL	1991, 1996, 1998	50% Excellent 50% Very good	2.3	Resource extraction, hydrological change, weed invasion	As above
Bent32 (16)	UCL	1996 and 1998	25% Good 75% Excellent	0.6	Resource extraction, weed invasion	As above
Bent33 (17)	UCL	1991, 1996 and 2009	100% Very good	5.4	Resource extraction, hydrological change and grazing by native or introduced species, weed invasion (past, present, future)	As above
Bent34 (18)	DBCA (Watheroo NP 24491)	1991, 1996, 2000 (condition	50% Excellent 50% Very good	2.5	Resource extraction, hydrological change and grazing by native or introduced species,	Long term hydrological monitoring, manage

		survey), 2009 and 2012			weed invasion (past, present, future)	water quality, feral animal control and weed control
Bent35 (19)	DBCA (Watheroo NP 24491)	1991, 1996 and 2000	100% Excellent	3.4	Resource extraction, hydrological change, weed invasion and grazing by native or introduced species (past, present, future)	As above
Bent36 (20)	DBCA (Watheroo NP 24491)	1996, 2000 and 2008	100% Good	2.6	Resource extraction and hydrological change (past, present, future)	As above
Bent37 (21)	DBCA (Watheroo NP 24491)	1996	100% Excellent	0.7	Resource extraction, hydrological change and grazing by native or introduced species, weed invasion (past, present, future)	As above
Bent38 (22)	DBCA (Watheroo NP 24491)	1991, 1996, 1998 and 2009	20% Completely degraded 50% Good 30% Very good	19.4	Resource extraction, recreational activities, weed invasion and hydrological change (past, present, future)	As above
Bent39 (23)	DBCA (Watheroo NP 24491)	1991 and 1996	100% Excellent	8.2	Resource extraction, recreational activities, weed invasion and hydrological change (past, present, future)	As above
Bent40 (24)	DBCA (Watheroo NP 24491)	1991 and 2008	100% Completely degraded	1.1	Resource extraction, recreational activities, weed invasion and	As above

					hydrological change (past, present, future)	
Lake A (26)	Private	2001	40% Good and 60% Excellent	22	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species, weed invasion (past, present, future)	Long term hydrological monitoring, manage water quality, liaise with property owners, feral animal control, weed control, seek to fence occurrences
BSBENT4 (28)	Private	2001	100% Very good	5.5	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above
BENTHS1 (29)	Private	N/A	Unknown	2.7	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species, weed invasion (past, present, future)	As above
BENTHS2 (30)	Private	N/A	Aerial photos indicate cleared	4.2	N/A	N/A
BENTOC1 (31)	Private	2001	100% Excellent	2.9	Weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	Long term hydrological monitoring, manage water quality, liaise with property owners, feral animal control, weed control, seek to fence occurrences

BENTOC3 (32)	Private	N/A	Unknown	3.9	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above
BENTOC2 (33)	Private	2001	100% Very good	7.9	Weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above
Dob03 (34)	Private	2012	Unknown	1.7	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above
Dob01 (35)	Private	2011	Unknown	3	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above
Dob02 (36)	Private	2012	Unknown	0.6	Resource extraction, weed invasion, hydrological change and grazing by native or introduced species (past, present, future)	As above

*Condition categories as they relate to condition scales from (Keighery 1994 Vegetation Condition Scale (Government of WA 2000)) are defined below:

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

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

Poor ('Degraded' using Bush Forever (2000) scale): Basic vegetation structure 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.

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

Table 1. Known vegetation condition occurrences that have been surveyed (5) of '*Herbaceous plant assemblages on Bentonite Lakes as originally described by Griffin and Associates (1991)*'

Condition Ranking (Keighery 1994) from Government of Western Australia 2000)	**Hectares**	**IUCN Criteria condition ranking**	**Hectares**
Pristine	0		
Excellent	52.85		
Very Good	44.02		
Good	27.75	**Good**	96.87
Degraded	0	**Medium**	27.75
Completely degraded ('collapsed')	4.98	**Poor**	4.98
Total	129.6	**Total**	129.6

APPENDIX 1 THREATS

The main threatening processes causing decline in the integrity of the community include salinisation, water-logging and increased inundation, weed invasion, vegetation clearing, removal of substrate for mining, trampling by feral animals, and nutrient enrichment.

Salinisation

Lake Pinjarrega which occurs northwest of the bentonite lake occurrences in Pinjaregga Nature Reserve is salinised and the closest occurrence of the community type south of Lake Pinjaregga, 'Bent 41', which is now 'collapsed', has become severely salt effected. This is evident through the hydrological data, visual observations of tree deaths, and the monoculture of halophytes.

If there is a large enough flow event, more salt may be transported to other areas of the nature reserve and this may result in further occurrences becoming saline. This issue would require special management action. The Yarra Yarra system which lies north of the catchment area is salinised. It is not known if the salt load from this salinised system will move towards the bentonite lakes over time.

Figure 1 shows that the collapsed occurrence Bent41, has a fluctuating salinity level that is above the 'requires close monitoring' threshold. A trigger for electrical conductivity at the Mound Springs of Three Springs, located 60km north-west of the nearest Bentonite lake, is set at 3,000µS/cm for close monitoring and 4,000µS/cm as a trigger for further investigation (pers. comm. [redacted][1]). Other bore locations (YRE-1D and YRE-1S located 2.6km south-west of Bent41, and YRD-2D located 10.2km north-west of Bent41) serve as a reference point. The evidence of relatively high salinity at Bent41 suggests that other occurrences of the community in close proximity to Bent41 (Bent16, 18Q6, 19, 20, 21, 22, 23, 24, 25, 26, 27 and 28) may also be affected by salinity. However, the extent to which they are affected is uncertain and a wider long-term study would be required to determine this.

Rising groundwater rise may also salinise soil profiles. The more elevated and remote bentonite lakes may have distinct hydrologic regimes in which salinity will only enter the system if there is a substantial rise in groundwater. Figure 2 shows ground water levels have been relatively stable between 1999 and 2019 in this region, despite evidence of ground water levels increasing 60km north-west in regions where the Mound Springs of Three Springs and Ferricrete floristic communities occur.

[1] [redacted] Department of Water and Environmental Regulation

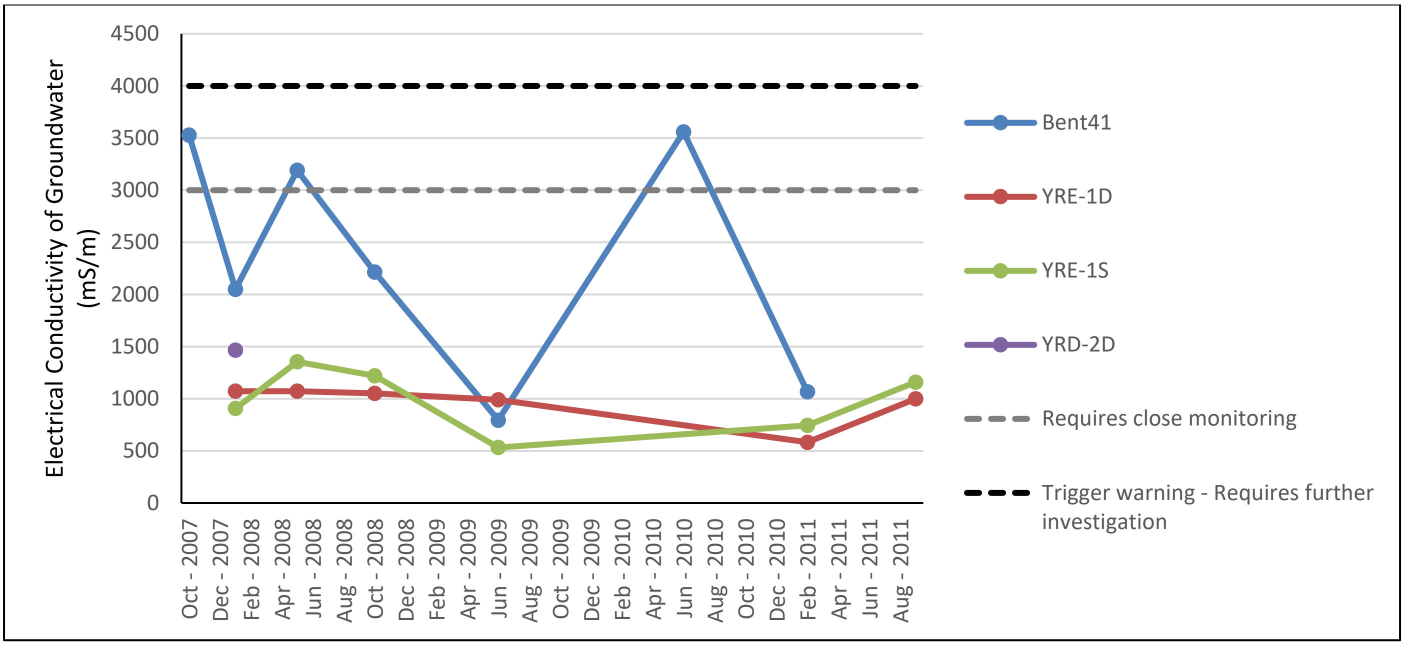

Figure 1. Salinity (Electrical Conductivity) of the collapsed occurrence Bent41, and three other bore sites within a 8km radius, between 2007 and 2011 (DoW 2012).

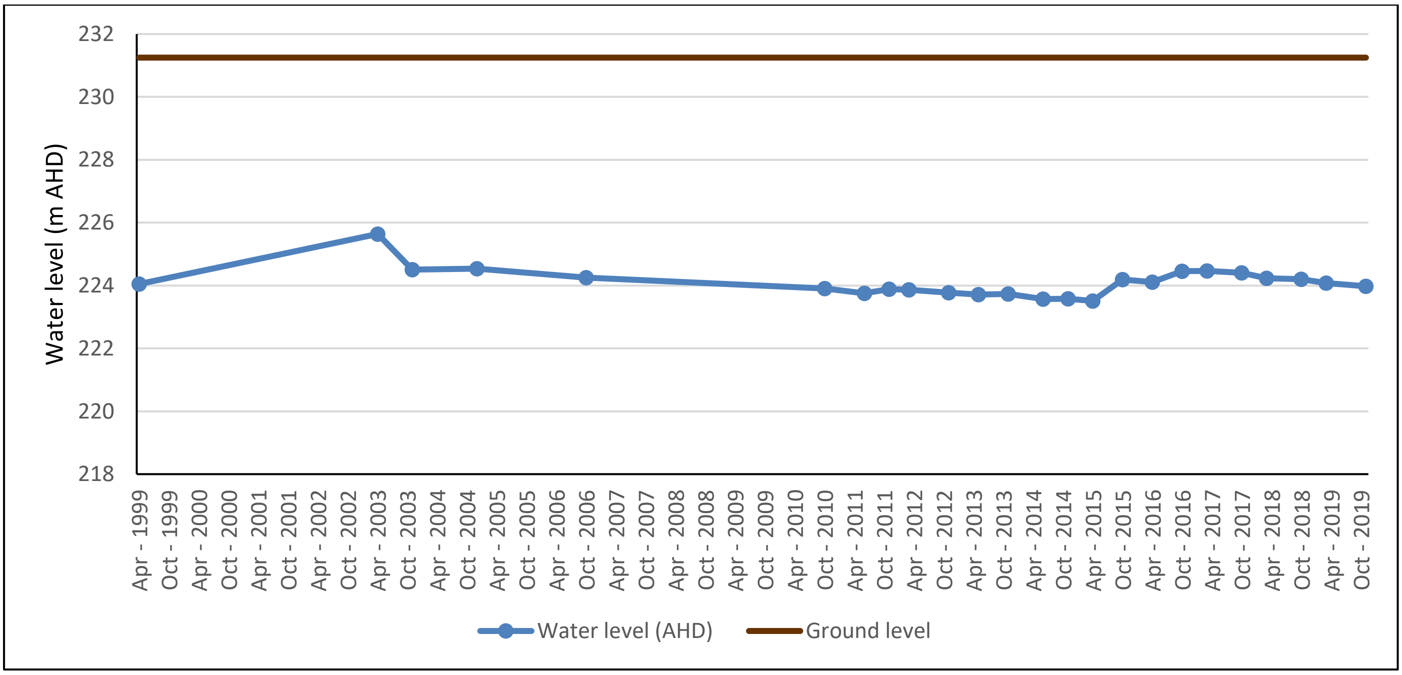

Figure 2. Hydrograph of monitoring bore located 10.3km north-west of occurrence Bent41 and 8.2km north-west of occurrence Bent16 (61710170), sampling the superficial aquifer (DoW 2019).

Excessive inundation and waterlogging

Waterlogging is likely to be a major threat to this lake-bed community as its components are thought to rely on the lakes drying out to facilitate germination of annual species. Excessive inundation, in particular with increasingly saline groundwater may reduce the chances of germination or render the seed store inviable if it is inundated for an increased period. Most of the flora are annuals and along with the other biota, particularly the non-insect invertebrate fauna ([redacted], pers. comm.[2]), probably depend on relatively fresh water and regular drying out of the lake-bed for survival.

[2] [redacted] Research Scientist, Department of Biodiversity, Conservation and Attractions.

The eventual death of tree and shrub species as they succumb to salinisation and the consequent lack of deeper roots that otherwise assist in lowering the water table can amplify the impacts of rising saline water tables.

Weed invasion

Weeds can have significant impacts on the assemblage through competition with the native species. Disturbances such as salinity and waterlogging can predispose areas to weed invasion if weed propagules are present. Some lake beds (eg. Lake 25) are already dominated by highly salt tolerant weeds that are more aggressive than the native species that can tolerate saline conditions.

Clearing

Mining of bentonite lakes involves removing the entire bentonite substratum, and this is detrimental to the survival of the plant community as it removes habitat. For economic reasons, mining activities have concentrated on the larger, and consequently more diverse lakes. To date, all occurrences on private property have been mined and there are currently two live mining tenements, one in UCL, and one in the national park in which mining has already commenced. Occurrence BENTHS2 (30) is suspected to have been cleared for agriculture.

Historically there have been unsuccessful applications to mine limestone from adjacent lakes. Limestone mining has the potential to increase surface water runoff, rates of weed invasion, and possibly change groundwater processes.

Physical damage

The lake beds can be damaged by vehicle tracks, trail bikes, and trampling by feral goats and cattle. This can result in the loss of component species, prevent recruitment and provide weed sources.

Nutrient enrichment

Nutrient enrichment can result from the faeces of feral goats and cattle or nutrient enriched surface water flowing from adjacent agricultural properties. This may affect plants through suppressing germination, nutrient toxicity, or by increasing weed levels.

Climatic drying

The drying climate may affect various components of the assemblage, as this community is reliant on rainfall and local hydrologic regimes. Reduced rainfall and subsequent alterations to hydrology may have a detrimental effect on the community.

Decreases in winter and spring (and annual) rainfall are projected with high confidence for the area in which the bentonite community occurs. There is strong model agreement and good understanding of the contributing underlying physical mechanisms driving this change (southward shift of winter and spring storm systems).

According to CSIRO data, early in the century (2030) and under all emission scenarios, winter rainfall is projected to decrease by up to 15 per cent. Late in the century, intermediate emissions (RCP4.5) lead to a projected decrease in winter rainfall of up to around 30%, and under high emissions (RCP8.5) winter rainfall decline is projected to decrease by up to 45%. Changes in autumn and summer are less clear, although downscaling results suggest a continuation of the observed autumn declines. (https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/sub-clusters/?current=SSWSW&tooltip=true&popup=true)

APPENDIX 2 'Herbaceous plant assemblages on Bentonite Lakes' community distribution (blue)

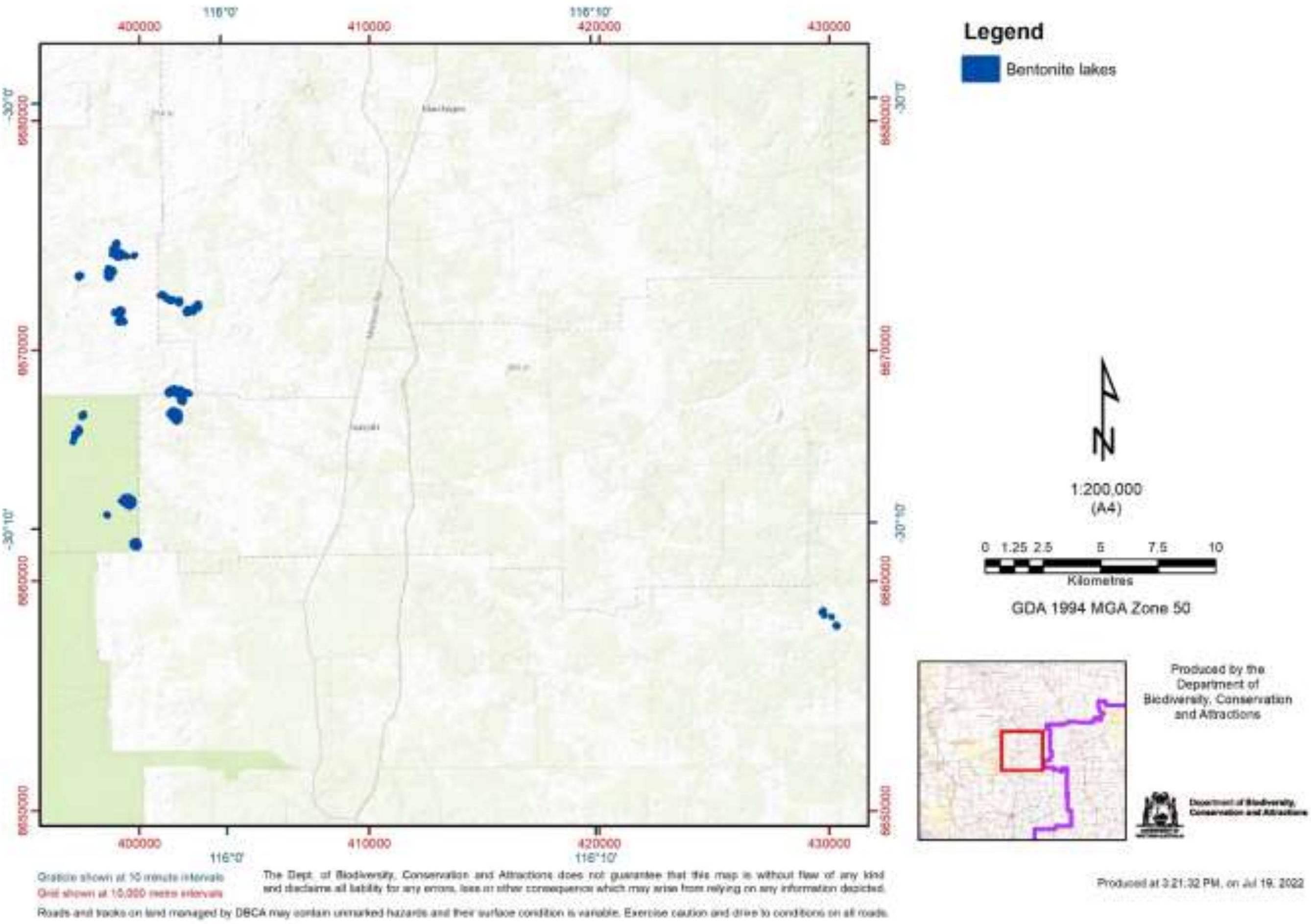

Figure 3: Distribution of the 'Herbaceous plant assemblages on Bentonite Lakes' community.

This community has a range of 14km, with the southernmost occurrence at Watheroo and the northernmost at Marchagee /Enagu. The figure indicates that occurrences of the community are highly fragmented.

The map was created from known mapped occurrences of the community contained on the Western Australian Threatened Ecological Community database (TECDB), as administered by the Department of Biodiversity and Conservation (DBCA).

References

Department of Agriculture and Food (2001). Soil-landscape mapping of the Dandaragan area by Ted Griffin and John Wagnon, Department of Agriculture and Food, Western Australia. (Unpublished data). Data accessed November 2019.

Department of Conservation and Land Management (2002). Interim Recovery Plan 2002-2007 for Herbaceous plant assemblages on bentonite lake beds (Vegetation Types 1,2,3&7) and margins (Vegetation Types 4,5&6) of the Watheroo-Marchagee region. Interim Recovery Plan No. 108. Department of Conservation and Land Management, Perth.

DoW (2019). Water INformation (WIN) database – discrete sample data Available from URL: http://wir.water.wa.gov.au/SitePages/SiteExplorer.aspx. Data accessed November 2019.

Griffin, E. A. and Associates (1991). *Flora and Vegetation of Watheroo Bentonitic Lakes*. Unpublished report prepared for Bentonite Australia Pty Ltd.

APPENDIX 3 IUCN Red List Criteria for ecosystems (version 2.2) (IUCN 2017)

A. Reduction in geographic distribution over ANY of the following time periods:					
			CR	EN	VU
A1	Present (over the past 50 years).		≥ 80%	≥ 50%	≥ 30%
A2a	Future (over the next 50 years).		≥ 80%	≥ 50%	≥ 30%
A2b	Future (over any 50 year period including the present and future).		≥ 80%	≥ 50%	≥ 30%
A3	Historic (since 1750).		≥ 90%	≥ 70%	≥ 50%
B. Restricted geographic distribution indicated by EITHER B1, B2 or B3:					
			CR	EN	VU
B1	Extent of a minimum convex polygon enclosing all occurrences (Extent of Occurrence)		≤ 2,000 km²	≤ 20,000 km²	≤ 50,000 km²
	AND at least one of the following (a-c):				
	(a) An observed or inferred continuing decline in **EITHER**:				
	i. a measure of spatial extent appropriate to the ecosystem; **OR**				
	ii. a measure of environmental quality appropriate to characteristic biota of the ecosystem; **OR**				
	iii. a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem.				
	(b) Observed or inferred threatening processes that are likely to cause continuing declines in geographic distribution, environmental quality or biotic interactions within the next 20 years.				
	(c) Ecosystem exists at …		1 location	≤ 5 locations	≤ 10 locations
B2	The number of 10 × 10 km grid cells occupied (Area of Occupancy)		≤ 2	≤ 20	≤ 50
	AND at least one of a-c above (same sub-criteria as for B1).				
B3	A very small number of locations (generally fewer than 5) **AND** prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus capable of collapse or becoming Critically Endangered within a very short time period (B3 can only lead to a listing as VU).				VU
C. Environmental degradation over ANY of the following time periods:					
			Relative severity (%)		
		Extent (%)	≥ 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:					
			Relative severity (%)		
		Extent (%)	≥ 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