GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Section 1 – Eligibility for Listing		
1. Name of the ecological community		
Assemblages of Bunda Bunda organic mound springs		
2. Listing Category for which the ecological community is nominated		
	Western Australia	EPBC Act (wholly or as a component)
Current listing category (Please check box)	☐ Critically endangered ☐ Endangered ☒ Vulnerable ☐ Priority 1-4 ☐ Data Deficient ☐ None – not listed	Name: ☐ Critically endangered ☐ Endangered ☐ Vulnerable ☒ None – not listed
Proposed listing category (Please check box)	☐ Collapsed ☒ CR: Critically endangered ☐ EN: Endangered ☐ VU: Vulnerable ☐ Priority 1-4	
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?
Assemblages of Bunda Bunda organic mound springs.
4. What authorities/surveys/studies support or use the name?

Although the community was not included in the original survey of Kimberley Rainforests by Keneally *et al*. (1991), the plant assemblages sampled in that survey were compared with assemblages of the Bunda Bunda organic mound springs. The rainforest species of this community are common to rainforest patches across northern Australia, many of which have much greater species diversity, but are unusual in such a seasonally arid environment.

The assemblages of Bunda Bunda organic mound springs was endorsed as a vulnerable threatened ecological community by the WA Minister for Environment in 2002. It was ranked as vulnerable (VU) using ranking criteria developed in WA that differ from those used for the IUCN RLE. The community is not currently 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).

Bunda Bunda springs occurs at the same latitude as the Big Springs organic mound springs community, listed as Vulnerable in WA:
Description: Big Springs organic mound spring communities, Dampierland Bioregion. The site consists of a complex system of freshwater seepages and organic mound springs with internal moats on the eastern shore of King Sound, east of the mouth of Meda River, and the habitat and assemblages differ substantially from the Bunda Bunda organic mound springs.

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.

Bunda Bunda organic mound springs community is comparable to the Big Springs organic mound springs community in its near-tidal setting however, it has an entirely different physiography and flora. The vegetation found in the Bunda Bunda community is also different from that of wetland rainforest patches described in the Kimberley Rainforest Survey (Keneally *et al*. 1991). Some of the same species also occur at Walcott Inlet, 250km east-north-east of Bunda Bunda however, that community is dominated by *Ficus* spp., *Nauclea orientalis* and *Celtis strychnoides* (Stoneman *et al*. 1991).

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 comprises a complex system of organic mound springs on tidal mudflats in Carnot Bay on the Dampier Peninsula north of Broome. Peaty mounds rise 2 to 3 m above the surrounding tidal flats and are composed of accumulated leaf litter and living vegetation, supporting a dense closed rainforest and tall shrubland, with mangroves forming a concentriform on the surrounding mudflats. The smaller mound is dry in the centre but encircled by a moat, fed by permanent freshwater seepage. The larger mound is wet and incompletely enclosed by a very fine scale channel or moat of variable depth, which broadens to a microscale saline lake on the north side. The moats and pools are saline and occasionally inundated during large tides. The western end of the large mound is covered by a very dense closed forest dominated by evergreen *Carallia brachiata* trees and a bracken-like layer of the fern *Cyclosorus interruptus* (swamp shield-fern). *Timonius timon* and *Sesbania formosa* (dragon tree) also occur. The eastern portion of the mound is covered by tall closed forest of *Melaleuca cajuputi*, *Timonius timon*, *Sesbania formosa* with fewer *Carallia brachiata* with an understorey of *Cyclosorus interruptus*. Climbers including *Cassytha filiformis* (love vine) and *Secamone elliptica*, drape from trees with ferns *Lygodium microphyllum* (climbing maidenhair) forming a curtain. A moat-like channel surrounding the large mound contains

mangroves, predominantly *Rhizophora stylosa* (spotted-leaved red mangrove) and *Avicennia marina* (white mangrove) with *Acrostichum speciosum* (mangrove fern). An endemic (Kimberley) mistletoe, *Amyema dolichopodum* also occurs on the site. The two mounds differ from each other and there is considerable spatial variation in vegetation within each site. There is a clear zonation in the vegetation around the smaller south-western mound spring. It is fringed by a ring of mangroves, predominantly *Rhizophora stylosa* and *Avicennia marina*. Within this lies a band of mangrove fern *Acrostichum speciosum* and trees of cadjeput *Melaleuca cajuputi* and *Timonius timon* to 12m. In the dry centre of the island is a tall shrubland dominated by *Acacia neurocarpa* to 5m, over grasses and sedges. The mudflats around the two mounds are bare of vegetation, but a *Sporobolus* grassland grows closer to the shore. The community is one of the most southerly occurrences of rainforest in Western Australia. The rainforest species of this community are common to rainforest patches across northern Australia, many of which have much greater species diversity, but are unusual in such a seasonally arid environment. The site provides an isolated refuge for rainforest and riparian plant species, as well as a cool microclimate and freshwater for birds and other fauna. *Carallia brachiata* produces a large crop of red berries around October, which is a food source for several species of bird including the Channel-billed Cuckoo (*Scythrops novaehollandiae*) and Pheasant Coucal (*Centropus phasianinus*). Other birds feed on flowering mangroves.

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

Bunda Bunda organic mound springs are situated on tidal mudflats in Carnot Bay on the Dampier Peninsula north of Broome. Saturated peaty black soils and thick leaf litter combine to form a quaking substrate. The smaller mound is dry in the center, but encircled by a moat fed by permanent freshwater seepage. The larger mound is wet and incompletely enclosed by a leptoscale channel or moat of variable depth which broadens to a microscale saline lake (300m long, 50m wide) on the north side. The moats and pools are saline and occasionally inundated during large tides.

The climate for the nearest town, Broome, located 88km to the south, is described as tropical with warm winters and hot, humid summers. In summer (December to February), the average maximum temperature is 33.4°C with an average minimum temperature of 26.3°C. In winter (June to August), the average maximum temperature is 29.5°C with an average minimum temperature of 14.6°C. The mean yearly rainfall is 628mm (at Broome Airport Station 003003; from 1940 to 2018), with the majority occurring during cyclone season from November to April (data obtained from Bureau of Meteorology website: http://www.bom.gov.au/climate/averages/tables/cw_003032.shtml).

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

Bunda Bunda organic mound springs are peaty mounds surrounded by a moat, stream channels and standing pools of water of variable depth. The smaller mound is dry in the centre, but encircled by a moat, fed by permanent freshwater seepage. The larger mound is wet and incompletely enclosed by a leptoscale channel or moat of variable depth which broadens to a microscale saline lake (300m long, 50m wide) on the north side. The moats and pools are saline and occasionally inundated during large tides (DBCA 2019).

The mound springs occur along the coast where groundwater discharges under pressure from depth through the overlying alluvium to the surface. The springs have underlying hydrogeology, mineral composition and biogeochemical processes that are likely to be complex and variable. When monitored in 2017, the water was found to be fresh, with the sum of major ions 85.2mg/L. Ionic composition consisted of potassium (11.8%) and sulphate (32%). Total nitrogen is generally low consisting of 0.71mg/L of total nitrogen and total phosphorus is 0.057mg/L (from DBCA 2019).

The mound springs lie on a shallow aquifer of surficial sediments, over a major unconfined freshwater aquifer in the Broome Sandstone which meets a saltwater wedge along the coast. The mound springs were identified by Department of Water (2017) as ecosystems with high probability of groundwater-dependence.

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 two mounds differ from each other and there is considerable spatial variation in vegetation within each site. There is a clear zonation in the vegetation around the smaller south-eastern mound spring. It is fringed by a ring of mangroves, predominantly *Rhizophora stylosa* and *Avicennia marina*. Within this lies a band of *Acrostichum speciosum* and trees of *Melaleuca cajuputi* and *Timonius timon* to 12m. It is likely that variation in physiography and flora assemblage occurs within occurrences of the Bunda Bunda organic mound springs community (DBCA 2019).

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.

Bunda Bunda organic mound springs community contains three species of invertebrates that have rarely or never been collected in Western Australia, including; a potentially new species of water mites *Axonopsella*; the darwinulid ostracod *Alicenula serricaudata*, also located in other Kimberley springs, is the first records for Australia; and a harpacticoid copepod *Nitokra* '*lacustris*' B07 also likely to be undescribed and not previously collected (DBCA 2019).

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

Department of Biodiversity, Conservation and Attractions (draft 2019) Biodiversity Survey, Mapping, Delineation and Assessment of Selected Organic Mound Springs of the Kimberley Region. Department of Biodiversity, Conservation and Attractions, Kununurra.

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.

Bunda Bunda organic mound springs community is known from two mapped occurrences occurring over a range of 1.2km and are approximately 200m apart. They are 300m from the shore north of Broome on unallocated Crown land (UCL) and surrounded by coastal tidal mudflats. Access to the springs is via Crown Reserve 22615 Carnot Bay. There are two mapped occurrences, covering a total of 26.27ha.

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 known area (in ha)? 26ha

14 b. What is the pre-industrialisation extent or its former known extent (in ha)? An ecological community is considered to be naturally restricted if it has a pre-industrialisation area of occupancy that is less than 10 000 ha or a pre-industrialisation extent of occurrence that is less than 100 000 ha (refer to the Attachment A)

The extent of Bunda Bunda organic mound springs community is considered stable.

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

See above

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

None

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). This could be presented as the range of patch sizes that comprise 90% of the occurrences.

The Bunda Bunda organic mound springs community was mapped using ArcGIS© and a range of data sources including quadrat and survey data, on ground survey, aerial photography and topographic maps. Minimum patch size is 3.6ha and maximum patch size is 22.7ha. The mean patch size is 13.1ha (see table below for patch size proportions).

Table 1. Proportion of occurrences with a certain patch size.

Patch size (hectares)	Number of occurrences
<1	0
<10	1 (50%)
<100	1 (50%)
>100	0

16. Quantify, if possible, 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 Bunda Bunda organic mound springs community that are in good condition have been mapped. 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 threatening processes.

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 Bunda Bunda organic mound springs community is naturally fragmented. It occurs as discrete patches located on tidal mudflats in Carnot Bay on the Dampier Peninsula north of Broome.

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.

The flora and invertebrates within the community are a major part of characterising and differentiating the community. Changes to the composition are likely to occur through the impact of introduced herbivores (cattle), weed invasion, and changes to fire regimes (frequency and intensity) and hydrology.

18 a. If yes, which species are affected?

Native flora species will be affected by competition with weeds. Frequent and intense fire will affect those species that are fire sensitive. Introduced herbivores (cattle) have trampled the mound springs vegetation, and introduce nutrients that can impact the invertebrates in the pools in the community.

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

Introduced herbivores (cattle) grazing and trampling, weed invasion, frequent fire and hydrological changes may impact on the mound springs resulting in a reduction in diversity and occurrences to dry out. Systematic monitoring is required to determine the severity of the impacts.

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.

The structure of the Bunda Bunda organic mound springs community is generally freshwater seepages and densely vegetated mound springs with internal moats. When in good condition the community contains well developed rainforest vegetation with a relatively rich aquatic habitat.

A condition class can be applied to the community as a whole based on:

- Presence of weed taxa, and level of weed cover
- Level of damage from introduced herbivores
- Presence or absence of previously recorded natural strata of the vegetation present
- The presence/absence and species composition of flora and fauna
- Level of hydrological change within the springs.

Survey and Monitoring

20. Has the ecological community been reasonably well surveyed?

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

An extensive survey of Bunda Bunda organic mound springs community was undertaken in 2017 (Pryde 2017). The survey was undertaken by a team with expertise in community identification and inventory, biological survey including flora and vegetation, aquatic invertebrate fauna identification and wetland inventory. The survey was coordinated by the Kimberley District Nature Conservation Coordinator, with collaboration of Traditional owners and Nyul Nyul Rangers. Only the largest location (Bunda01) was included due to time constraints. The following were included:

- general vegetation description, condition and structure across the mapped community;
- a fora list for vegetation within quadrats and from random locations throughout the mound spring community;
- notes on threatening processes;
- management recommendations compiled.

A quadrat was installed and the following were recorded:

- GPS locations;
- vegetation description, stratum and structure;
- soil and landform;
- collection of flora specimens from the mound springs seepage areas and damplands;
- Aquatic invertebrate survey and water chemistry in areas of standing water;
- Assessment and mapping using a handheld GPS in conjunction with aerial photography.
- Photographs taken of occurrence and surrounding landscape.

During the survey a potential new occurrence consisting of a vegetated mound 215m west of Bunda01, was located (DBCA 2019).

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.

Include commentary on issues to do with accessing different land tenures within the area of distribution, including private property, and the likelihood that these areas may include occurrences.

Boundaries of mapped occurrences of the Bunda Bunda organic mound springs community do not require checking or verification as they have been adequately surveyed. A potential new occurrence located to the west of the known occurrences needs assessing to determine whether it is part of the community (shown as Bunda03 in Appendix).

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

Historically, monitoring of the Bunda Bunda organic mound springs community has been opportunistic. The survey undertaken in 2017 by DBCA staff provided information on condition and threats to the main occurrence of the community, the establishment of permanent quadrats to record flora and vegetation, an inventory of aquatic invertebrates and water chemistry and soils, and an updated boundary. This information can be used as a baseline for future monitoring and procedures for monitoring.

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). Relevant here is recognition of different states following disturbance and the natural recovery of the occurrence towards a higher condition class.

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. impact from introduced herbivores (cattle) such as grazing and trampling, partial clearing, hydrological changes, 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.

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, good condition related to WA condition categories 'Very Good to Pristine' as below (see ^ below in Table 2) are considered to be in good condition, so therefore 20.41ha or 90% of the occurrences are considered to be in good condition, and contain high native flora and fauna species diversity, maintain integrity of vegetation structure, and minimal weed/introduced species cover. The location is subject to ongoing threats, and all require substantial management to protect from pressures such as trampling and grazing from cattle, spread of introduced species, inappropriate fire regimes, and hydrological changes.

Table 2: Vegetation condition in 2017

Total area (ha)*	Condition when last surveyed
0	^^^Poor ('degraded', 'completely degraded' using Bush Forever (2000) scale)
±5.87	^^Medium ('good' using Bush Forever (2000) scale)
±20.41	^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 '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 grazing, inappropriate fire regimes, hydrological changes, and 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 2 above), so therefore 5.87ha or 25.9% of the extent of the community is 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 categorised as 'Good' - Vegetation structure significantly altered by very obvious signs of disturbance. Retains basic vegetation structure or ability to regenerate it.

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 ^^^below and Table 2 above), none of the occurrences are considered to be in poor condition, with vegetation containing minimal native flora, presence of aggressive weeds, and evidence of much disturbance.

^^^This includes vegetation ranging from 'Degraded' Basic vegetation structure severely impacted by disturbance, the vegetation requires intensive management, and disturbance such as grazing, trampling, inappropriate fire regimes, partial clearing, hydrological changes are present, very aggressive weeds are present at high density, and very low native plant species diversity is observed (20 – 70%) to '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 areas 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 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*.

Past threats include grazing and trampling by introduced herbivores (cattle), spread of introduced flora, hydrological change, all of which are <u>actual</u> threats.

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

Current threats include grazing and trampling by introduced herbivores (cattle) (<u>actual</u>), too frequent or intense fire (<u>potential</u>), spread of introduced flora (<u>actual</u>) and hydrological change (<u>potential</u>).

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

Future threats include grazing and trampling by introduced herbivores (cattle) (<u>actual</u>), increased fire frequency and severity (<u>potential</u>), spread of introduced flora (<u>actual</u>) and hydrological change (<u>actual</u>).

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

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

Weeds

The highly invasive weed, stinking passionflower (*Passiflora foetida*), is present in an exposed patch within location Bunda01 and has smothered native vegetation, growing over the top of trees in a patch approximately 75

by 30m in size (pers. comm. [redacted][1]). This weed is likely to become a major threat if not managed. Introduced fruit trees, including bananas plants (*Musa* sp.), which occur in the south east portion of Bunda01 are likely to spread if not contained.

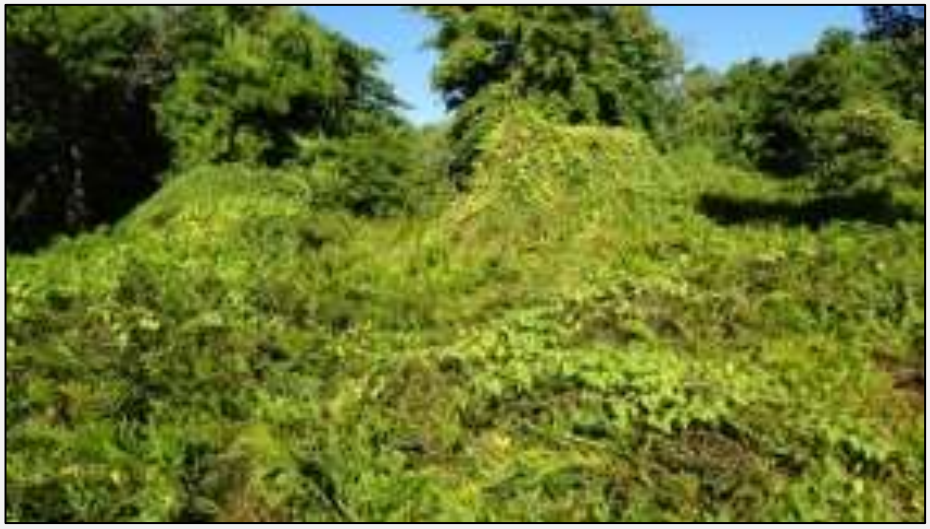

Figure 1. Stinking passionflower present at Bunda01 (from DBCA 2019)

Figure 2. Banana plants present in south-east corner of Bunda01 (from DBCA 2019)

Introduced herbivores (cattle)

Free ranging cattle access the Bunda Bunda organic mound springs community and utilise the water and shelter in the seepage area and mound spring island. This results in significant trampling of vegetation and churning up of pools, nutrient enrichment and introduction of weed seed.

[1] [redacted], Principal Coordinator, Wetlands Conservation, DBCA

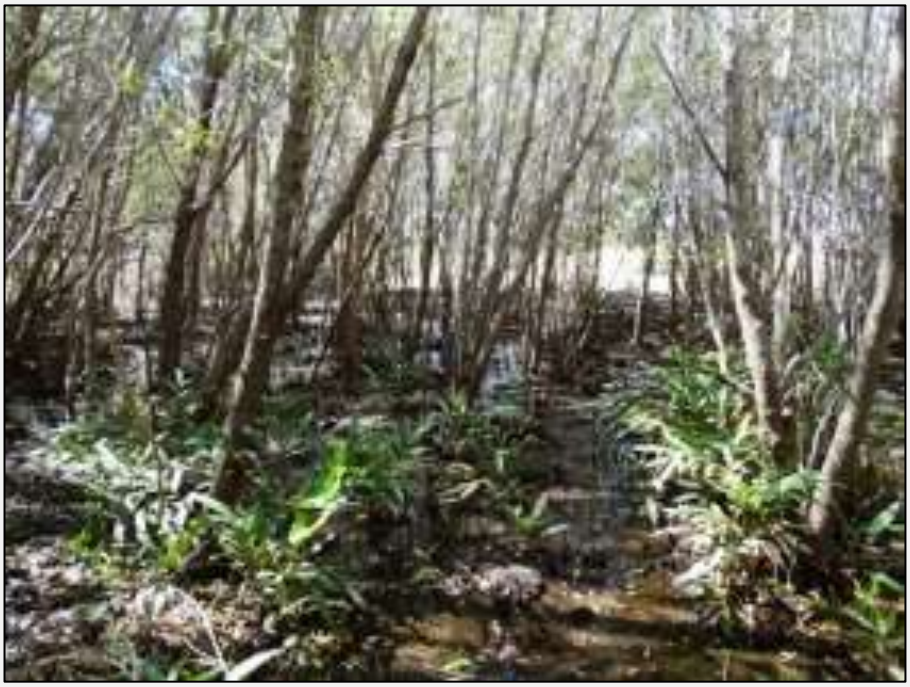

Figure 3. Trampling of understorey by cattle at Bunda Bunda 01 (from DBCA 2019).

Hydrological changes

The mound springs are dependent on a constant supply of fresh groundwater. Increasing future abstraction of groundwater for domestic and industrial use has the potential to impact the community due to drawdown. Some developments proposed for the area involve groundwater abstraction, and have potential for saltwater intrusion, interface upconing and subsequent impacts to this groundwater dependent ecosystem. Where abstraction proposals do occur within the area there will need to be particular management considerations.

Inappropriate fire regimes (too frequent and intense)

In the Kimberley Region and across northern Australia, inappropriate fire regimes pose a significant threat to biodiversity. Fire management regimes have changed since settlement from small scale, patchy burning by Aboriginal people, which resulted in small scale mosaics of burnt and unburnt vegetation, thereby providing buffers against unplanned wildfires to more recent recurring extensive and intense fire patterns in the mid to late dry season (Carwardine *et al*. 2011; Rangelands NRM 2011).

Inappropriate fire regimes are a potential risk to the Bunda Bunda organic mound springs community. Historically, fires in the mound springs were probably only very occasional and the majority of the community appears long unburnt. The surrounding grassland vegetation is highly flammable. It is unlikely a burn would take hold within the springs, however, due to the damp conditions. An increase in the fire frequency or severity within the community may alter the structure and composition, damaging the vegetation and the organic soil. The peat soils of the mound springs require particular fire management considerations as they can be damaged or destroyed by fires that smoulder for long periods.

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

- Cattle will continue to damage the community unless the site is fenced.
- It is likely that too frequent, intense fires will continue to threaten the integrity of the community through impacting on species diversity and encouraging weed invasion.
- *Passiflora foetida* is likely to become a major threat to the community if not managed (DBCA 2019).
- Increasing future abstraction of groundwater for domestic and industrial use has the potential to impact the community due to drawdown.

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

The threats listed above are likely to impact on all occurrences.

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.

The incidence of more frequent and intense fires is likely. Major fires can occur at any time and have potential for major impacts to the structure of the community, increasing weed invasion.

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?

Intense, frequent fires within the community may alter its structure and composition, removing the vegetation and the organic soil and increasing the invasion of weeds. The peat soils of the mound springs may also be damaged or destroyed by fires as it is likely they would smoulder for long periods. Peat accumulates over very long periods, up to thousands of years, so recovery from severe damage to the peat substrate would be very prolonged.

Cattle grazing and trampling causes physical damage and can alter the floristic composition of the community by selectively removing edible species.

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

Regeneration times following fire will be dependent on the severity of the fire. Recovery will be very prolonged if peat is severely damaged.

Threat Abatement and Recovery

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

Management recommendations occur in the following report:

Department of Biodiversity, Conservation and Attractions (2019) Biodiversity Survey, Mapping, Delineation and Assessment of Selected Organic Mound Springs of the Kimberley Region (*draft)*. Department of Biodiversity, Conservation and Attractions, Kununurra.

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.

A biodiversity survey, utilising funding from the Kimberley Science Conservation Strategy, was undertaken for selected organic mound springs of the Kimberley Region in 2017. The survey included information on threats and recommendations for management.

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? Give details including the name of the reserves, and the extent the ecological community is protected within these reserves.

Bunda Bunda mound springs occur on unallocated Crown land (UCL). Access to the springs is via Crown Reserve 22615 Carnot Bay.

37 a. Which of the reserves are actively managed?

Note which, if any, reserves have management plans and if they are being implemented.

The UCL is managed by Traditional owners and Nyul Nyul Rangers.

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

None

38. 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.

There are no culturally significant sites that occur on the area containing the community. The Traditional Owner group is Djaberadjabera and their permission is required to access the springs.

378 a. 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.

A Native Title Claim was registered with the Native Title Tribunal in 2016 by Bindunbur (refer WC2015/007).

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).

Recommendations made in DBCA (2019) include:

- Seek funds to fence the mound springs complex to restrict cattle entering the community ;
- Map *Passiflora foetida* across the community and seek ways to control or eradicate the highly invasive weed;
- Seek ways to remove fruit trees, particularly banana plants within Bunda01;
- Design and implement a project to determine the hydrological drivers of the mound spring ecosystem;
- Design and implement a monitoring program that utilises quadrats established during the current survey. This will probably require establishment of a more comprehensive network of quadrats, and should be designed to provide information about the success of land management in the sensitive environment of the mound spring ecosystem;
- Determine whether Bunda02 constitutes the community and if the vegetated mound (Bunda03) to the west of Bunda01 constitutes a new occurrence of the community. This would require hydrological investigation and vegetation survey.

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

No

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.

Surveys should be undertaken in August when the area is accessible, and during low tide at which time crocodiles are less likely to be present in the area.

Access to the springs is via Crown Reserve 22615 Carnot Bay. Permission is required from the Traditional Owner group (Djaberadjabera) to access the springs.

The following methods describe surveys of vegetation and invertebrates, taken from DBCA (2019):

Vegetation

A permanent 50x50m^2 quadrat should be established upland from a seepage zone. The quadrat should be permanently marked with one 1.6m star picket at NE corner site. Quadrat data collected should include:

- GPS location;
- vegetation description, stratum and structure;
- soil and landform;
- collection of flora specimens from the mound springs seepage areas and damplands surrounding the springs. Where suitable the flora specimens will be provided for lodging to the WA Herbarium.

Physico-chemical sampling

Measurements of pH, temperature and conductivity should be made where surface water was most substantial. From the same location three water samples should also be collected; a 150ml sample collected for analysis of total nitrogen and phosphorus (and ideally frozen if possible); another water sample filtered through a glass fibre filter paper for chlorophyll (with the filter paper frozen for later analysis of chlorophyll) and the filtrate further filtered (through a 0.45um filter paper) and frozen for analysis of total filterable phosphorus and nitrogen; and a third water sample used for analysis of major ion composition. The depth at which the benthic invertebrate sample is collected should be recorded and usually equates to the maximum depth of the water body.

Invertebrate sampling

Three types of invertebrate sample should be collected, depending on the amount of water present. Where possible, two samples of surface water aquatic invertebrates (a benthic and a plankton sample) should be taken at each site. Plankton (water column) samples are collected by scooping up water in 900ml jugs and passing this through a 50um mesh net, to give a total of 10L of collected water. All benthic samples should be collected by sweeping a 250um mesh net through the water column and stirring up the substrate and benthic debris for a distance of 10m. Coarse inorganic sediment and coarse organic matter should be removed from the benthic sample prior to sample preservation by washing debris and elutriating in buckets before passing the water back through the net. Samples are then preserved in 100% ethanol in the field and returned to the laboratory for processing.

Samples of interstitial fauna are normally taken in areas of saturated peat without significant surface water. An auger is used to extract an approximately 0.5m deep core of 8cm diameter and the resultant hole allowed to fill with water. Using a manual bilge pump, 80L of water (8 x 10L buckets) is pumped out through a 110µm mesh net and the contents of the net placed into 2 litre pots and preserved with 100% ethanol. Where ingress of surface water is a problem it can be impeded by creating a bund around the top of the hole. Samples are then processed, and microfauna identified in a laboratory.

Samples are washed with tap water and sieved through either 250µm, 90µm and 50µm sieve sizes (for the core and plankton samples) or 2mm, 500µm and 250µm sieve sizes (benthic samples). Each sieve fraction should be examined separately (except for the 50µm fractions from plankton and core samples), and representatives of each discernible species removed and preserved in 100% ethanol.

Identification of specimens is by comparison with known specimens, or through an expert. Taxa should be identified to the most detailed taxonomic level possible using keys and voucher specimens and undescribed taxa assigned morphospecies names based on previous survey work.

All specimens removed from samples should be retained and stored in ethanol in glass vials with the Western Australian Museum and a subset representing most species set aside for deposition.

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**

Justification for assessment under Criterion A:

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

The Bunda Bunda organic mound springs community has not incurred the threshold ≥30% reduction in geographic distribution over any 50-year time period, or a ≥50% reduction since ~1750 (ie. the minimum requirements to meet the category VU under criterion A).
Does not meet 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);** ☒ **B2** (specify at least one of the following) ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☒ **b)** ☒ **c);** ☐ **B3** (only for Vulnerable Listing)

Justification for assessment under 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 Bunda Bunda organic mound springs community is 0.35km^2 (≤2,000km^2, which is the minimum threshold for CR). There is also evidence of continuing decline in the community from the impacts of introduced herbivores (cattle) and weed invasion; and inferred from future changes to the hydrological regime from groundwater abstraction. Therefore, the community's status under criterion B1 is critically endangered.
B2: The Bunda Bunda organic mound springs community is estimated to occupy one 10 × 10km square grid cell (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 the impacts of introduced herbivores (cattle) and weed invasion; and inferred from future changes to the hydrological regime with groundwater abstraction. Therefore, the status under criterion B1 is critically endangered.
a): Inadequate data are available to support an inferred or observed continuing decline in a measure of spatial extent, environmental quality or disruption to biotic interactions for ranking under B1a or B2a.
b): Continuing decline observed from impacts of weeds and introduced herbivores (cattle); and inferred from future changes to the hydrologic regime associated with groundwater abstraction and too frequent or intense fire (damaging late season fires).
c) Ecosystem exists at one threat-defined location based on the close proximity of occurrences and presence of intact vegetation between them (threshold for CR is one and for EN is five threat-defined locations).

B3: The Bunda Bunda organic mound springs community is known from one threat-defined location and is dependent on certain biotic and abiotic conditions. Therefore, the effects of human activities or stochastic events may cause the ecosystem to collapse within a very short period of time, given the ongoing threat of cattle, weeds, inappropriate fire regimes, and hydrological change. The community therefore meets vulnerable under criterion B3.

Meets CR B1b,c; B2b,c. Meets VU B3.

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

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

Justification for assessment under Criterion C:

The most significant abiotic variable affecting the community is considered to be loss of peat substrate from frequent or intense fire. Collapse is defined as complete loss of the peat substrate that supports the community. An increase in the fire regime within the community has the potential to alter the floristic structure and composition, removing the vegetation, and the organic soil that support both the flora and invertebrate assemblages. The peat substrate of the mound spring requires particular fire management considerations as it can be damaged or destroyed by fires that smoulder for long periods. The impact of future fires is unknown. Available data indicate that degradation of the peat substrate is minimal and unlikely to meet the minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of abiotic processes (≥30%) over any 50-year period, or since 1750 to meet VU under criterion C.

Does not meet 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** ☐ **D2** ☐ **D3**

Justification for assessment under Criterion D:

D1, D2: Weed invasion is a significant biotic variable that affects the community. Stinking passion vine (*Passiflora foetida*) and Banana plants were present during a survey in 2017 (Pryde 2017). Although only covering a total area of approximately 1% of occurrence Bunda01, the species are invasive and likely to become a major threat to the community, with stinking passion vine already smothering native vegetation where it occurs in exposed patches. The community does not meet the minimum thresholds for proportion of the extent (30%) or proportional severity of disruption of biotic processes (30%) over any 50-year period.

D3: Does not meet the minimum proportion of the extent (50%) or proportional severity of disruption of biotic processes (50%) since 1750.

Does not meet criterion D

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

Criterion E ☐ CR ☐ EN ☐ VU ☒ not eligible	

Justification for assessment under Criterion E:

The ecosystem could not be assessed under Criterion E as there were no quantitative estimates of the risk of ecosystem collapse.

Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Does not meet criterion
A2a	-	• Does not meet criterion
A2b	-	• Does not meet criterion
A3	-	• Does not meet criterion
B1a	-	• EOO is ≤2,000km^2 • No available data to indicate decline in a measure of 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, weeds, too frequent or intense fires, and inferred from changes to the hydrological regime • Meets CR
B1c	CR	• EOO is ≤2,000km^2 • Ecosystem exists at one threat-defined location based on the threat from cattle impacts, and potential future threat from too frequent or intense fire and hydrological change • Meets CR as level of threat considered 'non-trivial'
B2a	-	• AOO is one grid cell • No available data indicate decline in a measure of spatial extent, environmental quality or disruption to biotic interactions that would meet lowest thresholds of the criterion (VU) • Does not meet criterion
B2b	CR	• AOO is one grid cell • Impacts observed from grazing and trampling by cattle, weeds, and potential future threat from too frequent or intense fire and hydrological change • Meets CR
B2c	CR	• AOO is one grid cell • Ecosystem exists at one threat-defined location based on the threat from cattle impacts and potential future threat from too frequent or intense fire, and hydrological change • Meets CR as level of threat considered 'non-trivial'
B3	VU	• Known from one threat-defined location • Prone to the effects resulting from cattle, weed invasion, hydrological change and too frequent or intense fires • Meets criterion for VU
C1	-	• Does not meet the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over past 50 years to meet VU.
C2	-	• Does not meet the minimum thresholds for proportion of the extent (80%) or proportional severity of degradation (80%) over any 50-year period to meet VU.
C3	-	• Does not meet the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750 to meet VU.
D1	-	• Does not meet 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	-	• Does not meet 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 CR under B1b,c; B2b,c. Meets VU B3. *The highest risk category obtained by any of the assessed criteria will be the overall risk status of the ecosystem'* (IUCN RLE Guidelines V1.1 page 42). **Meets CR B1b,c; B2b,c**

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.

Carwardine, J., O'Connor, J.T., Legge, S., Mackey, B., Possingham, H. and Martin, T. (2011) Priority threat management to protect Kimberley wildlife. CSIRO Ecosystem Sciences, Brisbane.

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 (draft 2019) Biodiversity Survey, Mapping, Delineation and Assessment of Selected Organic Mound Springs of the Kimberley Region. Department of Biodiversity, Conservation and Attractions, Kununurra.

Department of Water (2017) Groundwater dependent ecosystems of the Dampier Peninsula. Royalties for Regions groundwater investigation. Environmental Water Report series No. 29.

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

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.

Keneally, K.F., Keighery, G.J. and Hyland, B.P.M. (1991) Floristics and phytogeography of Kimberley rainforests, Western Australia. In: Kimberley Rainforests of Australia. McKenzie N.L., Johnston, R.B. and Kendrick, P.G. (eds) Surrey Beatty and Sons, Norton, NSW.

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

Pryde J (2017) Survey of assemblages of Bunda Bunda, and Big Springs organic mound springs of the west Kimberley threatened ecological communities: a report to the Kimberley Region - August 2017 survey of Bunda Bunda and Big Springs organic mound springs TECs. Department of Biodiversity, Conservation and Attractions, Kensington, WA. 26 p.

Stoneham, T.C., McArthur, W.M. and Walsh, F.J. (1991) Soils and landforms of Kimberley rainforests, Wester Australia. In: Kimberley Rainforests of Australia. McKenzie N.L., Johnston, R.B. and Kendrick, P.G. (eds) Surrey Beatty and Sons, Norton, NSW.

45. Statement on the Standard of Scientific Evidence

Published data on the Bunda Bunda organic mound springs community was sufficient to apply some of the criteria in the Red List of Ecosystem criteria. The outcomes of the assessment are considered robust for the criteria that were applied.

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 Principal Ecologist, DBCA Species and Communities Program. Operations Officer, DBCA West Kimberley District. Ecologist, DBCA Species & Communities Program, Kensington.
47. Do you wish to propose any areas of habitat for consideration as Critical Habitat for the nominated community? If so, refer to Ministerial Guideline No 5 and attached a separate nomination proposal addressing the matters required under that guideline. 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	[redacted]
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	[redacted]
Phone	[redacted]
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
Completed nominations may be lodged either: 1. by email to: **communities.data@dbca.wa.gov.au** ***If submitting by email, please also mail hard copies of attachments that cannot be emailed.*** OR 2. by mail to: Species and Communities Branch Department of Biodiversity, Conservation and Attractions, WA Government Locked Bag 104, BENTLEY DELIVERY CENTRE WA 6983 ***If submitting by mail, please include an electronic copy on memory stick or CD.***

Appendix 1. Bunda Bunda organic mound springs community (green) NB: The assemblage at Bunda03 requires further verification to determine if it aligns with the Assemblages of Bunda Bunda organic mound springs community.