Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Section 1 – Eligibility for Listing

1. Name of the ecological community

Banksia attenuata woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson *et al.* (1994))

2. Listing Category for which the ecological community is nominated

	Western Australia	EPBC Act (wholly or as a component)
Current listing category TEC list under WA Minister ESA list in policy (Please check box)	☐ Critically endangered ☒ Endangered ☐ Vulnerable ☐ Priority 1-4 ☐ Data Deficient ☐ None – not listed	Name: ☐ Critically endangered ☐ Endangered ☐ Vulnerable ☒ None – not listed (however many occurrences meet description of umbrella TEC 'Banksia woodlands of the Swan Coastal Plain')
Proposed listing category under *Biodiversity Conservation Act 2016* (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: CR ☐ Criterion C – Environmental degradation based on change in 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?

Banksia attenuata woodlands over species rich dense shrublands (floristic community type 20a as originally described in Gibson *et al*. (1994)).

4. What authorities/surveys/studies support or use the name?

The community was originally described in Gibson *et al*. (1994). The community has been recognised since the publication of that report, and was endorsed for listing as an Endangered TEC by the WA Minister for Environment in 2001 under the name *Banksia attenuata* woodlands over species rich dense shrublands. At that time it was ranked endangered using ranking criteria developed in WA, that do not match those used for the recently developed IUCN RLE. The community is also referred to in the shortened form 'SCP20a', meaning 'Swan Coastal Plain floristic community type 20a', or FCT20a meaning 'floristic community type 20a'. Hereafter the community will be referred to as FCT20a.

The community is referred to as above names by the Department of Biodiversity, Conservation and Attractions (DBCA), and data is stored in the departmental TEC database, including the name.

The recovery plan (Department of Parks and Wildlife (DPaW) 2016) uses the name.

5. How does the nominated ecological community relate to other ecological communities that occur nearby or that may be similar to it?
Does it intergrade with any other ecological communities and, if so, what are they and how wide are the intergradation zones?
Describe how you might distinguish the ecological community in areas where there is overlap (also see Description section below).

The nominated ecological community *Banksia attenuata* woodlands over species rich dense shrublands is part of the EPBC listed Banksia Woodlands of the Swan Coastal Plain ecological community where occurrences meet the description, condition and size thresholds of the EPBC listed TEC (EPBC Conservation Advice: Department of Environment and Energy (DEE) 2016).

FCT20a is one of three subtypes of floristic community type 20 as identified in Gibson *et al*. (1994), that differ in floristic composition. These are FCT20a, FCT20b and FCT20c. Gibson *et al.* (1994) states that FCT20a was distinctive in having a diverse shrub layer and *Mesomeleana pseudostygia* in all plots. The authors also state that FCT20a sites were differentiated from the other two subtypes by occurrence of species such as *Alexgeorgia nitens, Daviesia nudiflora, Synaphea spinulosa, Hibbertia racemosa* and *Stylidium calcaratum*.

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.

This community is very restricted and the richest of any Banksia community located on the coastal plain by Gibson *et al*. (1994). Sites of FTC20a were differentiated from the other two subgroups by occurrences of species such as *Alexgeorgia nitens*, *Daviesia nudiflora*, *Synaphea spinulosa*, *Hibbertia racemosa*, *Stylidium calcaratum* and a variety of other taxa occurring at low frequency (Gibson *et al*. 1994).

The *Banksia attenuata* woodlands occur on sands near Koondoola and at the base of the Darling Scarp between Chittering and Gosnells. This community is very species rich (average 67 species/100m2, with some sites having over 80 species per 100m2).

FCT20a is one of three subtypes of floristic community type 20 as identified in Gibson et al. (1994), that differ in floristic composition; these are FCT20a, FCT20b and FCT20c. Gibson *et al*. (1994) states that FCT20a was distinctive in having a diverse shrub layer and *Mesomeleana pseudostygia* in all plots. They also state that FCT20a sites were differentiated from the other two subtypes by occurrence of species such as *Alexgeorgia nitens, Daviesia nudiflora, Synaphea spinulosa, Hibbertia racemosa* and *Stylidium calcaratum*.

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).

This community is very species rich (average 67 species/100m2). It is usually dominated by *Banksia attenuata* (occasionally with *Eucalyptus marginata*) in the tree layer with *Bossiaea eriocarpa*, *Conostephium pendulum*, *Hibbertia huegelii*, *H. hypericoides*, *Petrophile linearis*, *Scaevola repens*, *Stirlingia latifolia*, *Mesomelaena pseudostygia* and *Alexgeorgea nitens* being common in the understorey. The introduced bulbous weed *Gladiolus caryophyllaceus* is also common in the community. Three threatened flora and 10 priority flora have been recorded in this community (Department of Parks and Wildlife (DPaW) 2016).

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

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

The community occur on sands at the base of the Darling Scarp between Chittering and Orange Grove and are found on the Bassendean, Forrestfield, Southern River and Karrakatta soil and landform units, and on the Coonambidgee unit of the Dandaragan Plateau. There have been a number of detailed groundwater studies completed for this community that suggest that it is partially groundwater dependent (DPaW 2016).

9. Provide information on the ecological processes by which the biological and non-biological components interact (where known).
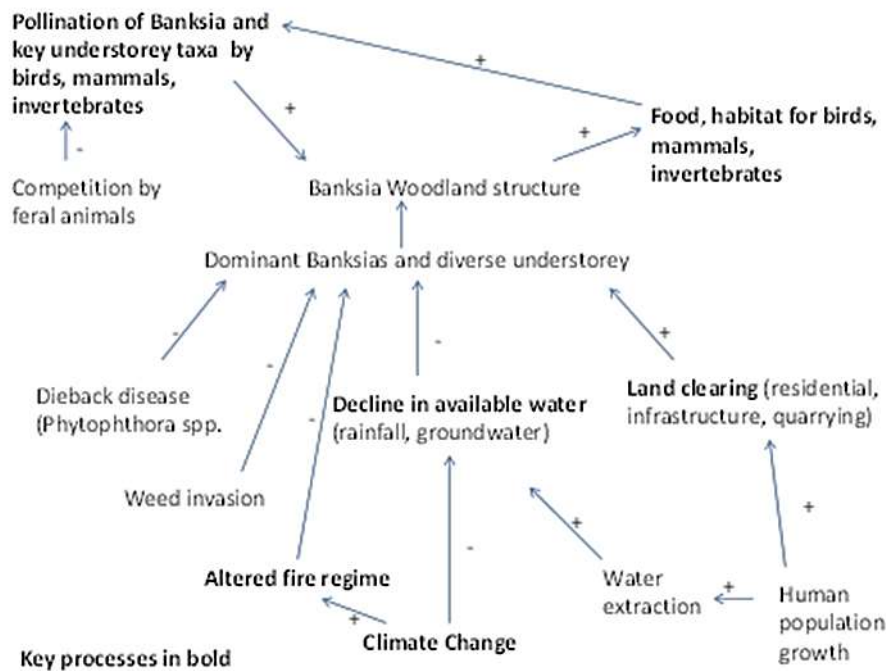
Figure 1. Cause-effect model of ecosystem dynamics for the *Banksia attenuata* woodlands over species rich dense shrublands showing positive (+) and negative (-) environmental and anthropogenic influences on ecosystem processes and components.

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.

See section 8 above.

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.

Three threatened flora and 10 priority flora have been recorded in occurrences of this community, as shown in the table below, from (DPaW 2016)

Table 2: Threatened and priority flora taxa that occur in the TEC

Species name	Conservation status (WA)	Conservation status (EPBC Act)
Banksia pteridifolia subsp. *vernalis*	P3	-
Chamelaucium sp. Gingin (N.G. Marchant 6)	DRF (VU)	EN
Conospermum undulatum	DRF (VU)	VU
Haemodorum loratum	P3	-
Hypolaena robusta	P4	-
Isopogon drummondii	P3	-
Jacksonia sericea	P4	-
Macarthuria keigheryi	DRF (EN)	EN

Persoonia sulcata	P4	-
Persoonia rudis	P3	-
Platysace ramosissima	P3	-
Schoenus griffinianus	P4	-
Schoenus pennisetis	P3	-

CR = critically endangered; EN = endangered; VU = vulnerable

Threatened, specially protected and priority fauna that occur within and close to occurrences of the community include (DPaW 2016):

• *Bettongia penicillata ogilbyi* (woylie) (critically endangered)

• *Calyptorhynchus latirostris* (Carnaby's cockatoo) (endangered)

• *Calyptorhynchus baudinii* (Baudin's Cockatoo) (endangered)

• *Calyptorhynchus banksia naso* (forest red-tailed black cockatoo) (vulnerable)

• *Dasyurus geoffroii* (chuditch) (vulnerable)

• *Hylaeus globiluferus* (a native bee) (Priority 3)

• *Neelaps calonotos* (black-striped snake) (Priority 3)

• *Tyto novaehollandiae novaehollandiae* (southern masked owl) (Priority 3)

• *Macropus irma* (western brush wallaby) (Priority 4)

• *Synemon gratiosa* (graceful sun moth) (Priority 4)

• *Isoodon obesulus fusciventer* (quenda) (Priority 4)

• *Falco peregrinus* (peregrine falcon) (other specially protected fauna)

• *Merops ornatus* (rainbow bee-eater) (other specially protected fauna)

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

Canham, C. A., Froend, R. H., and Stock, W. D. (2009). Water stress vulnerability of four Banksia species in contrasting ecohydrological habitats on the Gnangara Mound, Western Australia. Plant, Cell & Environment, 32(1), 64-72. Department of Biodiversity and Conservation (2017) Banksia Woodland Restoration Project Annual Report 6 January - December 2017

Department of Parks and Wildlife (2016) Interim Recovery Plan No. 359; *Banksia attenuata* woodlands over species rich dense shrublands (Swan Coastal Plain Community type 20a – Gibson et al. 1994). Unpublished report.

Environment Protection and Biodiversity Conservation Act (2016) (1999). (EPBC Act) (s 266B) Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community. www.environment.gov.au/biodiversity/threatened/communities/pubs/131-conservation-advice.pdf

Froend, R., Sommer, B. (2010) Phreatophytic vegetation response to climatic and abstraction-induced groundwater drawdown: Examples of long-term spatial and temporal variability in community response. Ecol. Eng. 36: 1191-1200

Gibson, N., Keighery, B., Keighery, G., Burbidge, A & Lyons, M. (1994) A floristic survey of the Southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.). Perth, Western Australia.

Groom, P.K., Froend, R.H. and Mattiske, E.M. (2000) Impact of groundwater abstraction on a Banksia woodland, Swan Coastal Plain, Western Australia. Ecological Management and Restoration 1, 117-124.

Groom, P.K., Froend, R.H., Mattiske, E.M. and Gurner, R.P. (2001) Long-term changes in vigour and distribution of Banksia and Melaleuca overstorey species on the northern Swan Coastal Plain. Journal of the Royal Society of Western Australia 84, 63-69.

Groves, H. (2014). Predicted risk to Banksia woodlands in the Swan Coastal Plain in response to groundwater decline. Western Australian Department of Parks and Wildlife in accordance with the hydrogeological industry placement for the completion of a Master of Hydrogeology degree at the University of Western Australia.
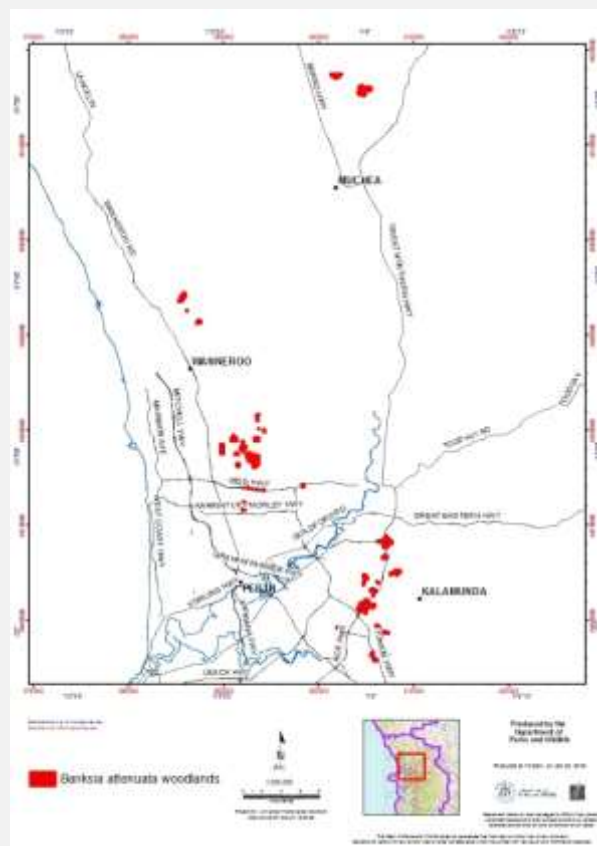
Keighery, G. and Keighery, B. (2016). How many banksia woodlands? Floristics of Banksia Woodlands of the Swan Coastal Plain. In Stevens J.C., Rokich D.P., Newton V.G., Barrett R.L. and Dixon K.W. (Eds) (2016, in press). Restoring Perth's Banksia woodlands. UWA Publishing. Crawley, Western Australia.

Zencich, S,J., Froend, R.H., Turner, J.V. , Gailitis, V. (2002) Influence of groundwater depth on the seasonal sources of water accessed by Banksia tree species on a shallow, sandy coastal aquifer. Oecologia, March 2002, Volume 131, Issue 1, pp 8–19 https://link.springer.com/article/10.1007/s00442-001-0855-7

Distribution

13. Describe the distribution across WA and nationally.

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

The map above (sourced from IRP 359, 2016) shows the distribution of the community. The map was created from 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).

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)?

There are 75 records of occurrences in the TEC database, totalling ~580 hectares.

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

Area calculations from digitised GIS mapping based on the Vegetation Survey of WA (Beard & Sprenger 1984) estimate that Banksia low woodland originally covered 4435.3 km2. In addition, Banksia woodland with scattered emergent eucalypts is estimated to have covered a further 2303.2km2. Therefore the original extent of all Banksia woodlands (including Banskia woodland other than ecological community 20a) as defined in this context is estimated to be 6738.5km2 which equates to 673,850 ha.

From digitised GIS mapping of remnant vegetation in WA as at 2008 (WA Department of Agriculture and Food) it is estimated that about 325669ha (3256.69km2) of the entirety of the Banksia woodlands categorised as "Banksia Woodlands of the Swan Coastal Plain IBRA region remained" (DPaW, 2016). The total loss of Banksia Woodlands on the Swan Coastal Plain is estimated at 52% (ie 3256.69/6738.5= 48% remaining: 52% decline). The extent of loss in a radius of 20 km around central Perth, is however, estimated to be greater than 90% with less than 10% remaining as intact vegetation.

It is assumed that the calculated level of decline of all Banksia woodlands on the Swan Coastal Plain also applies to FCT20a, as a sub-type of the Banksia woodlands. Based on this it is estimated FCT20a originally had a pre-industrialisation area of occupancy of approximately 1115ha (ie100/52 x 580ha), and is considered to be naturally rare or restricted. The 52% decline is expected to be an underestimate as this community occurs on yellow sands that are targeted for sand mining. In addition as the community largely occurs in the Perth metropolitan area, it has been particularly targeted for clearing for residential and associated infrastructure.

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

See section 15b above. The total loss of Banksia Woodlands on the Swan Coastal Plain is estimated to about 52% of its original extent. Clearing of 5 occurrences has occurred more recently (site identifiers Baal01, Baal02, Dianella03, Reid100, and perth07) with a total of ~70 ha cleared.

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

Several proposals for clearing have been submitted, affecting three occurrences of this community. A series of other occurrences are likely to be subject to future clearing proposals.

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.

Statistics for the community shows (calculated from the TEC database 11.02.2019) show an average occurrence size of 8.49 ha per occurrence, with mapped patches of the occurrence ranging from 0.0346ha to 104.7874ha.

Count:	75 occurrences
Minimum:	0.03 ha
Maximum:	105 ha
Sum:	580 ha
Mean:	8 ha
Standard Deviation:	16.1 ha

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.

The minimum condition to be considered viable is Good condition. This refers to a patch in which "Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance, e.g. from partial clearing, dieback, logging, grazing. 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 condition if they are subject to very minimal disturbance.

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.

Yes, this community is severely fragmented, with most occurrences in the Perth metropolitan area and separated by cleared lands with roads, buildings and other infrastructure.

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.

Disease

There has been a loss of the dominant Banksia species from many of the different Banksia communities as a consequence of dieback disease caused by *Phytophthora* species.

The main historical impact of *Phytophthora* spp. is likely to have been to change the structure and composition of Banksia woodlands towards dominance by taxa that are less susceptible to the disease.

A considerable proportion of the ability of the disease to cause significant impacts is related to levels of rainfall, as indicated by the occurrence maps for the disease that show far greater impacts in higher rainfall zones. The main

causes of disease spread that may occur in future are therefore likely to be associated with human activity, as south west WA has experienced declining rainfall in the last 50 years, and is likely to experience lower rainfall in future.

The area of mapped Banksia woodlands that coincide with inferred disease areas and those in which the disease has been detected is 19,984ha (2010 GIS data Forest Management Branch DEC). This represents about 3% of the overall extent of the Banksia Woodlands as at 2008. This may represent an underestimate of the area of the Banksia Woodlands that is dieback infested as detection of the disease as much of the extent of the Banksia Woodlands may not have been surveyed for the disease.

Groundwater decline;

Decline in available groundwater in Banksia woodlands near Perth has been clearly linked to a change towards non-woody, shallow-rooted species not dependent on specific hydrological conditions as follows (from Sommer and Froend, 2011) "However, since the drawdown event, the regional water table continued to decline, with the vegetation responding through progressive and uni-directional change in abundance and composition. The change in composition was primarily manifested as a shift towards non-woody, shallow-rooted species not dependent on specific hydrological conditions. This slow, progressive change in hydrology associated with reduced rainfall and land use changes has continued to force a transition in the floristics towards an alternative ecohydrological state."

Increasing groundwater abstraction and reductions in rainfall in the region will likely continue to cause groundwater levels to continue to decline into the future (DPaW, 2016; Groves 2014). Continued groundwater decline also has the potential to transition the composition and structure of the *Banksia attenuata* woodlands from deep rooted to shallow rooted plant species. Methods for interpreting risk to Banksia woodlands include graphs comparing maximum rooting depth of phreatophytic Banksia species, average surface elevation and changes in depth to groundwater in the past 20 years (Groves 2014).

Clearing

As mentioned several occurrences have been cleared (Baal01, Baal02, Dianella03, Reid100, perth07).

A series of other occurrences are likely to be subject to clearing proposals that may affect parts of, or whole occurrences in the near future. Removal of parts of occurrences reduces the future viability of the remaining patch.

18 a. If yes, which species are affected?

The dominant species in this community; *Banksia attenuata* (occurs in 74% of Gibson *et al*. 1994 quadrats) *B. menziesii* (occurs in 48% of Gibson *et al*. 1994 quadrats) *Eucalyptus marginata* (occurs in 57% of Gibson *et al*. 1994 quadrats) are all affected due to their particular susceptibility to groundwater decline, dieback disease, and increased disturbance from impacts associated with their largely urban habitat.

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

The Banksias (and other trees, including *E. marginata, Allocasuarina fraseriana*) form the upper stratum/structural layer that is important for shade and habitat for other species. In the absence of shade protection to provide appropriate habitat to help promote germination and survival of a diverse range of understorey species the community's composition will likely change significantly.

Reduction in community integrity

20. 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.

Threats include land clearing for roads, housing and related infrastructure, and sand quarrying, too frequent fire, weed invasion, and hydrological change. With many of the occurrences occurring within the greater Perth metropolitan area, the frequency of fires, impact of recreational users, weed invasion and incidence of illegal rubbish dumping has generally increased (DPaW 2016).

Decline in available groundwater in Banksia woodlands near Perth has been clearly linked to a transition towards non-woody, shallow-rooted species not dependent on specific hydrological conditions (see above under 19.)

Such compositional changes represent progress towards a collapsed state where groundwater decline occurs in areas of phreatophytic Banksia woodland vegetation and transition towards a complete change in floristics not dominated by Banksia woodlands occurs. It is surmised that declining rainfall will cause similar and cumulative effects on Banksia woodlands.

Survey and Monitoring
21. 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).

Surveys undertaken in this community include those undertaken by Gibson *et. al.* (1994 and subsequently by departmental staff, and consultants. Seven quadrats were established within this community during the survey by Gibson *et al.* (1994). A significant number of surveys have been undertaken, with at least 98 floristic quadrats in the community recorded in the DBCA TEC database. The presence of the community has been verified in the quadrats through statistical analysis against data from Gibson *et al*. (1994), or Bush Forever (Western Australian Government 2000).

Edith Cowan University initiated a PhD research project aimed at defining the habitat preferences for FCT20a and *Conospermum undulatum*. A survey of vegetation condition and threatening processes coupled with this study will assist in developing a risk assessment framework to assist future management.

22. 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.

There are a number of occurrences that are considered to be the community based on key combinations of component taxa and habitat features and the identity of these, and any other potential occurrences, should be confirmed where possible. Quadrats will need to be installed as per methods in Gibson *et al*. (1994) and appropriate statistical analyses completed to assign the community type.

In addition, many of the occurrences that have been surveyed are considered likely to contain dieback disease.

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

Ongoing monitoring occurs in the form of regular assessment of threatened flora within some occurrences of this community. Quadrats established by DBCA are reassessed when resources are available. Brief assessment of condition and threats are routinely completed and report forms that include information on condition and threats produced for occurrences.

Condition Classes and Thresholds

24. 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. from partial clearing, dieback, logging, grazing. Presence of very aggressive weeds." (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.

25. 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?

457 ha or 81.5% of known occurrences are considered to be in good condition, and contain high native plant species diversity, maintain integrity of vegetation structure, and minimal weed/introduced species cover. Nearly all occurrences are in urban areas, and are subject to the ongoing pressures/disturbances associated with this, and all require substantial management to protect from pressures such as spread of introduced species, rubbish dumping, too frequent fire and spread of disease including dieback.

Table 2: Vegetation condition of occurrences of *Banksia attenuata* woodlands over species rich dense shrublands for occurrences with condition recorded

Condition ranking (Keighery 1994) from Government of Western Australia 2000)	Hectares
Excellent	~360
Excellent-Very Good	21
Very Good	80
Very Good-Good	8
Good	92
Degraded	1
Completely Degraded	4

26. 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 26 above.

^*For the purposes of relating condition to other information in this nomination form, condition categories from (Keighery (1994) Vegetation Condition Scale in Bush Forever (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.

27. 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?

92ha or 16% of known occurrences are considered to be in medium condition, and contain medium plant species diversity, reduced of vegetation structure, and a medium level of weed/introduced species cover.
*For the purposes of relating condition to other information in this nomination form, condition categories from (Keighery (1994) Vegetation Condition Scale in Bush Forever (Government of WA 2000)) are defined below:

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.

28. 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 28 above

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

5ha or 0.8% of known occurrences are considered to be in poor condition, with vegetation containing minimal native flora, presence of aggressive weeds, and evidence of much disturbance.

^ *For the purposes of relating condition to other information provided in this nomination form, condition categories from (vegetation condition scale in Government of WA 2000) are defined below:

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

30. **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 30 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.

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

Past threats include clearing, disturbance through rubbish dumping, spread of introduced flora, presence of disease including dieback, too frequent fire, fragmentation through edge effects, recreational activities and grazing by native or introduced fauna, all of which are <u>actual</u> threats.

Table 3: Summary of location information and threats

Occurrence (not sequential/some cleared) / Site Identifier	Tenure	Year of survey	Past, current and future threats
Occurrence 1 Dundas01	37260 vested with FESA, C31709 vested with Water Corporation, C37997 vested with Conservation and Parks Commission, Main Roads WA, Department of Planning, Lands and Heritage (DPLH) for Parks and Reserves, Shire of Kalamunda	1994, 2002, 2015	Clearing Too frequent fire Weed invasion Disease Recreational activities
Occurrence 4 Koon01	City of Wanneroo, DPLH, Water Corp	1994, 2011, 2012, 2014,	Too frequent fire Recreational activities Weed invasion Disease Clearing
Occurrence 5 LAND01	City of Wanneroo, DPLH	1994, 2014	Clearing Recreational activities Too frequent fire Disease
Occurrence 6 IOPP	DBCA, public road, Shire of Chittering	1995, 1997, 2009, 2010, 2019`	Clearing Too frequent fire
Occurrence 7 ACTIV01	DBCA for Conservation of Flora and Fauna, public road, Shire of Kalamunda	1995, 2001, 2102	Clearing Too frequent fire
Occurrence 8 SULT 1/2	4 lots freehold vested with DPLH, Shire of Kalamunda	1995, 2010, 2011	Clearing Too frequent fire Disease
Occurrence 9 MYHART01	DPLH, public road, vested with Shire of Kalamunda	2000	Weed invasion Clearing

			Too frequent fire Disease
Occurrence 10 MYWHITE01	4 lots (2 vested with WAPC, 2 DBCA	2000, 2006, 2015, 2016, 2018	Clearing Weed invasion Too frequent fire Disease
Occurrence 11 MYPION01	DPLH, public road, Shire of Kalamunda	2000, 2007	Weed invasion Too frequent fire Rubbish dumping Disease Clearing
Occurrence 14 MYPION03	DPLH, Main Roads, Shire of Kalamunda	2000	Hydrological changes Weed invasion Too frequent fire Clearing Disease
Occurrence 16 Queens01	WAPC, public road vested with WAPC, City of Canning	2001, 2007	Too frequent fire Weed invasion Recreational activities Disease
Occurrence 18 MCDOWELL01	DPLH, public road, City of Canning	2001, 2005, 2007	Too frequent fire Weed invasion Disease
Occurrence 19 MCDOWELL02	DPLH	Insufficient data	Insufficient data
Occurrence 20 APBF04	DPIRD, Shire of Kalamunda	2001, 2007, 2017	Weed invasion Too frequent fire Clearing Disease
Occurrence 21 MAIDAV03	2 Lots, 1 DPLH, 1 vested with Maida Vale Primary School (Department of Education), Shire of Kalamunda	2011, 2013	Clearing Weed invasion Too frequent fire Vegetation trampling
Occurrence 23 (BUSHM01)	Private land Shire of Swan/Private	2001, 2011	Weed invasion Too frequent fire Clearing Disease Rubbish dumping
Occurrence 25 (MAIDA01)	DPLH, Shire of Kalamunda	2001, 2011, 2013	Weed invasion Too frequent fire Trampling
Occurrence 27 TELSTRA01	Vested with Telstra, City of Wanneroo	2002, 2007	Grazing by native or introduced species Weed invasion Disease
Occurrence 30 TELSTRA07	Vested with Telstra, City of Wanneroo	2002, 2007	Grazing by native or introduced species Weed invasion

			Disease
Occurrence 31 TELSTRA08	Vested with Telstra, City of Wanneroo		
Occurrence 33 BRAE01	DPLH, Shire of Kalamunda	2003, 2006, 2016	Weed invasion Too frequent fire Clearing
Occurrence 34 ALEXANDER01	DPLH, City of Wanneroo	2004, 2005, 2007, 2011, 2014	Clearing Too frequent fire Disease Rubbish dumping Weed invasion
Occurrence 37 MONTROSE01	DPLH	2004, 2006	Clearing Too frequent fire Weed invasion Disease
Occurrence 38 PALOMA01	DPLH	2004, 2006,	Clearing Too frequent fire Weed invasion Disease
Occurrence 39 MIDDLETON 01	DPLH	2004, 2006, 2007	Clearing Too frequent fire Weed invasion
Occurrence 40 MALAGA01	DPLH, Western Power	2004	Clearing Weed invasion Rubbish dumping
Occurrence 50 STIRLCRES05	Private, public road	2001, 2006, 2007	Fragmentation Clearing Weed invasion Too frequent fire Grazing by native or introduced species
Occurrence 56 APBF07	Private Freehold, Public Road	2007, 2007, 2017	Clearing Weed invasion Too frequent fire Disease
Occurrence 57 ERRINA01	DBCA, DPLH, public road and Department of Communities	2001, 2014	Clearing Weed invasion Too frequent fire Rubbish Dumping Grazing by native or introduced species
Occurrence 58 APBF01	DPLH, Department of Education, DPIR	1994, 2001, 2007, 2012, 2017	Clearing Weed invasion Too frequent fire Disease - invasion and spread
Occurrence 59 MARIJINUP01	Private freehold	2010	Weed invasion Rubbish dumping

			Clearing
Occurrence 61 VICTORIA22	Private Freehold	2007, 2014	Weed invasion
Occurrence 64 REIDHWY02	DPLH	2010, 2014	Recreational activities Weed invasion Rubbish dumping Too frequent fire Disease
Occurrence 66 5C03	DBCA, Public Road	1992, 2013	Disease Clearing Too frequent fire
Occurrence 69 CLIFFORD01	DPLH, Main Roads	2001, 2007, 2013, 2016, 2019	Clearing Weed invasion Too frequent fire Trampling
Occurrence 70 ReidHwy01	WAPC	2010, 2014	Recreational activities Weed invasion Rubbish dumping Too frequent fire Disease
Occurrence 71 MAIDA02	Department of Education	2001, 2011, 2013	Clearing Weed invasion Too frequent fire Trampling
Occurrence 73 GOLF01	DPLH	1994, 2001, 2014	Clearing Weed invasion Too frequent fire Disease
Occurrence 75 Ibis_IP0901	Private Freehold, Public Transport Authority	2007, 2009, 2011	Clearing Weed invasion Recreational activities Too frequent fire Disease
Occurrence 76 Ibis_IP0904	Private Freehold	2007, 2009, 2011	Clearing Weed invasion Recreational activities Too frequent fire Disease
Occurrence 77 Ibis_IP0906	Private Freehold	2007, 2009, 2011	Clearing Weed invasion Recreational activities Too frequent fire Disease
Occurrence 78 Ibis_IP0908	Private Freehold	2007, 2009, 2011	Clearing Weed invasion Recreational activities Too frequent fire Disease

Occurrence 79 Dianella01	DPLH	2015	Clearing Weed invasion Too frequent fire Disease	
Occurrence 80 Dianella 02	WAPC/Private Freehold and DPLH	-	Clearing Weed invasion Too frequent fire Disease	
Occurrence 81 Poison Gully 01	DPLH	-	Clearing Weed invasion Too frequent fire Disease	
Occurrence 82 StLawrence01	DPLH	-	Clearing Weed invasion Too frequent fire Disease	
Occurrence 90 PoisonGully02	DPLH	-	Clearing Weed invasion Too frequent fire Recreational activities Disease	
Occurrence 91 HAWTIN01	Private Freehold	2014, 2015	Clearing Weed invasion Too frequent fire	

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

Current threats include vegetation clearing, weed invasion, too frequent fire, hydrological change (declining groundwater levels), fragmentation, recreational activities, impacts of disease including dieback caused by *Phytophthora* species, grazing by native or introduced fauna, and disturbance through rubbish dumping, all of which are actual threats

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

Future threats include vegetation clearing, weed invasion, too frequent fire, hydrological change (declining groundwater levels), fragmentation, recreational activities, impacts of disease including dieback caused by *Phytophthora* species, grazing by native or introduced fauna, and disturbance through rubbish dumping, all of which are actual threats.

The following model https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/sub-clusters/?current=SSWSW&tooltip=true&popup=true details the predictions for changing rainfall for the South West of Western Australia.

"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%." Reduced rainfall and altered hydrology are likely to favour terrestrialisation of the community and is an actual threat. Fire frequency and intensity are also likely to increase as a consequence of reduced rainfall and are inferred threats.

For each threat describe:
33 a. How the threat has impacted on this ecological community in the past.

Several occurrences are known to have been cleared recently.

57 occurrences are known to be subject to weed invasion. Weeds displace and outcompeting native flora and reducing diversity and abundance of native flora. In a recent study of Banksia resilience to climate change, weed invasion was shown to be a major factor influencing local extinctions of Banksia spp. (Randell 2016). Current weed levels in most occurrences are still quite low, with the exception of some localized areas within occurrences subject to heavy disturbance historically. Many sites are burnt relatively frequently in fires that are deliberately lit by arsonists and have suffered increased weed invasion as a consequence (eg occurrences 3, 10, 11, 13 and 46). Most of the occurrences of this community are close to or surrounded by urban areas that act as weed sources and would be vulnerable to weed invasion following any disturbance. Common weeds in occurrences include *Aira caryophyllea*, *Ehrharta calycina*, *Vulpia* sp. and *Gladiolus caryophyllaceus*.

29 occurrences are recorded to be affected by disease, with several occurrences having been tested and confirmed to contain *Phytophthora* spp. "Phytophthora dieback is caused by the plant pathogen, *Phytophthora cinnamomi*, which kills susceptible plants, such as banksias, jarrah and Xanthorrhoeas, by attacking their root systems. Phytophthora affects more than 40 per cent of the native plant species and half of the endangered ones in the south-west of Western Australia. The plants die because they cannot take up the water and nutrients they need." (URL: https://www.dpaw.wa.gov.au/management/pests-diseases/phytophthora-dieback accessed March 2019). Other species of *Phytophthora* also induce plant disease.

The *Phytophthora* Disease Interpretation Report Dundas Nature Reserve (2011) states "Within the *Banksia* woodland areas *Phytophthora* disease was noted in dead and dying *Banksia menziesii, Xylomelum occidentale, Xanthorrhoea preissii* and *Xanthorrhoea gracilis, Eucalyptus marginata* (jarrah) were also presumed to be affected in some areas. Within long term infested areas, *Banksia* has been severely reduced by the disease, allowing resistant sedges, *Conostylis* species and weeds to dominate. An example of this level of impact may be seen around MGA reference E 404448, N 6461736 in the northern most corner of the assessment area. Newer infestations were evident in scattered recently dead *Banksia menziesii*. Within the low lying flats, disease expression has reached an endemic equilibrium. Only scattered *Xanthorrhoea* deaths were noted throughout the low lying areas, however, the recent *Xanthorrhoea* deaths were present in enough numbers to condemn the landform type as entirely infested. No tree species were present within the central part of the landform type, very occasional stumps and rotten trunks were noted, presumed to be *Banksia littoralis."* (see map at Appendix A)

The *Phytophthora* Disease Interpretation Report Stirling Crescent TEC Site (2011) (occurrence 50) states "The disease expression was generally obvious with a number of fresh deaths along the infested boundaries. The main infested area is a low-lying seasonal creek-line/wetland and extends both north and south of the Great Eastern Highway Bypass. The area had a number of fresh deaths along its boundaries including *B. menziesii* and *X. preissii.* The small infested areas in the north-east corner are relatively new and the most likely vector is the road/track

that forms the eastern-most border of the TEC site. The small area of 'uninterpretable' land on the northern side of the Great Eastern Highway Bypass. lacks a significant number of indicator species to allow confidence in determining its hygiene category. The 'excluded' area on the southern side of the junction between Stirling Cr. and the Great Eastern Highway Bypass was determined in response to the high numbers of *B. grandis* deaths caused by drought or fire in this area. The vegetation here was not accurately representing its natural state at the time of interpretation. The southern edge of this 'excluded' area backs onto a commercial trucking company and has become highly degraded due to vehicle-use, rubbish-dumping, weed invasion and evidence of soil movement by machinery. The northern edge of this 'excluded' area runs east along the Great Eastern Highway Bypass. This area has been cleared of all road-side vegetation, either from vehicle use or road-works activity. At the southern end of the site and west of Roe Hwy lies another 'excluded' area. This location was void of native lower and mid-storey species." (see map at Appendix A).

- 24 occurrences are recorded to be subject to rubbish dumping, observed through survey/site visits to the occurrences.
- 18 occurrences are recorded to be affected by the impacts of vegetation damage through recreational activities.
- One occurrence is known to contain *Armillaria lubteobubalina* that "infects the roots of living trees, spreads towards the root collar below the bark and eventually kills the tree when it girdles the root collar. Seedlings and saplings are most susceptible to infection, however, healthy vigorous trees older than about 20 years have some resistance and develop callus tissue at the margin of lesions." (Robinson, 2008) DBCA https://library.dbca.wa.gov.au/static/FullTextFiles/070382.pdf

As mentioned, decline in available groundwater in Banksia woodlands near Perth has been clearly linked to a change of Banksia woodlands towards non-woody, shallow-rooted species not dependent on specific hydrological conditions (Sommer and Froend 2011).

There have been a number of detailed groundwater studies completed for this community that suggest that this community is partially groundwater dependent. Source: Australian Government Department of Climate Change and Energy Efficiency Fact Sheet. Rainfall in south-west WA has already reduced by around 15 per cent since the mid-1970s. There is evidence that greenhouse gases emitted by human activities are responsible for half the decline in rainfall in south-west WA. Modelling suggests a decrease in mean annual rainfall of 7 per cent and a 14 per cent reduction in surface water runoff in the period 2021 to 2050 relative to the period 1961 to 1990. If current climate trends continue, south-west WA will potentially experience 80 per cent more drought-months by 2070. A hotter, drier climate would inflict a high economic impact on water supply infrastructure across the country, with Perth likely to be the most severely impacted city in Australia through climate change induced water scarcity. This will place increased pressure on utilising the Gnangara Mound on which a reasonably significant proportion of the Banksia Woodlands occur and rely. In addition, Hope (2015): https://www.climatechangeinaustralia.gov.au/en/publications-library/cluster-reports details that "There has been a prolonged period of extensive drying from the 1970s in SSWFW and from the 1990s to the present in both sub-clusters, particularly in autumn and early winter. Decreases in winter and spring (and annual) rainfall are projected with high confidence. There is strong model agreement and good understanding of the contributing underlying physical mechanisms driving this change (relating to the southward shift of winter storm systems and greater prevalence of high pressure systems)."

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

The effects of all threats are expected to increase, particularly given the location of occurrences of the ecological community within a predominantly urban environment.

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

The threats listed in Section 32 above, are applicable to most occurrences of this community.

- Spread of introduced flora occurs at edge of vegetation, and where seeds are carried by wind etc, and within occurrences, adjacent to paths and tracks that can be traversed on foot, or by vehicle.

- Spread of disease including dieback occurs along tracks and paths, and through vegetation where vehicles or pedestrians carry contaminated wet or damp soil on footwear and tyres through bushland. The disease then spreads further through presence of water in creeks and surface water runoff.

- Clearing of the community occurs for road and other infrastructure and residential uses. Five occurrences are known to have been completely cleared.

- Rubbish dumping occurs both internally and at edges of occurrences of the community.

- Too frequent fire occurs both internally and at edges of occurrences of the community.

35. 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 (Source: Australian Government Department of Climate Change and Energy Efficiency Fact Sheet) URL: https://www.environment.gov.au/climate-change

Occasional fires cause a flush of regeneration, however too frequent fire will deplete seed stores, particularly in the case of obligate seeding taxa that will require a particular inter-fire interval to mature and produce seed.

The incidence of damaging wildfires is likely to increase with increased temperatures and reduced rainfall over the south west of WA. Very hot fires can cause death of Banksias. The levels of stress, and ultimately deaths of the dominant Banksias and other sensitive species in the Banksia woodlands caused by reduced rainfall and availability of groundwater, in combination with increased temperatures and incidence of damaging fires is expected to increase, but impacts would be site-specific across the range of the Banksia woodlands.

The CSIRO climate models indicate that the likely increases in summer temperatures over the range of the Banksia woodlands ranges from 1-30°C (both the 10th and 50th percentiles), and 2-50°C on the 90th percentile. The 50th percentile is considered the most likely scenario. Projections indicate that the annual average number of days above 35°C in Perth could increase from the 28 currently experienced to up to 67 days by 2070 without global action to reduce emissions. Projections also indicate an increase in the intensity and frequency of bushfires. The 2010-11 WA bushfire season was one of the most devastating and destructive in the state's history.

36. 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.

As stated decline in available groundwater in Banksia woodlands near Perth has been clearly linked to a change of Banksia woodlands towards non-woody, shallow-rooted species not dependent on specific hydrological conditions (Sommer and Froend 2011).

36 a. How does it respond to disturbance?

There are few data available through which fire regimes that enhance/protect the composition of *Banksia attenuata* woodlands can be elucidated, so that what actually constitutes an appropriate fire regime will require investigation (DPaW 2016). It seems likely that fire regimes such as long periods of fire exclusion, sustained frequent burns, and post-fire grazing (eg by rabbits) will be detrimental to the community. Many of the occurrences of this community are within the Perth metropolitan area and have been burnt relatively frequently in recent years.

Brundrett and Longman (DBCA 2017) studied the effects of hot summer wildfire on plant diversity and have documented the timing and method of recovery of some species in Banksia woodlands; "A banksia woodland monitoring program was established in 2013 to measure changes to plant diversity, cover, density and condition following perennial veldt grass control (31 quadrats at five locations). Effective weed control initially increased the dominance of annual plants, as well as some perennial native plants and banksia seedlings. Fauna monitoring in restoration areas and banksia woodland reference sites established that there were few native mammals, but substantial numbers of birds, reptiles and amphibians in all areas and that these were already beginning to use the restoration sites.

A severe bushfire in Banjup in February 2014 burnt seven monitoring quadrats in Shirley Balla Swamp. This created an opportunity to study the impact of fire on banksia woodland plant diversity, cover and density. There was a 39% mortality rate for banksia trees, but also a very high rate of post-fire germination of banksia seed (6,000 seedlings per ha). Post-fire, more plant species recovered by seed germination than through resprouting, however the latter resulted in greater foliage cover. Major benefits to native plants cover and diversity due to weed management were also measured post-fire."

Disturbances within remnants often lead to an increase in weed invasion, particularly where remnants are small. In addition, the risk of fire is increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than the original native species in the herb layer. The increased number of fires may potentially be impacting the community in terms of structure, composition and level of weed invasion.

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

See 36a above.

Threat Abatement and Recovery
37. **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).

Department of Parks and Wildlife (2016). Interim Recovery Plan for *Banksia attenuata* woodlands over species rich dense shrublands (Swan Coastal Plain Community type 20a – Gibson *et al.* 1994) Plan number 359. 2016-2021. DPaW, Kensington.

38. **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.

Actions recently completed for occurrence 2 include completion of fencing of reserves 37997 and 37260. Internal rabbit proof fencing, rabbit baiting, translocation (re-establishment) of *Macarthuria keigheryi* have been completed, and rehabilitation of degraded areas of Reserve 37997 has been initiated.

Many occurrences of *Banksia attenuata* woodlands occur within reserves managed by local government. The majority of these reserves are fenced and include interpretation panels and are actively managed for conservation purposes. Management activities include rubbish removal and weed control. Community groups assist in promotion of conservation values of the bushland and take part in bush care activities.

39. **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.**

Approximately 165 ha is in reserves for conservation and 201 ha in reserves managed by local government authorities. Approximately 44ha is on private property (DPaW 2016). The remainder is on reserves vested with other authorities.

45 occurrences covering approximately 433 ha are within Bush Forever sites and are proposed to be provided increased protection through reservation or through other planning processes. Occurrences 1-4, 6-29, 34-35, 38-41, 44 (part), 45-47, 51, 54-57, 64, 66, and 74 are included in Bush Forever, in areas of 'regionally significant bushland to be retained and protected forever' (Government of WA 2000).

Negotiations with land owners have resulted in the transfer of a number of occurrences to more secure tenure purposed for the conservation of flora and fauna; Occurrence 6 that was previously privately owned freehold land is now a Class A nature reserve. Occurrence 5 previously Crown freehold is now a Class C nature reserve managed by DBCA. Occurrences 3, 33 and 43 previously freehold land are now Crown reserves vested with the City of Wanneroo. Occurrence 29 previously privately owned freehold land is now a reserve for the conservation of flora and fauna managed by the Shire of Kalamunda. Freehold land that accounts for around half of occurrence 34 is now a reserve for the conservation of flora and fauna managed by the City of Swan. Lots 30-31, 43-44 and 63 within Crown Reserve 37997 (part of Occurrence 2), previously managed by WA Planning Commission was transferred to the Conservation and Parks Commission and is now managed by DBCA for the protection of fauna and flora.

39 a. Which of the reserves are actively managed?
Note which, if any, reserves have management plans and if they are being implemented.

At least 11 occurrences of this community have been fenced. Weeds have been mapped and controlled in a suite of occurrences and a private landowner manages weeds and feral animals within their property. A number of occurrences have been subject to dieback (*Phytophthora*) treatment or have gates installed and limestone paths established. Revegetation work has been completed and access management works undertaken in some areas of the community.

A biodiversity strategy that details recovery actions for all reserves managed by the City of Wanneroo is in place (City of Wanneroo 2011). The City of Wanneroo has management plans that specifically detail recovery actions for;
- Koondoola Regional Bushland, that contains occurrence 3 (City of Wanneroo 2008),
- Montrose Conservation Reserve, that contains occurrence 31 (City of Wanneroo 1995a),
- Highview Park, that contains occurrences 35 and 36 (City of Wanneroo 1995b),
- Marangaroo Conservation Reserve, that contains occurrence 1 (City of Wanneroo 1990).

Community groups in the City of Wanneroo assist in managing areas that contain the community including: Koondoola Regional Bushland, Landsdale Park, and Marangaroo Conservation Reserve.

A biodiversity strategy is in place for areas of this community managed by the Shire of Kalamunda, (Shire of Kalamunda 2008), City of Swan (City of Swan 2015), City of Gosnells (City of Gosnells 2010). The City of Stirling has developed management plans for regionally significant conservation reserves. The City of Canning considers natural bushland as key assets that they actively manage with the support of friends groups. An Environment Management Plan has been prepared for Telstra Corporation to oversee management of the community at Cullacabardee (BSD Consultants Pty Ltd 2002).

Negotiations with land owners have resulted in the transfer of a number of occurrences to more secure tenure purposed for the conservation of flora and fauna. Occurrence 6 that was previously privately owned freehold land is now a Class A nature reserve. Occurrence 5 previously Crown freehold is now a Class C nature reserve managed by DBCA. Occurrences 3, 33 and 43 previously freehold land are now Crown reserves vested with the City of Wanneroo. Occurrence 29 previously privately owned freehold land is now a reserve for the conservation of flora and fauna managed by the Shire of Kalamunda. Freehold land that accounts for around half of occurrence 34 is now a reserve for the conservation of flora and fauna managed by the City of Swan. Lots 30-31, 43-44 and 63 within Crown Reserve 37997 (part of Occurrence 2), previously managed by DPLH was transferred to the Conservation and Parks Commission and is now managed by DBCA for the protection of fauna and flora.

Edith Cowan University has initiated a PhD research project aimed at defining the habitat preferences for the *Banksia attenuata* woodlands and *Conospermum undulatum*. A survey of vegetation condition and threatening processes coupled with this study will assist in developing a risk assessment framework to assist future management.

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

This community is located within the following reserves, of which all are anticipated to be permanent. A total of approximately 219ha is located within the reserves.

- Marangaroo Conservation Reserve, Decourcey Way, Le Grand and Caroline Gardens, Marangaroo (21.55ha)
- Reserves 37260, 36238, 37981, 37997, Lots 30, 31, 43, 44, 63, road reserve Forrestfield (39.61ha)
- Koondoola Regional Bushland (Reserve 48449) Alexander drive, Koondoola (104.79ha)
- Reserve 49709 Adelaide St, Roe Highway road reserve, High Wycombe (11.02ha)
- Reserve 41156, Dawson Ave, Forrestfield (1.78ha)
- Reserve 41156, Lot 1, Dawson Ave, Forrestfield (4.56ha)
- Lot 2, 501, 15, reserve 32901, 33963, road reserve Schofield Road, Wattle Grove (5.07ha)
- Reserve 41156, 36238 Dawson Ave, Forrestfield (4.55ha)
- Reserve 984, road reserve McDowell St, Welshpool (1.46ha)
- Reserve 984, McDowell St, Welshpool (0.09ha)
- Reserve 29815 Bougainvillea Ave, Forrestfield (0.78ha)

- Reserves 14088, 18689 Ridge Hill Road, Maida Vale (1.11ha)

- Reserve 14088 Ridge Hill Road, Maida Vale (0.98ha)

- Reserve 18689 Kalamunda Road, Maida Vale (0.42ha)

- Reserve 50763 Brae Road, High Wycombe (1.05ha)

- Hepburn Park (Reserve 34683) Alexander Drive, Landsdale (7.76ha)

- Montrose Park (Reserve 33343) Montrose Ave, Girrawheen (5.69ha)

- Reserve 41225 Jefferson Drive, Marangaroo (4.96ha)

- Middleton Park (Reserve 47420) Middleton Road, Alexander Heights (2.02ha)

Unnamed Nature Reserves vested in the Conservation and Parks Commission include R50678, (Iopollo Road); 37997 31709 (Dundas NR); 49079 (Active).

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

The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. According to the Department of Aboriginal Affairs, Aboriginal Heritage Sites Register there are a number of registered sites known to occur in or near occurrences of these *Banksia attenuata* woodlands. There are art sites in the vicinity of occurrences 6, 9, 16, 19, 20, 21, 30, 38, 40 and 41. There is a scarred tree site in the vicinity of occurrence 26, and an unspecified site near occurrence 8. A site occurs near occurrence 3 and two occurrences are within Bennett Brook Registered site. Occurrences 7, 29, 60-63, 66, and 70-74 are within the site registered as Poison Gully Creek (DPaW 2016). Comment was sought from the Council about any aspects of the recovery plan, but particularly about the proposed on-ground actions. Action 1 in DPaW (2016) identifies the intention to continue liaison with relevant groups, including indigenous groups.

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

See 39c. above.
A Noongar native title claim that occurs between Jurien and Ravensthorpe affects the area covered by community was settled in 2015.
The South West Aboriginal Land and Sea Council (SWALSC), which represented six claimant groups. A perpetual trust — the Noongar Boodja Trust, will manage up to 320,000 hectares of land for development and cultural purposes. Other parts of the deal include a capital works program and a Noongar Land Fund, set to receive up to $47 million over 10 years. The specific details of how the settlement of the claim will affect management of FCT20a are not known.

40. 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).

- Identifying, mapping and controlling significant weeds, including invasive weeds such as *Ehrharta calycina*, *Vulpia* sp., *Gladiolus caryophyllaceus* and *Watsonia meriana*.
- Fence construction and maintenance.

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

See 39a above.

42. 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.	

Sampling protocols and timelines best used for identifying and conducting surveys in this ecological community are identified in DEE (2016) and include: "At least one hour per plot in early to mid-spring and a second survey in late spring may be required to detect the majority of species. Sampling should be based upon plot sizes of at least 100 m² (= 0.01 ha, 10m x 10m, or an appropriate shape of equivalent size). However, larger and more variable areas of vegetation will need more samples or plots to assess a site accurately…consideration must be given to the role that season and disturbance history may play in an assessment. For example, flowering may be necessary to identify some shrub species and active growth will indicate population sizes of annual weeds. Immediately after a fire one or more vegetation layers, or groups of species (e.g. obligate seeders), may not be evident for a time. The cover of native plants also varies between seasons and between years in response to variability in environmental conditions and also with respect to cycles of recurring disturbance such as fire. Timing of surveys should therefore allow for a reasonable interval after a disturbance (natural or human-induced) to allow for regeneration and be timed to enable component species to be detected and identified. For instance, surveys at least one year post fire may be required to assess a site against the key diagnostic characteristics and minimum condition thresholds."

Taxonomy should be reconciled between datasets to current or historic species names. The species data from quadrats established should then be compared and analysed against quadrat data held in Gibson *et al.* (1994) or Keighery *et al*. (2012) using appropriate statistical techniques and parameters (eg PATN, Primer or PC-ORD).

Species lists for vegetation units can be collected and analysed using other methods where native species richness is inadequate to provide good quality data for statistical analysis; for example where vegetation is not in suitable condition. Substrate can be very useful in verifying the FCT present in this case.

The flora and vegetation can be surveyed along a series of transects or relevés across the site, with species recorded for different vegetation units being compiled in separate lists. Detailed notes should be recorded about the species present, vegetation condition on Bush Forever scales, and soils and landform. Plant species that may be particularly significant in differentiating the floristic community types should also be noted.

43. Are there other any aspects relating to the survival of this ecological community that you would like to address?	

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.

44. 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	☐ **A1**
☐ EN	☐ **A2a**
☒ VU	☐ **A2b**
☐ not eligible	☒ **A3**

Justification for assessment under Criterion A:

For criteria A and B, the ecosystem is assumed to collapse when the mapped distribution declines to zero.

Area calculations from digitised GIS mapping based on the Vegetation Survey of WA (Beard & Sprenger 1984) estimate that Banksia low woodland originally covered 4435.3 km2. In addition, Banksia woodland with scattered emergent eucalypts is estimated to have covered a further 2303.2km2. Therefore the original extent of all Banksia woodlands (including Banksia woodland other than ecological community 20a) as defined in this context is estimated to be 6738.5km2 which equates to 673,850 ha.

From digitised GIS mapping of remnant vegetation in WA as at 2008 (WA Department of Agriculture and Food) it is estimated that about 325669ha (3256.69km2) of the entirety of the Banksia woodlands categorised as "Banksia Woodlands of the Swan Coastal Plain IBRA region remained" (DPaW 2016). The *Banksia attenuata* over species rich dense shrublands is known from a current total of 563.91ha. The total loss of Banksia Woodlands overall on the Swan Coastal Plain is estimated to about 52%. DEE (2016) states that the loss of Banksia woodlands is in the order of 50-60%. It is assumed that the *Banksia attenuata* woodlands over species rich dense shrublands has suffered the same level of decline as other Banksia woodlands. Based on this it is estimated that the community had a pre-industrialisation area of occupancy of approximately 880ha. The estimate of loss of 52% of the *Banksia attenuata* over species rich dense shrublands falls into the A3 subcriterion of ≥50% historical reduction (since approximately 1750). This indicates the community is eligible for listing as Vulnerable. As the *Banskia attenuata* over species rich dense shrublands community is largely confined to urban areas, and is targeted for mining of the yellow sands upon which it sits, the loss is likely to be greater than for other Banksia woodlands, therefore 52% loss is a conservative estimate. The extent of vegetation clearing in a radius of 20 km around central Perth is much greater and is estimated to be greater than 90% loss.

Community meets VU under A3.

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:

Extent of minimum convex polygon EEO (km²) is 858 km², which is ≤2000km (threshold for CR), and AAO is seven grid cells.

a. Continued decline in spatial extent of the ecological community is inferred, with clear evidence of ongoing proposals to clear the community. Community eligible to be listed as critically endangered under B1ai.

b. Under subcriterion B2, 7 10x10km grid cells are occupied (meets the ≤ 20 grid cell threshold for EN). In addition to land clearing, weed invasion, too frequent fires, declining groundwater levels and dieback impacts are observed and inferred threatening processes that are likely to cause continuing decline in geographic distribution, environmental quality and biotic interactions within the next 20 years. The community is eligible to be listed as Critically Endangered under B1b and Endangered under B2ai and B2b.

c. Community considered to exist at 7 threat-defined locations based on clusters of bushland that contain occurrences and may be subject to similar threats such as inappropriate fire regimes and hydrological changes (threshold for VU is ≤ 10 threat-defined locations). Meets VU under B1c, B2c.

Community does not meet sub-criterion B3 as it occurs at >5 threat-defined locations.

Eligible for listing as Critically Endangered under B1ai,b and Endangered under B2ai,b. Meets VU under B1c, B2c.

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:

- **C1, C2:** Too frequent and intense fires are a significant abiotic threat to the community. For criterion C, collapse of the community is defined as a fire regime of very frequent intense fires. It is assumed that collapse is total loss of fire sensitive shrubs, and trees, including Banksias, that are key to the structure of the community as a consequence of too frequent or intense fires.

- C1, C2: Fire frequency and severity are likely to increase with increased temperatures and decreased rainfall with drying climate. No systematically collected data were sourced that link the frequency or severity of fire to compositional and structural changes in the community. No available evidence indicates the community meets the minimum proportion of the extent (≥30%) or proportional severity of disruption of abiotic processes (≥30%) over any 50-year period to meet criteria C1 or C2.

- C3: No available data indicate that the community meets the threshold proportion of extent (≥50%) or severity of disruption of abiotic processes (≥50%) since 1750 to meet VU.

No available data indicate that the community meets criterion C.

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

Criterion D

☐ CR
☐ EN
☐ VU
☒ not eligible

☐ D1
☐ D2
☐ D3

Justification for assessment under Criterion D:

D1, D2: the impacts of dieback disease caused by *Phytophthora* species is a significant biotic variable affecting the community. The severity of dieback impacts associated with collapse is uncertain, but it is assumed conservatively that the community reaches a collapsed state when 90% of the dieback sensitive flora in the community have been killed by the disease.

The main historical impact of *Phytophthora* spp. is likely to have been to change the structure and composition of Banksia woodlands towards dominance by taxa that are less susceptible to the disease.

The area of mapped Banksia woodlands that coincide with inferred disease areas and those in which the disease has been detected is 19,984ha (2010 GIS data Forest Management Branch DEC). This represents about 3% of the overall extent of the Banksia Woodlands as at 2008. This may represent an underestimate of the area of the Banksia Woodlands that is dieback infested as detection of the disease requires substantial resources, and much of the extent of the Banksia Woodlands may not have been surveyed for the disease. It is assumed that the *Banksia attenuata* woodlands over species rich dense shrublands community is affected to the same degree as other Banksia woodlands. This also may be an underestimate as *Banksia attenuata* over species rich dense shrublands community is largely urbanised so is subject to considerable impacts from human use of the bushland areas. This is likely to cause increased impacts of the disease when compared to other Banksia woodlands that are not as readily accessible.

To meet the criteria for vulnerable using the impact of this disease, a demonstrable minimum of ≥30% relative severity over ≥30% of the extent of the community in any 50 year period, or ≥50% of the extent of the community, with ≥50% severity since 1750.

Based on available data on the abovementioned extent of the disease mapped in 2008 it is unlikely that the threshold levels of disruption of biotic processes by dieback disease over the required proportions of the extent of the community that are required to meet VU will be met. This is also likely to be the case allowing for a substantial potential underestimate of the extent of the disease in these woodlands.

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:
　　No quantitative analysis of probability of ecosystem collapse has been completed
Unable to assess

Table 4: Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Available data do not indicate if community meets criterion
A2a	-	• Available data do not indicate if community meets criterion
A2b	-	• Available data do not indicate if community meets criterion
A3	VU	• Estimated decline of >52% of geographic extent since 1750 • Meets VU
B1a	CR	• EOO is 858 which is ≤2,000km² threshold for CR • An observed and inferred continuing decline in (i) a measure of spatial extent through ongoing clearing of this community • Meets CR under B1ai
B1b	CR	• EOO is 858 km² (≤2,000km²) • Ecosystem subject to observed and inferred threatening processes likely to cause continuing declines in geographic distribution, environmental quality and biotic interactions within the next 20 years • Meets criterion for CR
B1c	VU	• EOO is 858 km² (≤2,000km²) • Ecosystem exists at 7 threat-defined locations • Meets criterion for VU
B2a	EN	• AOO is seven grid cells • Ongoing inferred decline in a measure of spatial extent • Meets criterion for EN B2ai
B2b	EN	• AOO is seven grid cells • Subject to observed and inferred vegetation clearing likely to cause declines within the next 20 years • Meets criterion for EN
B2c	VU	• AOO is seven grid cells • Ecosystem exists at 7 threat-defined locations • Meets VU
B3		• Ecosystem exists at 7 threat-defined locations • Does not meet criterion for B3
C1	-	• No available data indicate that the community meets criterion C.
C2	-	• No available data indicate that the community meets criterion C.
C3		• No available data indicate that the community meets criterion C.
D1	-	• Does not meet criterion
D2	-	• Does not meet criterion
D3	-	• Does not meet criterion
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Meets CR under B1ai,b. Meets EN under B2ai,b. Meets VU under A3, B1c, B2c. *'The highest risk category obtained by any of the assessed criteria will be the overall risk status of the ecosystem'* (IUCN RLE Guidelines V1.1 page 42). **Meets CR B1a(i),b**

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.

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

Canham, C. A., Froend, R. H., and Stock, W. D. (2009). Water stress vulnerability of four Banksia species in contrasting ecohydrological habitats on the Gnangara Mound, Western Australia. Plant, Cell & Environment, 32(1), 64-72.

Coffey Eco Logical (2020). Condition Environmental Management Plan, Flora and Vegetation, Inland Waters, Perth to Darwin National Highway (Swan Valley Section). St Georges Terrace, Perth. January 2020.

City of Wanneroo (1990). Marangaroo Conservation Reserve Draft Management Plan. City of Wanneroo, Western Australia.

City of Wanneroo (1995a). Montrose Conservation Reserve Management Plan. City of Wanneroo, Western Australia.

City of Wanneroo (1995b). Highview Park Management Plan. City of Wanneroo, Western Australia.

City of Wanneroo (2008). Koondoola Regional Bushland Management Plan (July 2008). Prepared by Ecoscape for the City of Wanneroo, Western Australia.

City of Wanneroo (2008). City of Wanneroo Local Environmental Plan 2009-2014. Wanneroo, Western Australia.

City of Wanneroo (2011). Local Biodiversity Strategy (2011-2016). City of Wanneroo.

Department of Environment and Conservation (2011a). *Phytophthora* Disease Interpretation Report Dundas Nature Reserve, Forest Management Branch, Department of Environment and Conservation (Release 1.1), 18 July 2013.

Department of Environment and Conservation (2011b) *Phytophthora* Disease Interpretation Report Stirling Crescent TEC Site, Forest Management Branch, Department of Environment and Conservation (Release 1.00), 18 July 2013.

Department of Parks and Wildlife (2016) Interim Recovery Plan No. 359; *Banksia attenuata* woodlands over species rich dense shrublands (Swan Coastal Plain Community type 20a – Gibson et al. 1994). DPaW, Kensington.

Department of the Environment (2016). Shrublands and Woodlands of the eastern Swan Coastal Plain in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgibin/sprat/public/publicshowcommunity.pl?id=20&status=Endangered

Department of Environment and Energy (2016). (EPBC Act) (s 266B) Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community, under the *Environment Protection and Biodiversity Conservation Act 1999*.
www.environment.gov.au/biodiversity/threatened/communities/pubs/131-conservation-advice.pdf

Froend, R., Sommer, B. (2011) Phreatophytic vegetation response to climatic and abstraction-induced groundwater drawdown: Examples of long-term spatial and temporal variability in community response. Ecological Engineering 36: 1191-1200.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A. and Lyons, M. (1994). A floristic survey of the Southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.). Perth, Western Australia

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

Groom, P.K., Froend, R.H. and Mattiske, E.M. (2000) Impact of groundwater abstraction on a Banksia woodland, Swan Coastal Plain, Western Australia. Ecological Management and Restoration 1, 117-124.

Groom, P.K., Froend, R.H., Mattiske, E.M. and Gurner, R.P. (2001) Long-term changes in vigour and distribution of Banksia and Melaleuca overstorey species on the northern Swan Coastal Plain. Journal of the Royal Society of Western Australia 84, 63-69.

Groves, H. (2014). Predicted risk to Banksia woodlands in the Swan Coastal Plain in response to groundwater decline. Report for completion of a Master of Hydrogeology degree at the University of Western Australia. UWA, Nedlands.

Hope, P. et al. (2015), Southern and South-Western Flatlands Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia.

Keighery, B.J. (1994). Bushland Plant Survey: A Guide to Plant Community Survey for the Community, Wildflower Society, Floreat.

Keighery, G. and Keighery, B. (2016). How many banksia woodlands? Floristics of Banksia Woodlands of the Swan Coastal Plain. In Stevens JC, Rokich DP, Newton VG, Barrett RL and Dixon KW (Eds). Restoring Perth's Banksia woodlands. UWA Publishing. Crawley, Western Australia.

Robinson, R. (2008). Recognising Armillaria Root Disease. Department of Environment and Conservation, Manjimup.

Zencich, S,J., Froend, R.H., Turner, J.V. , Gailitis, V. (2002) Influence of groundwater depth on the seasonal sources of water accessed by Banksia tree species on a shallow, sandy coastal aquifer. Oecologia, March 2002, Volume 131, Issue 1, pp 8–19 https://link.springer.com/article/10.1007/s00442-001-0855-7

46. Statement on the Standard of Scientific Evidence

Published studies on the Banksia woodlands of the Swan Coastal Plain has appeared in peer reviews journals (referenced above) and when combined with unpublished information and survey data, were sufficient to apply the Red List of Ecosystem criteria. There are likely to be inaccuracies in various aspects of the assessment, particularly with distinguishing recently cleared lands. For the criteria applied for assessment, the outcomes are considered robust

Uncertainties exist in aspects of the hydrological status, and current status of disease within the occurrences. A well designed, systematic, long term monitoring program (Lindenmayer & Likens 2010) with spatially and temporally linked data for parameters including floristics, hydrology, fires, and invasive species is required to better understand the relationships between changes in the ecosystem and the most significant threatening processes. Such a program would be resource intensive but could provide the necessary data to help guide future management of this community.

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

Reviewed by:

Conservation Officer, DBCA Wanneroo

Principal Ecologist DBCA Kensington

Ecologist, DBCA, Kensington

48. 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

49. Contact Details

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

Title/Full Name	▉▉▉▉▉▉▉
Organisation or Company name	Department of Biodiversity, Conservation and Attractions
Postal address	DBCA Kensington
Email	▉▉▉▉▉▉▉@dbca.wa.gov.au
Phone	9219 ▉▉
Fax	
50. 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 A:

2011 Dieback mapping at Dundas Nature Reserve (occurrence 1) (from Department of Environment and Conservation 2011a).