Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Southern wet shrublands, Swan Coastal Plain (floristic community type 2 as originally described in Gibson *et al*. (1994))
Other names:	SCP02, FCT02 as described by Gibson *et al.* (1994).
Description:	The community comprises shrublands or open woodlands. It occurs on seasonally inundated sandy clay soils that are restricted to small remnants on the eastern side of the Swan Coastal Plain. This community is otherwise known as 'floristic community type 2' as defined in Gibson *et al*. (1994). It has been recorded from Forrestfield to Busselton. The community has moderate species richness with the occurrence of species reflecting the wetter nature of the sites. Typical and common native taxa in the community are the shrubs *Kingia australis* (Kingia), *Pericalymma ellipticum* (swamp teatree), *Hakea ceratophylla* (horned leaf hakea), *Calothamnus lateralis, Hypocalymma angustifolium* (white myrtle), *Eutaxia virgata, Stirlingia latifolia* (blueboy), *Banksia dallanneyi* (couch honeypot) and herbs, rushes and sedges including *Dampiera linearis* (common dampiera), *Comesperma virgatum* (milkwort), *Stylidium brunonianum* (pink fountain triggerplant), *Thysanotus multiflorus* (many-flowered fringe lily) and *Mesomelaena tetragona* (semaphore sedge). The community also contains priority flora including *Isopogon formosus* subsp. *dasylepis* (priority 3) and *Grevillea brachystylis* subsp. *brachystylis* (priority 3). This community is also known as "floristic community type 2" as originally described in Gibson N., Keighery B.J., Keighery G.J., Burbidge A.H. and Lyons M.N. (1994) "A floristic survey of the southern Swan Coastal Plain" (unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia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.)).
Nomination for:	Listing ☐ Change of status ☒ Delisting ☐

1. *Is the ecological community currently on any conservation list, either in a State or Territory, Australia or Internationally?* 2. *Is it present in an Australian jurisdiction, but not listed?*	*Provide details of the occurrence and listing status for each jurisdiction in the following table*

Jurisdiction	**List or Act name**	**Date listed or assessed (or N/A)**	**Listing category eg. critically endangered (or none)**	**Listing criteria eg. B1ab(iii)+2ab(iii) (or none)**
National	EPBC Act			
Western Australia	Current ranking under WA Minister ESA list in policy	6/11/2001	Endangered	EN B) ii) under previous ranking criteria developed in WA
	Priority list		1 ☐ 2 ☐ 3 ☐ 4 ☐	
Other State/Territory				

Nominated conservation status: category and criteria (include recommended status for deleted ecological communities)					
Critically endangered (CR) ☒	Endangered (EN) ☐	Vulnerable (VU) ☐	Collapsed (CO) ☐		
Priority 1 ☐	Priority 2 ☐	Priority 3 ☐	Priority 4 ☐	None ☐	
What criteria support the conservation status category for listing as a threatened ecological community or collapsed ecological community? *Refer to Section 32 of the Biodiversity Act 2016 for definition of 'Collapsed', and Appendix 3 table 'IUCN Red List Criteria for ecosystems version 2.2'.*	**CR** A3				
Eligibility against the criteria					
*Provide justification for the nominated conservation status; is the ecological community eligible or ineligible for listing against the five criteria. For **delisting**, provide details for why the ecological community no longer meets the requirements of the current conservation status.*					
A.	Reduction in geographic distribution *(evidence of decline)*	☐ **A1** ☐ **A2a** ☐ **A2b** ☒ **A3**			
	Justification of assessment under Criterion A.	For criteria A and B, the ecosystem was assumed to collapse when the mapped distribution declines to zero. • Community SCP02 occurs predominantly on the Abba and Southern River vegetation complexes. The remaining proportion of pre-European extent of these complexes is 6% and 10% (Government of Western Australia, 2019). It is assumed that the reduction in extent of native vegetation on the land units is indicative of the level of clearing of the community. The extent of decline in these vegetation complexes since pre-industrialisation, ranges from 90% to 94%. This is indicative of an estimate of a >90% reduction of SCP02 since 1750, by Gibson *et al*. (1994). • Based on available evidence, the community plausibly meets criterion A3 as the distribution decline ranges from 90%-94% which is above the >90% threshold to meet CR under A3. The timing of the clearing is not known so is conservatively inferred to be since 1750. • **Plausibly meets criteria for Critically Endangered A3**		
B.	Restricted geographic distribution *(EOO and AOO, number of locations and evidence of decline)*	☒ **B1** (specify at least one of the following): ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☒ **b)** ☐ **c);** ☒ **B2** (specify at least one of the following): ☐ **a)(i)** ☐ **a)(ii)** ☐ **a)(iii)** ☒ **b)** ☐ **c);** ☐ **B3 (only for Vulnerable Listing)**		
	Justification of assessment under Criterion B.	• B1: EOO is 3097km^2 (≥ 2,000km – threshold for CR, and ≤20,000km^2 - threshold for EN).			

		The community's EEO is less that the 20,000km^2 threshold for rank EN. Community meets threshold for rank EN under criterion part B1. • B1 a(ii): Bore data are available to infer continued decline in a measure of disruption to environmental quality to support ranking under B1a(ii) and B2a(ii). There is an observed and inferred continuing decline in groundwater levels in some occurrences (see Appendix 1 for details). • B1 a(iii): Weed data and dieback data are available to infer continued decline, representing a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem (see Appendix 1 for details). There is an observed and inferred continuing decline of native taxa in one occurrence, and an observed and inferred continuing increase in dieback at six occurrences. • B1 b): Continuing decline observed from the impacts of; land clearing, hydrological change, weed invasion, trampling, altered fire regimes, disease, grazing by introduced herbivores, and a drying climate (see Appendix 1 for details of threats). • B1 c) Community is considered to occur at 6 threat defined locations, based on the identification of 6 of the community that may be subject to similar threats such as those that affect a particular aquifer, or bushland location. The community meets VU under B1c) as the threshold for EN is ≤5 and for VU is ≤10 threat-defined locations. (1 threat defined location is indicative of CR). • B2: AOO. Community covers 5 grid cells. The community meets EN under criterion B2 for which the AOO threshold is ≤20 grid cells (threshold for CR ≤2 grid cells) (b and c of B1 are the same for B2) • B3: community is considered to consist of 6 threat defined locations, based on the identification of 6 clusters of the community that may be subject to similar threats such as those that affect a particular aquifer, or bushland location. Does not meet VU under criterion B3, as community occurs at more than 5 threat defined locations. • **Meets criteria for Endangered B1a(ii),(iii),b; B2a(ii),(iii),b. Meets VU B1c, B2c.**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☒ **C2** ☐ **C3**

	Justification of assessment under Criterion C.	• Hydrological change in the form of groundwater decline is an abiotic variable that is a significant threat to the community. • For criterion C, the assessment of decline in abiotic processes focussed on hydrological change using data on the depth of the water tables. It was assumed conservatively that the community would collapse if the water table depth fell to about 10m below ground surface based on the maximum water depth accessed by deep rooted phreatophytic taxa in nearby areas (Froend and Loomes 2006), and observations that the vigour of canopies declined in groundwater dependent trees in association with declining water table levels (Froend *et al.* 2004). • Bore data was available in the vicinity of five occurrences of the community. The steady water table decline at the Ambergate reserve, where occurrences AMBR02, AMBR05 and AMBR07 occur (representative of 52% of the community), is likely due to a drying climate and also maybe associated with damming of surface water and groundwater extraction and therefore less recharge to the aquifer. The rapid water table decline at occurrences bedford01 and M5304 at the Roe Tonkin Hwy junction, are probably associated with heavy urban and road development, and water abstraction by nearby industries and local government (see Appendix 1). • Based on current and future forecasted groundwater levels at the Ambergate reserve, it is predicted that within the next 50 years there will be 41% severity in relation to collapse assuming groundwater levels decline at the current calculated rate (y=-0.0046x + 21.023) (Figure 1 in Appendix 1). This can therefore be quantified at a 41% severity at a 52% extent of the community. This does not meet criteria for VU as neither extent or severity is >80% for these occurrences. • Based on current groundwater levels at the Roe Tonkin Hwy junction, it is predicted that these occurrences have already reached the stated collapse level (Figure 2 in Appendix 1). This can therefore be quantified at a 100% severity at a 14% extent of the community. The does not meet criteria for VU as the extent does not meet the minimum threshold of >30%. • Based on current and future forecasts of groundwater levels across the community, 66% of the extent of the community has a quantified severity ranging from 41%-100% over 50 years. With a calculated extent of 66% of the extent, the range in severity falls within the boundaries of VU (>50%) and EN (>80%) under C2. • **Available data indicates VU to EN is plausible under C2.**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☐ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	• Dieback disease caused by *Phytophthora* species is a significant biotic threat to the community. • For criterion D, collapse of this community is defined as 100% loss of dieback sensitive species in the community. It is

		assumed that this would result from very severe infestation and impacts of disease caused by *Phytophthora* species. • Based on dieback surveys completed for 6 occurrences, a minimum of approximately 8.8ha (24%) of the community is infected with the disease. Based on this a minimum severity of >30%, with an extent of >80%, of the dieback sensitive would be required to be affected by the disease to meet VU/EN/CR. • Although there are dieback maps that encompass the community, currently, there are inadequate systematic collected quantitative data about the impacts of dieback on individual sensitive species to support assessment of the community against criterion D. There is insufficient evidence to determine the total loss of susceptible native vegetation lost through dieback infestation, to support assessment of the community against criterion D**.** • There are inadequate quantitative data to indicate 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 D1 or D2. • There are inadequate quantitative data to indicate that the community meets the minimum proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750. • Weed invasion is an additional significant biotic threat to the community. • The severity of weed invasion associated with collapse is uncertain, but it is assumed conservatively that the community reaches a collapsed state when only 10% (plausible range 0–20%) of its plant species are native. • Quadrat data for occurrence AMBR02 within Ambergate Reserve (representative of 26% of the community) indicate an increase in the proportion of exotic species in the three of the quadrats between 1994 to 2017-2018 with 6% reduction of native taxa. It is assumed that the increase in exotic taxa, as indicated by 3 quadrats, is linear and is representative of weed invasion across the occurrence. Based on these assumptions the proportion of this community does not fall below the collapse threshold for the proportion of native taxa within the 25-year period and in a 50-year forecast (Appendix 1). • Based on current and future forecasts of the proportion of native plant taxa within the AMBR02 occurrence of the community, it does not meet the minimum extent (≥30%) and minimum severity (≥30%) to meet VU, within any time period. • **Insufficient evidence to indicate the community meets criterion D.**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse have been completed • **Not evaluated under criterion E**
Reasons for change of status		

Genuine change ☐ New knowledge ☐ Previous mistake ☐ Review/Other ☒			
Provide details: The community was initially ranked as Vulnerable using ranking criteria developed in WA that differ to those in the IUCN Red List Criteria for Ecosystems (version 2.2).			
Summary of assessment information *(provide detailed information in the relevant sections of the nomination form)*			
EOO	3097km^2	AOO	500km^2 (10x10km grid method).
No. locations	9	Severely fragmented	Yes ☒ No ☐ Unknown ☐
Current known area			37 ha
Pre-industrialisation extent or its former known extent (if known)			Community SCP02 occurs predominantly on the Abba and Southern River vegetation complexes. The proportion of the pre-industrial extent of these complexes remaining is 6% and 10% (Government of Western Australia 2019). The reduction in extent of native vegetation on the land units is indicative of the level of clearing of the community. These data inferred to indicate the likely historic decline of the community.
Estimated percentage decline			The extent at which the vegetation complexes, on which the community occurs have declined since pre-industrialisation, ranges from 90% to 94% (Government of Western Australia 2019). This is similar to the Gibson *et al*. (1994) estimate of a >90% reduction of the community since ~1750.

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	CR	• Based on available evidence, the community plausibly meets criterion A3
B1a	EN	• EOO is ≤20,000km^2 • Groundwater level data for some occurrences indicative of likely continuing decline in environmental quality associated with falling groundwater levels. • Weed and dieback data for occurrences are indicative of a measure of disruption to biotic interactions and hence ongoing decline in the diversity of native taxa. • Meets criterion for EN under B1aiii
B1b	EN	• EOO is ≤2,000km^2 • Observed and inferred continuing decline from land clearing, hydrological change, weed invasion, trampling, altered fire regimes, disease, grazing by introduced fauna, and a drying climate and inferred future decline in environmental quality from groundwater decline • Meets criterion for EN
B1c	VU	• AOO is 5 grid cells • Ecosystem exists at 6 threat defined locations • Meets criterion for VU
B2a	EN	• AOO is 5 grid cells • Groundwater level data in some occurrences indicative of likely continuing decline in environmental quality associated with falling groundwater levels • Weed and dieback data for occurrences are indicative of a measure of disruption to biotic interactions and hence ongoing decline in the diversity of native taxa. • Meets criterion for EN under B1aiii
B2b	EN	• AOO is 5 grid cells • Observed continuing decline from grazing, weeds and fire; inferred changes to hydrological regime • Meets criterion for EN
B2c	VU	• AOO is 5 grid cells • Ecosystem exists at 6 threat defined locations • Meets criterion for VU
B3		• Known from 6 threat-defined locations • Does not meet criterion
C1	-	• Available data indicate community does not meet minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over the past 50 years to meet VU.
C2	VU	• Extent of decline and range of severity indicate VU and EN are plausible under C2.
C3	-	• Available data indicate community does not meet minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750 to meet VU.
D1	-	• Inadequate quantitative data to indicate if the community meets the minimum proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over the past 50 years to meet VU.
D2	-	• Inadequate quantitative data to indicate if the community meets the minimum proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over any 50-year period to meet VU.

D3	-	• Inadequate quantitative data to indicate if the community meets the minimum 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 A3. Meets EN B1a(ii),(iii),b; B2a(ii),(iii),b. Meets VU under B1c, B2c. Plausible rank VU to EN under C2. Plausible range of rank: VU to CR. *'The highest risk category obtained by any of the assessed criteria will be the overall risk status of the ecosystem'* (IUCN RLE Guidelines V1.1 page 42). **Meets CR under A3.**

Summary of location (occurrence) information *(provide detailed information in the relevant sections of the nomination form)*						
Occurrence ID (Occurrence No.)	Land tenure	Survey information: date of survey	Condition*	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
Bedford01 (quadrat) PM41 (transect) (28)	WAPC Bush Forever site 319	2002, 2005, 2010, 2011 (condition survey) and 2013	100% excellent	2.74	Hydrological change, inappropriate recreational activities, disease, grazing by native or introduced species, drying climate	Fencing and weed management.
WATKINS PLOT2 (27)	DBCA (Nature Reserve 23012) Bush Forever site 360	2002, 2006 and 2011	100% excellent	2.58	Weed invasion, hydrological change, disease, drying climate and trampling	Weed control and fence maintenance.
davies04 (31)	DPLH	2003 and 2011	100% excellent	0.83	Weed invasion, hydrological change, resource extraction and grazing by native or introduced species	Fencing and weed management.
YOON02 (Quadrat) JP03, JP32 (transects) (3)	Shire of Busselton (Yoongarillup Reserve 1459)	1995, 2006, 2011, 2015 and 2017	65% very good 25% good 10% degraded	7.85	Weed invasion, too frequent fire, recreational activities, disease and grazing by native or introduced species, hydrological change	Fencing, intensive weed management and appropriate fire regime.
AMBR02,05,07 (Quadrats) JP01 (Transect) (2)	DPLH (Ambergate Crown Reserve 22614)/Public road	1995, 2002, 2003, 2008, 2010, 2011 (condition survey), 2012,	50% very good 50% excellent	9.89	Hydrological change, weed invasion, disease, too frequent fire, grazing by native or	Fencing, weed management and appropriate fire regime.

		2014, 2015 and 2017			introduced species and edge effects	
myAMBR06 (30)	DPLH (Reserve 22614)	1996, 2003, 2006, 2011 (condition survey) and 2012	50% very good 50% excellent	7.38	Hydrological change, too frequent fire, disease, drying climate, edge effects and grazing by native or introduced species	Fencing and appropriate fire regime.
myAMBR08 (32)	DPLH (Reserve 22614)	1992, 2003 (condition survey) and 2012	95% excellent 5% good	1.86	Hydrological change, weed invasion, disease, too frequent fire and grazing by native or introduced species	Fencing, weed management and appropriate fire regime.
FISH05 (quadrat) JP27 (transect) (1)	DBCA (Nature Reserve 23321)	1995, 2007, 2008, 2011 (condition survey) and 2017	100% good	1.60	Weed invasion, too frequent fire, grazing by native or introduced species, edge effects, hydrological change and a drying climate	Fencing, intensive weed management and appropriate fire regime
M5304 (quadrat) +[destroyed] JP02 (transect) +[destroyed] PM42 (transect) (29)	WAPC, DPLH, Main Roads, Water Corp and DBCA (Reserves 53131 and 53136) Bush Forever site 319	2002, 2005, 2006, 2010, 2011 and 2013	70% excellent 25% very good 5% good	2.62	Weed invasion, hydrological change, drying climate, trampling and grazing by native or introduced species	Fencing and weed management.

+ Part cleared for Roe Tonkin upgrade 2015. Transect JP02 and Plot M5304 destroyed.

*For the purposes of relating condition to IUCN Criteria, condition categories from (Keighery (1994) Vegetation Condition Scale (Government of WA 2000)) are defined below:

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

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

Poor ('Degraded' using Bush Forever (2000) scale): Basic vegetation structure severely impacted by disturbance such as partial clearing, dieback, logging and grazing. Scope for regeneration but not to a state approaching good condition without intensive management.

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

Table 1. Vegetation condition of occurrences of the 'Southern wet shrublands, Swan Coastal Plain (floristic community type 2 as originally described in Gibson *et al.* (1994))'

Condition Ranking (Keighery 1994) from Government of Western Australia 2000)	**Hectares**	**IUCN Criteria condition ranking**	**Hectares**
Pristine	0		
Excellent	18.4		
Very Good	16		
Good	2.2	**Good**	34.4
Degraded	0.79	**Medium**	2.2
Completely degraded	0	**Poor**	0.79
Total	37.4	**Total**	37.4

APPENDIX 1 THREATS

Clearing

There is an infrastructure corridor through occurrence 29 and in 2015 the occurrence was part cleared for the Roe-Tonkin Highway junction upgrade. Both the Plot (M5304) and Transect (JP02) were destroyed. The occurrence in Ambergate Crown Reserve 22614 is dissected by Queen Elizabeth Avenue and Doyle Road, Busselton and there is potential for road maintenance activities to impact the community. There is potential for spillage of clay from storage ponds from the nearby minesite into occurrence 31 at Yoganup, and this is equated with 'clearing'. Resource extraction of gravel, sand, wood, and minerals in this occurrence has also been a threat historically.

Hydrological changes

Altered hydrology due to anthropogenic causes is an increasing threat to the Southern wet shrublands. Drainage to lower water tables, clearing resulting in a decline in evapotranspiration and increased surface runoff, and water quality declines are likely to increasingly impact the hydrologic regimes of the community. Any changes in natural hydrology can affect composition of the flora taxa as a result of timing of waterlogging and drying at appropriate times of the year. The widespread clearing of native perennial vegetation and its replacement with urban areas and farmlands, raising groundwater in the surrounding region has the potential to result in increased surface water runoff.

Froend *et al*. (2004) notes that wetlands in which the groundwater is within 0-3m of natural ground surface, as is indicated in available data for some occurrences of the community, are highly susceptible to changes in groundwater levels and would be considered to be highly groundwater dependent. Froend *et al*. (2004) also note that for wetlands for which groundwater is within 0-3m of surface, a change in groundwater level of <0.25m is regarded as low risk, a change of between 0.25m and 0.5m is moderate risk, and a change of >0.5m results in high risk of impact to the wetlands.

Increased nutrient levels (from fertilizer) in surface water in occurrences adjacent to areas such as farmlands is likely to favor weeds as weeds are adapted to higher nutrient levels than native flora. Hydrological changes such as increased depth or period of inundation may cause salt accumulation near the surface. This has been noted in areas of the southern Swan Coastal Plain since around the 1950s as a result of clearing (Smith and Ladd 1994). The southern occurrences of the community are more likely to be at risk from salinity as groundwater is used for irrigation and therefore well drained ([redacted] pers comm[1]). Salinity levels in the community will need to be monitored to determine if salinisation poses a major threat to the communities, and the sources determined.

Monitoring bore BN32S (site ref: 61030097), located at the centre of occurrences AMBR02, myAMBR06 and myAMBR08 (occurrence numbers 2, 30, 32) of SCP02, within Reserve 22614 of Ambergate, shows an approximate 1.5m groundwater decline between 1987 and 2019 (Figure 1). Bore BN32S samples the Superficial Swan aquifer, on which the occurrence at that location likely depends. The steady water level decline of this area is likely due to reduced rainfall resulting in reduced aquifer recharge. The decline may also be associated with leakage into the underlying aquifer (Leederville aquifer) as licences for water abstraction from the Leederville aquifer surround the Amerbgate reserve. The Ambergate reserve has a specified Ecological Water Requirement (EWR) of 16.85 mAHD (using bore BN32S) reported in the 'South West groundwater areas allocation plan' (DWER 2009). As shown in figure 1, water levels do not currently fall below the EWR threshold, however, figure 2 shows water levels will fall below this threshold in the next 50 years if water continues to decline at the current rate (y=-0.0119x + 14.693). This rate of decline would increase if increased drainage, water abstraction occurs and could potentially contribute to the collapse of the community. Falling below this threshold will trigger increased monitoring of the water levels for this occurrence. Additionally, it is assumed conservatively that the community would collapse if the water table depth fell to about 10m below ground surface based on the maximum water depth accessed by deep rooted phreatophytic taxa in nearby areas (Froend & Loomes 2006), and observations that the vigour of canopies declined in groundwater dependent trees in association with declining watertable levels (Froend et al. 2004). As seen in Figure 1, water table levels at this occurrence have not yet declined below the total collapse threshold, and this is also not predicted in the next 50 years.

Monitoring bores (site ref: 61615057 and 61615054), located at the junction of Tonkin Highway and Roe Highway, within occurrence m5304 (29) and 40-50m from occurrence PM41 (28), show groundwater levels are declining (Figure

[1] [redacted]: Consultant hydrogeologist

3 and 4). Three monitoring bores recorded an approximate groundwater decline of 9.5m and 35m, over a 40-year time period. Water levels in these occurrences have rapidly declined compared to those occurrences in Ambergate. Occurrences including those located at the junction of Tonkin Highway and Roe Highway are at greater risk of collapse than other occurrences that are not surrounded by urban and major road development. The groundwater levels at occurrences m5304 (29) and bedford01 (28) are likely impacted by heavy urban and road development associated with drainage, and water abstraction by nearby industries and local government (DWER 2019) in conjunction with reduced rainfall. Both bores indicate water levels have dropped below the specified threshold of collapse. The vegetation of these occurrences has not been surveyed since the 2015 Roe Tonkin Hwy upgrade.

Figure 5 indicates that the groundwater levels for monitoring bore (site ref: 61000018) located within the Yoongarillup Reserve, 85m west of occurrence JP03 (3), are relatively stable over the ten year period 2008-2018.

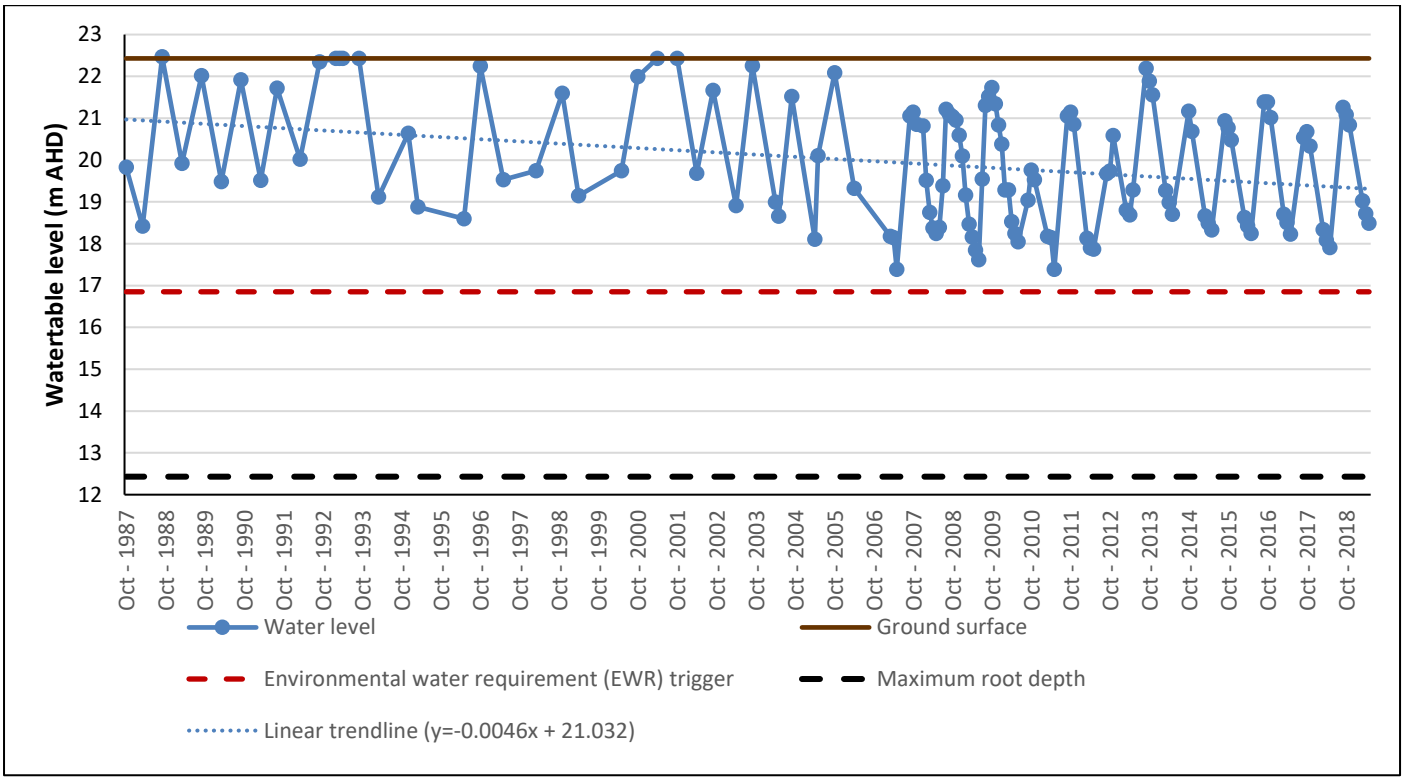

Figure 1. Hydrograph of bore located at the centre of occurrences AMBR02, myAMBR06, myAMBR08 (occurrence numbers 2, 30, 32) within Reserve 22614 of Ambergate (site ref: 61030096). Bore data produced by sampling the Superficial Swan aquifer (DoW 2019).

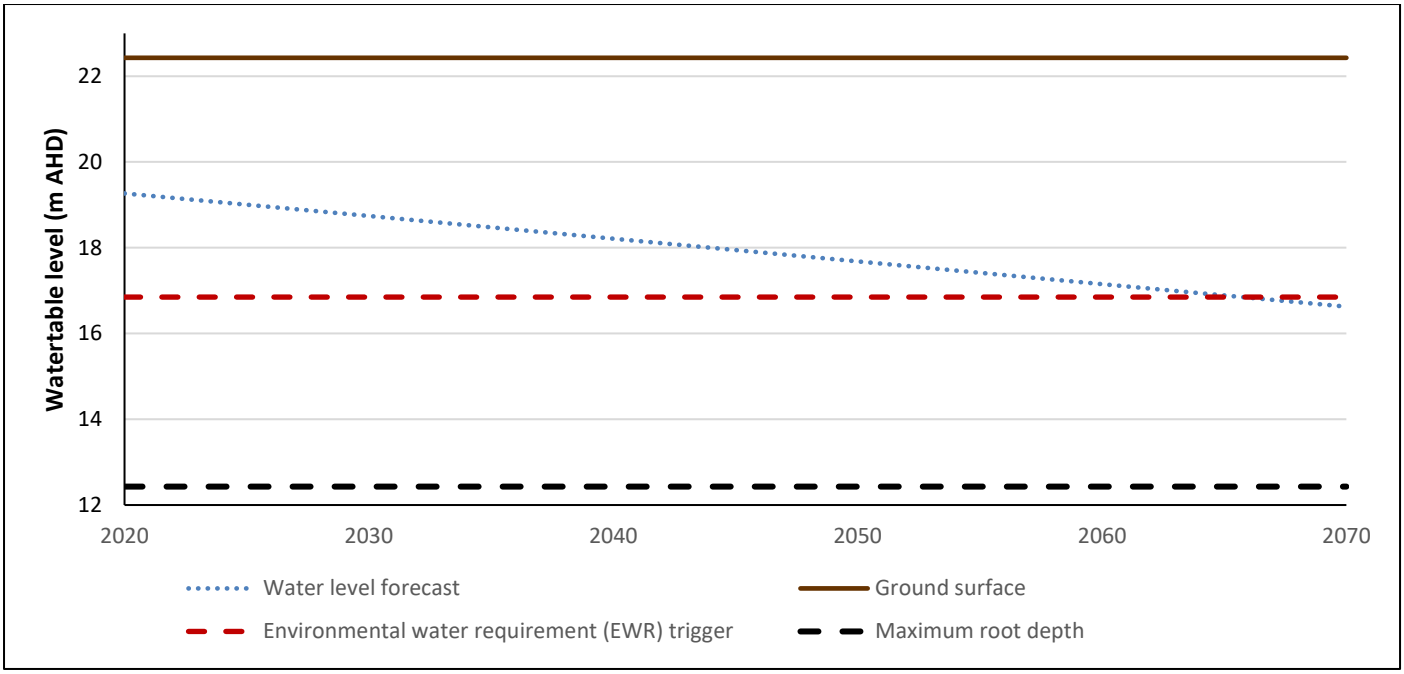

Figure 2. A 50-year forecast of groundwater level decline at the centre of occurrences AMBR02, myAMBR06, myAMBR08 (occurrence numbers 2, 30, 32) within Reserve 22614 of Ambergate (site ref: 61030096), calculated using the trendline (y=-0.0046x + 21.032) (DWER 2019).

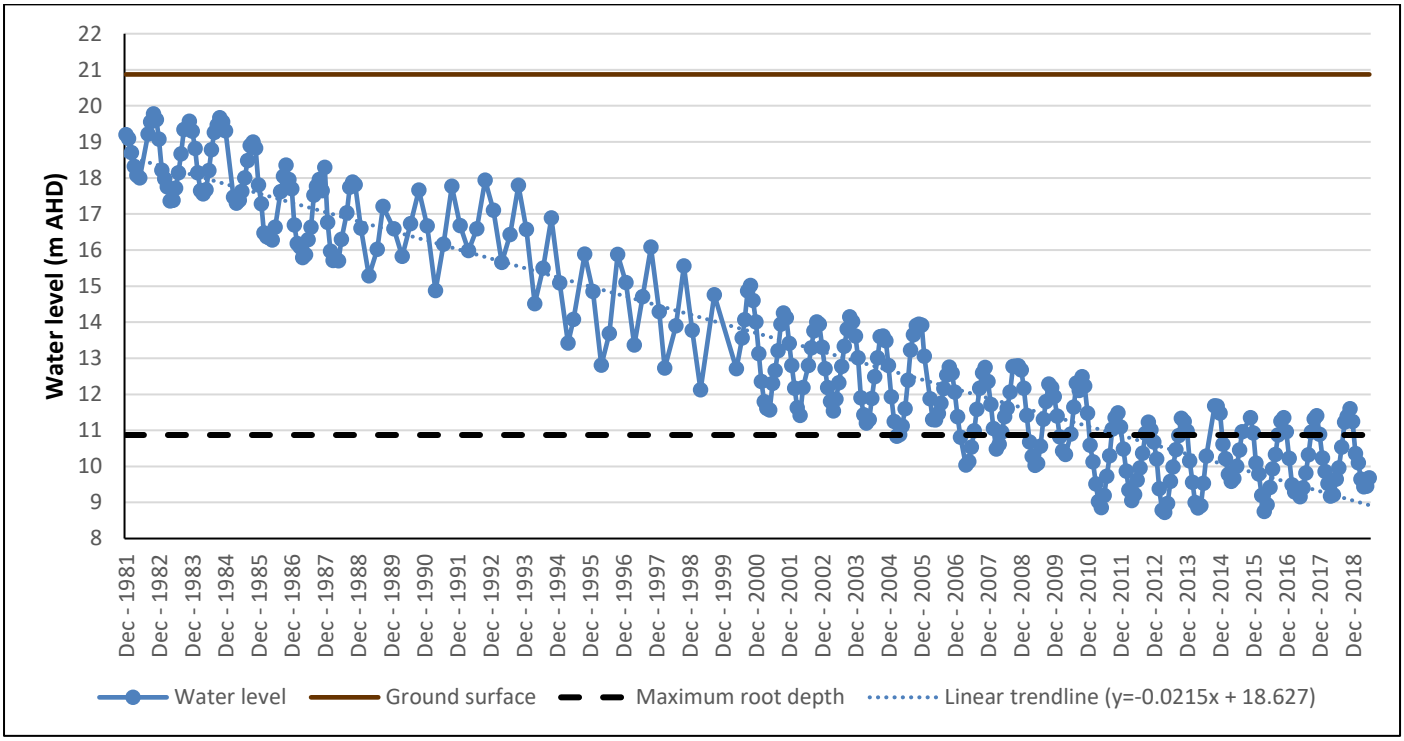

Figure 3. Hydrograph of monitoring bore located within occurrence m5304 (29) and 50m from occurrence PM41 (28) at the junction of Tonkin Highway and Roe Highway (site ref: 61615057), sampling the Leederville aquifer (DWER 2019).

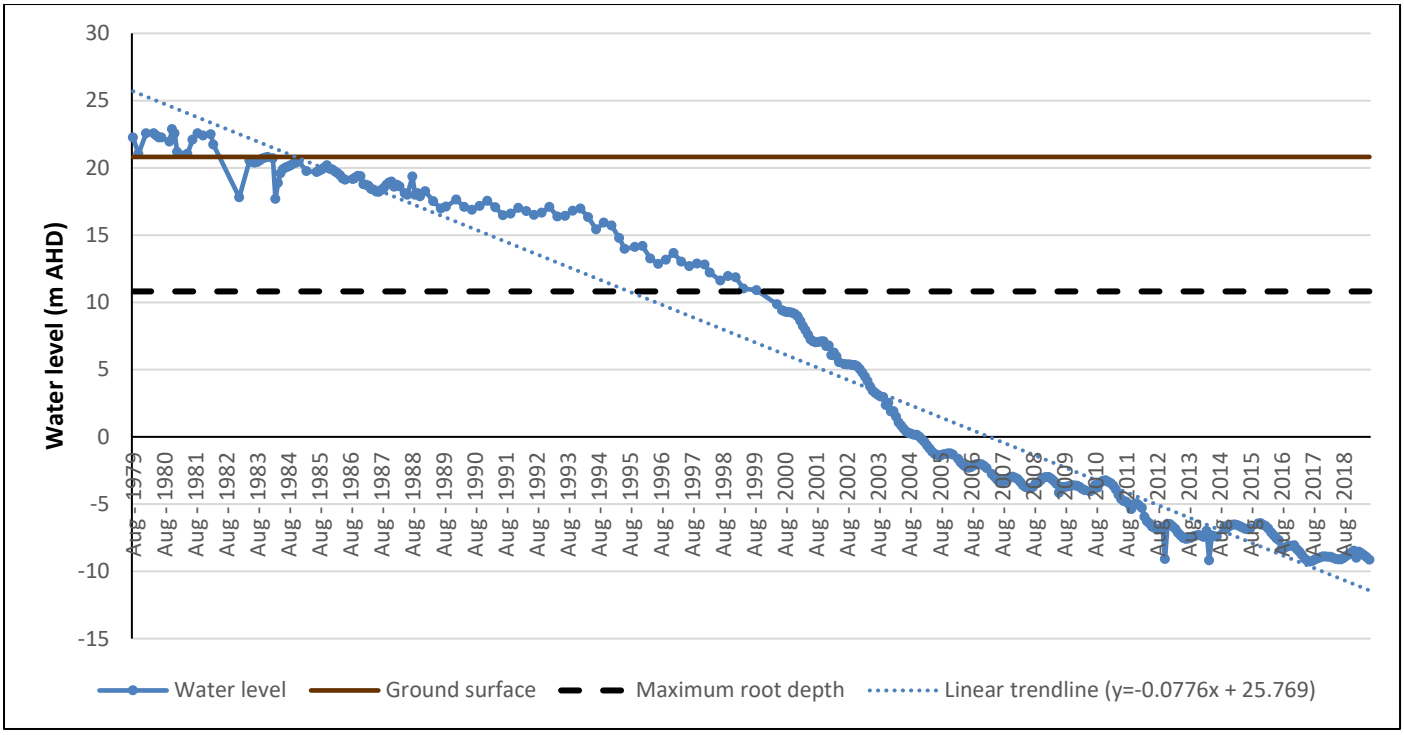

Figure 4. Hydrograph of bore located within occurrence m5304 (29) and 40m from occurrence PM41 (28) at the junction of Tonkin Highway and Roe Highway (site ref: 61615054), sampling from the Superficial Swan aquifer to the Yarragadee aquifer (DWER 2019).

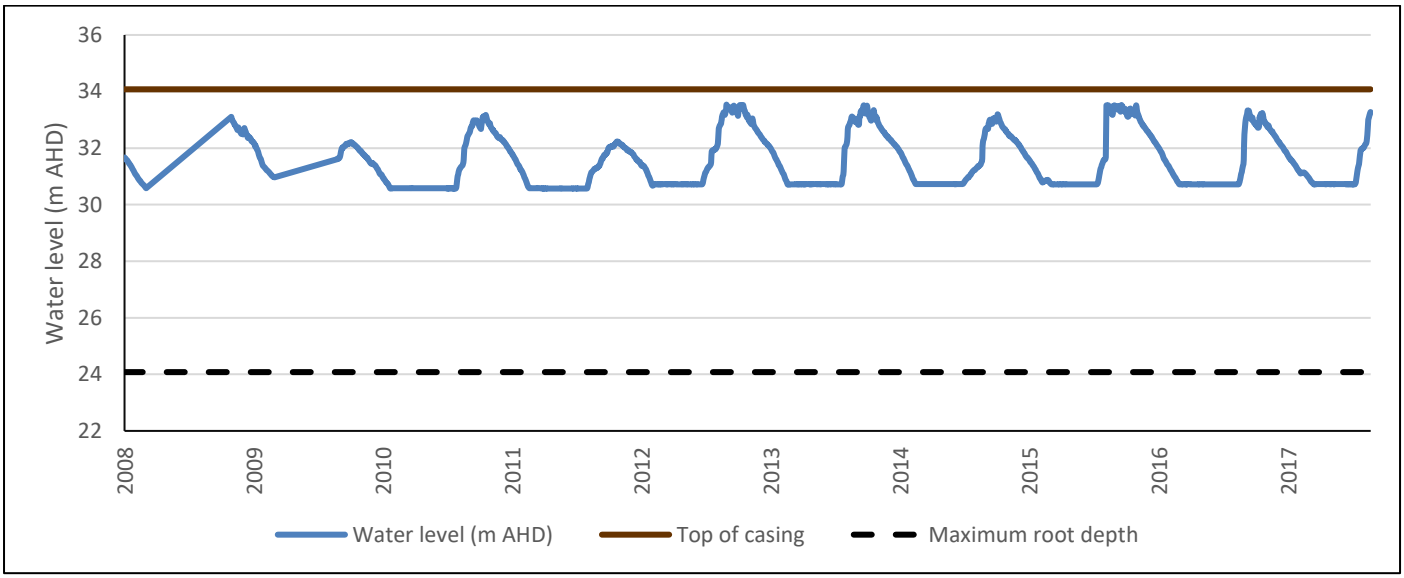

Figure 5. Hydrograph of bore located within the Yoongarillup Reserve, 85m west of occurrence JP03 (3) (site ref: 61000018), sampling from the Superficial Swan aquifer (DWER 2019).

Weed invasion

Weeds displace native plants, particularly following disturbances such as too frequent fire, grazing or partial clearing, and compete with them for light, nutrients and water. They can also prevent recruitment, cause changes to soil nutrients, and affect abundance of native fauna. They can also impact on other conservation values by harbouring pests and diseases and increasing the fire risk.

Sources of weed invasion include adjoining areas of agricultural and urban use, drains, and tracks within the community. All these sources increase vulnerability to weed invasion following any type of disturbance. In the past, weed frequency was low for the majority of occurrences of the Southern wet shrublands, the most commonly recorded was an annual herb, flat weed, *Hypochaeris glabra*. However due to disturbance events over the past 20 years, more weeds are now observed within or nearby that have the potential for more severe impacts on the community. Figure 6 reflects a gradual increase in exotic taxa within the southern occurrences of the community, at Ambergate Reserve.

The rate of weed invasion at Ambergate is trivial compared to that of Yoongarillup Reserve (YOON02) and at Fish road (FISH05) (personal communication [redacted] 2020[2]) Annual herbs observed invading moist disturbed areas include the narrowleaf trefoil (*Lotus angustissimus)*, slender serradella (*Ornithopus pinnatus*) and lesser loosestrife (*Lythrum hyssopifolia*). The weeds of most concern include introduced South African bulbous plants, including wild gladiolus (*Gladiolus undulatus*), bugle lily (*Watsonia meriana* var. *bulbillifera), pink watsonia, (Watsonia borbonica),* onion grass (*Romulea rosea*) and a rhizomatous (tuber-like) perennial herb, arum lily (*Zantedeschia aethiopica*) which is a declared pest in Western Australia (WA).

Other plants of concern include South African grasses that are highly competitive because of rapid growth and early flowering. Also sweet vernal grass, *Anthoxanthum odoratum,* which forms extensive ground cover and has the ability to invade the community following disturbance events. Other potentially invasive weeds observed in this community include Kikuyu Grass, *Cenchrus clandestinus,* that grows rapidly forming dense mats and can be serious weed of bushland and black berry nightshade *Solanum nigrum* that competes vigorously for space and nutrients.

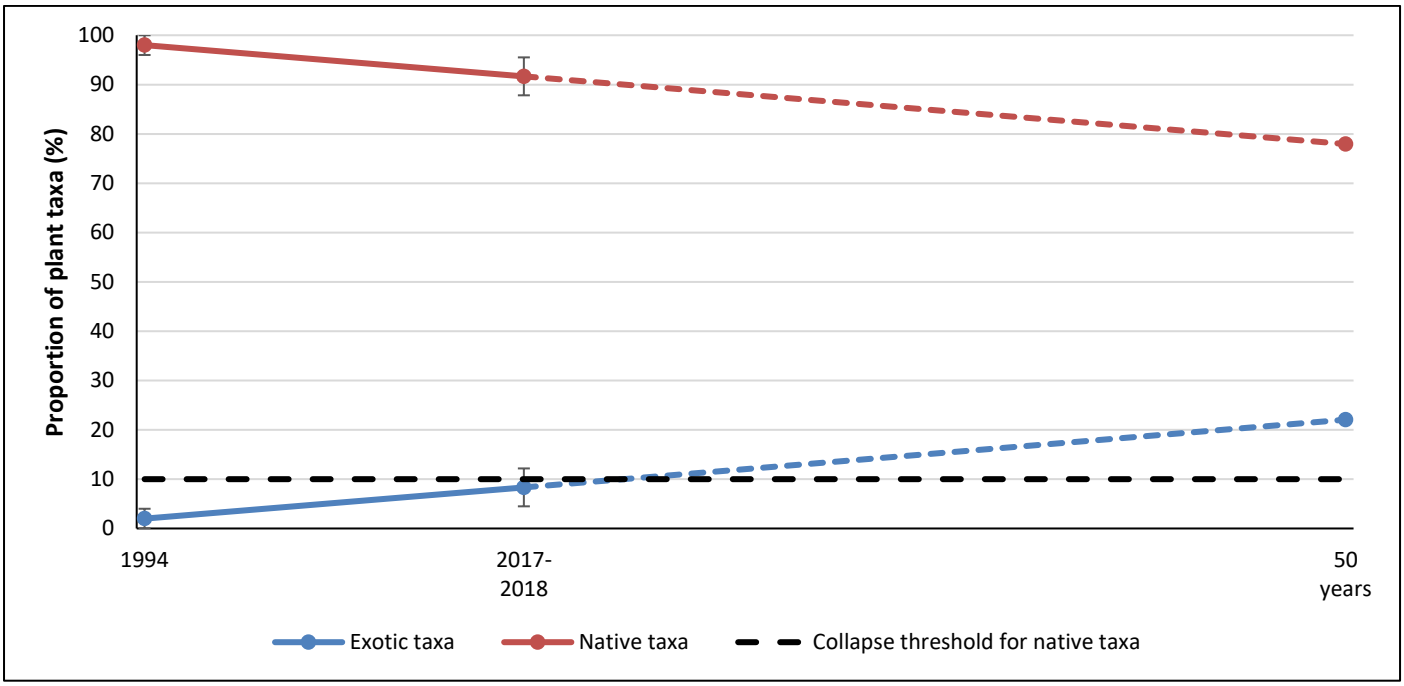

Figure 6. Trend in the proportion of native and exotic plant species in 'Southern wet shrublands, Swan Coastal Plain (floristic community type 2 as originally described in Gibson et al. (1994))', based upon the mean of 3 sampled quadrats (AMBR02,05,07) of 1 occurrence, located within Ambergate Reserve (n = 3). Quadrats were initially scored in 1994, and re-scored between 2017 and 2018. An additional 50-year forecast was calculated using a linear trendline of the proportion of exotic taxa (y=0.2639x+1.7361) and the proportion of native taxa (y=-0.2639x+98.264) (Webb 2019).

Inappropriate fire regimes

Many flora taxa that commonly occur in the Southern wet shrublands are adapted to fire with some species surviving 100% scorch with basal sprouts, others sucker or have available soil seed storage. Response time varies between flora species, with time to first flowering being two months in some species, and more than five years in others. The community may be adapted to occasional fire as it contains species that will easily carry fire when vegetation is dry, and some component shrubs would reproduce from seed following fire. With different maturation times of the flora taxa that occur within the community, a suitable regime of fire management needs to be determined.

The risk of fire can be exacerbated by surrounding land uses. Three occurrences, including Ambergate Reserve, Fish Road Nature Reserve and Spanish Settlers Reserve, are surrounded by rural land where pasture and grassy weeds proliferate on the edges of occurrences and are often more flammable than many of the original native species in the herb layer. The occurrence at Watkins Road Nature Reserve at Mundijong has recently been burnt in a bushfire

Anecdotal evidence indicates that fire may exacerbate the impact of drying climate in the Southern wet shrublands. For example, following fire in Ambergate reserve, community structure has altered. Reduced rainfall is also believed to be a contributing factor. Shrub species such as *Pericalymma ellipticum* and *Verticordia plumosa* subsp. *ananeotes*

[2] [redacted]: Previous Senior Principal Research Scientist, DBCA Kensington

have not recovered well post-fire and there has been a notable increase in sedge cover ([3] [redacted] personal communication).

Grazing by introduced and native herbivores

Grazing of native vegetation causes alterations to species composition through selective removal of edible species, the introduction and enhancement of weeds by the addition of dung, and through trampling and general disturbance. Feral animals such as rabbits (*Oryctolagus cuniculus)* disturb the vegetation by grazing and burrowing. Rabbit burrowing and scats have been recorded at all occurrences of the Southern wet shrublands. In the case of the three south west occurrences, Ambergate Reserve, Fish Road Nature Reserve and Spanish Settlers Reserve (Yoongarillup Reserve), grazing by high numbers of kangaroos is impacting the vegetation. Grazing pressure is exacerbated due to the lack of intact natural vegetation surrounding the community.

Disease

Phytophthora spp. particularly affect the Proteaceae and Myrtaceae families and many of the flora taxa that comprise the community belong to these families. Plant growth form may influence susceptibility to *Phytophthora* dieback disease, with the herbaceous perennials, annuals and geophytes that occur in the community being apparently less affected, however woody perennials which structurally dominate this community, are generally found to be the most susceptible.

Phytophthora assessments have been undertaken for the majority of reserves where the community occurs including Ambergate reserve, Yoongarillup reserve and Dundas road reserve. In 2012, a full *Phytophthora* dieback interpretation was completed on the 75-hectare Ambergate Reserve in the City of Busselton (Dieback Treatment Services 2012). Figure 6 shows two small areas located in the centre and north-west of the reserve were determined to be infested by the disease. These two portions do not overlap but border, on occurrences AMBR02 and myAMBR06 within the Ambergate reserve. In 2015, dieback was also mapped in Yoongarillup Reserve, where occurrence JP03 occurs (Dieback Treatment Services 2015). In summary 18ha (58%) was infested, 10ha (32%) was uninterpretable and 3ha (10%) was excluded from the analysis (Figure 7). Occurrence JP03 is located at the centre of the reserve so it is likely portions of this occurrence are infested with dieback. In 2011 the extent of distribution of the disease on 47 ha of Dundas Road Reserve and additional adjacent areas was mapped (DEC 2013). In summary, 20ha (43%) was un-infested, 22ha (47%) was infested, and 5ha (11%) was excluded from the analysis (Figure 8). Occurrences m5304 and PM41 are located directly next to the Roe Tonkin Hwy junction (south-west portion of the reserve) and are therefore assumed to be 100% infested, as shown in figure 8.

The disease Myrtle Rust (*Puccinia psidii sens. lat*) also has potential to impact the Southern wet shrublands if it becomes established in Western Australia, as it may affect *Pericalymma ellipticum,* one of the most dominant myrtaceous shrubs in the community (Australian Network for Plant Conservation 2012). Loss of overstorey including taller shrubs caused by either *Phytophthora* species or Myrtle Rust may lead to a change in the herb layer as a result of increased sun penetration and decreased shading.

[3] [redacted], DBCA, Busselton

Figure 6. Dieback infestation coverage of the Ambergate Reserve where occurrences AMBR02, myAMBR06 and myAMBR08, are located. Red represents those areas infested, purple represent those areas where presence was uninterpretable, and green represents areas un-infested (Dieback Treatment Services 2012).

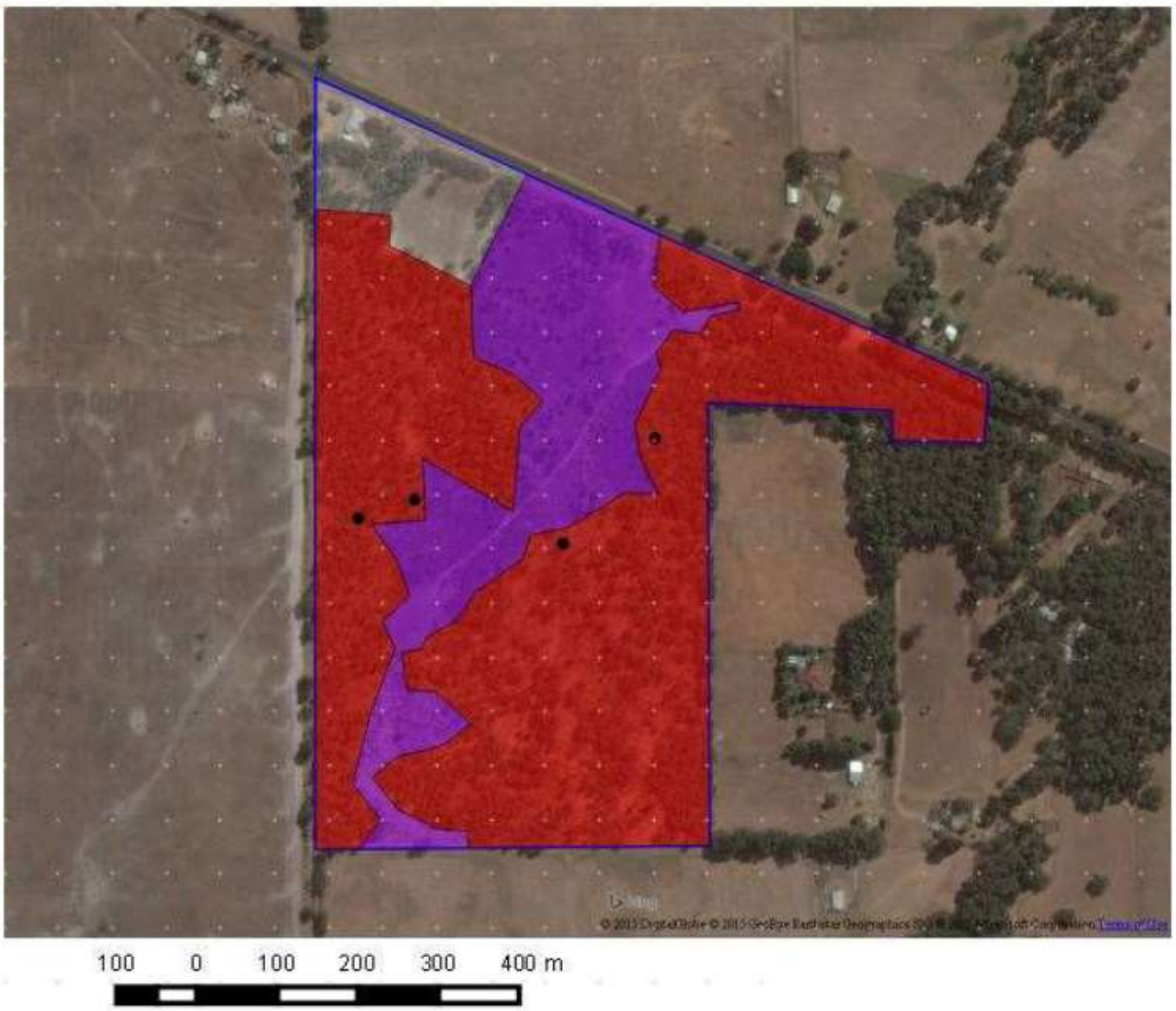

Figure 7. Dieback infestation coverage of the Yoongarrillup Reserve where occurrence JP03 (3) is located. Red represents those areas infested, purple represent those areas where presence was uninterpretable, and no colour within the perimeter of the reserve represents area not tested (Dieback Treatment Services 2015).

Figure 8. Dieback infestation coverage of the Dundas road reserve where occurrence m5304 and PM41 are located. Pink represents those areas infested, green represents those areas where there was no infestation and no colour within the perimeter of reserve represents areas not able to be mapped at the time (DEC 2013). (NB: dieback mapping only available as PDF documents from original reports).

Climate drying

Reduced rainfall may affect various components of the community, as it is reliant on rainfall and local hydrologic regimes. Reduced rainfall and altered hydrology may have a detrimental effect on the herbaceous community. Altered periods or depths of ponding may impact the timing of growth of herbs in the understorey and may also affect the species composition of the community by favouring different plant species.

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 (southward shift of winter and spring storm systems).

According to data provided by the CSIRO, early in the century (2030) and under all emission scenarios, winter rainfall is projected to decrease by up to 15 per cent. Late in the century, intermediate emissions (RCP4.5) lead to a projected decrease in winter rainfall of up to around 30%, and under high emissions (RCP8.5) winter rainfall decline is projected to decrease by up to 45%. Changes in autumn and summer are less clear, although downscaling results suggest a continuation of the observed autumn declines. (from URL https://www.climatechangeinaustralia.gov.au/en/climate-projections/future-climate/regional-climate-change-explorer/sub-clusters/?current=SSWSW&tooltip=true&popup=true, accessed November 2019)

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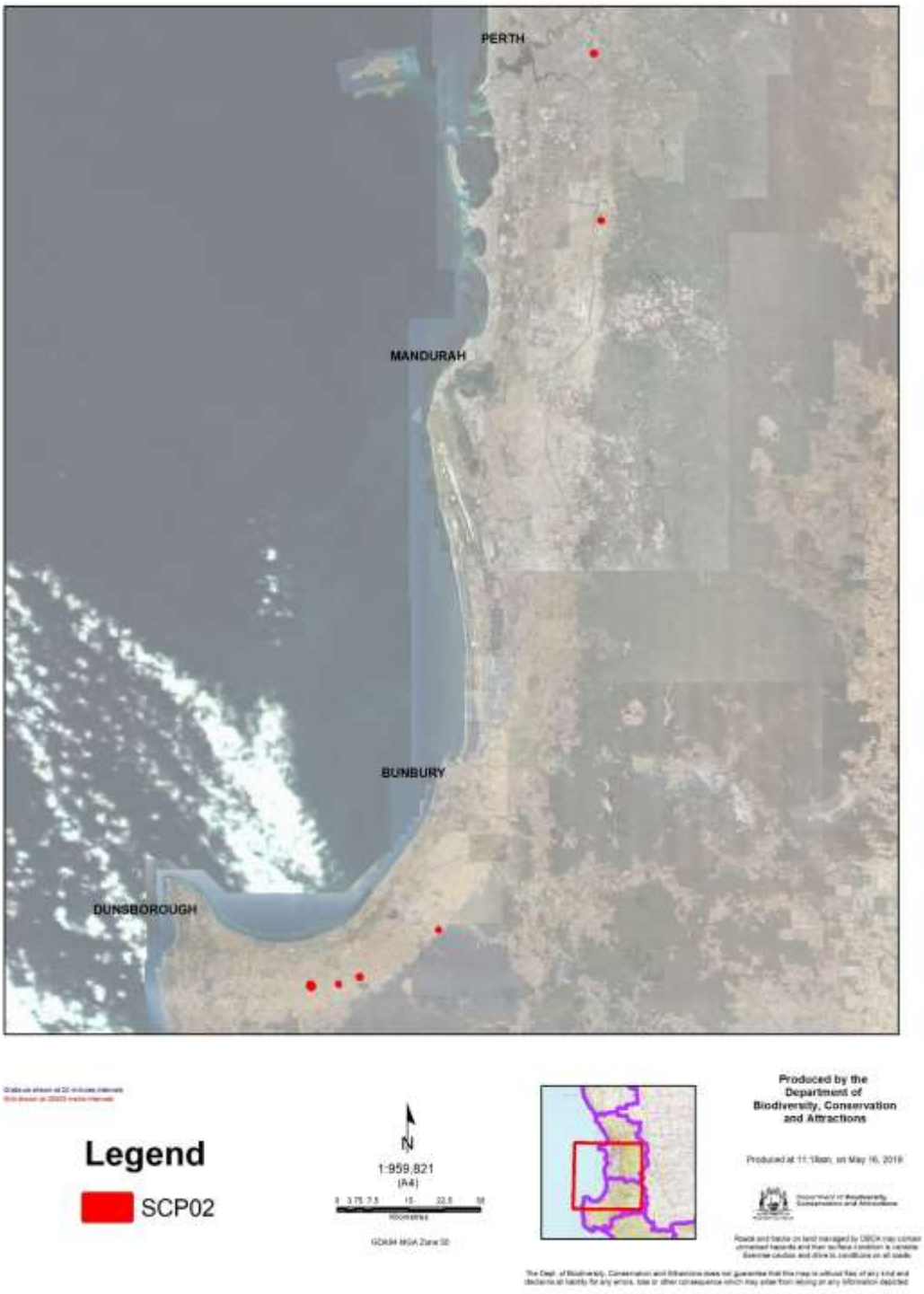
APPENDIX 2 Distribution of the southern wet shrublands community



The map above was created using ArcGIS version 10.6.1 and shows the extent of distribution of the SCP02 community. This community has a range of 172km, with the southernmost occurrence at Chapman Hill and the northernmost at Forrestfield. The figure indicates that occurrences of the community are highly fragmented.

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

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

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

		CR	EN	VU
A1	Present (over the past 50 years).	≥ 80%	≥ 50%	≥ 30%
A2a	Future (over the next 50 years).	≥ 80%	≥ 50%	≥ 30%
A2b	Future (over any 50 year period including the present and future).	≥ 80%	≥ 50%	≥ 30%
A3	Historic (since 1750).	≥ 90%	≥ 70%	≥ 50%

B. Restricted geographic distribution indicated by EITHER B1, B2 or B3:

		CR	EN	VU
B1	Extent of a minimum convex polygon enclosing all occurrences (Extent of Occurrence)	≤ 2,000 km²	≤ 20,000 km²	≤ 50,000 km²
	AND at least one of the following (a-c):			
	(a) An observed or inferred continuing decline in **EITHER**:			
	i. a measure of spatial extent appropriate to the ecosystem; **OR**			
	ii. a measure of environmental quality appropriate to characteristic biota of the ecosystem; **OR**			
	iii. a measure of disruption to biotic interactions appropriate to the characteristic biota of the ecosystem.			
	(b) Observed or inferred threatening processes that are likely to cause continuing declines in geographic distribution, environmental quality or biotic interactions within the next 20 years.			
	(c) Ecosystem exists at …	1 location	≤ 5 locations	≤ 10 locations
B2	The number of 10 × 10 km grid cells occupied (Area of Occupancy)	≤ 2	≤ 20	≤ 50
	AND at least one of a-c above (same sub-criteria as for B1).			
B3	A very small number of locations (generally fewer than 5) **AND** prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and thus capable of collapse or becoming Critically Endangered within a very short time period (B3 can only lead to a listing as VU).			VU

C. Environmental degradation over ANY of the following time periods:

C1 The past 50 years based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

C2 The next 50 years, or any 50-year period including the present and future, based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

	≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

C3 Since 1750 based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

	≥ 90	≥ 70	≥ 50
≥ 90	CR	EN	VU
≥ 70	EN	VU	
≥ 50	VU		

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

D1 The past 50 years based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:

Extent (%)	Relative severity (%) ≥ 80	≥ 50	≥ 30
≥ 80	CR	EN	VU
≥ 50	EN	VU	
≥ 30	VU		

D2

	≥ 80	≥ 50	≥ 30

	(D2a) The next 50 years, or (D2b) any 50-year period including the present and future, based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table: OR	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
D3	Since 1750, based on a change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 90	CR	EN	VU
		≥ 70	EN	VU	
		≥ 50	VU		
E. Quantitative analysis					
			CR	EN	VU
	… that estimates the probability of ecosystem collapse to be:		≥ 50% within 50 years	≥ 20% within 50 years	≥ 10% within 100 years