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Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Herb rich saline shrublands in clay pans (floristic community type 7 as originally described in Gibson *et al.* (1994))
Other names:	Swan Coastal Plain type 7 (SCP07); floristic community type 7 (FCT07)
Description:	The community is generally dominated by *Melaleuca viminea* (mohan), *Melaleuca osullivanii*, *Melaleuca cuticularis* (saltwater paperbark) or *Casuarina obesa* (swamp sheoak) or a mixture of these species. It has been recorded between Mogumber and Ambergate on heavy clay soils that are generally inundated from winter into mid-summer. The species *Melaleuca cuticularis* and *Casuarina obesa* may indicate some saline influence for at least some part of the year. Herbs such as *Brachyscome bellidioides*, *Centrolepis polygyna* (wiry centrolepis), *Pogonolepis stricta* (stiff angianthus) and *Cotula coronopifolia* (waterbuttons: Note: listed as alien in Florabase) are typical of this community. In addition, species such as *Angianthus drummondii* (priority 3), *Eryngium pinnatifidum* subsp. palustre (priority 3), and *Blennospora drummondii* occur in the community in low frequency. A suite of annual flora is seen in the community as the season progresses. In early spring many of the occurrences of the community are covered by free water up to 30 cm deep. *Cotula coronopifolia* sometimes forms yellow floating mats in some pools while others may be dominated by *Ornduffia submersa* (priority 4). Aquatic species are common in the community early in the growing season. As the wetland dries a succession of species such as *Centrolepis* spp. and annual *Stylidium* spp. successively germinate, grow and flower, resulting in an extended flowering period of over three months. The community is also known as "floristic community type 7" 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B.J., Keighery G.J., Burbidge A.H. and Lyons M.N. (1994) "A floristic survey of the southern Swan Coastal Plain" (unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia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	27/03/2012	Critically Endangered under umbrella TEC 'Clay pans of the Swan Coastal Plain'	
Western Australia	Current ranking under WA	6/11/2001	Vulnerable	VU B)

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	Minister ESA list in policy			
	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'.*	EN B1a(iii),b; B2a(iii),b.

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** CR, EN, VU are plausible. VU is most robust
	Justification of assessment under Criterion A.	For criteria A and B, the ecosystem was assumed to collapse when the mapped distribution declines to zero. • Gibson *et. al* (1994) lists communities that are thought to have declined by >90% based on their analysis of the level of clearing of vegetation on the geomorphologies and landforms that support the community. This clay pan type was included in that group. • The proportion that remains of the pre-1750 extent of the vegetation complexes in which the community occurs is provided in statistical data in Government of Western Australia (2019). • The reduction in extent of native vegetation in the vegetation complexes on the Swan Coastal Plain that support the community is assumed to be indicative of the level of clearing of the community.

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		• The following vegetation complexes support the community, with the proportion cleared in brackets: Guilford (95%), Yanga (84%), Vasse (69%), Beermullah (93%), Southern River (82%), Karrakatta Complex-Central and South (77%), Bassendean Complex-North (28%), Bassendean Complex Central and South (68%), and Abba (93%). • The range of values for the level of clearing of vegetation complexes that support the community is 28-95% (Government of Western Australia 2019). • The timing of the vegetation clearing is not known so is conservatively inferred to be since 1750. • Threshold for level of clearing since 1750 to meet CR is ≥90%, for EN is ≥70%, and for VU is ≥50% • Community plausibly meets rank for CR, EN or VU under criterion A3, or may not meet the criterion based on a portion of the community that occurs in a vegetation complex that is 28% cleared. • VU under A3 is a reasonably conservative rank as vegetation clearing data are regional and not sufficiently corroborated in relation to this community to support a higher rank.
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 7847km^2. Community meets the threshold for Endangered as it occupies ≤20,000km^2 (threshold for EN is ≤20,000km^2 and for CR is ≤2,000km^2) • B1a(iii) Community is subject to measurable decline from observed and inferred ongoing weed invasion (ie biotic interactions, see criterion D, and Appendix 1 below) • B1 b): Continuing decline observed from the impacts of; vegetation clearing, hydrological change, weed invasion, altered fire regimes, grazing by introduced fauna, and declining rainfall (see Appendix 1 for details of threats). • B2: AOO is 1400km^2 (occupies 14 10x10 km^2 grid cells). Community meets threshold for endangered with ≤20 cells occupied (threshold for CR is ≤2 grid cells. • B1c: Community is considered to occur at 27 threat-defined locations based on clusters of bushland areas subject to similar management, and threats. • Community exists at more than 10 threat-defined locations. Does not meet B1c, B2c or B3. • **Meets criteria for Endangered B1a(iii),b; B2a(iii),b**

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C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**

	Justification of assessment under Criterion C.	• Altered hydrology is a significant abiotic variable affecting the community. Alterations to depths or seasonality of surface water will result in subsequent changes to composition, in particular to the defining herbaceous layer in the community. • For criterion C, it is assumed the community will collapse when seasonal inundation with surface water no longer occurs. It is assumed that such severe changes to surface water will results in loss of the defining herbaceous wetland adapted flora in the community. Reductions and other changes to seasonal inundation patterns are directly related to rainfall (See Appendix 1 for further details). • There are inadequate quantitative data to link changes to surface water regimes (depths and seasonality) to compositional changes in the community. Bore data of groundwater levels are available for occurrences at Bambun Reserve and Yoongarillup Reserve, however, as mentioned there is a lack of connection of groundwater to surface water. • It is therefore not possible to determine the severity of current or projected declines in rainfall and surface water in relation to the collapse state (also see Appendix 1 for details of threats)**.** • There are inadequate data to determine if community meets minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50 year period, or (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750 to meet the criteria for VU. • **Insufficient evidence to determine if the community meets criterion C**
D.	Disruption of biotic processes or interactions *(Evidence of decline over 50-year period)*	☐ **D1** ☒ **D2** ☐ **D3**
	Justification of assessment under Criterion D.	• Weed invasion is a significant biotic threat to the community. • 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.

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		• Weed data taken from 17 quadrats across 12 occurrences (AUSTB01, AUSTB07, AUSTB08, BAMBUN01, BULL06, CARAB02, GINGIN01, MUCH02, YULE05, FISH01, RUAB04 and YOON03) (representative of 58% of the extent of the community) indicate an increase in the average proportion of exotic species between 1994 to 2017-2018 with an 11% reduction of native taxa. • It is assumed that the increase in introduced taxa as indicated by 17 quadrats is linear and is representative of weed invasion across the occurrences in which the specific quadrats occur. Based on these assumptions, 58% of the extent of the community has a projected 24% decline in native taxa in the next 50 years. This represents a projected reduction to the proportion of native species to 44% (ie 56% are weed taxa) across 58% of the extent of the community over the next 50 years. This corresponds to a projected 62% severity in relation to the collapse point of ≥90% weeds (ie 56/90 x100%), within the next 50 years, in the absence of effective weed management. • The community does not fall below the collapse threshold of ≤10% native taxa (ie ≥90% weeds) within the surveyed 25-year period and is not projected to do so within the next 50 years. • According to available weed monitoring data, the community meets the minimum threshold of ≥50% of the extent of the community subject to relative severity of weed invasion of ≥50% to meet VU under criterion D2a. • **Meets criteria for VU under D2a**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse. • Unable to assess

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 from 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	7847km^2	AOO	1400 km^2 (14 10x10km grid method).
No. locations	27	Severely fragmented	Yes ☒ No ☐ Unknown ☐
Current known area			Known from 31 occurrences totalling 217ha.

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Pre-industrialisation extent or its former known extent (if known)	Based on current area of 217ha and decline of between 28-95%, original area is estimated as between 643ha and 5920ha.
Estimated percentage decline	The range of values for the level of clearing of complexes that support the community is 28-95% - assumed to reflect the level of clearing of the community.

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Table 1: Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Available data do not indicate community meets criterion
A2a	-	• Available data do not indicate community meets criterion
A2b	-	• Available data do not indicate community meets criterion
A3	CR, EN or VU, or 'Does Not Meet'	• Plausibly meets criteria for CR, EN, VU or Does Not Meet. • VU is reasonably conservative rank.
B1a	EN	• Measurable decline due to observed and inferred ongoing weed invasion • Meets criterion for B1a(iii)
B1b	EN	• EOO is ≤20,000km^2 • Known and inferred threats are likely to cause continuing declines in geographic distribution, environmental quality and biotic interactions within the next 20 years • Meets criterion for EN B1b
B1c	-	• EOO is ≤20,000km^2 • Community exists at more than 10 threat-defined locations • Does not meet criteria for B1c
B2a	EN	• Measurable decline due to observed and inferred ongoing weed invasion • Meets criterion for B1a(iii)
B2b	EN	• AOO is 14 grid cells • Known and inferred threats are likely to cause continuing declines in geographic distribution, environmental quality and biotic interactions within the next 20 years • Meets criterion for EN B2b
B2c	-	• Ecosystem exists at more than 10 threat-defined locations • Does not meet B2c
B3	-	• Known from more than 5 threat-defined locations • Does not meet criterion
C1	-	• Inadequate data to determine if community meets minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over past 50 years to meet VU.
C2	-	• Inadequate data to determine if community meets the threshold for proportion of the extent (≥30%) for proportional severity (≥30%) over any 50-year period to meet VU under C2b.
C3	-	• Inadequate data to determine if community meets the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750 to meet VU.
D1	-	• Available data about weed invasion do not meet minimum thresholds for proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over past 50 years to meet VU.
D2	VU	• Meets the thresholds for proportion of the extent (≥50%) and proportional severity of disruption of biotic processes (≥50%) for weed invasion over a 50-year period. • Meets criterion for VU under D2A
D3	-	• Inadequate data to determine if community meets minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of biotic processes (≥50%) since 1750 to meet VU.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.

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		Plausibly meets CR, EN, VU or Does Not meet under A3 but VU under A3 is a conservative rank. Meets criteria for EN under B1a(iii),b; B2a(iii),b. Meets VU under D2a. *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 EN under B1a(iii),b; B2a(iii),b.**

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Summary of location (occurrence) information *(provide detailed information in the relevant sections of the nomination form)*						
Occurrence	Land tenure	Survey information: date of survey. Note: Survey by DBCA unless otherwise stated.	Condition	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
Occurrence 1 YOON03	Shire of Busselton - Yoongarillup Reserve (1459)	1995 & 2013	100% degraded	15.5	Clearing, weed invasion, too frequent fire and rubbish dumping	
Occurrence 2 FISH01	DBCA - Fish Rd Nature Reserve (23321)	1995, 2007 & 2013	100% good	7.2	Clearing, weed invasion, too frequent fire, overgrazing and rubbish dumping	
Occurrence 3 RUAB04	DBCA – Ruabon Townsite Nature Reserve (33269)	1995, 2012 & 2013	100% very good	3.9	Weed invasion, overgrazing and track/firebreak maintenance	
Occurrence 4 YULE05	UWA	1995	100% excellent	11.8	Clearing, too frequent fire and altered surface drainage	Maintenance of fence
Occurrence 5 BAMBUN01	Shire of Gingin – Recreation Reserve (22831)	1994, 2007, 2008, 2010 & 2019	100% very good	6.8	Weed invasion, drying climate and overgrazing	
Occurrence 6 GINGIN01	DBCA – Reserve (46414)	1994, 2008 & 2017	50% good 50% degraded	5.8	Weed invasion, clearing and too frequent fire	
Occurrence 7 MUCK02	Shire of Gingin – Reserve (20366) Unvested Reserve (25431)	1994	100% excellent	10.8	Clearing, too frequent fire and weed invasion	
Occurrence 8 BULL06	DBCA – Bullsbrook Nature Reserve (1654) Private Public Rd	1995, 2008 & 2010	100% excellent	18.8	Weed invasion, overgrazing & drying climate	

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Occurrence 9 CARAB02	DBCA – Carrabungup Nature Reserve (4990)	1995	100% very good	3.7	Weed invasion and too frequent fire	
Occurrence 10 AUSTB07	DBCA – Austin Bay Nature Reserve (4490 & 38749)	1995 & 2009	100% excellent in 1995	8.9	Weed invasion, too frequent fire and recreation activities	
Occurrence 11 AUSTB01	DBCA – Austin Bay Nature Reserve (4490)	1995	90% excellent 10% very good	6.4	Weed invasion, too frequent fire and recreation activities	
Occurrence 12 AUSTB08	DBCA – Austin Bay Nature Reserve (4490)	1995	80% excellent 20% very good	27.1	Weed invasion, too frequent fire and recreation activities	
Occurrence 13 MYKENWK01	City of Gosnells	2000 & 2013	80% excellent 20% very good	0.3	Weed invasion, too frequent fire and recreation activities	
Occurrence 14 PAUL04	Public road and railway	2002	100% very good	0.09	Clearing, weed invasion and too frequent fire	
Occurrence 15 PUNR01	Shire of Serpentine-Jarrahdale DPLH	2002 & 2010	100% very good	5.9	Weed invasion, overgrazing, too frequent fire and recreation activities	
Occurrence 16 PUNR04	Shire of Serpentine-Jarrahdale DPLH	2002	70% excellent 20% very good 10% good	0.9	Weed invasion, overgrazing, too frequent fire, recreation activities and rubbish dumping	
Occurrence 17 myperth01	Commonwealth of Australia – Perth Airport	2002 & 2005	100% excellent	4.4	Clearing, too frequent fire and weed invasion	
Occurrence 18 myperth02	Commonwealth of Australia – Perth Airport	2002	100% excellent	0.3	Clearing, too frequent fire and weed invasion	
Occurrence 19 davies02	Private Public road DPLH	1995	100% very good	2.3	-	
Occurrence 20	Reserve (16044) – Rifle range	2002	90% excellent	0.5	Clearing, too frequent fire, weed	

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Swamp02			10% very good		invasion, rubbish dumping and overgrazing	
Occurrence 21 myAMBR05	Shire of Busselton – Reserve (22614)	2002 & 2012	90% excellent 10% good	0.2	Weed invasion, too frequent fire, clearing and overgrazing	
Occurrence 24 REHOBOTH02	Private	2004	90% excellent 10% good	0.3	Clearing, hydrological change and weed invasion	
Occurrence 25 REHOBOTH03	Private	2004	100% excellent	0.02	Clearing, hydrological change and weed invasion	
Occurrence 26 myperth04	Commonwealth of Australia – Perth Airport	2005	-	1.2	-	
Occurrence 27 AC03	Private Reserve (50025)	2009	-	9.7	-	
Occurrence 28 AC13	Private	2009	-	13.2	-	
Occurrence 29 AC07	Private	-	-	Boundary mapping required	-	
Occurrence 30 AC06	Private	2009	-	2.2	-	
Occurrence 32 AC11	Private	2009	-	6.8	-	
Occurrence 33 WN021MNR	DBCA – Mogumber Nature Reserve (38649)	2011	50% excellent 50% good	Boundary mapping required	Overgrazing and hydrological change	
Occurrence 34 AUSTSTH01	DBCA – Austin Bay Nature Reserve (4990)	2011	50% excellent 50% good	Boundary mapping required	Overgrazing and hydrological change	

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Occurrence 35 AUSTSTH02	DBCA – Austin Bay Nature Reserve (4990)	2011	100% excellent	40.1	Overgrazing and hydrological change	
Occurrence 36 PinjAborig01	DBCA – Reserve (45057)	2011	100% excellent	Boundary mapping required	-	
Occurrence 37 Furnissdale	Private Shire of Busselton – Spanish settlers reserve (1459)	-	-	0.6	-	
Occurrence 38 PROP01	City of Bunbury – Reserve (670 & 32963)	2016	100% very good	1.3	Recreational activities	

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.

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', 'Completely degraded' using Bush Forever (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.

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APPENDIX 1 THREATS

Taken from Department of Parks and Wildlife ((DPAW) 2015)

Major threats

Vegetation clearing

The seasonal clay-based wetland communities of the south west are amongst the most threatened assemblages in Western Australia. It is estimated that >90% of the original extent of these wetlands has been cleared for agricultural use (Gibson *et al*. 2005). Clay pans in the Perth area have also historically been cleared and quarried for clay for use in manufacturing bricks and tiles.

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.

Introduced South African bulbous plants are a particularly serious group of weeds in clay pans. As the taxa occur in similar habitat in South Africa, many have the ability to invade relatively undisturbed clay pan habitat and displace the rich herbaceous flora. *Watsonia meriana*, *Sparaxis bulbifera* (harlequin flower), *Moraea flaccida* (one leafed cape tulip), *Hesperantha falcata* and *Freesia alba* x *lechtlinii* (freesia) are of particular concern. Seed and cormels are spread into undisturbed areas in sheet waterflow across wetlands (Brown and Brooks 2003b; Brown *et al*. 2008). South African perennial grasses are another serious group of weeds that also occur in similar habitat in South Africa and have the ability to invade clay pans in good condition following disturbance events such as fire. *Tribolium uniolae* (haas grass), *Eragrostis curvula* (lovegrass) and *Hyparrhenia hirta* (tambookie grass) are of particular concern and are a priority for control. The impacts of annual weeds are less well known but many move into intact vegetation following a disturbance event and appear to displace the native annual flora. These include *Cyperus hystrix*, *Parentucellia viscosa* (bartsia) and *Hypochaeris glabra* (flat weed).

Sources of weed invasion include adjoining areas of urban and agricultural use, drains, and tracks within and near the clay pans. All these sources increase vulnerability to weed invasion following any type of disturbance. The clay pans may appear reasonably resistant to weed invasions due to seasonal inundation and hardness of soils in the summer and changes to these elements may alter their ability to resist weed invasion (Keighery 1996). Quadrats established in 1992 in ephemeral claypans during a regional survey of the Swan Coastal Plain (Gibson *et al*. 1994), were resurveyed in 2012 (Gibson *et al*. 2018). A decrease in native species richness, from an average of 38.7 in 1992 to 32.9 per quadrat was indicated after 20 years (Gibson *et al*. 2018). Invasive taxa had increased in richness by 33% from an average of 10.8 taxa to 14.2 taxa per quadrat over the same 20-year period. Six particularly aggressive South African exotic flora had spread into an additional 37% of the previously non-invaded quadrats with 60% of quadrats containing these taxa at the latter timepoint; an increase of 23%. The increase in exotic taxa could be expected due to the highly fragmented nature of the remnants (Gibson *et al*. 2018). The authors surmise that variability in inundation period in the last decade may be increasingly facilitating a longer period of weed establishment in some years. This indicates that declining rainfall may also be implicated in increased weed invasion in claypans.

Webb (2019) also compared data for proportion of native and weed species in occurrences of the community in 1994, and at a timepoint between 2010 and 2018. Linear projections of a 50 year forecast based on these trends are shown in Figure 1 below. Linear projections have been calculation based on these two timepoints. The projection indicates that if weeds are unmanaged in these occurrences, the proportion of native species will decline to approximately 56% of the total number of species in the community within the next 50 years (ie 44% weeds).

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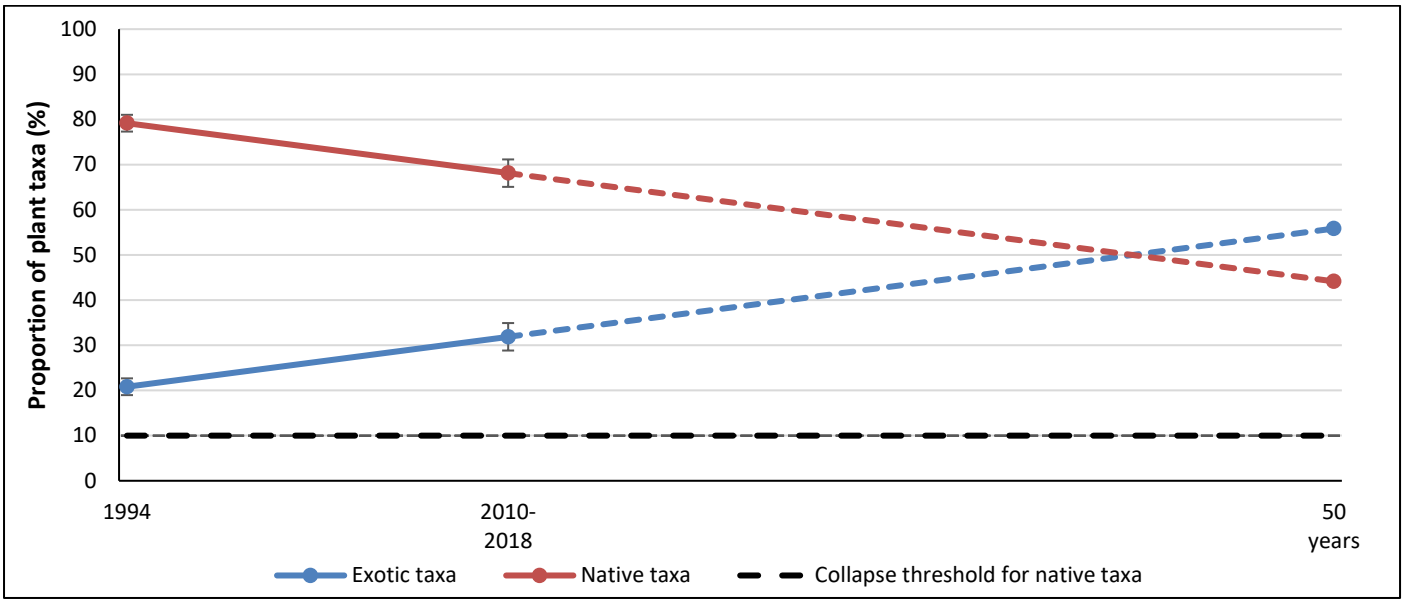

Figure 1. Trend in the proportion of native and exotic plant species based on the mean of 17 sampled sites. 13 sites are located in the Swan region and 4 located in the South-west region (n = 17). A 50-year forecast was calculated using a linear trendline of the proportion of exotic taxa (y=0.4608x+20.363) and the proportion of native taxa (y=-0.4608x+79.637) (Webb 2019).

Hydrological changes

DPaW (2015) states "The hydrology is the main driver of the ecological functions of the assemblages that occur in clay pans. Variations in depth and timing of inundation have a major influence over the suites of flora that occur in a particular location and this explains some of the variation in the community's composition across its extent. Changes in hydrological status will significantly alter the assemblages in the communities."

According to the study by Sudmeyer *et al.* (2016), predictions for the south west of WA are as follows:

- By 2030, mean annual temperature is projected to increase by 0.5–1.2°C
- Reduction in rainfall by 2030 by 2-14%. The southwest is predicted to experience some of the largest reductions in rainfall in all of Australia.
- Reduction in runoff by 10-42% (median 24%) by 2030.
- Decline in groundwater levels by 2030 (extractive yields may decrease by a third to a half in some areas).

These scenarios are indicative of trends in climatic drying that are likely to affect the depth and seasonality of inundation of the clay pan communities. This has major implications for the future of the clay pan floral assemblages.

Altered hydrology due to anthropogenic causes, in urbanised areas in particular, is likely to be an increasing threat to the clay pans. Drainage to lower watertables, 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 clay pan communities. Altered periods of ponding may affect the timing of growth of herbs in the understorey, and may also affect the species composition of the community by favouring different taxa. Any changes to the natural hydrology of the clay pans can affect composition as they are dependent on the timing of filling and drying at appropriate times of the year.

Increased nutrient levels in surface water in occurrences adjacent to areas such as farm lands and residential areas is likely to favour weeds as they are adapted to higher nutrient levels than native flora.

There are data for some bores that occur close to or within the clay pan communities, extracted from Department of Water and Environmental Regulation (2020) Water Information (WIN) database. The figures below provide data about changes in groundwater depth over time beneath examples of the clay pan communities

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Figure 2 and 3 indicate the seasonal nature of the superficial watertable, and the lack of connection of groundwater to surface in each case. Groundwater levels are relatively stable over the ten-year period (2008-2018) at these occurrences.

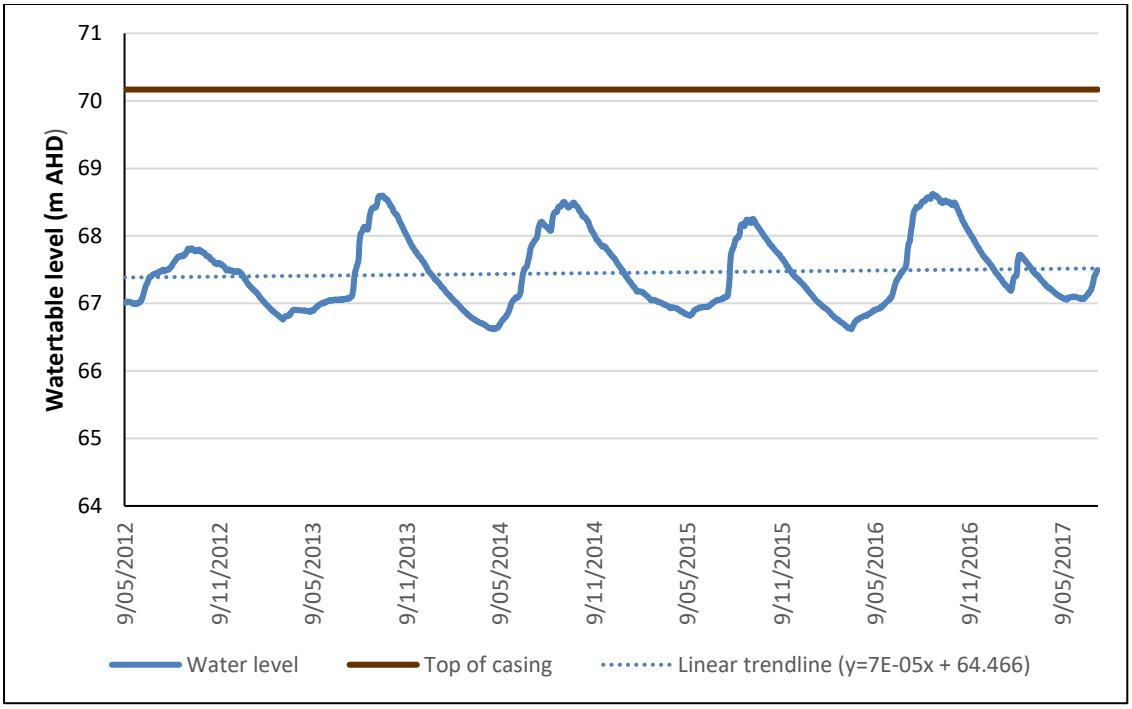

Figure 2. Hydrograph of bore located within Bambun Reserve, 20m north of occurrence BAMBUN01 (site ref: 61710485) (DWER 2020).

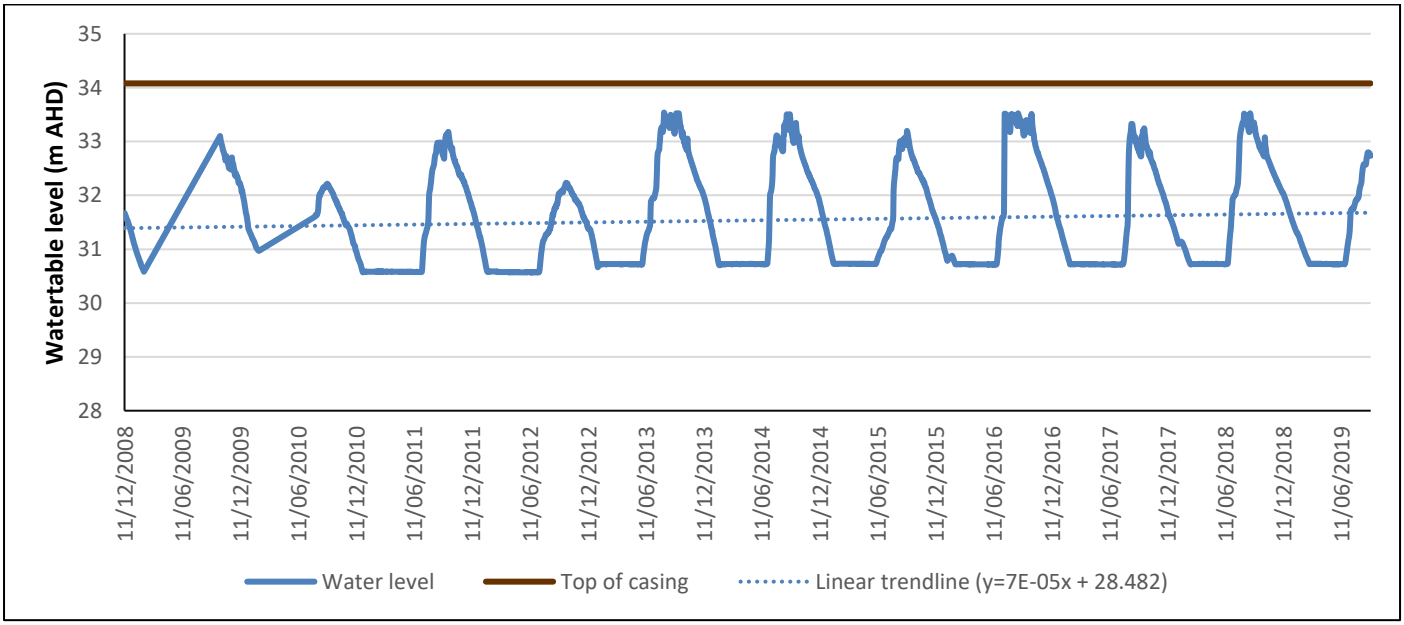

Figure 3. Hydrograph of bore located within the Yoongarillup Reserve, where occurrence YOON03 (1) occurs (site ref: 61000018) (DWER 2020).

Fire regimes

Inappropriate fire regimes are a significant threat to the clay pan communities. Historically, fire within the clay pans was probably only very occasional. It is likely that some of the clay pan sub-types such as the Shrublands on dry clay flats may be adapted to occasional fire as they contain species that will easily carry fire when vegetation is dry, and

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some component shrubs would reproduce from seed following fire. The fire response of the major types of clay pan vegetation needs to be determined, however.

The risk of fire is generally increased by the presence of urban areas nearby. In addition, grassy weeds in the understorey are often more flammable than many of the original native species in the herb layer.

Anecdotal evidence indicates that fire may exacerbate the impact of drying climate in clay pan communities. For example, following fire in Ambergate reserve (myAMBR05) community structure altered and reduced rainfall is believed to be a contributing factor. Shrub species such as *Pericalymma ellipticum* and *Verticordia plumosa* var. *ananeotes* have not recovered well post-fire and there has been a notable increase in sedge cover ([redacted] personal communication).

Minor threats

Grazing

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. The presence of feral animals such as rabbits (*Oryctolagus cuniculus)* and pigs (*Sus scrofa*) is a concern as they disturb the vegetation by grazing and burrowing.

Occurrences at Fish Road (FISH01), Bullsbrook (BULL06), Austin Bay (AUSTB08) have all been threatened by grazing to some degree, namely by rabbits, horses and kangaroos. The significance of the impact, however, has not been quantified through monitoring. Pigs have been recorded at Goonaping, and Moore River and Drummond Nature Reserves (occurrences 22, 111, 99 and 100).

Disease

Soil types have a clear correlation with the occurrence of dieback disease caused by the water moulds *Phytophthora* species around the Perth metropolitan area. Davison and Tay (1986) state 'Increased sporulation and growth of *P. cinnamomi* will not occur in waterlogged soil because aeration is inadequate'. The clay pan communities occur on heavier soils that are thus probably a less susceptible habitat, resulting in a reduced susceptibility of the communities to the disease, although the disease has been recorded at Bullsbrook Nature Reserve, where occurrence BULL06 is located.

Phytophthora dieback disease particularly affects Proteaceae and Myrtaceae families that are floristically and structurally dominant in some areas of the clay pan communities. In 2015, dieback was mapped in Yoongarillup Reserve, where occurrence YOON03 (1) occurs (Dieback Treatment Services 2015). In summary, 18ha (58%) was infested, 10ha (32%) was uninterpretable and 3ha (10%) was excluded from the analysis (Figure 4). Occurrence YOON03 (1) makes up two thirds of the vegetation within this reserve, and is located mainly on the peripheries surrounding a different floristic community type. Therefore, it is likely the majority of this occurrence is infested with dieback based upon the dieback survey of this 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), where myAMBR05 is located. Figure 5, shows two small areas located in the centre and north-west of the reserve, that were determined to be infected with the disease. As myAMBR05 is located on the east border of this reserve it is likely this occurrence is not infected with Dieback.

The disease Myrtle Rust (*Puccinia psidii sens. lat*) also has potential to impact the clay pans if it becomes established in Western Australia, as it may affect some of the 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 layers as a result of increased sun penetration and decreased shading.

[1] [redacted], Department of Parks and Wildlife, Busselton

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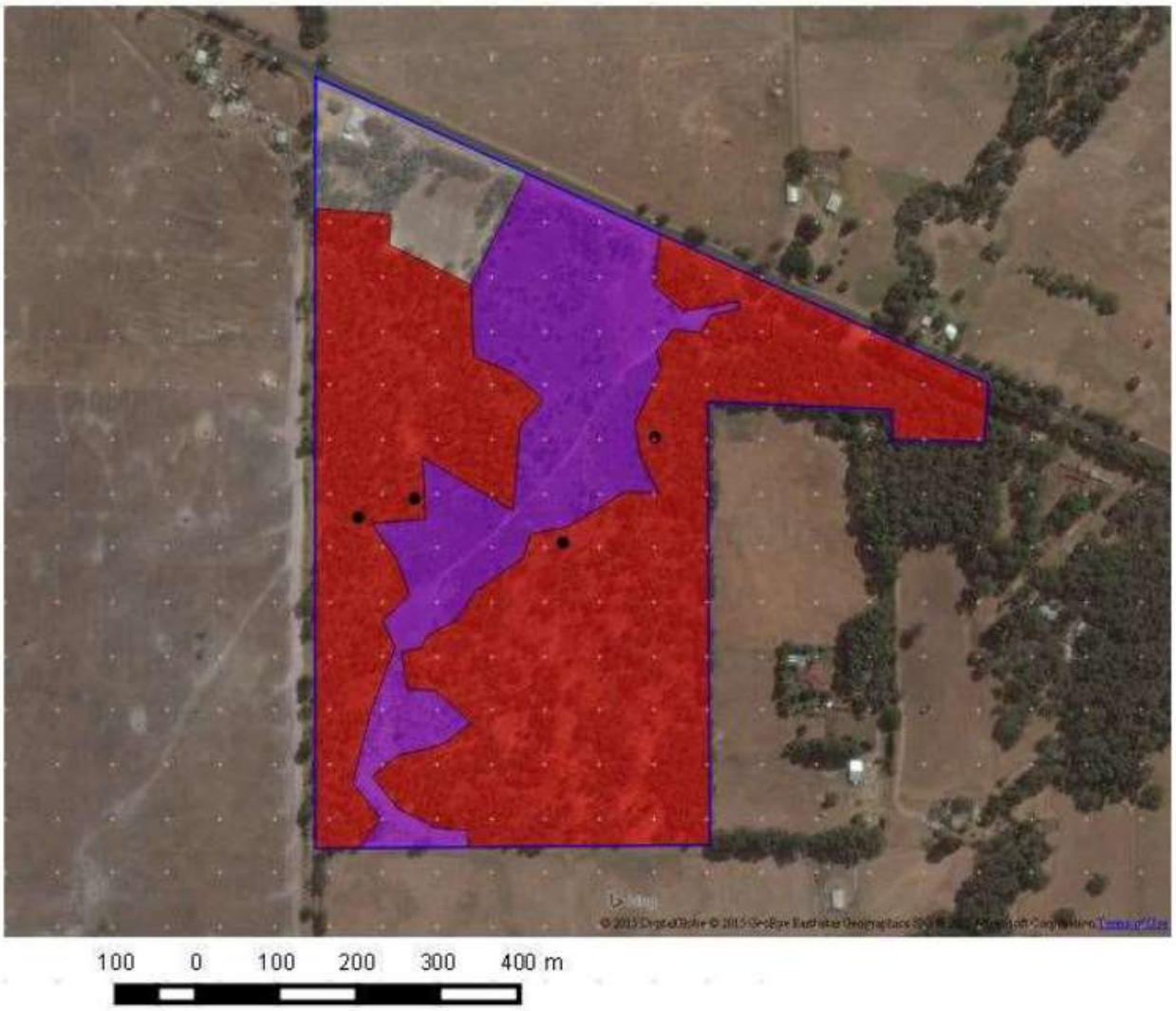

Figure 4. Dieback infestation coverage of the Yoongarrillup Reserve where occurrence YOON03 (1) is located. Red represents those areas infested, purple represent those areas where presence was uninterpretable, and no colour within the perimeter of the reserve represents area not tested (Dieback Treatment Services 2015).

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Figure 5. Dieback infestation coverage of the Ambergate Reserve where occurrences myAMBR05 is located. Red represents those areas infested, purple represent those areas where presence was uninterpretable, and green represents areas un-infested (Dieback Treatment Services 2012).

Disturbance from recreational activities

Inappropriate recreational uses such as four wheel drive vehicles and dirt bikes pose a risk to the clay pan communities. Rubbish dumping also occurs in clay pans that are close to urban areas such as Brixton St Wetlands. These activities cause direct damage to vegetation, and can lead to weed, or disease introductions such as *Phytophthora* species.

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APPENDIX 2: Herb rich saline shrublands in clay pans (floristic community type 7 as originally described in Gibson *et al.* (1994))

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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:

	Relative severity (%)		
Extent (%)	≥ 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		

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

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	≥ 70	≥ 50
≥ 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