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GOVERNMENT OF WESTERN AUSTRALIA

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (floristic community type 19 as originally described in in Gibson *et al*. (1994))
Other names:	Floristic community type 19 (FCT19), and Swan Coastal Plain community 19 (SCP19)
Description:	The community is within wetland depressions (swales) occurring between parallel Holocene dunes, mostly located on the Rockingham-Becher Plain but also extending further north to Lancelin and south to Dalyellup. Typical and common native species in the community are the shrubs *Acacia rostellifera* (summer-scented wattle), *Acacia saligna* (orange wattle) and *Xanthorrhoea preissii* (balga), the sedges *Baumea juncea* (bare twigrush), *Ficinia nodosa* (knotted club rush) and *Lepidosperma gladiatum* (coast sword-sedge), and the grass *Poa porphyroclados.* The community is also known as "floristic community type 19" 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B.J., Keighery G.J., Burbidge A.H. and Lyons M.N. (1994) "A floristic survey of the southern Swan Coastal Plain" (unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia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 under BC Act ☒ 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	16/07/2000	Endangered	
Western Australia	TEC list: WA Minister ESA list in policy	10/12/2002	Critically Endangered	B) iii)
	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 ☐

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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 B2a(i),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**
	Justification of assessment under Criterion A.	• A) It is assumed that the level of clearing of floristic community types on the southern Swan Coastal Plain is reflected in the level of clearing of the vegetation complexes in which they occur. Community SCP19 occurs predominantly on the Quindalup vegetation complex. The remaining proportion of the pre-1750 extent of the Quindalup complexes is 60% (Government of Western Australia 2019). • A number of occurrences also occur within the Rockingham-Point Becher Plain where at least 80% of the vegetation has been cleared (DEC 2011). The Rockingham-Point Becher Plain represents ~20% of the total area of occupancy of the community. Although the area is not large, it represents ~60% of all occurrences. • As the timing of clearing is not known, it is assumed that clearing of the vegetation complexes on the Rockingham Becher Plain has occurred since 1750. • These data are not indicative of an estimated minimum ≥30% reduction of SCP19 within a 50-year period, or ≥50% since ~1750, to meet VU. • Several future developments are also proposed, with a further reduction in geographic distribution of the community likely to occur, but cover relatively limited areas of the community. • **Does not meet criterion A**
B.	Restricted geographic distribution *(EOO and AOO, number of locations and evidence of decline)*	☐ **B1** (specify at least one of the following): CR ☐ **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)**

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	Justification of assessment under Criterion B.	• B1: EOO is 5,235km^2 (≤20,000km^2, which is the threshold for EN). **Meets EN under B1** B2: AOO is two 10x10 km grid cells (threshold for EN is 20, and for CR is two grid cells). Although the community occupies eight grid cells, most of the occurrences are very small and account for <1% of the grid cell area, and negligibly contribute to risk spreading (**IUCN guidelines V1.1 2017** state '*large numbers of small patches contribute a negligible risk-spreading effect to that of larger patches and a correction may be applied by excluding from the AOO those grid cells that contain patches of the ecosystem type that account for less than 1% of the grid cell area).* Using these guidelines, six cells were excluded from the AOO calculation. **Meets CR under criterion B2** • ai): An observed decline in a measure of spatial extent has occurred. 63% of all occurrences occur within the Rockingham-Point Becher Plain, an area in which at least 80% of the vegetation has been cleared (DEC 2011). Six occurrences (total 4.4ha) have been cleared in part or completely cleared recently. It is inferred a further seven occurrences (total area 2.3ha) are to be cleared in the immediate future. **Meets CR under criterion B2a(i)** • b): There is observed or inferred continuing decline from weeds, too frequent fire, recreational activities, fragmentation; and future decline in environmental quality from hydrological changes, that are likely to cause continuing decline in the next 20 years (see Appendix 1 for further information on threats). **Meets CR under criterion B2b** • c): Known from 16 threat-defined locations based on the clusters of occurrences and the major threatening processes, such as exposure to too frequent fire and clearing, and hydrological changes due to impacts to local aquifers (threshold for CR is one, for EN is five, and for VU is 10 threat-defined locations). Does not meet B1c or B2c. • B3): Known from 16 threat-defined locations based on the identification of clusters of occurrences of the community (does not meet VU as ≥5 threat defined locations). • **Meets criteria for CR B2a(i),b. Meets EN under B1a(i),b**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	• For criterion C, hydrological change from groundwater abstraction and a drying climate in the form of rainfall and groundwater decline is an abiotic variable that is a significant threat to the community.

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		• Semeniuk and Semeniuk (2013) have observed groundwater levels in the Becher Suite wetlands progressively declining over the last decade, below levels of the 1990s, resulting in the wetlands becoming drier and the vegetation changing. A recent study by Soh (2016) found overall there is an increasing rate of change in depth to groundwater level for two sites, averaging 0.03 – 0.05 m/year across bores in East Rockingham and Port Kennedy. Data from the Department of Water and Environmental Regulation (DWER) Groundwater - Water Information System (WIN) showed decline in groundwater from a number of active bores within the superficial and deep aquifers. However, determining hydrological risk is problematic due to the complexity of the underlying aquifers, and lack of data linking groundwater levels, flora composition and persistence of the community. • It is expected that future decline in rainfall resulting from drying climate and higher temperatures will impact on the community. The likely relative severity of the changes and their impacts on the community is uncertain. • Inadequate evidence to indicate if the community meets the minimum threshold for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50-year period to meet VU. • Available evidence does not indicate if the community meets criterion C. • **Community is data deficient under 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.	• For criterion D, collapse of this community is assumed conservatively to occur when vegetation condition reaches completely degraded (Bush Forever scales: defined as 'the structure of the vegetation is no longer intact, and the areas are completely or almost completely without native species'). • Significant biotic variables affecting the community are weeds and too frequent fire, which have the potential to cause major degradation of vegetation. Vegetation condition is considered to reflect a combination of species richness, species composition and dominance, abundance of key species and other biotic interactions and is likely assumed to be negatively impacted by frequent fire and weed invasion. Many of the occurrences have not been surveyed for a number of years, and current condition is not known. Therefore there is no available evidence to indicate relative decline and whether the community meets the minimum proportion of the extent (30%) or proportional severity of disruption of biotic processes (30%) over any 50-year period, or since 1750 (50% disruption of biotic processes / 50% of the extent) to meet VU.

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		• Available evidence does not indicate if the community meets criterion D. • **Community is data deficient under criterion D.**
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 ranked critically endangered using ranking criteria developed in WA that do not match 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	5,235km^2	AOO	Two 10x10 km grid cells
No. occurrences	108 (three occurrences likely to have been recently cleared)	Severely fragmented	Yes ☒ No ☐ Unknown ☐
Justification	The community is fragmented as it occurs in Holocene dune swales on the Swan Coastal Plain. The coastal vegetation in most areas where the community occurs has been subject to significant clearing. Many occurrences now exist in small pockets of vegetation that are surrounded by cleared urban areas.		
Current known area			~195 ha
Pre-industrialisation extent or its former known extent (if known)			Not known
Estimated percentage decline			It is estimated that ~40% of Quindalup vegetation complex has been cleared; and at least 80% of occurrences on the Rockingham-Becher Plain has been cleared. Based on these broad estimates of decline the original extent is estimated between ~ 325ha (based on 40% decline ie 195x100/60) and 975ha (based on 80% decline ie 195x100/20).

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Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Insufficient evidence to indicate if community meets criterion
A2a	-	• Insufficient evidence to indicate if community meets criterion
A2b	-	• Insufficient evidence to indicate if community meets criterion
A3	-	• Insufficient evidence to indicate if community meets criterion
B1a	EN	• EOO is ≤20,000km^2 • An observed decline in (i) spatial extent has occurred due to clearing and is inferred to continue. • Meets criterion for ENB1ai
B1b	EN	• EOO is ≤20,000km^2 • Observed and inferred threats likely to cause decline in the next 20 years • Meets criterion for EN B1b
B1c	-	• EOO is ≤20,000km^2 • Ecosystem exists at 16 threat-defined locations based on the clusters of occurrences and the major threatening processes, such as fire and clearing • Does not meet criterion
B2a	CR	• AOO is two grid cells • Observed and inferred decline in (i) spatial extent due to clearing. • Meets criterion for **CRB2ai**
B2b	CR	• AOO is two grid cells • Observed and inferred threats likely to cause decline in the next 20 years • Meets criterion for **CRB2b**
B2c	-	• AOO is two grid cells • Ecosystem exists at 16 threat-defined locations based on the clusters of occurrences and the major threatening processes, such as fire and clearing • Does not meet criterion
B3	-	• Known from 16 threat-defined locations • Prone to the effects of human activities or stochastic events within a short time period in an uncertain future • Does not meet criterion
C1	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over past 50 years to meet VU.
C2	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50-year period to meet VU.
C3	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of abiotic processes (≥50%) since 1750 to meet VU.
D1	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50-year period to meet VU.
D2	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥30%) or proportional severity of degradation (≥30%) over any 50-year period to meet VU.

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D3	-	• Inadequate evidence to indicate if the community meets the minimum thresholds for proportion of the extent (≥50%) or proportional severity of disruption of biotic processes (≥50%) since 1750 to meet VU.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Meets criteria for critically endangered under B2ai, B2b. Meets EN under B1ai, B1b. *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 B2a(i),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	Condition*	Area of occurrence (ha)	Threats *(note if past, present or future)*	Specific management actions
PB01 PtBecher01north PtBecher01south PB06 PointBecher32 PointBecher01 PointBecher02 MyPoint Becher07 PointBecher35 PointBecher03 PtBecher38Sc MyPoint Becher01 MyPoint Becher02 MyPoint Becher03 MyPoint Becher04 MyPoint Becher05 MyPoint Becher06 MyPoint Becher08 PointBecher07 PointBecher Plot01	Port Kennedy Scientific Park (CPC)	1994 2001 2002 2010 2011	100% excellent 90% excellent 10% degraded (Point Becher32) 60% very good, 40% excellent (PointBecher01,02,03,07,35) 50% very good 50% excellent (PtBecher38Sc) 100% completely degraded (MyPointBecher01,02,03)	4.174 2.0054 0.9337 0.4939 0.8353 0.2863 0.658 6.4972 0.0803 0.6886 0.1213 0.081 0.1708 0.0707 0.2475 1.9127 =19.2567	Hydrological changes, land clearing, grazing, weeds, inappropriate fire regimes, recreational activities, rubbish dumping, fragmentation (*past, present, future*) Climate change (*current and future*) *Threats broadly apply to all occurrences*	
Rich01 Rich02 Rich03 Rich04 Rich05 Rich07 Rich06	Crown Reserves 9458, 47145, 48310, 47553 (DPLH) Road reserve	2001 2005	100% excellent/very good	18.147 0.628 6.3033 3.133 =28.2113		

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MyCool01	Crown freehold (WAPC- Regional Park) Road reserve	2001	100% excellent	0.6438		
PtKennedy98 PtKennedy101 PtKennedy103 PtKennedy95 PtKennedy113 Pt Kennedy 94 Pt Kennedy 91 Pt Kennedy 92 Pt Kennedy 90 Pt Kennedy 97 Pt Kennedy 96 Pt Kennedy new 01 Pt Kennedy124 Pt Kennedy115 Pt Kennedy125 PtKennedy104 Pt Kennedy 100	Freehold- WA Land Authority	2001 2002 2005 2010	100% excellent/very good	0.1519 0.3248 0.4815 0.0943 0.1782 0.0563 0.0579 0.0563 0.058 0.1835 0.0732 0.0411 0.0585 0.3995 0.0307 0.163 0.1108 =2.5195		
Larkhill22 Larkhill23 Larkhill26 Larkhill158 Larkhill160 Larkhill18 Larkhill21 Larkhill24 Larkhill27 Larkhill29 Larkhill17	Freehold- DPLH	2001 2003 2006 2010	100% excellent/very good/good	0.0981 0.164 0.5396 0.0795 0.0628 0.3484 0.1921 1.4074 0.5162 0.2863 0.2967 =3.9911		

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SecretHarbour16	Freehold- DPLH	2001	100% excellent	5.7449		
SecretHarbour42	Crown reserve 46831 (DPLH)	2005	100% excellent	0.2598		
SecretHarbour54 (cleared – historic record only) PtKennedy23 *PtKennedy26 (cleared – historic record only)*	*Freehold* Crown reserve 48116 (DPLH)	2005	100% excellent	*4.57 (cleared)* 0.1252 *0.6 (cleared)* =0.1252		
PtKennedy18	Crown reserve 47165 (DPLH)	2005	100% excellent	1.768		
PtKennedy50 PtKennedy49	Unallocated Crown Land (DPLH)	2001	100% excellent	0.6502 1.8644 =2.5146		
PtKennedy16	Unallocated Crown Land (DPLH)	2001	100% excellent	3.8667		
Walyungup01	Crown freehold (WAPC- Regional Park)	2001	100% excellent	1.1224		
PtKennedy120	Freehold- WAPC Shire road reserve	2001	100% excellent	0.1506		
PtKennedy 116 Pt Kennedy 118	Freehold- WAPC (Regional Park)	2002	100% good 95% excellent 5% good	0.13 0.0991 =0.2291		
Pt Kennedy 123 Pt Kennedy 122	Freehold- Water Corporation	2015	50% good 50% degraded	0.3844 1.002 =1.3864		
Pt Kennedy 119 PtKennedy121	Freehold- WAPC (Regional Park)	2002	100% excellent	0.1436 0.0611 =0.2047		
MyPoint Becher09	Unallocated Crown Land (DPLH)	2002	100% completely degraded	0.8669		

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Secret Harbour 168 (cleared – historic record only) *Secret Harbour 20 (cleared – historic record only)* Secret Harbour 19 Secret Harbour 169	Freehold- Dept of Education	2011	50% good 50% degraded	*0.42 (cleared)* *0.24 (cleared)* 0.3464 0.0605 =0.4069		
Walyungup06 Cool09 Walyungup02 Walyungup03 Walyungup07 Walyungup08	Freehold (WAPC-Regional Park)	1994 2005	100% excellent	1.7878 2.1164 0.9154 0.8733 3.0135 4.8049 =11.7235		
LarkHill152 LarkHill150 LarkHill13	Crown Reserve 24059- Water Corporation Freehold- WAPC (managed by DBCA)	2006	100% excellent/good	0.1226 0.1628 1.1018 =1.3872		
MyGB03 MyGB02 MyGB05 *MyGB06 (cleared)* *MyGB07 (cleared)* MyGB01	Freehold -Housing Authority; private	2010	50% excellent/good 50% degraded 100% excellent (MyGB02)	0.0245 0.0317 0.0504 *0.0264 (cleared)* *0.0677 (cleared)* 0.0391 =0.1497		
MyGB04	Freehold -Housing Authority; private Crown Reserve 34664- DPLH	2010	100% excellent	0.4588		

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PrestonBch01	Crown reserve 41776- DPLH	2012	50% very good 50% excellent	Not mapped		
Lancelin01	UCL- DPLH	2017	100% good	0.0122		
Lancelin02	UCL- DPLH	2016	20% very good 80% degraded	0.01		
Lancelin03	Crown reserve 33549- DPLH	2016	60% good 40% very good	0.0249		
Lancelin04	Crown reserve 33549- DPLH	2016	60% good 40% degraded	0.0191		
Lancelin05	Crown reserve 33549- DPLH	2016	40% good 60% degraded	0.0132		
Preston01	Freehold- Dept of Communities; Water Corporation	2017	50% excellent 50% good	6.3211		
Preston02	Freehold- Dept of Communities	2017	100% very good	1.4991		
PtKenndey01	Crown reserve 44077 (Regional Park)	2019		Not mapped		
IP14-07 MyIP14-09 MyIP14-10 MyIP14-12 MyIP14-13	Freehold- WA Land Authority	2010	100% degraded	11.7452		
IP14 Plot1 IP14-05 IP14-06	Freehold- WA Land Authority Unallocated Crown land Freehold Road reserve	2016	100% good	24.7738		
IP14-02 IP14-09Centre IP14-09North IP14-09South	Freehold- WA Land Authority	2002 2016	100% very good 50% good 50% degraded	2.6924 4.5533 =7.2457		

IP14-Plot2 IP14-Plot3 *MyIP14-02 (historic record only)* *MyIP14-03 (historic record only)* *MyIP14-04 (historic record only* *MyIP14-08 (historic record only)*						
IP14-08 *(partly cleared)*	Freehold- WA Land Authority; private Road reserve	2010	50% good 50% very good	3.1075 *(1.37 ha cleared)*		
IP14-03 *(partly cleared)* IP14-10North IP14-10South IP14-04 *(mostly cleared)*	Freehold- WA Land Authority; private Road reserve	2002 2010 2015	100% very good 50% good 50% degraded	1.7645 *(0.655 cleared)* 4.2361 0.650169 *(2.068831 cleared)* =6.6508		
XYan10	CPC- National Park	2016	100% degraded	0.0227		
Cool14 Cool15	Crown reserve 18452-DPLH	2001	100% excellent	0.7693 0.6974 =1.4667		
PtKennedy28	Freehold- Water Corporation; private UCL- WAPC	2015	100% excellent	1.8793		
LarkHill30	Freehold- private Road reserve	1996	100% excellent	1.6321		

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GoldenBay Plot1 GoldenBay Plot2 GoldenBay01 Golden Bay02	Freehold Crown reserves 42604, 42734- DPLH Road reserve	2010	100% excellent	11.1842 0.4391 =11.6233		
SecretHarbour46 SecretHarbour01	Freehold- golf course	2005	100% excellent	0.2404 0.2485 =0.4889		
Pt Kennedy 25	Freehold- Water Corporation	2015	100% excellent	1.1477		
Walyungup04 Walyungup05	Crown freehold (DBCA)	2002	100% excellent	24.5044		
IP14-01	Freehold- WA Land Authority	2001	100% very good	2.1679		
Muddy01 Muddy02	Freehold	2010	50% excellent 50% very good	~2		
MyIP14-05 (historic record only) *MyIP14-06 (historic record only)* *MyIP14-07 (historic record only)*	Freehold- Water Corporation					

Condition categories from Keighery (1994) Vegetation Condition Scale (in 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 and native plant species diversity fully retained or almost so, zero or almost so weed cover/abundance, to 'Excellent' - Vegetation structure intact, with disturbance only affecting individual species, weeds are non-aggressive species, and the area contains high native plant species diversity, with less than 10% weed cover, and 'Very Good' - Vegetation structure altered, obvious signs of disturbance eg: from repeated fires, dieback, logging, grazing, aggressive weeds are present, with moderate native plant species diversity, and typical weed cover is less than 20% (5 – 20%).

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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, logging, grazing, and very aggressive weeds are present, with low native plant diversity (5 – 50%).

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 are present, very aggressive weeds are present at high density, and very low native plant species diversity is observed (20 – 70%) to 'Completely Degraded' where vegetation structure is no longer intact and the area is completely or almost completely without native flora, referred to also as 'Parkland Cleared', with very low to no native species diversity (weed species greater than 70%).

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APPENDIX 1 THREATS

Land clearing

Rapid urbanisation and expansion of the Rockingham region has occurred over the past 25 years, with extensive clearing of wetlands. It is likely that less than 20% of the original area of the swale wetlands now remains on the Rockingham-Becher Plain. Although many occurrences of the community are located in various types of reserves, many unreserved occurrences may be planned for developments that involve clearing. Future clearing is likely to be associated with developments for road works, housing or industry. Some occurrences within East Rockingham Industrial Park (IP14) have been partly or completely cleared for heavy industry (MYIP1402, 03, 04, 05, 06, 07, 08). Plans for development in the immediate future include occurrences at Bakewell Drive in Port Kennedy (light industry), on the western side of Golden Bay (housing), and more recently Kennedy Bay Point Becher (housing, hotel development). The economic value of both areas if developed is high and both suites of occurrences in these areas are potentially threatened by clearing and secondary effects following clearing such as hydrological change (DEC 2011).

Inappropriate fire regime (too frequent)

It is likely that the burn regime in areas that contain the sedgelands has been modified to one of far more frequent fires, especially hot burns, since 1750. A fire count assessment (figures 1 and 2) undertaken by [redacted][1], for wetlands within Point Becher and its surrounds, showed that 20% of occurrences of the sedgeland community have been burnt once from 1988 to 2018 and 10% have been burnt more than once.

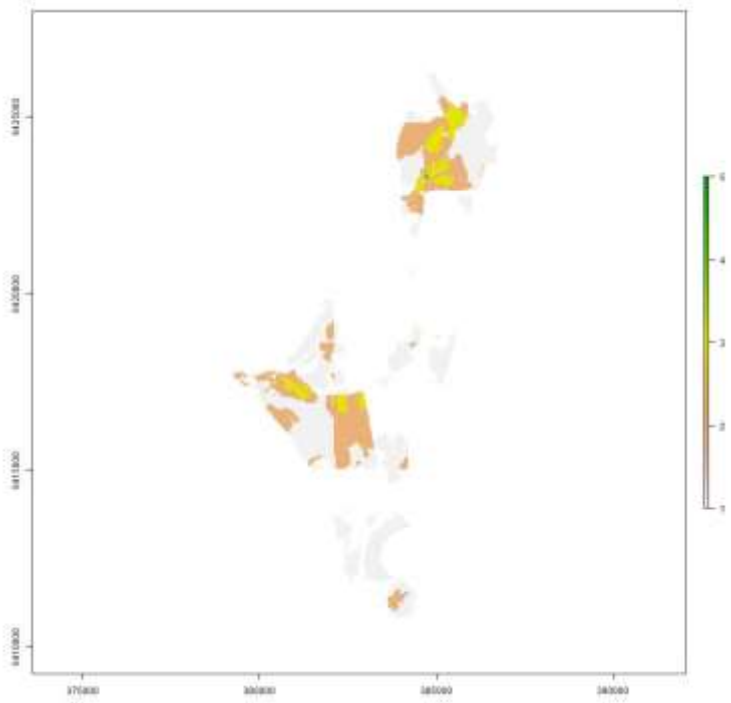

Figure 1. Fire count from 1988 to 2018 for sedgeland occurrences within Point Becher and it surrounds (from [redacted]).

[1] Remote sensing officer, DBCA

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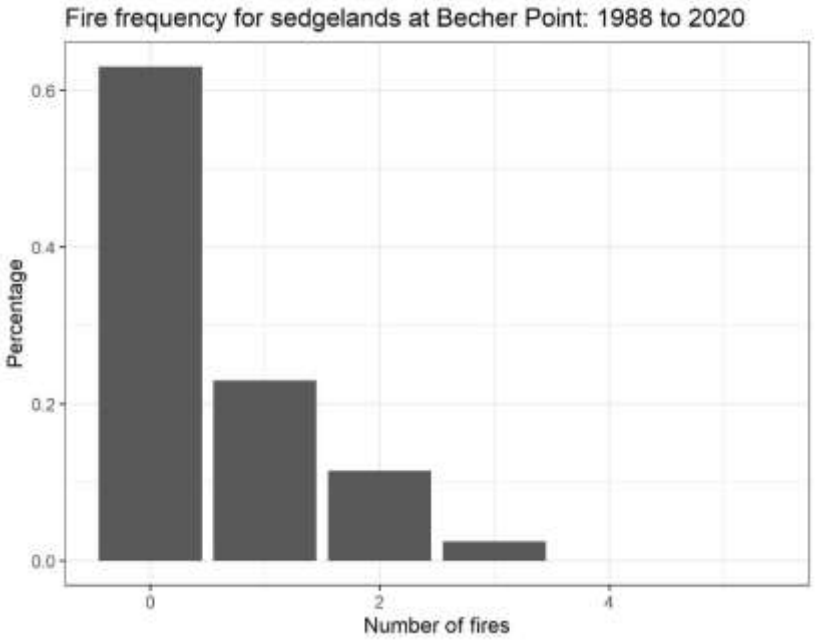

Figure 2. Fire count frequency for sedgeland occurrences within Point Becher and its surrounds from 1988 to 2019 (from [redacted]).

Too frequent fire can increase the risk of invasive weeds establishing within small remnants of native vegetation (Abbott and Burrows 2003), including occurrences of this community. The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the native species in the herb layer. As a wetland community, frequent fire poses a major threat to the sedgelands (DEC 2011). The community typically develops a less permeable peaty sediment at the surface over time that assist in maintaining moisture in the substrate. When this substrate is burnt in severe fires, these wetlands can become increasing dry ([redacted] personal observation).

Weed invasion

Most occurrences of this community are close to weed sources such as urban developments and weed invasion is most significant in areas where disturbance levels are high. Occurrences subject to frequent fires are more prone to weed invasion as many weeds recorded in the sedgelands come from a fire responsive environment and native species often do not have sufficient time to regenerate or resprout before weed populations establish. Where occurrences are in good condition, lower weed numbers are likely associated with the high density of cover of native species, especially sedges. The occurrences with dense sedgelands demonstrate resistance to weed invasion if left undisturbed ([redacted] personal observation). Some of the weed species that currently pose the greatest threat to the sedgelands, and are some of the highest priorities for control include Geraldton carnation weed (*Euphorbia terracina*), dune onion weed (*Trachyandra divaricata*), bridal creeper (*Asparagus asparagoides*), sharp rush (*Juncus acutus*), rose pelargonium (*Pelargonium capitatum*), cottonbush (*Gomphocarpus fruticosus*) and pampas grass (*Cortaderia selloana*) (DEC 2011).

A weed survey following systematic weed control in IP14 found that the proportion of quadrats that had greater than 50% coverage of weeds was reduced from 70.6% in 2014 to 45.3% in 2017 and 32.3% in 2018 (PGV Environmental 2018). The largest representation of weed species in 2018 was from the Poaceae family (grasses) (PGV 2018).

Hydrological changes

The sedgelands in Holocene dune swales is reliant on surface water for soil moisture and therefore a decrease in rainfall combined with their relatively small extent, makes dune swales highly susceptible to hydrological influences. The groundwater regime, including depth-to-groundwater (DTG), time and duration of flooding and dry periods, further influences species distribution (DEC 2011).

As the Perth metropolitan area continues to expand, significant urbanisation has occurred near most occurrences of the sedgeland community. Historically, water tables rose in the superficial aquifer as a consequence of clearing in the catchment. Rising water-tables have the potential to cause longer and deeper wetting of these wetlands and therefore to significantly modify the ecological community. It is expected however, that the sedgelands are under greater threat

from a decrease in groundwater levels due to the combination of a drying climate, and water extraction for irrigation, residential use, and industrial purposes. This is evident from a recent study by Soh (2016) and data from the Department of Water and Environmental Regulation (DWER) Groundwater - Water Information System (WIN).

Soh (2016) found that both Port Kennedy and IP-14 (East Rockingham) sites demonstrated a minor increase in DTG from the start of monitoring until 2015. The average DTGs were greater in East Rockingham as expected due to its higher topography and the increase in DTG was most notable in bores closer to the boundaries of reserves and nearer urban areas, specifically bores PK-III (mean rate of change = 1.59m below ground level (BGL)) and ER-I (mean rate of change = 2.67mBGL). Overall there was an increasing rate of change in DTG for both sites, averaging 0.03 – 0.05 m/year across most bores (figure 3).

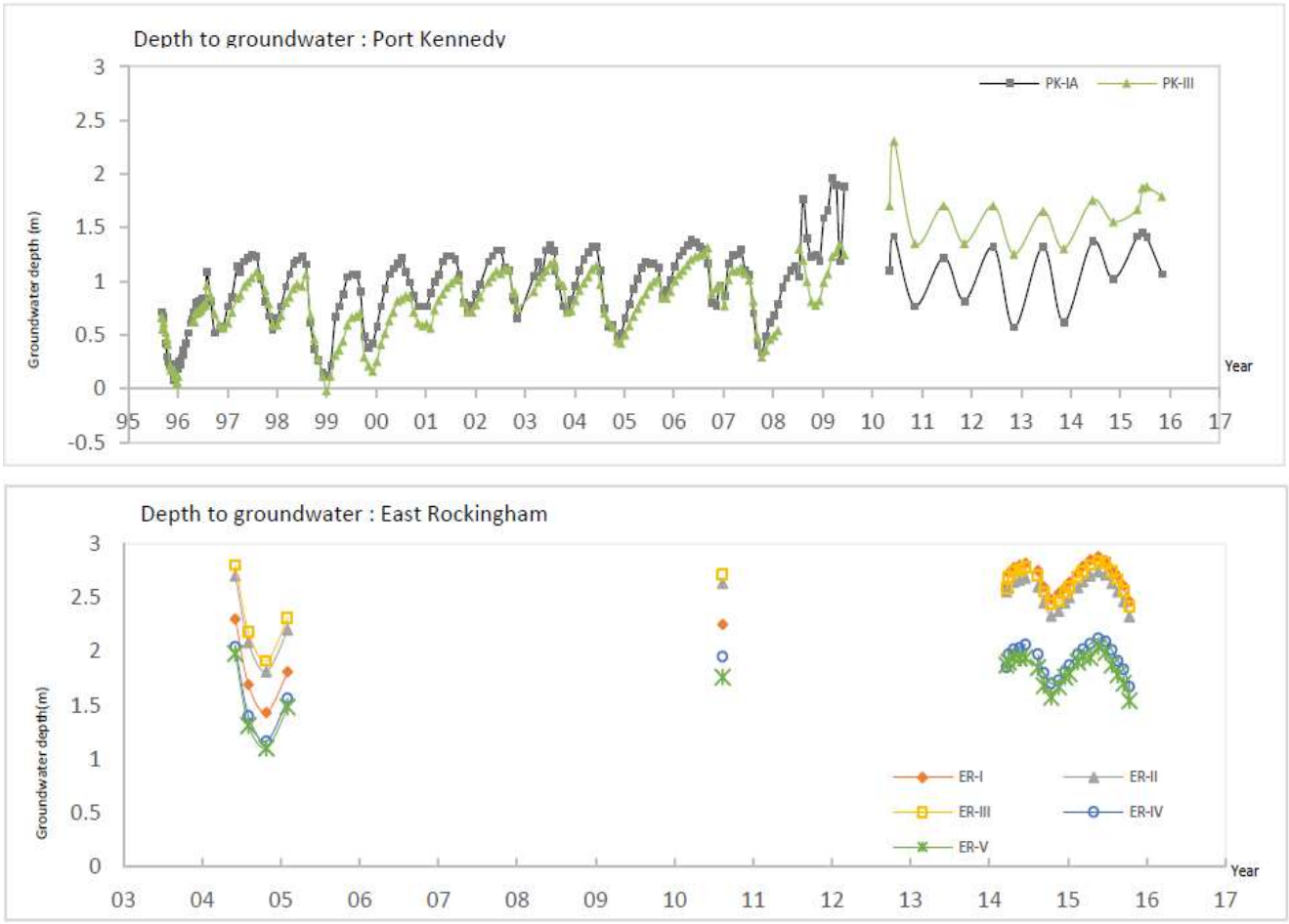

Figure 3. Monthly depth to groundwater (DTG) at Port Kennedy (top) and East Rockingham Industrial Park (IP14) (bottom) from 2015 to 2016. (Graphs from Soh 2016; data from Bennett Environmental Consulting 2015).

Water data from consultants' reports (RPS Environment and Planning 2010; Semeniuk 2007; and Coffey Environments 2009) indicate that groundwater levels on the Rockingham-Becher Plain are within 3m from the ground surface where bores are drilled. These data can provide a rough guide to the dependence of the community on groundwater and the probable susceptibility to change. Froend *et al*. (2004) notes that wetlands in which the groundwater is within 0-3m of natural ground surface, are considered to be highly groundwater dependent and are therefore highly susceptible to changes in groundwater levels. A change in groundwater level of 0.5m may result in high risk of impact to the wetlands. This would indicate the need to maintain changes to groundwater levels to within 0.25m of recent historic levels. Using Soh's (2016) maximum rate of change in DTG for the Port Kennedy and IP14 sites of 0.05 m per year, DTG has already reached the limit of 0.25m acceptable change from historic levels suggested by Froend *et al*. (2004). In the IP14 area a decline of 0.9m has occurred in annual high groundwater levels from 1991 to 2004 (Coffey Environments 2009). A noticeable drop of annual groundwater levels by about 0.8m in DWER bores close to occurrence 33 (SecretHarbour16) also occurred after 1993.

Semeniuk and Semeniuk (2013) have monitored groundwater in the Becher Suite wetlands for 25 years and observed the levels progressively declining over the last decade, below levels of the 1990s. This may be due to a number of

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factors but is probably mainly as a consequence of the drying climate. Increased water extraction for surrounding industry and residential use may also be contributing to declining groundwater levels (DEC 2011). This has resulted in the wetlands becoming drier and the vegetation changing (Semeniuk and Semeniuk 2013). Semeniuk and Semeniuk (2013) state 'falls in the water table to a level such that the water table annually does not intersect the wetland floor, the muddy sediments of wetlands, now located above the subregional water table, act to perch rain water, and this becomes the main source of water to maintain the wetland vegetation, whereas during wetter periods it was both'.

According to Department of Water and Environmental Regulation's (DWER's) Water Information Network (WIN) data there are no active bores located close to or within occurrences of the sedgeland community. Data from bores that occur adjacent to occurrences of the sedgeland community have the potential to provide useful information on the trend of groundwater in the area. Figures 4 to 7 below show declining trends for groundwater in the local and deep aquifers. Bores 61410033 (figure 4a) and 61410034 (figure 4b) (IP14), and 61410029 (Secret Harbour) (figure 6a) and 61618500 (XYan10) (figure 7a) sample the Superficial Swan aquifer, which is the aquifer the most likely to influence the community. The bores show a gradual decline of approximately 0.5 to 1.5m. Of particular concern is the projected groundwater level within the occurrence within Yanchep National Park (XYan10) which shows a forecast decline of approximately 5m over the next 50 years (figure 7b). Significant groundwater level declines are shown in bores sampled from the underlying Perth-Leederville and Yarragadee aquifers (figures 5a and 5c). The likely impacts this will have on the sedgelands community are not known but potentially may result in a decline of the superficial aquifer due to leakage.

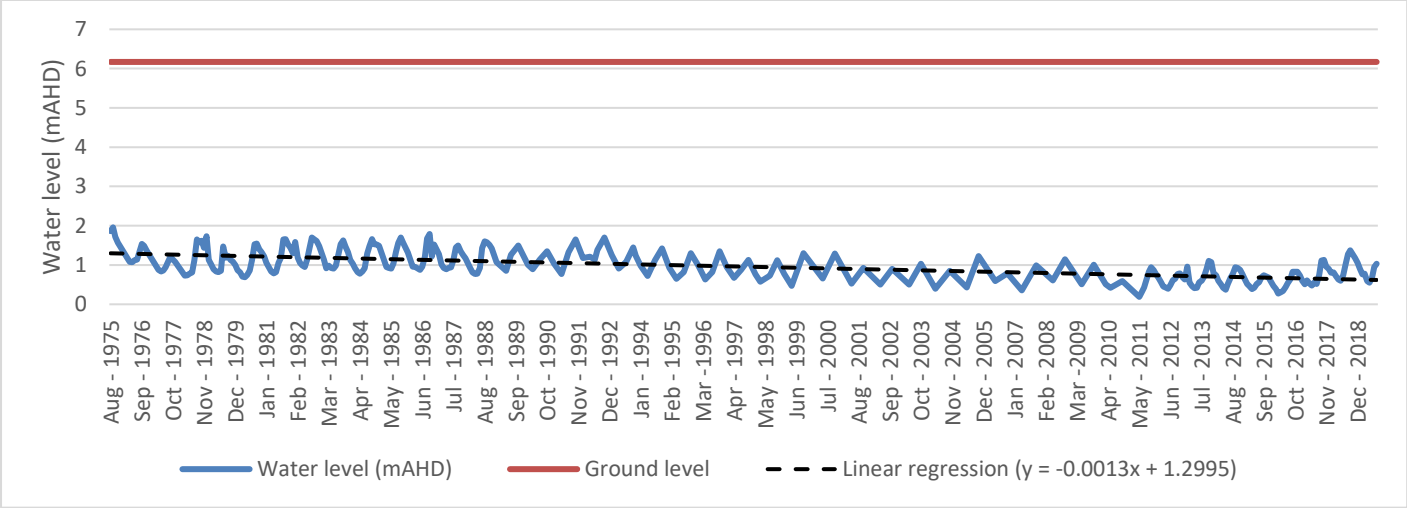

Figure 4a. Hydrograph of bore (site ref: 61410033) located 0.4km east from occurrence IP14Plot1 (SCP19b). Bore located on western road reserve of Day Road, east Rockingham. Bore data produced by sampling the Perth Superficial Swan aquifer.

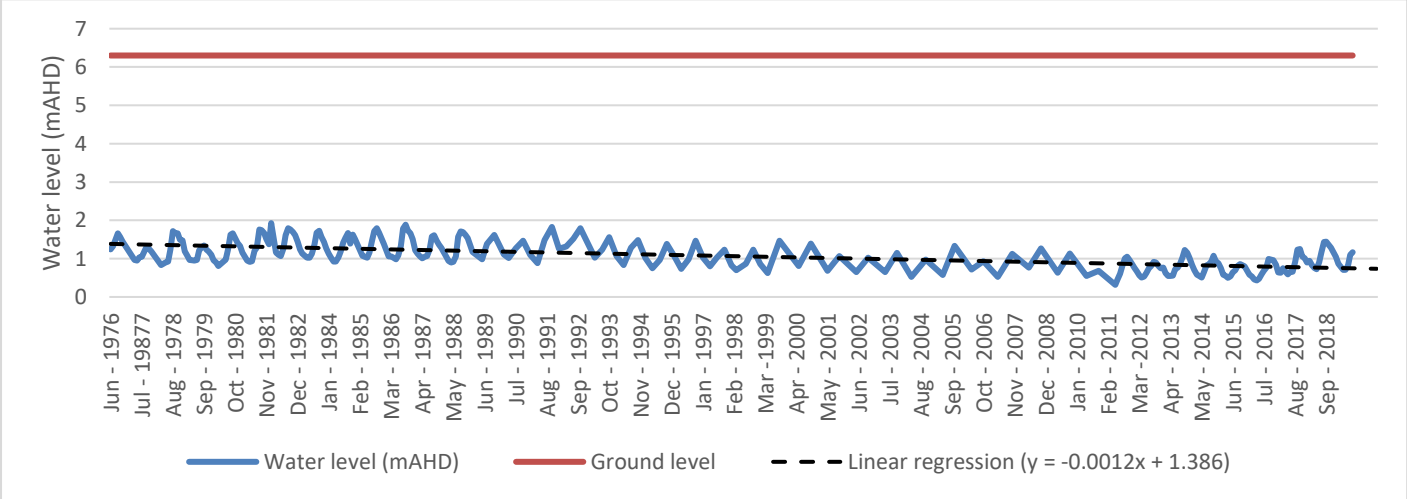

Figure 4b. Hydrograph of bore (site ref: 61410034) located 0.4km east from occurrence IP14Plot1 (SCP19b). Bore located on western road reserve of Day Road, east Rockingham. Bore data produced by sampling the Perth Superficial Swan aquifer.

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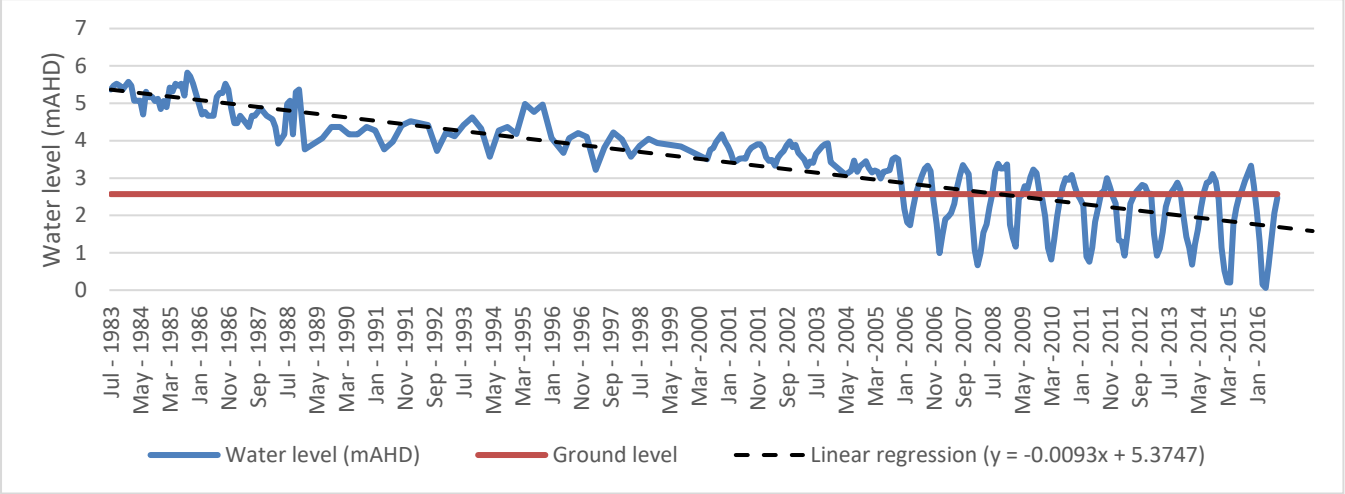

Figure 5a. Hydrograph of bore located 0.4km southeast of occurrence MyPointBecher09 (SCP19a) and 120m northwest of occurrence PointBecher01 (SCP19a). Bore located within Port Kennedy Scientific Park (site ref: 61415003). Bore data produced by sampling the Perth Leederville aquifer.

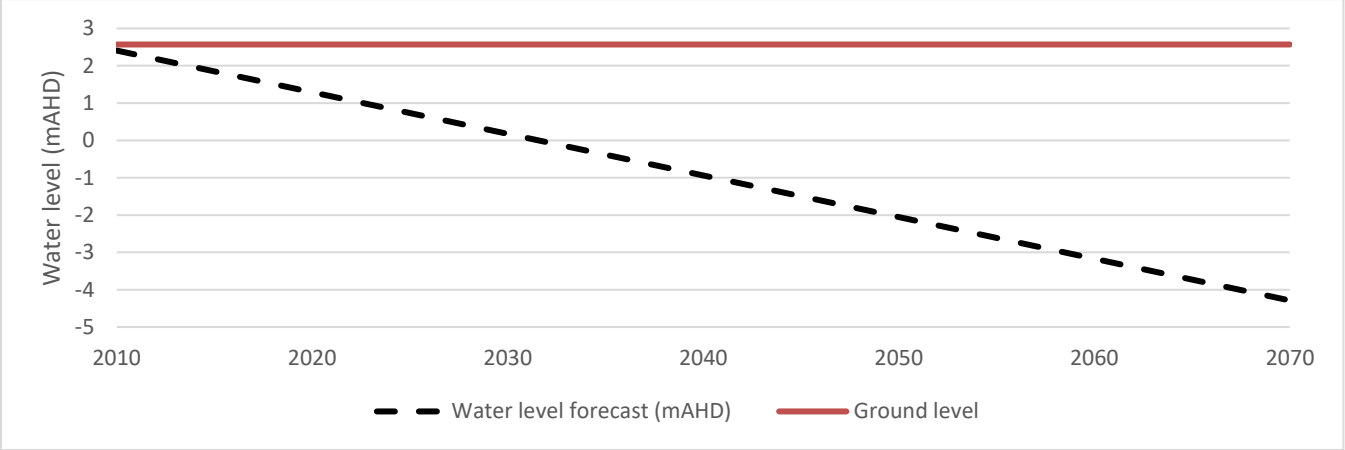

Figure 5b. A 50-year forecast of groundwater level decline at bore (site ref: 61415003), located 0.4km southeast of occurrence MyPointBecher09 (SCP19a) and 120m northwest of occurrence PointBecher01 (SCP19a), calculated using the trendline (y = -0.0093x + 5.3747).

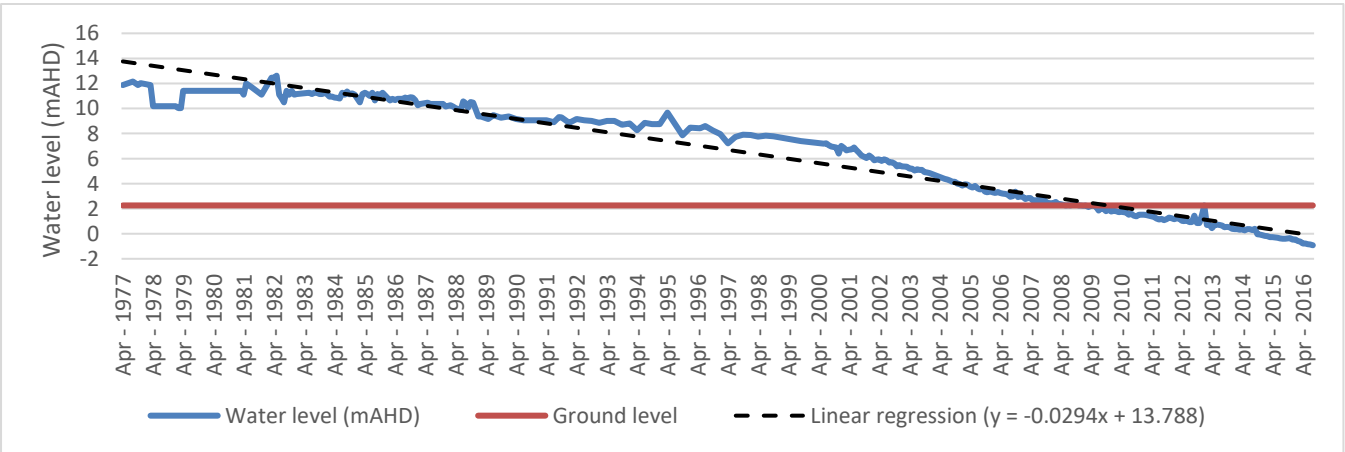

Figure 5c. Hydrograph of bore located 0.4km southeast of occurrence MyPointBecher09 (SCP19a) and 120m northwest of occurrence PointBecher01 (SCP19a). Bore located within Port Kennedy Scientific Park (site ref: 61415002). Bore data produced by sampling the Perth Yarragadee North aquifer.

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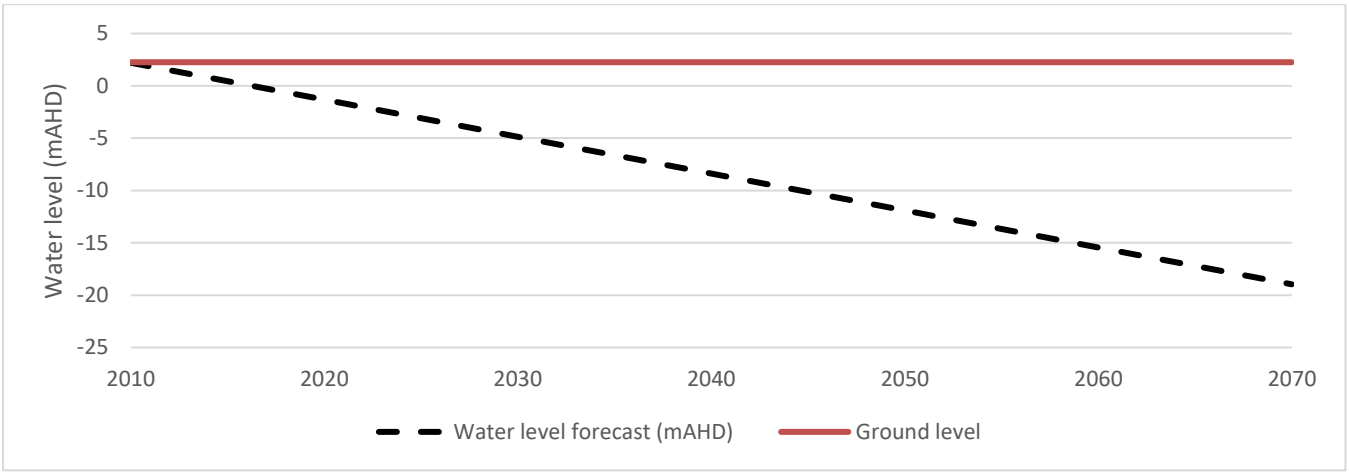

Figure 5d. A 50-year forecast of groundwater level decline at bore (site ref: 61415002), located 0.4km southeast of occurrence MyPointBecher09 (SCP19a) and 120m northwest of occurrence PointBecher01 (SCP19a), calculated using the trendline (y = -0.0294x + 13.788).

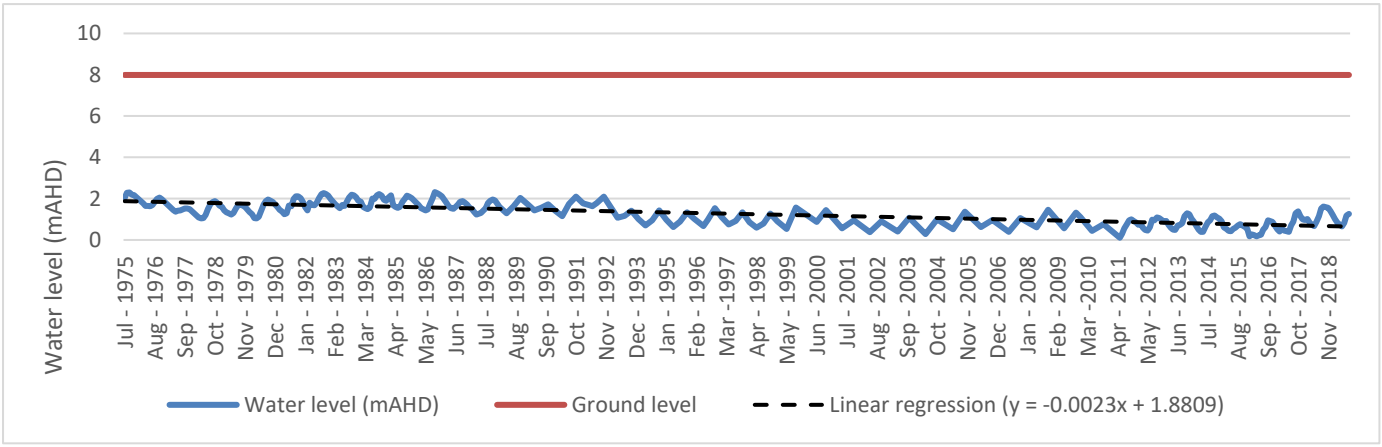

Figure 6a. Hydrograph of bore located 200m north from occurrence Secret Harbour16 (SCP19a). Bore located on Anstey Road (site ref: 61410029). Bore data produced by sampling the Perth Superficial Swan aquifer.

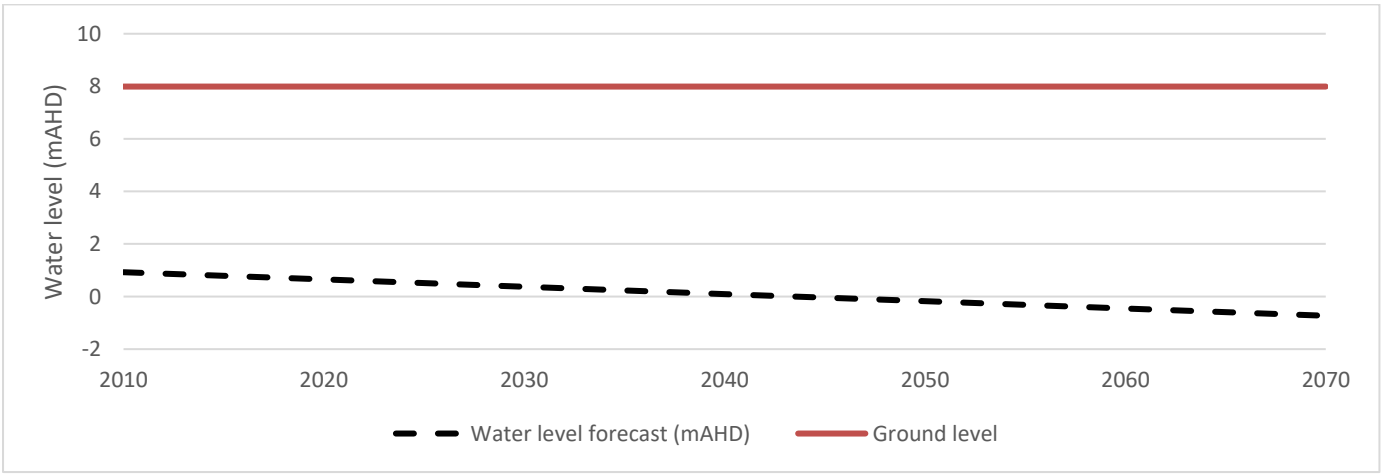

Figure 6b. A 50-year forecast of groundwater level decline at bore (site ref: 61410029), located on Anstey Road, 200m north of occurrence SecretHarbour16 (SCP19a), calculated using the trendline (y = -0.0023x + 1.8809).

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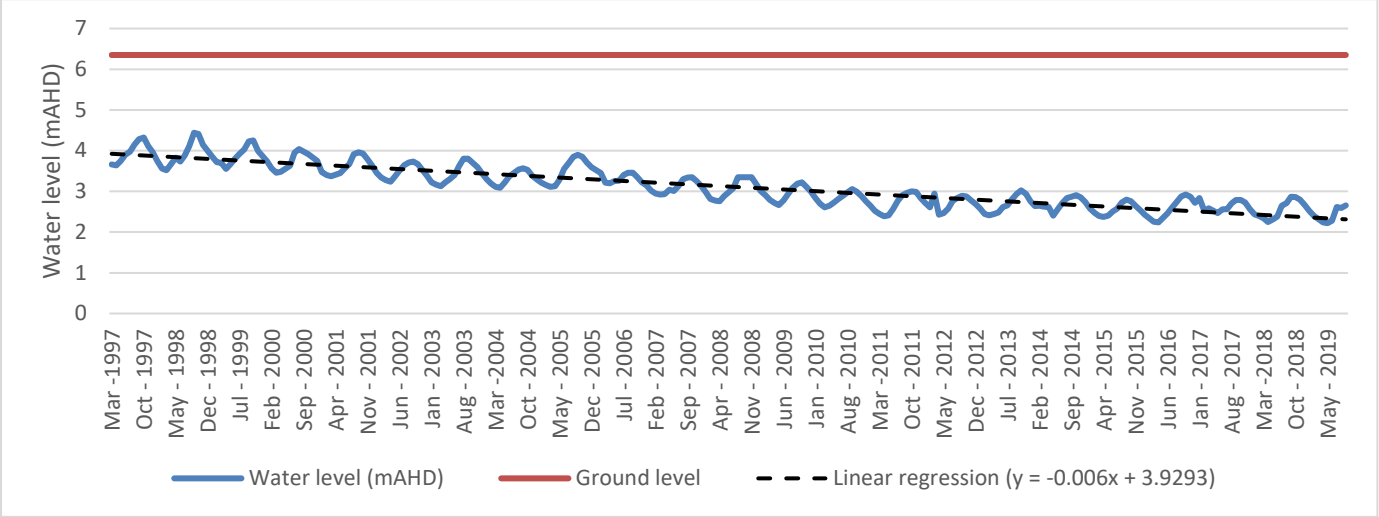

Figure 7a. Hydrograph of bore located 500m east from occurrence XYan10 (SCP19b). Bore is located within Yanchep National Park (site ref: 61618500). Bore data produced by sampling the Perth Superficial Swan aquifer.

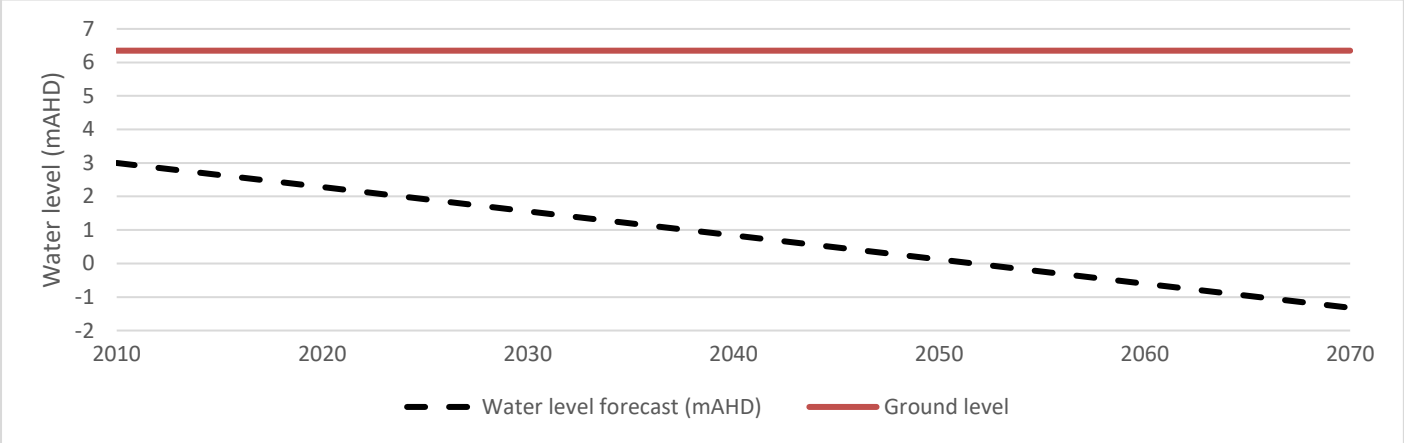

Figure 7b. A 50-year forecast of groundwater level decline at bore (site ref: 61618500), located within Yanchep National Park 500m east of occurrence XYan10 (SCP19b), calculated using the trendline (y = -0.006x + 3.9293).

Vegetation distribution is affected by depth to groundwater and depth and thickness of calcrete cement perching water in the unsaturated zone (Soh 2016). Soh (2016) found the groundwater regime and low permeability layers in the soils dictate species distributions in the dune swales. The number of shrubs and sedge species present in Port Kennedy did not change significantly from 2005 to 2015 and typically one shrub or sedge species was lost or gained between years (figure 8). Grass and herb species drastically reduced in 2009, which may have coincided with a fire. In East Rockingham, no major changes were evident between years, although loss of abundance in some grass species was associated with rehabilitation work. Both rainfall and groundwater are important contributors to soil moisture however with increasing DTG it is expected that there will be some disconnection between these two sources of groundwater. Sites with drier sandy profiles will shift towards phreatophytic vegetation while sites with thick cement or organic layers will continue to support shallow-rooted littoral or supra littoral vegetation (Soh 2016).

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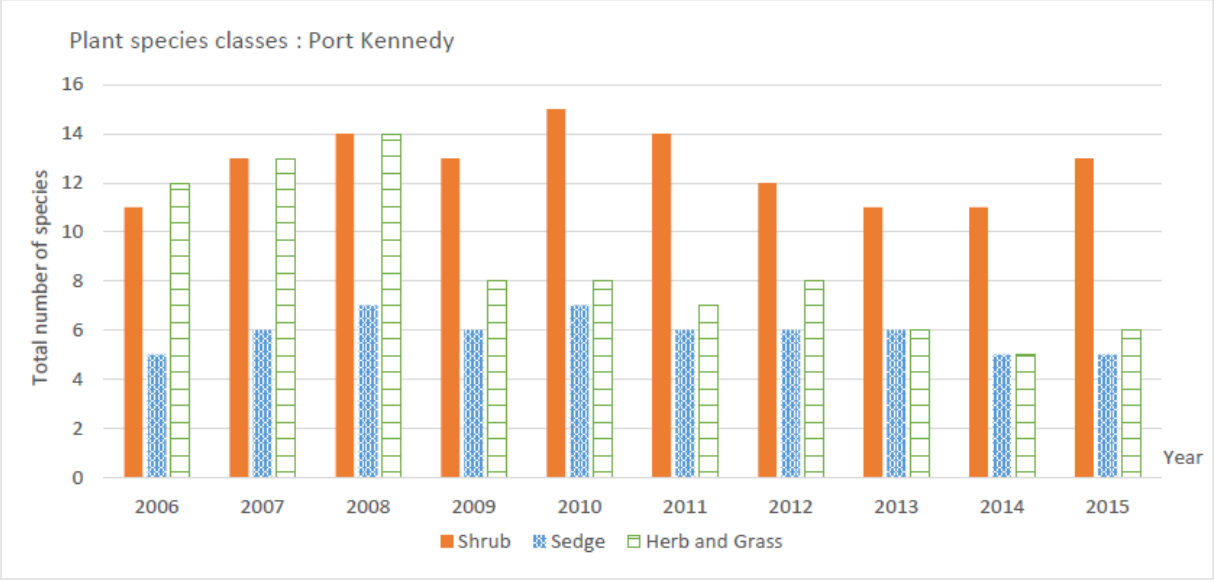

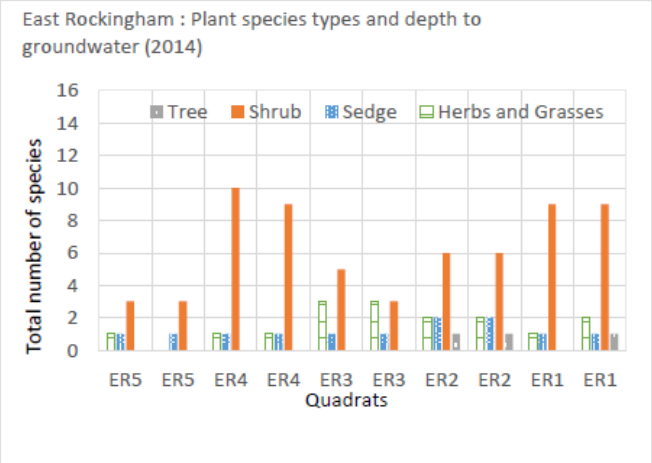

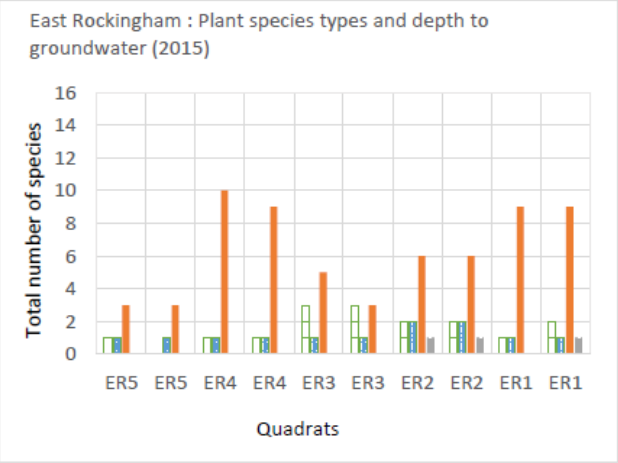

Figure 8. Total number of species by vegetation lifeform at Port Kennedy (top) and East Rockingham (bottom). (Graphs from Soh 2016).

Recreational activities

The majority of occurrences are located in close proximity to urban areas and are therefore affected by recreational activities. Pedestrian access by means of formal and informal walk trails can have a negative effect on the community as people walk through occurrences and trample vegetation. Unauthorised vehicle access is a major problem in several clusters of occurrences, in particular Port Kennedy Scientific Park, IP14 and east of Bakewell Drive. Fences bordering these sites are constantly breached enabling four-wheel drives and trail bikes access resulting in rubbish dumping, increased fire frequency, vegetation damage and increased weed invasion (DEC 2011).

Grazing

High numbers of rabbits have selectively grazed vegetation in several occurrences in Lark Hill, Golden Bay and Port Kennedy Scientific Park, removing palatable species and damaging vegetation from creation of high densities of warrens. Some occurrences near Golden Bay and Dalyellup support high kangaroo numbers and damage to vegetation is evident in their resting areas and along the pathways they create. Damage may have been exacerbated by increased density of animals due to loss of alternative habitat on adjacent lands (DEC 2011).

Rubbish dumping

Due to the proximity of occurrences to urban areas, rubbish dumping frequently occurs as a consequence of recreational activities such as camping, and pedestrian access on formal and informal walk trails. Unauthorised vehicle

access facilitates dumping of larger rubbish items including car bodies and furniture in areas that contain the community, particularly at IP14 and occurrences east of Bakewell Drive (DEC 2011).

Fragmentation

Several occurrences of the sedgeland community occur in areas of remnant vegetation that have a large edge to area ratio. This can cause a range of problems including increased damage from wind and accelerated drying out of the wetlands. Potential flow-on effects from other threats are increased such as weed invasion and opportunity for rubbish dumping. Where native vegetation still occurs adjacent to occurrences, the retention of these areas would assist in maintaining their role as buffers (DEC 2011).

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References

Abbott, I. and Burrows, N. (eds) (2003) Fire in ecosystems of south-west Western Australia: impacts and management. Bachhuys Publishers, Leiden, Netherlands.

Bennett Environmental Consulting (2015) Port Kennedy Scientific Park: Dampland Vegetation Monitoring, June 2015. Western Australia: Prepared for Coterra Environment.

Coffey Environments (2009) Rockingham Industry Zone strategic environmental assessment. Published report to LandCorp. Perth, Western Australia.

Department of Environment and Conservation (2011) Interim Recovery Plan 2011-2016 for Sedgelands in Holocene dune swales. Interim Recovery Plan No. 314. Department of Environment and Conservation, Perth.

Froend, R., Loomes, R. Horwitz, P., Bertuch, M., Storey, A. and Bamford, M. (2004) Study of Ecological Water Requirements on the Gnangara and Jandakot Mounds under Section 46 of the Environmental Protection Act. Task 2: Determination of Ecological Water Requirements. Report prepared for the Water and Rivers Commission by Centre for Ecosystem Management, ECU, Joondalup.

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

Keighery, B.J. (1994) Bushland Plant Survey. A Guide to Plant Community Survey for the Community. Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.

PGV Environmental (2018) Rockingham Industry Zone Conservation Area Weed Survey 2018. Unpublished Report No 2018-412 prepared for Landcorp.

RPS Environment and Planning Pty Ltd (2010a). Groundwater monitoring report May 2009 to April 2010. Kennedy Bay. Unpublished report to Turnpoint Pty Ltd. Perth, Western Australia.

Semeniuk, C. (2007) The Becher Wetlands – A Ramsar site. Wetlands Research Association, Perth, WA, Australia.

Semeniuk, C.A. and Semeniuk, V. (2013) The response of basin wetlands to climate changes: a review of case studies from the Swan Coastal Plain, south-western Australia. *Hydrobiologia* 708: 45-67.

Soh, M.Y. (2016) Hydrogeological controls on vegetation distribution of the Sedgelands over Holocene dune swales, Rockingham, Western Australia. Masters thesis, University of Western Australia.

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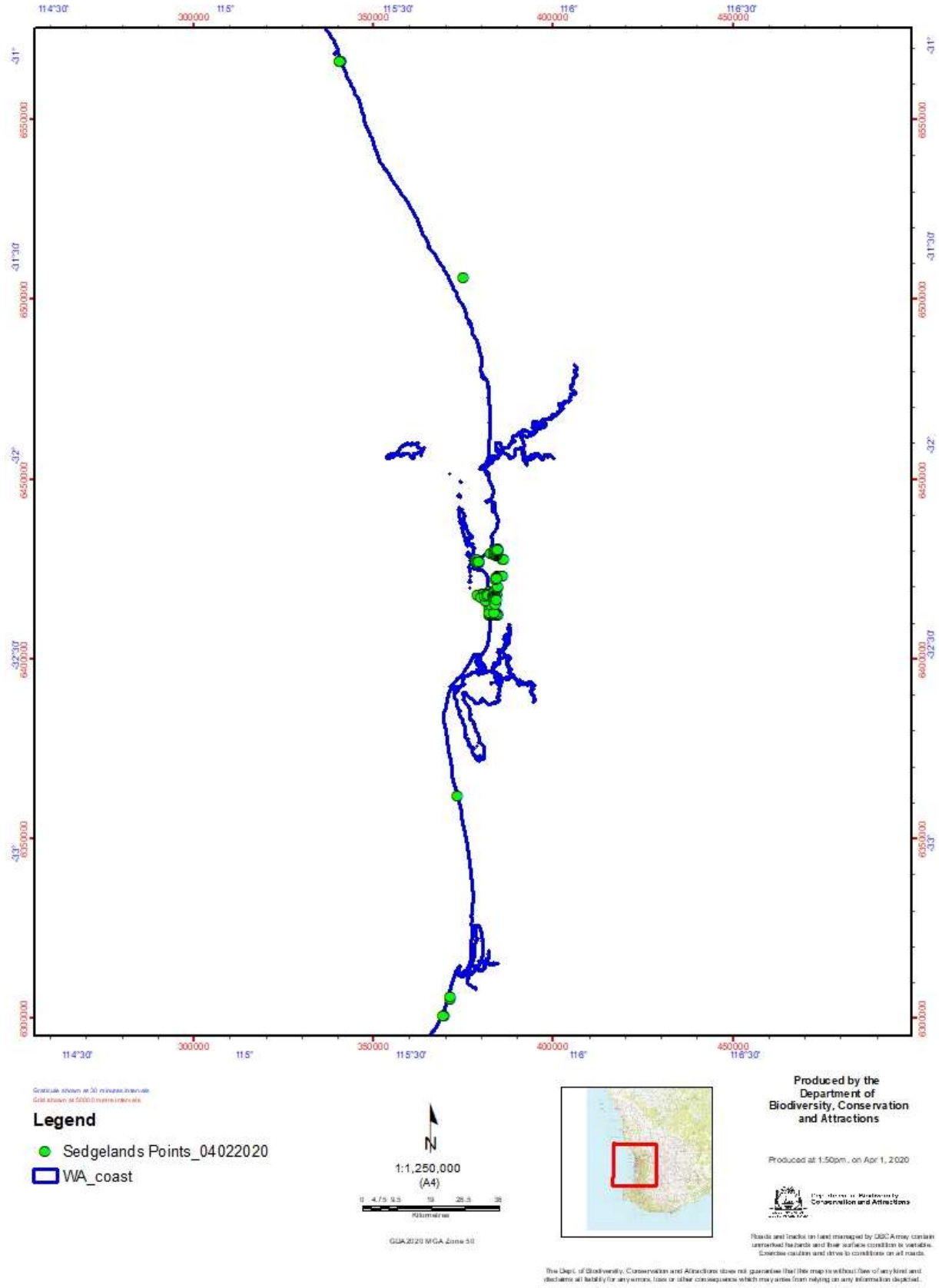
APPENDIX 2 Sedgelands in Holocene dune swales community SCP 19 distribution (green dots)



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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:

			Relative severity (%)		
		Extent (%)	≥ 80	≥ 50	≥ 30
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:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
C2	The next 50 years, or any 50-year period including the present and future, based on change in an abiotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
C3	Since 1750 based on change in an abiotic 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		

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

			Relative severity (%)		
		Extent (%)	≥ 80	≥ 50	≥ 30
D1	The past 50 years based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 80	≥ 50	≥ 30
D2	(D2a) The next 50 years, or (D2b) any 50-year period including the present and future, based on change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table: OR	≥ 80	CR	EN	VU
		≥ 50	EN	VU	
		≥ 30	VU		
			≥ 90	≥ 70	≥ 50
D3	Since 1750, based on a change in a biotic variable affecting a fraction of the extent of the ecosystem and with relative severity, as indicated by the following table:	≥ 90	CR	EN	VU
		≥ 70	EN	VU	
		≥ 50	VU		

E. Quantitative analysis

	CR	EN	VU
… that estimates the probability of ecosystem collapse to be:	≥ 50% within 50 years	≥ 20% within 50 years	≥ 10% within 100 years