GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Nomination *(to be completed by nominator)*

Current conservation status	
Name of ecological community:	Species-rich faunal community of the intertidal flats of Roebuck Bay
Other names:	
Description:	The community occurs on the intertidal mudflats of Roebuck Bay. The bay is a sheltered marine embayment on the macrotidal Kimberley coast. It contains large intertidal flats composed predominantly of carbonate sediments that receive freshwater inputs mainly during the wet season. The community comprises a diverse and abundant marine fauna, with an estimated 300 to 500 species of macrobenthic fauna as well as a high diversity and abundance of migratory shorebirds. The threatened species *Caretta caretta* (loggerhead turtle), *Chelonia mydas* (green turtle), *Natator depressus* (flatback turtle) and the sawfish (*Pristis clavata*) (priority 1), as well as large proportions of the Australian populations of the birds *Limosa lapponica* (bar-tailed godwit) (migratory species) and the threatened *Calidris tenuirostris* (great knot), utilise the habitat and comprise part of the assemblage. Roebuck Bay is recognized as a Wetland of International Importance (1990), National Heritage listed place (2011), marine park (2016) and Indigenous Protected Area (2016), and is known as one of the most important sites in the world for migratory waders.
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	Threatened list	22/6/2001	Vulnerable	B)
	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'.*	VU B3

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. • A: No information supports an inference that a ≥30% reduction at least in geographic distribution has or will occur over any 50-year period, or a ≥50% reduction since ~1750 (ie. the minimum requirements to meet the category VU under criterion A). • **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): EN ☐ **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 979km^2 (≤2,000km^2, which is the threshold for CR). • B2: AOO is 15 10x10 km grid cells (threshold for EN is 20 and for CR is two grid cells) • a): Inadequate quantitative data to support a measure of decline in spatial extent, environmental quality or disruption to biotic interactions to meet thresholds for VU. Does not meet B1a, B2a. • b): No available data indicate that the level of environmental degradation or declines in biotic processes is significantly increasing as a consequence of impacts from increased nutrient loads from urban sources and subsequent blooms of *Lyngbya majuscule* (*Lyngbya*), disturbance to shorebird roosts from recreational activities, industrial and urban pollution, dredging and reclamation of mudflats, and excessive pumping of groundwater from the shallow aquifers

		of the hinterland, and inferred from future changes to the hydrologic regime (see Appendix 1 for details of threats). • c): Ecosystem exists at one threat-defined location and based on current knowledge the level of environmental degradation is not significantly increasing as a consequence of observed of inferred threats. • B3: Known from one threat-defined location and prone to impacts of changes to nutrient levels. Community is considered prone to effects of human activities or stochastic events within a very short time period in an uncertain future and thus capable of collapse or becoming CR within a very short time period (meets VU as <5 threat defined locations). • Although plausibly meets criteria for critically endangered, level of environmental degradation or declines in biotic processes as a consequence of nutrient levels, and *Lyngbya majuscula* in particular, is not significantly increasing as a consequence of observed of inferred threats. • **Meets vulnerable B3**
C.	Environmental degradation of abiotic variable *(Evidence of decline over 50-year period)*	☐ **C1** ☐ **C2** ☐ **C3**
	Justification of assessment under Criterion C.	• C1, C2: The most significant abiotic variable affecting the community is considered to be changes to water quality and quantity. • Collapse of the community is conservatively defined under criterion C as excessive levels of nutrients that result in a 90% change in the invertebrate species in the Roebuck Bay assemblage. • ANZECC/ARMCANZ (2000) trigger values for estuaries for total nitrogen and phosphorus can be used to indicate decline in the community and would require ongoing monitoring. Raised nitrogen and phosphorus levels occurred within the majority of sites sampled at the northern end of the Bay from 2010 to 2012, indicating ongoing eutrophication. This may eventually lead to a shift towards other opportunistic primary producers, such as phytoplankton or macroalgae occurring that may ultimately lead to a change in the invertebrate assemblage. There has been no nutrient monitoring in the bay since 2012. Estrella (2013) concluded that high levels of nutrients (N and P) together with the opportunistic blooms of cyanobacteria *Lyngbya majuscula* were indicative of nutrient enrichment and potentially eutrophication. This in turn significantly affected and modified the benthic invertebrate community. A collapse point would be reached when prolonged eutrophication occurs which results in a significant change to the invertebrate assemblage. • Although actions have been taken to reduce nutrient inputs the appropriate monitoring has not taken place since 2012 to indicate if this has been effective in reducing nutrients. • There is inadequate evidence to suggest the community meets the minimum thresholds for relative severity or extent

		of degradation (≥30%) in relation to nutrient enrichment over any 50-year period. • C3: Inadequate data are available to indicate that the community meets the minimum proportional severity of disruption of abiotic processes (≥50%) since ~1750. • **Inadequate evidence to indicate 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.	• D1, D2: Blooms of *Lyngbya majuscula,* a cyanobacteria is a significant biotic variable affecting the community. It can be toxic to other life forms and can severely impact upon the biodiversity of shallow wetlands thereby affecting the foraging behaviour of shorebirds. • Collapse of the community is conservatively defined under criterion D as high levels of *Lyngbya* (ie mean biomass > 300g AFDM (Ash Free Dry Mass)) within the more critical northern shores of the bay (Town Beach to Fall Point). This location has a more diverse benthic fauna than the more uniform southern shores, supporting more abundant and diverse wader populations. If this area was affected by high *Lyngbya* blooms then assemblages and diversity not found in the southern parts of the bay, where there are finer sediments, would be lost, having a greater impact on waders (pers comm [redacted][1]). • In 2010 to 2012, the presence of *Lyngbya majuscula* at high densities (mean biomass > 300g AFDM) significantly affected the composition, abundance and diversity of benthic macroinvertebrates in those parts of Roebuck Bay affected by the bloom (Estrella 2013). *Lyngbya* blooms covered approximately 13km^2 (1%) of the community. Based on available evidence, the community does not meet the minimum proportion of the extent (≥30%) or proportional severity of disruption of biotic processes (≥30%) over any 50-year period. • D3: Based on available data that indicates 1% of the extent community has been affected by *Lyngbya*, the community does not meet the minimum proportion of the extent (≥50%) or proportional severity of disruption of biotic processes (≥50%) since ~1750. • **Does not meet criterion D**
E.	Quantitative analysis *(statistical probability of ecosystem collapse)*	• No quantitative estimates of the risk of ecosystem collapse. • **Not assessed**
Reasons for change of status		

[1] Director, Wetland Research and Management

<table>
<tr><td colspan="4">Genuine change ☐ New knowledge ☐ Previous mistake ☐ Review/Other ☒</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td colspan="4">Summary of assessment information (provide detailed information in the relevant sections of the nomination form)</td></tr>
<tr><td>EOO</td><td>979 km^2</td><td>AOO</td><td>Fifteen 10x10km grid cells</td></tr>
<tr><td>No. occurrences</td><td>1</td><td>Severely fragmented</td><td>Yes ☐ No ☒ Unknown ☐</td></tr>
<tr><td>Justification</td><td colspan="3">There is a single occurrence</td></tr>
<tr><td colspan="3">Current known area</td><td>32,061 ha</td></tr>
<tr><td colspan="3">Pre-industrialisation extent or its former known extent (if known)</td><td>Has not declined in extent</td></tr>
<tr><td colspan="3">Estimated percentage decline</td><td></td></tr>
</table>

Summary assessment against IUCN RLE Criteria

Criterion	Rank indicated	Overall conclusion
A1	-	• Does not meet
A2a	-	• Does not meet
A2b	-	• Does not meet
A3	-	• Does not meet
B1a	-	• EOO is ≤2,000km^2 • Inadequate data to indicate a measure of decline in spatial extent, environmental quality or disruption to biotic interactions that would meet minimum thresholds of the criterion (VU) • Does not meet criterion
B1b	-	• EOO is ≤2,000km^2 • No available data indicate community is in significant decline. • Does not meet criterion
B1c	-	• EOO is ≤2,000km^2 • Ecosystem exists at one threat defined location and no evidence to indicate significant decline • Does not meet criterion
B2a	-	• AOO is 15 grid cells • Inadequate data available to indicate a measure of decline in spatial extent, environmental quality and disruption to biotic interactions • Does not meet criterion
B2b	-	• AOO is 15 grid cells • No available data to indicate community is in significant decline. • Does not meet criterion
B2c	-	• AOO is 15 grid cells • Ecosystem exists at one threat defined location and no evidence to indicate significant decline
B3	VU	• Known from one threat-defined location • Prone to the effects resulting from increased nutrient loads, recreational activities, industrial and urban pollution, dredging and reclamation of mudflats, and inferred from future changes to the hydrologic regime associated with groundwater abstraction, and capable of Collapse or becoming CR within a very short time period • Meets criterion for VU
C1	-	• Inadequate data available to indicate community meets the minimum thresholds for extent, or severity of degradation (≥30%) over past 50 years to meet VU.
C2	-	• Inadequate data available to indicate community meets the minimum thresholds for extent, or proportional severity of degradation (≥30%) over any 50-year period to meet VU.
C3	-	• Inadequate data available to indicate 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	-	• Does not meet criterion D.
D2	-	• Does not meet criterion D.
D3	-	• Does not meet criterion D.
E	NA	• No quantitative estimates of the risk of ecosystem collapse.
		Meets VU under B3

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GOVERNMENT OF WESTERN AUSTRALIA

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
ROEBUCKCN ROEBUCKNW ROEBUCKSW	Conservation, recreation and traditional and customary aboriginal use and enjoyment reserve (management order with Yawuru Native Title Holders Aboriginal Corporation RNTBC and Conservation Commission of WA); crown reserves (DPLH; Kimberley Port Authority; freehold); Roebuck Plains station (LPL N049900); road reserves; Yawuru Nagulagun/Roebuck Bay Marine Park	1997	100% good	32,061 ha	Nutrient enrichment, industrial and urban pollution, hydrological changes (*past, present, future*) Climate change (*future*)	Monitor nutrients, Lyngbya and invertebrate assemblage. Reduce input of nutrients into Roebuck Bay.

*Condition categories are estimated based on level of threats.

APPENDIX 1 THREATS

Changes to water quality

In 2005 nutrient enrichment was linked to blooms of the cyanobacteria *Lyngbya majuscule* in Roebuck Bay. Lyngbya can be toxic to other life forms and can severely impact upon the biodiversity of shallow wetlands thereby affecting the foraging behaviour of shorebirds. A natural inhabitant of sub-tropical and tropical coastal and estuarine areas of the world, the cyanobacteria is likely to have been naturally present in Roebuck Bay for many years. Ideal conditions including extended sunny periods and heavy rains in December, warm January temperatures, sediments high in ammonia and phosphorus, and elevated nutrient levels in the water have resulted in blooms (Bennelongia 2003; see figure below from Estrella 2013). The presence of *Lyngbya majuscula* at high densities (mean biomass >300 g AFDM) significantly affected the composition, abundance and diversity of benthic macroinvertebrates where blooms occurred (Estrella 2013).

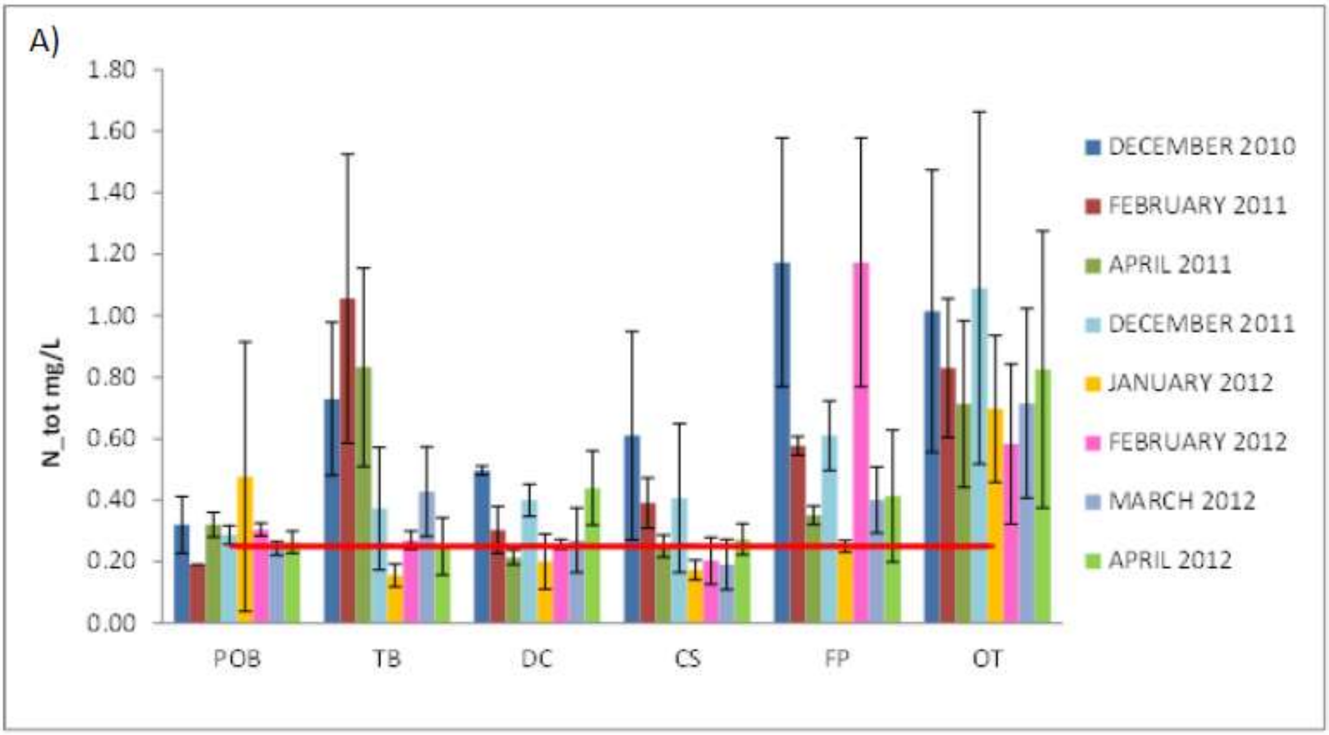

Figure 1. Concentration of total nitrogen in water from five sampling stations over 2010, 2011 and 2012 in Roebuck Bay. ANZECC/ARMCANZ (2000) trigger value is indicated by the red line (recommended total nitrogen=0.25mg/L for estuaries). Data showed as mean ± SD (figure from Estrella 2013; POB = Port of Broome, TB= town beach, DC= Dampier Creek, CS= Camp Site, FP= Fall Point, OT= One Tree).

Monitoring of *Lyngbya* abundance by Nutt (2018) indicates that sites nearer to Broome and potential urban nutrient sources (Slipway and Demco in Figure 2 below), which are also closer to nutrient sources such as the Broome South Waste Water Treatment Plant and Broome Golf Course, have higher levels of *Lyngbya* abundance, possibly a result of increased groundwater concentrations of iron, phosphorus and organic matter. Differences in *Lyngbya* abundance also occurred between years suggesting that it responds to variations in environmental and/or anthropogenic drivers such as sea surface temperature. Estrella (2013) concluded that the fact that *Lyngbya* may not always present extensive and dense blooms every year in the Bay does not mean that the potential eutrophication process has declined or ceased as specific conditions, including heavy rain and high ambient light, sediment rich in nutrients, are required for blooms to occur (Estrella 2013). More recent wet season monitoring indicated little to no *Lyngbya* recorded in the wettest season (2018) for Broome on record (results not included in graph).

Estrella (2103) concludes:

- *Nutrient (N and P) concentrations in the coastal waters of Roebuck Bay are above the trigger values indicated in the ANZECC/ARMCANZ (2000) water quality guidelines.*
- *High levels of nutrients (N and P) together with the opportunistic blooms of cyanobacteria* Lyngbya majuscula *are indicative of nutrient enrichment and potentially eutrophication.*

- *Blooms of* Lyngbya majuscula *significantly affected and modified the benthic invertebrate community of Roebuck Bay.*
- *The induced changes in the benthic invertebrate community of Roebuck Bay have had a cascade effect on the foraging behaviour of at least one species of long distance migratory shorebird, whose diet was modified in presence of high density* Lyngbya *blooms.*

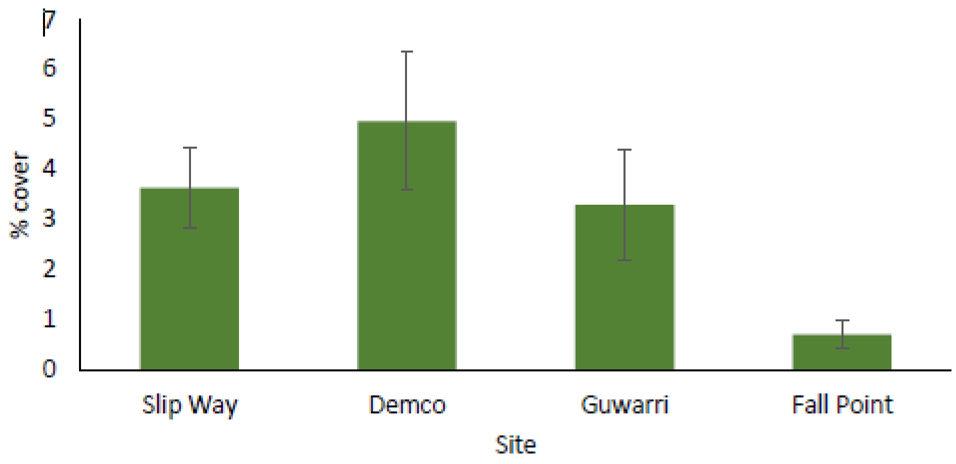

Figure 2. Mean *Lyngbya* abundance at four sites over the study period from 2011 to 2016 (graph from Nutt 2018).

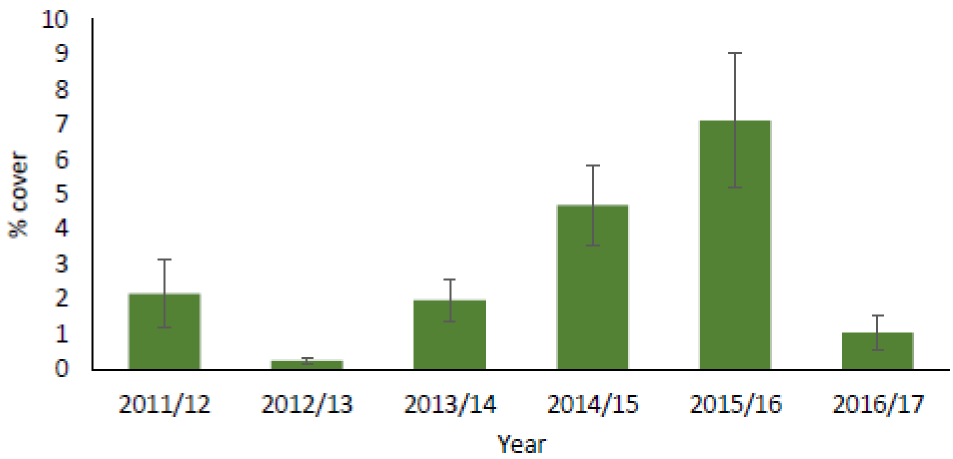

Figure 3. Mean *Lyngbya* abundance recorded by year (November to October) for all sites combined (graph from Nutt 2018).

Monitoring in the bay indicated the likely major sources of nutrient inputs (Nutt 2018). Improvements have been made to sewage processing infrastructure to reduce inputs of nutrients into the bay.

Compton (2018) used historical data collected from a long-term monthly monitoring program and spatially comprehensive mapping to provide insight into developing an approach for long term monitoring of the ecological health of Roebuck Bay, using macrobenthos as an indicator of shorebird foraging possibilities. Macrobenthos are commonly used as an indicator of the ecological health of coastal systems as they are sedentary communities that cannot avoid disturbances, and either die out or adapt themselves and/or their environment to mitigate change (Compton 2018).

The monthly monitoring program ("MonRoeb") provides data that can be used to assess seasonal and yearly changes in the benthos of RB at two locations within Roebuck Bay, Fall Point (FP) and One Tree (OT), using replicated sampling (WRM 2019). WRM (2019) results indicate variability in average species richness and abundance in MonRoeb data between years was comparatively large, even when comparing the same month across years. Plots for June and October data for 1996 to 2016 (see figures 4 and 5 below) show average values for samples typically varied by more than 20% each year. WRM state "…for June data, greatest change in species richness between consecutive years was 67% (FP-B, 2006 to 2007), and greatest change in abundance was 74% (FP-B, 2013 to 2014). For October data, greatest change in species richness between consecutive years was 60% (FP-B, 1996 to 1997), and greatest change in abundance was 50% (OT-A, 1996 to 1997). It is of course unknown if this reflects natural variability in the fauna, or a response to unknown anthropogenic impacts (WRM 2019)…."

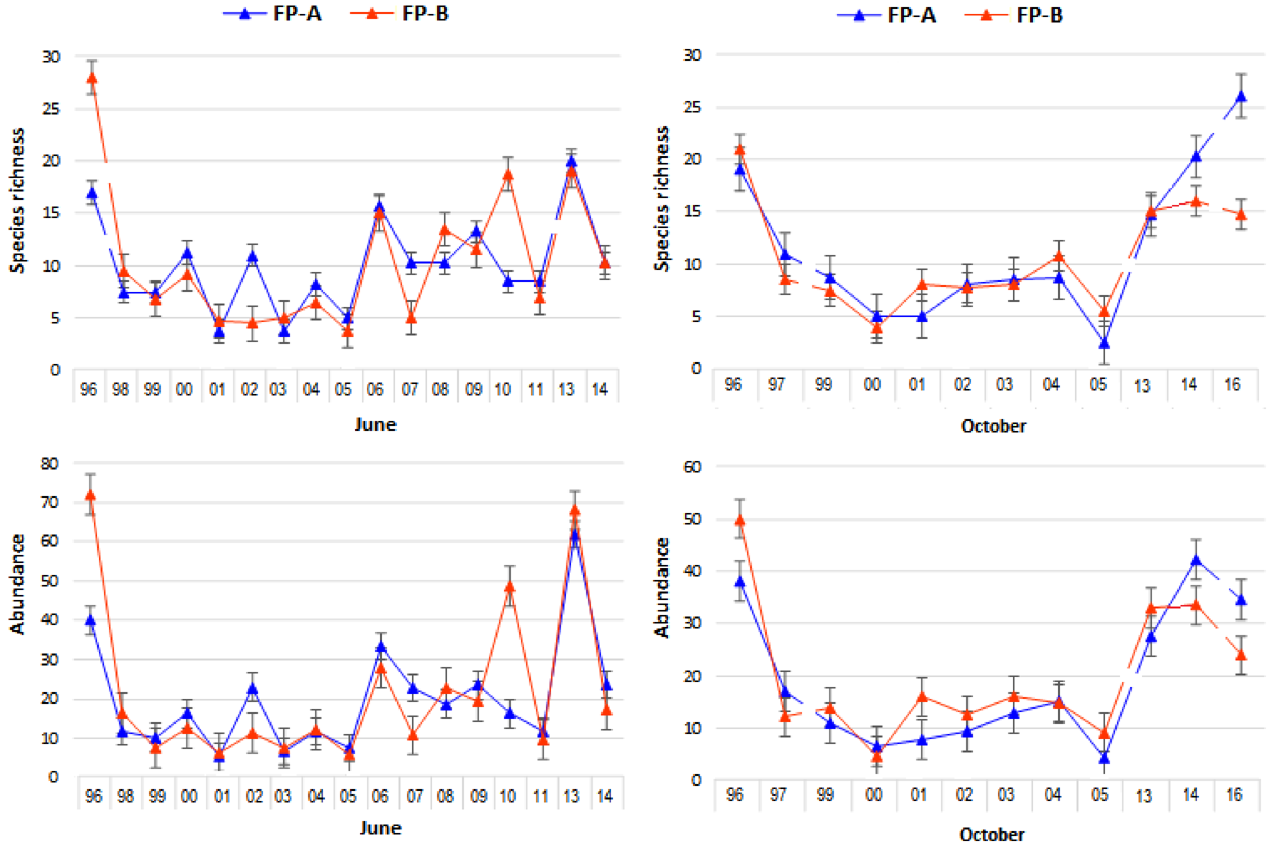

Figure 4. Monthly monitoring program at Fall Point (FP), within Roebuck Bay. Average species richness (top) and abundance (bottom) of the site from 1996 to 2014 (graphs from WRM (2019)).

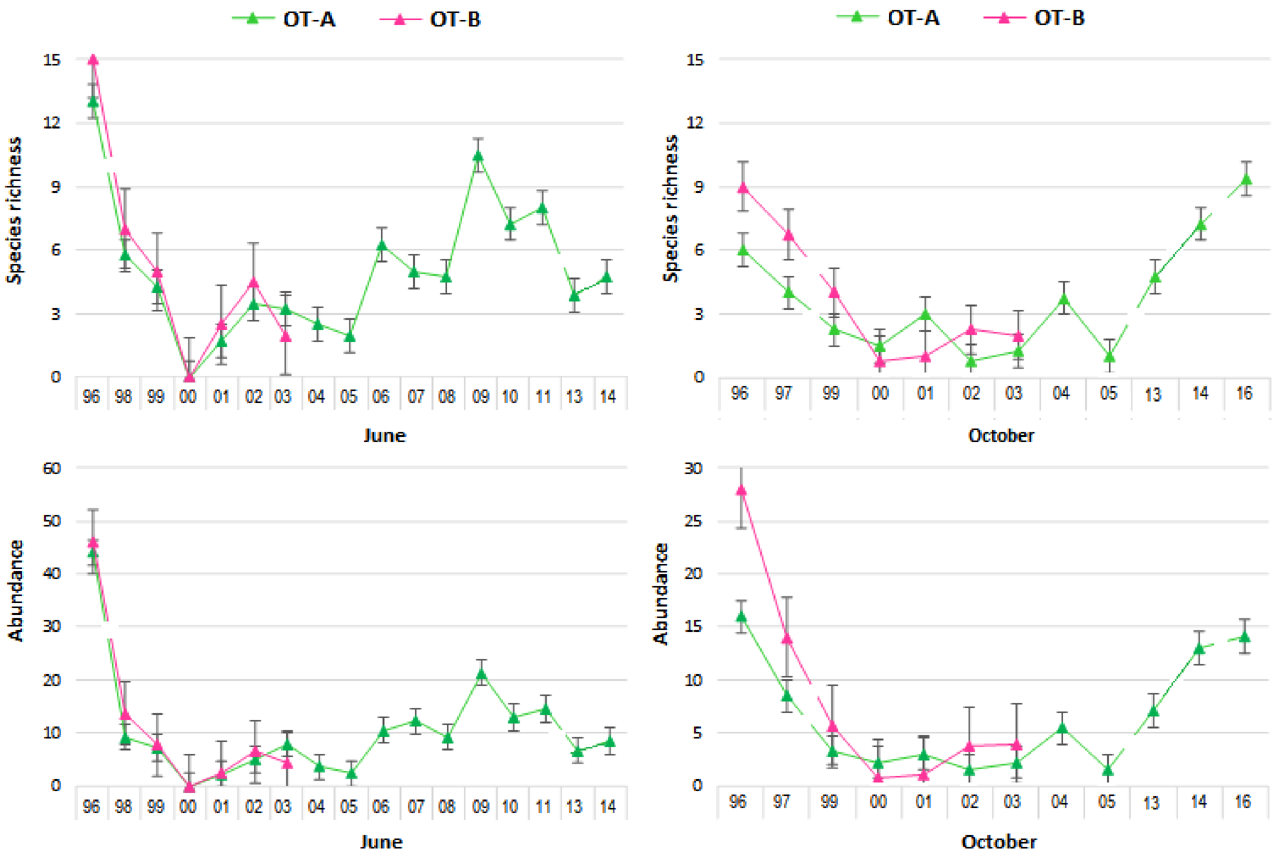

Figure 5. Monthly monitoring program at One Tree (OT), within Roebuck Bay. Average species richness (top) and abundance (bottom) of the site (graphs from WRM (2019)).

Physical damage and disturbance

There is growing tourist use of the Ramsar site, particularly in the cooler months of the dry season (May to September). The northern part of Roebuck Bay is used for fishing and bird watching and there are several boat-launching sites in both areas. Large numbers of small boats and hovercraft use the mudflat areas. Existing and foreseeable land uses are incompatible with the Roebuck Bay Ramsar site remaining an important site for waders. High tide wader roosts along much of the northern shore of the Bay are vulnerable to disturbance from off-road vehicles and pedestrian traffic. Careful management of increasing tourism is necessary to reduce disturbance at important roosts, especially on the accessible northern shore of the Bay.

Grazing of cattle occurs on pastoral leases (Roebuck Plains and Thangoo Stations). There is also commercial fishing, prawning, pearling and industrial use, with deepwater port facilities at Broome. The Broome TAFE supported by the Department of Fisheries has an active aquaculture research facility located near the Port which is dependent on high quality water abstracted from the Bay at the end of the present wharf (Bennelongia 2009).

Pollution

Industrial pollution and accidental sewage spills from the Broome wastewater treatment plant and future petroleum exploration have the potential to adversely impact the benthic fauna, although the risks are reduced by strong tidal flushing. Proposed operations in the hinterlands behind the mangroves could result in dewatering of shallow surface aquifers, potentially activating sediment bound acid sulphates that may have deleterious effects on the ecology of wetlands and the biodiversity values in the Bay. Similar impacts could occur from proposed intensive irrigated agriculture (e.g. for cotton) in the catchment area of the Bay. The impact of commercial net fishing operations on the benthic fauna of the Bay and on indigenous fish harvests is not well understood. Rapidly increasing tourism, mineral exploration and the development of Broome as a base for North West Shelf gas exploration will accelerate human activity in and around Roebuck Bay (Bennelongia 2009).

Groundwater extraction

Extensive urban and industrial development is likely to place additional demands on groundwater supplies in Broome, with uncertain impacts on the Roebuck Bay Ramsar site.

Roebuck Bay is fed by direct recharge from rainfall on the Broome Sandstone outcrop and is part of the La Grange sub-basin to the east and south. Groundwater discharge from the Broome Sandstone occurs in all landward directions, which may create freshwater dependant ecological niches that can be threatened by regional water use or pollution (Vogwill 2003; Bennelongia 2009).

A search of DWER's bore network failed to locate any bores that indicate long-term groundwater level data trends. There are often decades between measurements and often only one measurement is taken. In DWER (2018) it was noted that regional groundwater levels remained relatively stable from 2012 to 2017 and no changes to salinity were detected indicating the seawater interface is most likely stable. However, Vogwill (2003) theorised that the aquifer is 200-250m thick in the vicinity of the Water Supply Borefield, while the water supply bores are 50-100m deep. Therefore, any saltwater incursion into the aquifer will generally occur at the base of the aquifer (due to the greater density of sea water) where the partially penetrating bores do not reach. Despite this on-ground irrigation projects have increased water usage, and as at December 2017, allocation limits were increased from 35GL to 83GL (DWER 2017). It is likely that significant groundwater pumping on Roebuck Plains will affect the location and quantities of discharge of fresh groundwater into the Roebuck Bay ecosystem. Groundwater pumping in the hinterland may also cause a decline in the watertable and the incursion and upwelling of salt water (Vogwill 2003; Benelongia 2009). It is likely that the hydrology of inland areas north of Roebuck Bay have changed due to increased groundwater pumping for urban and horticultural needs in the past 10 years, but the affects on the Bay are not known. Potentially acid sulphate soils exist in the modern and palaeo mudflats of the Bay and dewatering/disturbance could generate increased acidity and liberate metal contaminants (Bennelongia 2009).

Climate change

The tidal community of Roebuck Bay is at risk from potential changes to the inland extent of tidal movement and changed patterns of inundation in the different habitats of the Bay associated with climatic warming. These changes could lead to landward migration of habitats to match the new flooding regime (Bennelongia 2009). The tolerance of particular species to changes that may occur in association with a climate change, including changes in rainfall and temperatures, is generally unknown but it is likely that since *Lyngbya* blooms in Roebuck Bay appear to be triggered by high nutrient levels, sun, initial rain and high temperatures, the predictions of climate change in the NW (increase of temperatures and change in rainfall) are likely to have a significant effect on the *Lyngbya* blooms and hence the macroinvertebrates benthic assemblages, particularly in the areas where the seagrass meadows are found (pers comm. [redacted][2]).

Climate change predictions for northern WA are as follows (from ***NCCARF*** website: https://www.nccarf.edu.au/sites/default/files/attached_files_publications/PDF%20Report%20Card%20Low%20Res.pdf); accessed 2019):

- Rainfall will reduce slightly in the Kimberley by 2030, compared to 1975-2007 baseline.
- Increased runoff has been recorded in the Pilbara, Canning Basin and West Kimberley in recent decades.
- Changes in annual rainfall and temperature may result in loss of vegetation due to a change in surface water runoff from a decline in rainfall.

References

ANZECC (2000) National Water Quality Management Strategy. Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 1: The Guidelines. Australian and New Zealand Environment and Conservation Council, Canberra.

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CSIRO and Bureau of Meteorology (2015) Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia.

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Vogwill, R. (2003) Hydrogeology and aspects of the environmental geology of the Broome area, Western Australia. PhD thesis, Curtin University, Perth.

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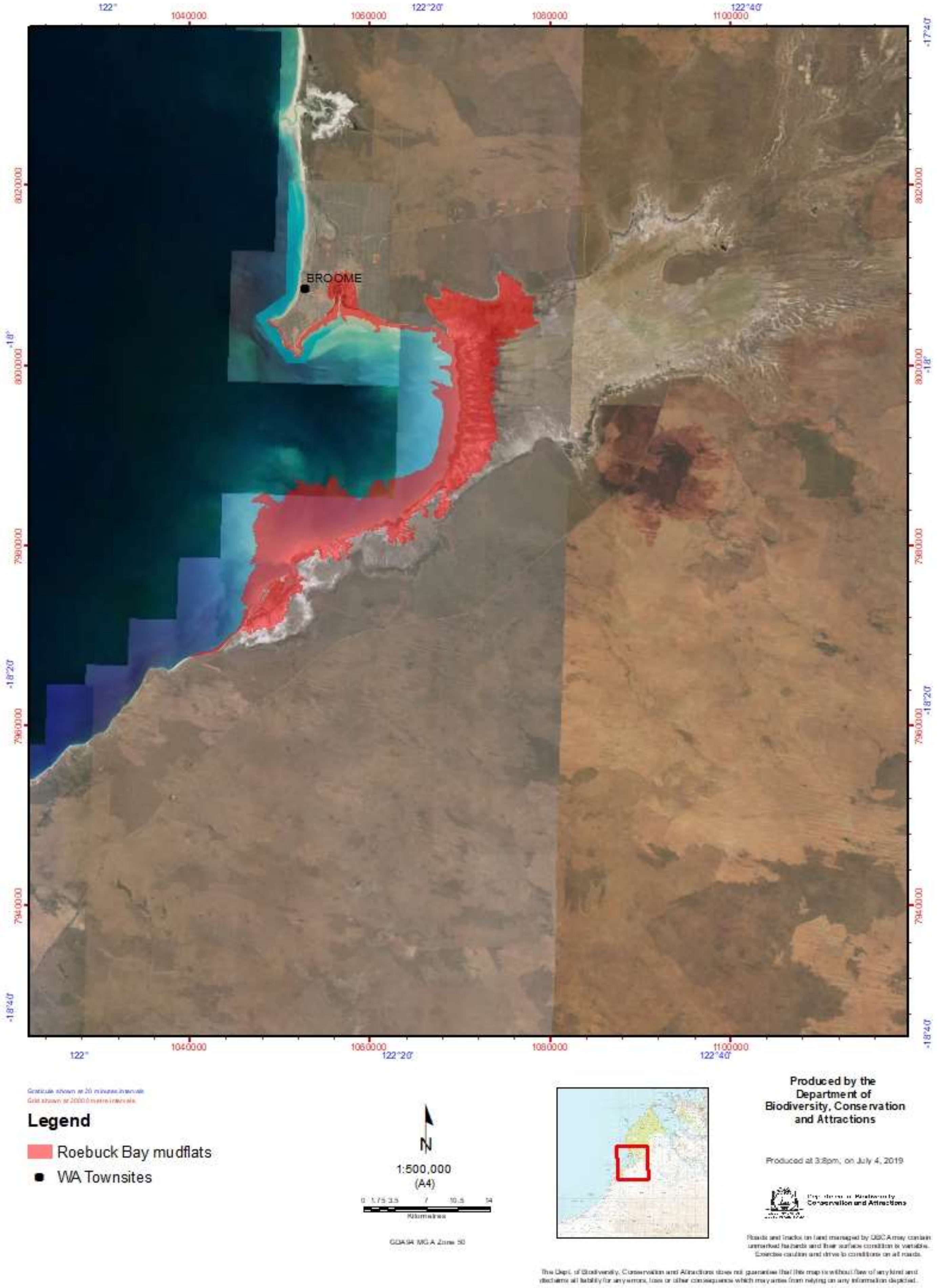
[2] South West Campus Coordinator, Centre for Ecosystem Management | School of Science, Edith Cowan University

APPENDIX 2 Species-rich faunal community of the intertidal flats of Roebuck Bay (red)



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 km^2	≤ 20,000 km^2	≤ 50,000 km^2
	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 <u>abiotic</u> 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 <u>abiotic</u> 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 <u>abiotic</u> 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		

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 <u>biotic</u> 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		
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