Ecological indicator report for the Vasse-Wonnerup Wetlands – Benthic macroinvertebrates 2022

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Methods

Benthic macroinvertebrate sampling was undertaken in the Vasse-Wonnerup wetlands at 40 sites in 2022 in summer (January) and spring (November). Monitoring and calculation of indices were undertaken following the methodology outlined in Cronin-O'Reilly et al. (2023). The Wetland Benthic Community Index (WBCI) integrates information on various biological variables (metrics). Each of these quantified an aspect of the structure and/or function of the invertebrate community and how they respond to stress. The five metrics, namely Simpson's (Diversity) index, qualitative taxonomic distinctness, community dominance, crustacean richness and SIGNAL2, are calculated and summarised into a health score ranging from 100 to 0, with corresponding health grades ranging from A (*Excellent*) to E (*Very poor*). Validation of the WBCI is scheduled for 2024 when sufficient independent data is available. Only the spring WBCI scores generated in this report are used in the Vasse Wonnerup wetlands Report card. This is to allow annual comparison of indicators when macroinvertebrate populations are at their highest to monitor the aim "to maintain healthy populations of macroinvertebrates". Summer indicators are included in this report as additional information to contribute to our understanding of seasonal dynamics of macroinvertebrate communities in the Vasse Wonnerup wetlands.

Key findings and observations 2022

- The average total density of invertebrates was 191 individuals per grab sample across both seasons in 2022, with the highest abundances of invertebrates encountered in the Upper and Lower Wonnerup (Table 1). A seasonal increase in total abundance also occurred between summer and spring 2022, with the size of this increase smaller than the three preceding years (Appendix 1). The greater abundance of invertebrates in the Wonnerup are due to the polychaete worms *Capitella 'capitata'* and *Polydora* sp.that have been steadily increasing in numbers and shifting the community to one numerically dominated by infaunal species in these two regions (Appendix 2 and 3). The same trend is not evident in the Vasse regions, which remain dominated by epifaunal individuals. A summary of the diversity of the invertebrate communities from March 2017 to date is provided in Appendix 2 and 3.
- In spring 2022, benthic ecological health of the Vasse-Wonnerup was *Very Good*, with consistent WBCI scores recorded throughout the estuary and a mean system-wide score of 72 (grade B; Table 2). All regions were awarded a B (*Very Good*) health grade. Compared to preceding years, the health of the

estuary remained stable in most regions or improved in others, with a potential marginal decline in health in the Upper and Lower Wonnerup as these regions have achieved an A (*Excellent)* grade during spring monitoring previously (Table 3). All regions received moderate to high values of all five index measures of community composition (i.e. Simpson's index, qualitative distinction, community dominance, crustacean richness and SIGNAL2; Appendix 5).

- Benthic ecological health was worse in January 2022, with the estuary having an average WBCI score of 47 (grade D, *Poor*; Table 4). Most regions in the estuaries were awarded a D or E (*Very poor*) grade except for the Wonnerup regions, which achieved a grade of C (*Fair*) or higher (Table 5). A seasonal decline consistent with previous monitoring years occurred (Appendix 4). This seasonal decline is as expected due to a range of seasonal stressors (e.g. reduced freshwater inflow, higher water temperatures, higher salinities, reduced water levels, extended water residence times, nutrient concentration and retention), with seasonal changes in ecological health typical in south-western Australian estuaries (Hallett et al. 2012). Predation by waders and other bird species that feed on macroinvertebrates may also contribute to summer declines. The lowest health scores were received in the Vasse Exit Channel, with low metric scores of all five index measures, while other regions experienced a decline in the number of crustacean species and Simpson's diversity (Appendix 5).
- Since biannual monitoring began in November 2020, WBCI scores have remained relatively similar within each region, experiencing a trend of seasonal inclines/declines of a similar magnitude (Appendix 6). Exceptions to this trend were improved benthic ecological health in the Wonnerup in November 2021 following a large amount of rainfall (811 mm of annual rainfall, www.bom.gov.au) and a more severe decline in health that occurred solely in the Lower Wonnerup in summer 2022.

Triggers and management

- Triggers have yet to be established for the benthic macroinvertebrate community. Triggers are due to be proposed together with WBCI validation in 2024.

Recommendations

- Given the difference in the abundance of infaunal polychaetes between the Wonnerup and Vasse estuaries, which is resulting in one estuary harbouring substantially more invertebrates during spring, an investigation into the drivers of this distinct community change is recommended. Understanding the above macroinvertebrate community trends may help to improve benthic productivity of the Vasse estuary, enabling it to support greater bird populations.
- As the behaviour of the WBCI continues to be evaluated under varying seasonal conditions, it is recommended that invertebrate monitoring continue as such (spring and summer sampling, n = 80) to help improve our understanding of index performance.

Results

Table 1. Density (individuals per 225 cm^2, ± 1 standard error) of dominant groups of benthic macroinvertebrates in 2022 averaged across the two sampling seasons. Note that insects (Hexapoda) are now considered crustaceans, but are separated from other crustaceans (amphipods, ostracods etc.) here for convenience.

	Total	**Annelida and Nematoda (worms)**	**Mollusca (Gastropods)**	**Hexapoda**	**Crustacea**
Vasse Wonnerup wetlands	191 ± 32	112 ± 27	6 ± 2	27 ± 5	46 ± 10
Regions					
Upper Vasse	58 ± 22	1 ± 1	0	6 ± 1	51 ± 22
Lower Vasse	118 ± 33	19 ± 9	18 ± 11	12 ± 3	69 ± 29
Upper Wonnerup	340 ± 100	230 ± 93	9 ± 5	70 ± 19	31 ± 11
Lower Wonnerup	422 ± 84	310 ± 73	1 ± 1	39 ± 13	71 ± 30
Vasse Exit Channel	16 ± 6	2 ± 1	2 ± 1	5 ± 2	7 ± 3

Table 2. Wetland Benthic Community Index (WBCI) scores (± 1 standard error) and health grades for the Vasse-Wonnerup wetland in spring 2022 (November).

Ecological region	Index Score	Grade
Vasse-Wonnerup Wetlands	72.3 ± 2.4	B
Regions		
Upper Vasse	73.7 ± 2.1	B
Lower Vasse	69.8 ± 3.1	B
Upper Wonnerup	75.2 ± 2.7	B
Lower Wonnerup	72.9 ± 4.3	B
Vasse Exit Channel	69.7 ± 11	B

Table 3. Annual Wetland Benthic Community Index (WBCI) health grades for the Vasse-Wonnerup wetland in spring 2017-22 (October/November). Boundary grades are provided for scores of the WBCI within 1 score point of the grade boundary, with the first letter listed and colour indicating the side of the boundary that the WBCI score fell on.

Ecological region	2017	2018	2019	2020	2021	2022
Vasse-Wonnerup Wetlands	B	B	C	B	B	B
Regions						
Upper Vasse	B	B	D	B	B	B
Lower Vasse	B/C	B	C/D	B	B	B
Upper Wonnerup	A/B	B/A	B	B	A	B
Lower Wonnerup	A	A	B	C	A	B
Vasse Exit Channel	B	C	C	D	B	B

Table 4. Wetland Benthic Community Index (WBCI) scores (± 1 standard error) and health grades for the Vasse-Wonnerup wetland in summer 2022 (January).

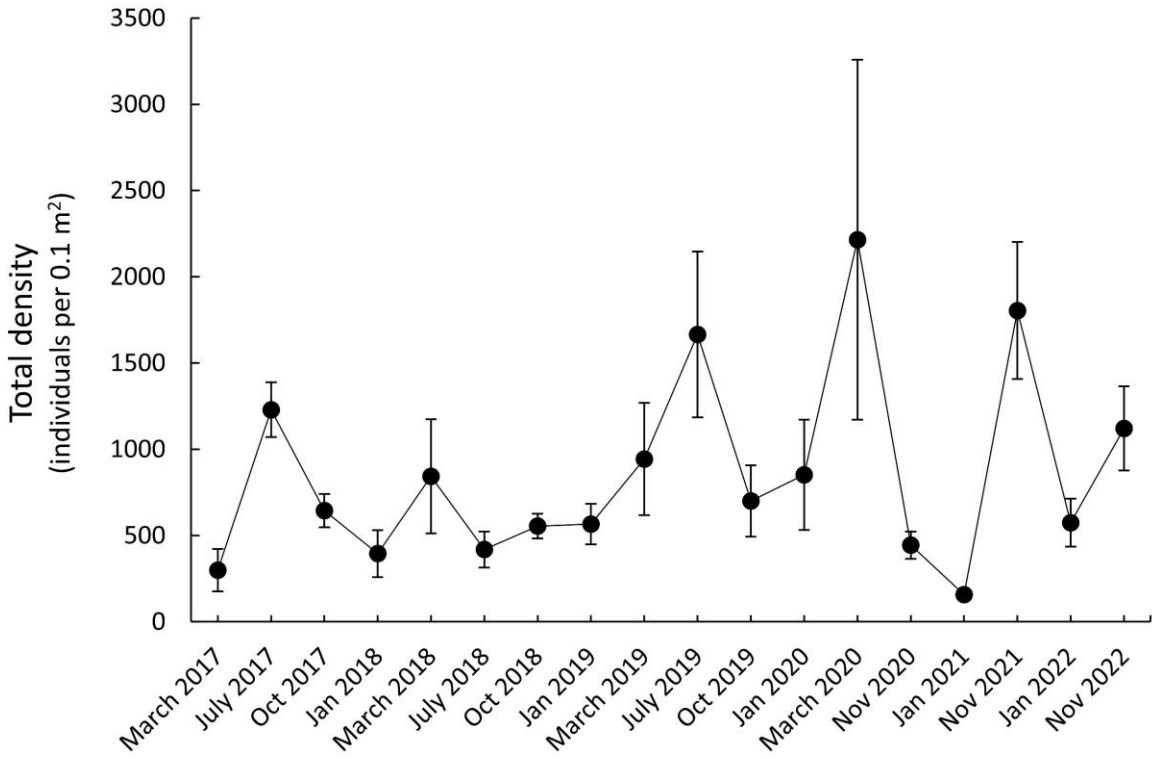
Ecological region	Index Score	Grade
Vasse-Wonnerup Wetlands	46.9 ± 4.3	D
Regions		
Upper Vasse	45.7 ± 9.8	D
Lower Vasse	40.0 ± 8.6	D
Upper Wonnerup	68.3 ± 3.3	B
Lower Wonnerup	63.3 ± 3.1	C
Vasse Exit Channel	17.1 ± 9.1	E

Table 5. Annual Wetland Benthic Community Index (WBCI) health grades for the Vasse-Wonnerup wetland in summer (January) 2018-22. Boundary grades are provided for scores of the WBCI within 1 score point of the grade boundary, with the first letter listed and colour indicating the side of the boundary that the WBCI score fell on.

Ecological region	2018	2019	2020	2021	2022
Vasse-Wonnerup Wetlands	C/B	C	D	C	D
Regions					
Upper Vasse	B	D	B/C	D	D
Lower Vasse	C/B	C	D	C	D
Upper Wonnerup	B	B	D	B	B
Lower Wonnerup	C/D	B/C	C	C	C
Vasse Exit Channel	C/D	E	D	E	E

Appendices

Appendix 1. The total density of invertebrates (individuals per 0.1 m^2, ± 1 standard error) recorded on each sampling occasion between 2017 and 2022.



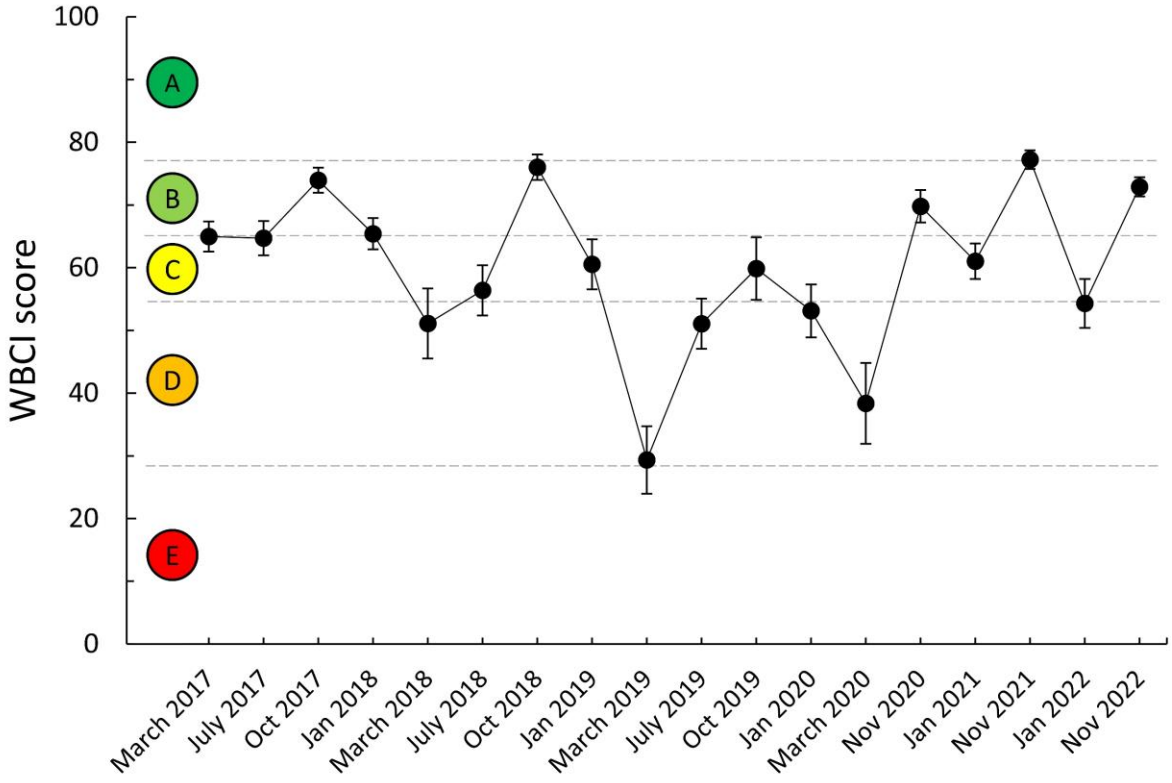
Appendix 2. Summary of the mean number of species, density (invertebrates per 225 cm^2), Simpson's (Diversity) Index and qualitative taxonomic distinctness and the proportion of infaunal and epifaunal individuals to the total invertebrate fauna in the subtidal waters of each region of the Vasse-Wonnerup in spring 2017-2021. The values for the first four metrics separately are reflected in their colour shading from red (low) through yellow (intermediate) to green (high values). Proportions of invertebrates classified as infauna (living within the sediment) and epifauna (living on top of the sediment) are also provided, with greater proportions shaded dark blue.

Metric	Date	Upper Vasse	Lower Vasse	Vasse Channel	Lower Wonnerup	Upper Wonnerup
Number of species	Oct-17	10	7	9	11	9
	Oct-18	12	6	5	9	8
	Oct-19	4	6	5	5	8
	Nov-20	7	10	3	7	7
	Nov-21	11	12	5	13	14
	Nov-22	7	9	6	9	9
Density (inds. per 225 cm^2)	Oct-17	237	81	89	157	162
	Oct-18	207	133	145	77	62
	Oct-19	13	263	52	291	169
	Nov-20	76	210	10	148	56
	Nov-21	288	441	103	426	773
	Nov-22	110	203	28	548	373
Simpson's Diversity	Oct-17	0.38	0.63	0.53	0.78	0.56
	Oct-18	0.66	0.57	0.37	0.78	0.69
	Oct-19	0.62	0.23	0.33	0.49	0.48
	Nov-20	0.63	0.72	0.48	0.48	0.66
	Nov-21	0.61	0.60	0.54	0.60	0.68
	Nov-22	0.69	0.66	0.84	0.47	0.56
Qual. Taxonomic Distinctness	Oct-17	76.5	76.7	77.5	76.0	66.5
	Oct-18	74.5	79.7	90.8	73.1	73.7
	Oct-19	37.0	73.0	69.1	84.5	75.5
	Nov-20	73.3	66.4	60.9	72.1	77.0
	Nov-21	67.6	69.8	66.7	76.6	78.9
	Nov-22	69.7	75.6	65.7	81.5	81.3
% infaunal individuals	Oct-17	19.2	15.2	3.4	25.0	3.6
	Oct-18	6.0	7.5	74.8	2.6	23.5
	Oct-19	23.1	94.1	41.3	72.1	2.8
	Nov-20	14.2	4.9	73.1	51.0	30.0
	Nov-21	0.3	1.6	3.8	57.9	39.5
	Nov-22	0.7	18.2	15.4	73.3	78.7
% epifaunal individuals	Oct-17	80.8	84.8	96.6	75.0	96.4
	Oct-18	94.0	92.5	25.2	97.7	76.5
	Oct-19	76.9	5.9	58.7	27.9	97.2
	Nov-20	85.8	95.1	26.9	49.0	70.0
	Nov-21	99.7	98.4	96.2	42.1	60.5
	Nov-22	99.3	81.8	84.6	26.7	21.3

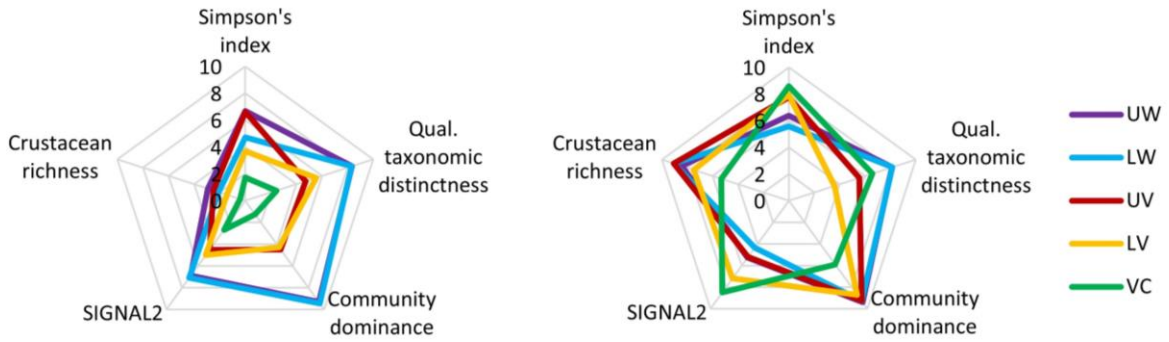
Appendix 3. Summary of the mean number of species, density (invertebrates per 225 cm^2), Simpson's (Diversity) Index and qualitative taxonomic distinctness and the proportion of infaunal and epifaunal individuals to the total invertebrate fauna in the subtidal waters of each region of the Vasse-Wonnerup in summer 2018-2022. The values for the first four metrics separately are reflected in their colour shading from red (low) through yellow (intermediate) to green (high values). Proportions of invertebrates classified as infauna (living within the sediment) and epifauna (living on top of the sediment) are also provided, with greater proportions shaded dark blue.

Metric	Date	Upper Vasse	Lower Vasse	Vasse Channel	Lower Wonnerup	Upper Wonnerup
Number of species	Jan-18	6	6	3	4	4
	Jan-19	3	5	2	8	8
	Jan-20	5	4	2	4	3
	Jan-21	3	4	1	5	6
	Jan-22	3	2	1	6	6
Density (inds. per 225 cm^2)	Jan-18	43	114	20	251	18
	Jan-19	291	179	10	103	54
	Jan-20	23	573	5	327	31
	Jan-21	17	84	5	40	31
	Jan-22	7	33	4	296	306
Simpson's Diversity	Jan-18	0.76	0.42	0.28	0.36	0.68
	Jan-19	0.02	0.34	0.10	0.37	0.77
	Jan-20	0.59	0.05	0.54	0.21	0.23
	Jan-21	0.43	0.29	0.01	0.60	0.75
	Jan-22	0.59	0.33	0.17	0.41	0.57
Qual. Taxonomic Distinctness	Jan-18	83.2	83.6	86.9	93.3	80.1
	Jan-19	89.3	87.4	23.2	77.5	71.6
	Jan-20	81.7	85.0	50.0	92.0	72.6
	Jan-21	78.3	83.0	12.5	68.0	80.5
	Jan-22	45.2	51.8	24.4	84.8	82.5
% infaunal individuals	Jan-18	32.9	26.9	17.9	60.3	9.9
	Jan-19	99.1	23.6	5.3	1.5	2.8
	Jan-20	58.1	97.3	42.1	98.4	78.4
	Jan-21	80.9	86.2	97.2	63.6	21.5
	Jan-22	27.3	0.8	8.6	74.2	54.2
% epifaunal individuals	Jan-18	67.1	73.1	82.1	39.7	90.1
	Jan-19	0.9	76.4	94.7	98.5	97.2
	Jan-20	41.9	2.7	57.9	1.6	21.6
	Jan-21	19.1	13.8	2.8	36.4	78.5
	Jan-22	72.7	99.2	91.4	25.8	45.8

Appendix 4. WBCI scores (± 1 standard error) for regions above the surge barriers (excluding the Vasse Exit Channel) over the full monitoring period (March 2017-November 2022), with dashed lines depicting the score thresholds for each health grade (A-E). The number of samples was 16 per season (except in March 2017, 15 samples) prior to November 2020, and 32 per season thereafter.

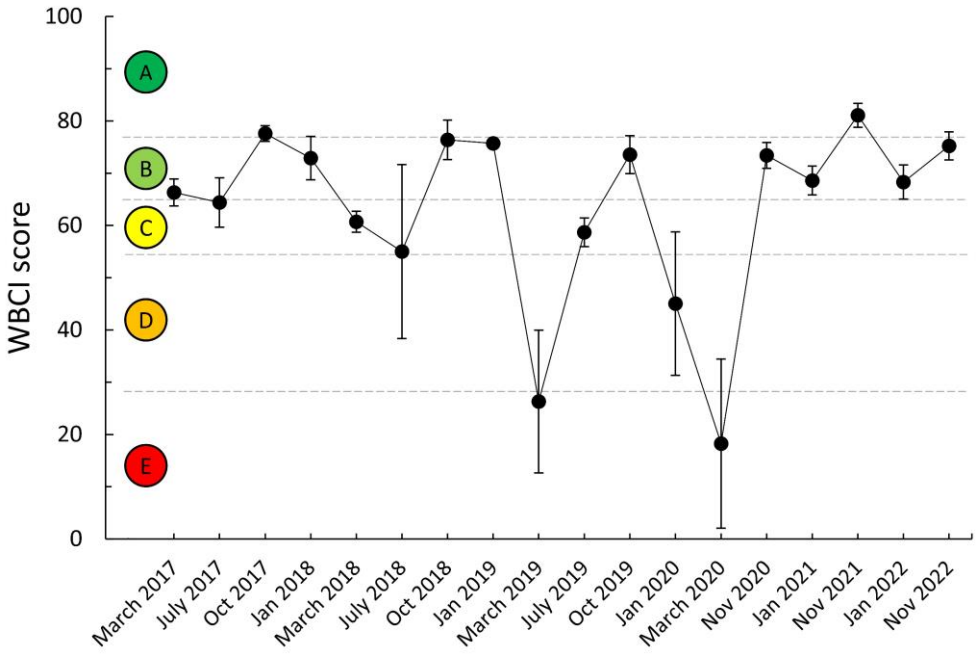


Appendix 5. Average metric scores (0-10) for each community metric measured in each region (UW, Upper Wonnerup; LW, Lower Wonnerup; UV, Upper Vasse; LV, Lower Vasse; VC, Vasse Exit Channel) in summer (January, left) and spring (November, right) 2022. The larger the area covered by the radar plot, the better the benthic ecological health of that region.

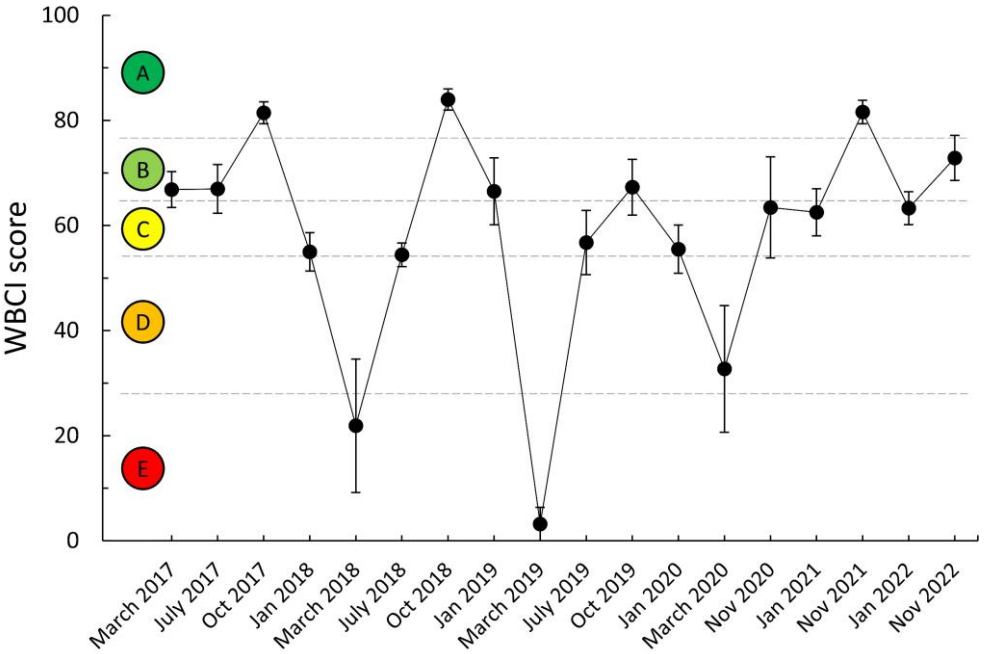


Appendix 6. WBCI scores (± 1 standard error) for the (a) Upper Wonnerup, (b) Lower Wonnerup, (c) Upper Vasse, (d) Lower Vasse and the (e) Vasse Exit Channel, over the full monitoring period (March 2017-Nov 2022), with dashed lines depicting the score thresholds for each health grade (A-E). The number of samples was 4 per region (except in the Lower Wonnerup in March 2017, 3 samples) prior to November 2020, and 8 per region thereafter.

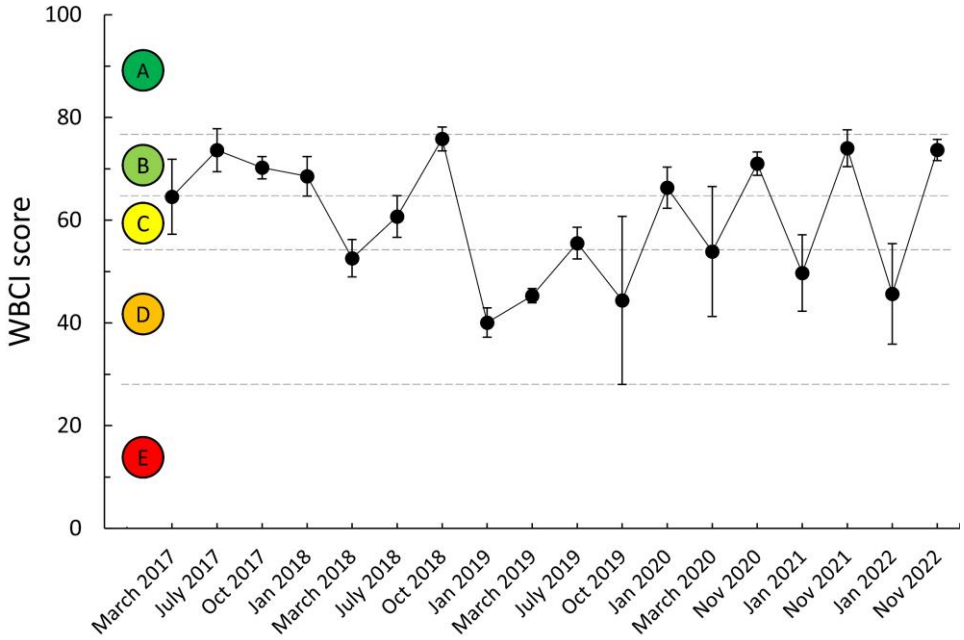
(a) Upper Wonnerup



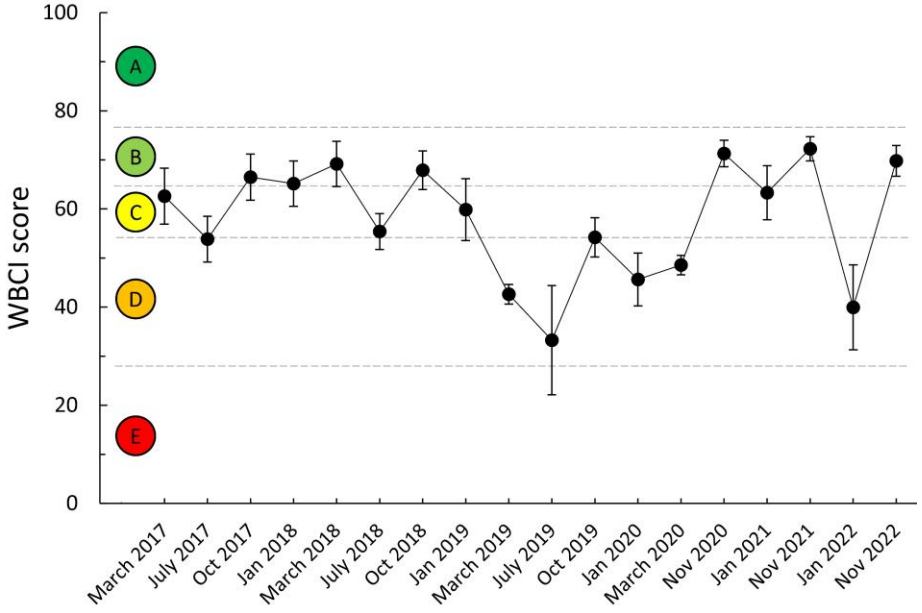
(b) Lower Wonnerup



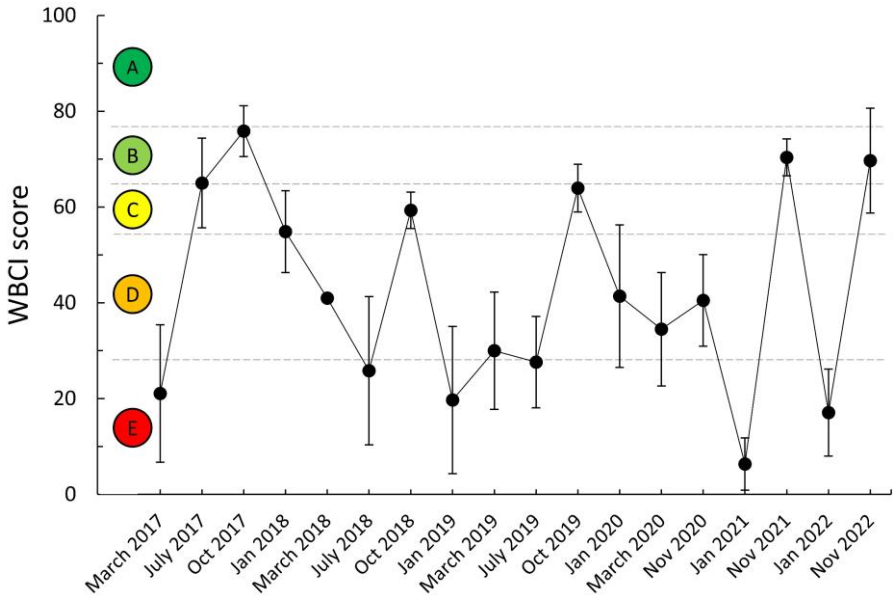
(c) Upper Vasse



(d) Lower Vasse



(e) Vasse Exit Channel



References

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Hallett C, Valesini F, Clarke K, Hesp S, Hoeksema S (2012) Development and validation of fish-based, multimetirc indices for assessing the ecological health of Western Australian estuaries. Estuarine, Coastal and Shelf Science 104-105:102-113