

Tidal Exclusion Barriers Fragment An Invertebrate Community into Taxonomically and Functionally Distinct Estuarine and Wetland Assemblages

Supplementary Materials

Table S1. Trait modality scores for each of the 42 taxa that were able to be identified to a sufficient taxonomic level to be reliably assigned to functional guilds. Traits are denoted by different colours. Score utilises fuzzy coding, where a score (ranging from 0 to 1) is applied across modalities that correspond with the affinity of each taxon to the trait (e.g., 1 if it belongs solely to that modality or if a taxon has equal affinities to two modalities, 0.5 for each) and darker shading denotes a larger score. Taxa assigned using the South Australian Macrobenthic Traits (SAMT) and Australian River Assessment System (AusRivAS) trait databases [1,2].

Trait Modality	Bioturbation mode				Body size			Feeding mode							Living habit				Sediment position			
	Bdiff	Birrig	Surmo	Nbio	Lar	Med	Sma	Defe	Fisus	Graz/Sc	On	Pred	Scav	Ssdefe	Burr	Free	Tubdw	Att/S	Be-pel	Deep	Surfsh	Att
<i>Arthritica semen</i>	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00
<i>Potamopyrgus</i> sp.	0.00	0.00	0.50	0.50	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Capitella</i> 'capitata' (species complex)	0.00	0.50	0.50	0.00	0.00	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.00	0.00	0.00	0.00	1.00	0.00
<i>Corophium minor</i>	0.00	1.00	0.00	0.00	0.25	0.75	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
<i>Simplisetia aequisetis</i>	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.25	0.25	0.00	0.00	0.75	0.25	0.00
Chironominae spp. (larva)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Chironominae spp. (pupa)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Procladius</i> sp. (larva)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Scoloplos normalis</i>	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Corixidae spp. (larva)	0.00	0.00	0.00	1.00	0.00	0.50	0.50	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Hydrochus</i> sp. (adult)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Barnardomelita matilda</i>	0.00	0.00	1.00	0.00	0.00	0.50	0.50	0.00	0.25	0.00	0.00	0.50	0.25	0.25	0.50	0.50	0.00	0.00	0.50	0.00	0.50	0.00
<i>Hiatula biradiata</i>	0.00	0.50	0.50	0.00	1.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Nereididae sp.	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.25	0.00	0.00	0.00	0.50	0.25	0.00	0.75	0.00	0.25	0.00	0.00	0.75	0.25	0.00
Spionidae sp.	0.00	0.00	1.00	0.00	0.00	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	1.00	0.00
Orthocladiinae sp. (larva)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Pseudopolydora kemp</i> i	0.00	0.00	1.00	0.00	0.00	0.50	0.50	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	1.00	0.00
<i>Chironomus occidentalis</i> (larva)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Oligochaeta spp.	0.00	0.25	0.75	0.00	0.25	0.25	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.75	0.50	0.50	0.00	0.00	0.00	0.25	0.75	0.00
<i>Mytilocypris mytiloides</i>	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Agraptocorixa</i> sp. (juv.)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Mytilocypris ambigua</i> s	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Boccardiella limnicola</i>	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00
<i>Chironomus alternans</i> (larva)	0.00	0.00	0.00	1.00	0.00	0.75	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Hydrophilidae sp. (adult)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Micronecta robusta</i> (juv.)	0.00	0.00	0.00	1.00	0.00	0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Berosus</i> sp. (larva)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Armandia intermedia</i>	0.00	1.00	0.00	0.00	0.25	0.50	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
<i>Austrochiltonia subtenuis</i>	0.00	0.00	1.00	0.00	0.00	0.50	0.50	0.00	0.25	0.00	0.00	0.00	0.50	0.25	0.50	0.50	0.00	0.00	0.50	0.00	0.50	0.00
Dytiscidae sp. 1 (larva)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Enchytraeidae sp.	0.00	0.25	0.75	0.00	0.25	0.25	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.75	0.50	0.50	0.00	0.00	0.00	0.25	0.75	0.00
<i>Alboa worooa</i>	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Hydrophilidae sp. 2 (larva)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Megaporus</i> sp. (larva)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Naididae sp.	0.00	0.25	0.75	0.00	0.25	0.25	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.75	0.50	0.50	0.00	0.00	0.00	0.25	0.75	0.00
<i>Candonocypris novaezelandiae</i>	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Ceratopogonidae sp. (larva)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.25	0.00	0.25	0.00	0.50	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Coxiella striatula</i>	0.00	0.00	1.00	0.00	0.00	0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Desdemona ornata</i>	0.00	1.00	0.00	0.00	0.50	0.25	0.25	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Mysida sp.	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
<i>Paranisops</i> sp. (adult)	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Planorbidae sp.	0.00	0.00	0.00	1.00	0.00	0.50	0.50	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00

Table S2. PERMANOVA test results for differences in the community-level weighted means of trait values among regions. Significant differences ($P < 0.05$) shaded grey. Regions: DW = Deadwater, IT = Wonnerup Inlet, VC = Vasse Channel, LV = Lower Vasse, LW = Lower Wonnerup, UV = Upper Vasse, UW = Upper Wonnerup.

Species richness							Total abundance						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.82						IT	0.57					
VC	5.18	4.74					VC	6.44	5.68				
LV	3.37	2.81	2.20				LV	1.16	0.85	2.76			
LW	5.24	4.60	1.41	1.11			LW	6.25	5.05	2.00	1.72		
UV	2.33	1.90	2.06	0.19	1.07		UV	5.71	4.76	1.65	1.81	0.28	
UW	1.65	1.21	2.70	0.86	1.82	0.58	UW	3.85	3.26	1.88	1.32	0.35	0.53
Simpson's index							Quantitative taxonomic distinctness						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	3.02						IT	1.19					
VC	4.81	3.28					VC	5.07	4.33				
LV	2.18	1.18	1.13				LV	0.57	0.23	4.21			
LW	0.76	0.87	3.45	1.55			LW	3.45	2.28	2.61	2.19		
UV	1.04	2.51	4.58	2.43	1.28		UV	2.43	1.45	3.05	1.46	0.65	
UW	0.09	1.72	4.12	1.97	0.54	0.86	UW	1.70	1.11	2.63	1.18	0.48	0.04
Functional richness							Functional evenness						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.60						IT	1.42					
VC							VC						
LV	4.05	2.85					LV	1.63	4.51				
LW	3.76	2.62		0.73			LW	1.28	0.22		4.16		
UV	2.31	1.46		1.68	1.21		UV	2.03	1.22		4.37	1.32	
UW	3.07	2.10		1.07	0.50	0.68	UW	1.52	0.60		3.21	0.70	0.25
Functional dispersion							Rao's quadratic entropy						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	1.92						IT	2.27					
VC							VC						
LV	9.63	3.56					LV	15.03	4.07				
LW	4.84	1.71		1.83			LW	4.13	1.74		1.30		
UV	6.17	0.50		5.04	1.84		UV	7.59	1.30		4.97	1.01	
UW	2.50	0.75		2.13	0.69	0.51	UW	3.97	1.38		2.04	0.43	0.52
Community-level weighted means							Species composition						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	1.48						IT	1.05					
VC	1.99	1.36					VC	2.20	2.07				
LV	6.74	5.04	2.04				LV	3.38	3.10	2.12			
LW	5.18	4.18	1.90	1.02			LW	2.24	2.15	1.39	1.56		
UV	6.26	4.66	1.78	0.96	0.53		UV	2.42	2.27	1.59	1.42	1.21	
UW	6.43	4.67	1.82	1.77	0.68	1.10	UW	2.75	2.57	1.81	1.51	0.85	1.37

Table S3. PERMANOVA test results for differences in the community-level weighted means of trait values among regions. Significant differences ($P < 0.05$) in bold.

Trait modalities	Term	d.f.	Mean squares	Pseudo-F	P
Biodiffusor	Region	6	0.12	4.752	0.007
	Residual	21	0.03		
Bioirrigator	Region	6	0.13	11.976	<0.001
	Residual	21	0.01		
Surface modifier	Region	6	0.04	1.151	0.368
	Residual	21	0.03		
No bioturbation	Region	6	0.5	8.552	<0.001
	Residual	21	0.06		
Large	Region	6	0.02	3.633	0.017
	Residual	21	0.01		
Medium	Region	6	0.08	1.5	0.228
	Residual	21	0.05		
Small	Region	6	0.06	0.989	0.45
	Residual	21	0.06		
Deposit feeder	Region	6	0.16	20.823	<0.001
	Residual	21	0.01		
Filter/Suspension feeder	Region	6	0.08	8.167	<0.001
	Residual	21	0.01		
Grazer/Scraper	Region	6	0.24	3.164	0.033
	Residual	21	0.07		
Omnivore	Region	6	0.04	3.15	0.026
	Residual	21	0.01		
Predator	Region	6	0.01	0.664	0.783
	Residual	21	0.01		
Scavenger/Opportunist	Region	6	0.15	2.883	0.035
	Residual	21	0.05		
Sub-surface deposit feeder	Region	6	0.05	2.69	0.027
	Residual	21	0.02		
Burrower	Region	6	0.45	19.62	<0.001
	Residual	21	0.02		
Free living/Surface crawler	Region	6	0.47	21.361	<0.001
	Residual	21	0.02		
Tube dwelling	Region	6	0	4.655	0.009
	Residual	21	0		
Bentho-pelagic	Region	6	0.74	17.664	<0.001
	Residual	21	0.04		
Deeper	Region	6	0.15	18.299	<0.001
	Residual	21	0.01		
Surface shallow	Region	6	0.28	9.553	<0.001
	Residual	21	0.03		

Table S4. PERMANOVA test results for differences in the community-level weighted means of trait values among regions. Significant differences ($P < 0.05$) in bold. Note that pairwise tests were not conducted for functional divergence and functional redundancy, as the main test was not significant (Table 2). Regions: DW = Deadwater, IT = Wonnerup Inlet, VC = Vasse Channel, LV = Lower Vasse, LW = Lower Wonnerup, UV = Upper Vasse, UW = Upper Wonnerup.

Biodiffusor							Bioirrigator						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.80						IT	0.07					
VC	2.11	0.97					VC	2.58	2.51				
LV	5.50	2.20	1.03				LV	5.20	5.10	3.07			
LW	3.83	1.64	0.50	1.00			LW	5.22	5.13	3.10	0.00		
UV	5.50	2.20	1.03	0.00	1.00		UV	4.37	4.28	2.03	1.10	1.14	
UW	5.50	2.20	1.03	0.00	1.00	0.00	UW	3.55	3.47	1.18	1.53	1.54	0.67
No bioturbation							Large						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.31						IT	0.66					
VC	1.44	1.44					VC	1.40	0.68				
LV	5.29	5.29	1.32				LV	3.96	2.10	1.03			
LW	5.62	5.62	1.86	0.82			LW	3.90	2.05	0.99	1.00		
UV	8.61	8.62	1.86	0.72	0.28		UV	3.64	1.89	0.85	1.26	0.91	
UW	6.57	6.57	1.72	0.56	0.33	0.10	UW	3.96	2.10	1.03	0.00	1.00	1.26
Deposit feeder							Filter/Suspension feeder						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	1.89						IT	1.95					
VC	0.81	1.57					VC	5.44	1.45				
LV	15.10	20.18	4.13				LV	15.02	2.00	0.43			
LW	9.65	12.00	3.56	0.96			LW	12.96	1.93	0.35	0.12		
UV	8.80	10.89	3.41	1.10	0.19		UV	4.09	0.58	1.14	1.99	1.88	
UW	4.72	5.80	2.38	1.57	0.98	0.84	UW	28.30	2.29	0.81	0.90	0.94	2.48
Grazer/Scraper							Omnivore						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	1.00						IT	0.00					
VC	1.00	1.00					VC	1.00	1.00				
LV	2.97	2.96	1.81				LV	1.00	1.00	0.91			
LW	1.28	1.28	0.24	1.57			LW	2.01	2.01	1.98	1.66		
UV	3.64	3.63	1.28	0.98	0.96		UV	1.32	1.32	1.24	0.27	1.55	
UW	2.24	2.23	0.01	2.12	0.30	1.87	UW	12.33	12.33	11.27	1.92	1.17	1.46
Scavenger/Opportunist							Sub-surface deposit feeder						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.51						IT	1.74					
VC	1.19	1.35					VC	1.11	0.30				
LV	1.25	1.28	1.30				LV	5.42	3.50	1.88			
LW	2.41	2.44	2.47	0.75			LW	5.02	3.39	1.83	0.62		
UV	1.74	1.78	1.84	0.24	1.19		UV	1.48	2.39	1.46	1.68	1.45	
UW	3.06	3.09	3.13	0.96	0.17	1.54	UW	0.69	1.90	1.30	1.54	1.39	0.34

Table S4. Continued.

Burrower							Free living/Surface crawler						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	1.56						IT	1.68					
VC	2.83	1.81					VC	2.98	1.96				
LV	38.60	8.30	2.22				LV	42.17	9.19	2.22			
LW	12.46	6.19	1.71	1.16			LW	12.93	6.72	1.71	1.16		
UV	20.27	7.21	1.89	1.44	0.28		UV	21.27	7.93	1.89	1.44	0.28	
UW	13.29	6.22	1.63	1.56	0.19	0.54	UW	13.83	6.77	1.63	1.56	0.19	0.54
Tube dwelling							Benthopelagic						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	0.08						IT	0.47					
VC	3.05	1.97					VC	1.65	1.67				
LV	3.05	1.97	0.00				LV	50.19	54.40	2.48			
LW	3.05	1.97	0.00	0.00			LW	15.79	16.00	2.13	1.17		
UV	3.05	1.97	0.00	0.00	0.00		UV	13.37	13.52	2.00	1.44	0.32	
UW	3.05	1.97	0.00	0.00	0.00	0.00	UW	7.93	8.00	1.66	1.54	0.77	0.52
Deeper							Surface shallow						
	DW	IT	VC	LV	LW	UV		DW	IT	VC	LV	LW	UV
IT	2.24						IT	2.43					
VC	4.75	1.53					VC	0.11	1.21				
LV	15.06	3.52	1.82				LV	14.91	8.28	2.70			
LW	10.63	2.97	1.26	1.12			LW	11.19	7.54	2.46	1.12		
UV	14.27	3.37	1.66	1.26	0.71		UV	5.54	5.76	2.05	1.28	0.69	
UW	15.06	3.52	1.82	0.00	1.12	1.26	UW	2.99	4.02	1.51	1.54	1.16	0.61

References

1. Lam-Gordillo, O.; Baring, R.; Dittmann, S. Establishing the South Australian Macroinvertebrate Traits (SAMT) database: A trait classification for functional assessments. *Ecology and Evolution* **2020**, *10*, 14372-14387, doi:https://doi.org/10.1002/ece3.7040.
2. Kefford, B.J.; Botwe, P.K.; Brooks, A.J.; Kunz, S.; Marchant, R.; Maxwell, S.; Metzeling, L.; Schäfer, R.B.; Thompson, R.M. An integrated database of stream macroinvertebrate traits for Australia: concept and application. *Ecological Indicators* **2020**, *114*, 106280, doi:https://doi.org/10.1016/j.ecolind.2020.106280.