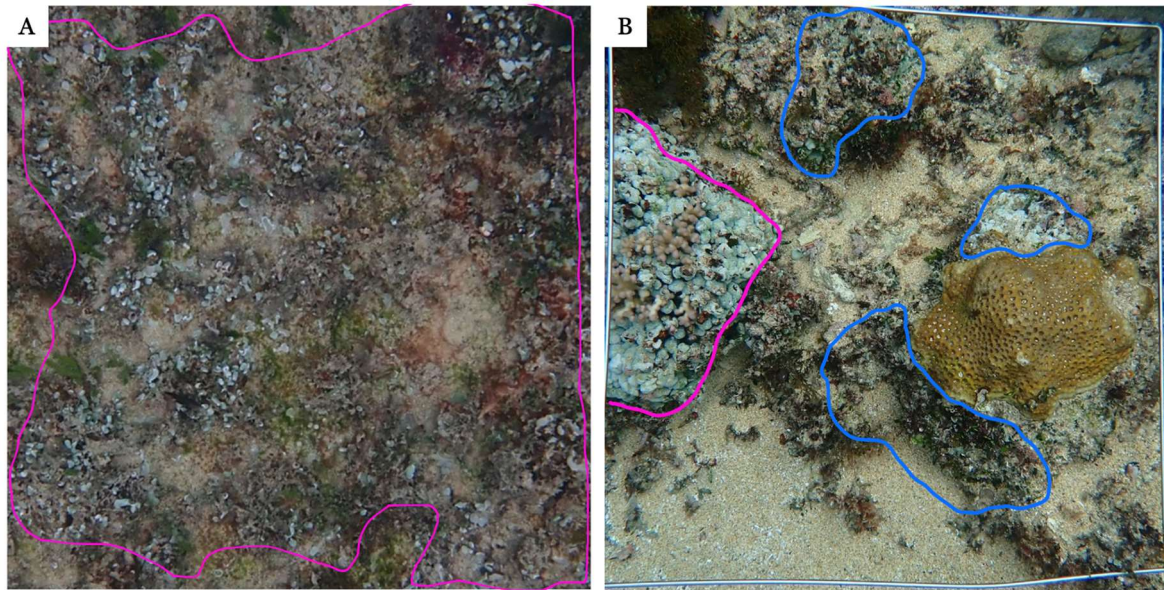


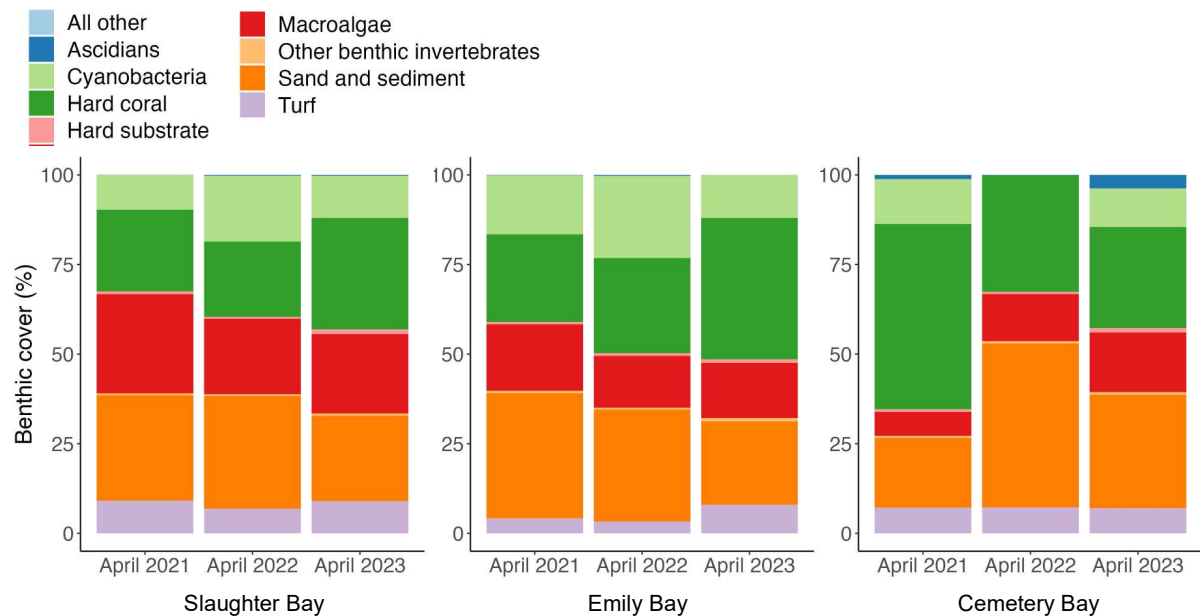
# Supplementary Material

**Table S1.** Specifically identified taxa and groups classified in CoralNet and included in the broad benthic categories used for data analysis.

Benthic category	Group	Specifically identified taxa
All other		
Ascidians		
Cyanobacteria	Red cyanobacteria Black cyanobacteria	
Hard coral		<i>Acanthastrea</i>
		<i>Acropora</i> branching
		<i>Acropora</i> plating
		<i>Goniopora</i>
		<i>Montipora</i> encrusting
		<i>Montipora</i> plating
		<i>Platygyra</i>
		<i>Pocillopora</i>
		<i>Porites</i>
	All other hard corals	
Hard substrate	Bare rock	
	Dead coral	
	Rubble	
Macroalgae	Fleshy: Foliose	Dictyotaceae
	Fleshy: Corticated	<i>Caulerpa</i>
	Fleshy: Leathery	
	Articulated calcified algae (ACA)	
	Crustose coralline algae (CCA)	
Other benthic invertebrates	Anemone	
	Sea cucumber	
	Sea urchin	
	Soft coral	
Sand and sediment	Sand	
	Sediment	
Turf	Green turf	
	All other turf	



**Figure S1.** Substrate preference and interaction methodology. (A) The ascidians in this picture are counted as one ascidian unit. They are growing on sand and ~70% of the ascidians are interacting with turf. (B) There are two ascidian units in this picture. One is growing and interacting with coral (pink), and the other unit is growing on sand and mainly interacting with turf (blue). Photo credits: Norfolk Island, Charlotte Page and Sophie Vuleta, used with permission.



**Figure S2.** Percent cover-based frequency distribution of the benthic categories ascidians, cyanobacteria, hard coral, hard substrate, macroalgae, other benthic invertebrates, sand and sediment, turf, and all other present at each site in April 2021, April 2022, and April 2023. Each bar represents the relative proportion of frequency for a specific category, calculated based on its mean percent cover value.

**Table S2.** Mean percent cover and standard error (SE) for all the benthic categories identified in the ecological surveys in all sites at all three time points (TP). Mean percent cover rounded to one decimal points and SE to two decimal points.

TP	Site	Category	Mean cover (%)	SE
Apr-21	SB	All other	0.0	0.01
		Ascidians	0.1	0.05
		Cyanobacteria	9.6	1.95

Apr-22		Hard coral	22.8	4.34
		Hard substrate	0.7	0.27
		Macroalgae	27.7	4.23
		Other benthic invertebrates	0.5	0.11
		Sand and sediment	29.4	3.90
		Turf	9.1	1.64
	EB	All other	0.0	0.00
		Ascidians	0.1	0.07
		Cyanobacteria	16.5	3.89
		Hard coral	24.5	5.21
		Hard substrate	0.6	0.29
		Macroalgae	18.5	3.13
		Other benthic invertebrates	0.7	0.21
		Sand and sediment	34.9	4.05
		Turf	4.2	0.74
	CB	All other	0.0	0.00
		Ascidians	1.2	0.88
		Cyanobacteria	12.5	1.87
		Hard coral	51.7	7.27
		Hard substrate	0.7	0.19
		Macroalgae	6.7	1.79
		Other benthic invertebrates	0.5	0.25
		Sand and sediment	19.5	3.11
		Turf	7.2	1.51
	SB	All other	0.0	0.00
		Ascidians	0.2	0.09
		Cyanobacteria	18.5	2.59
		Hard coral	21.1	2.32
		Hard substrate	0.5	0.10
		Macroalgae	21.2	2.56
		Other benthic invertebrates	0.5	0.13
		Sand and sediment	31.2	4.34
		Turf	6.9	1.02
	EB	All other	0.0	0.01
		Ascidians	0.3	0.12
		Cyanobacteria	23.0	4.11
		Hard coral	26.6	3.40
		Hard substrate	0.7	0.55
		Macroalgae	14.5	1.61
		Other benthic invertebrates	0.6	0.10
		Sand and sediment	31.1	6.24
		Turf	3.3	0.66
	CB	All other	0.0	0.00
		Ascidians	0.1	0.12

Apr-23		Cyanobacteria	0.0	0.00
		Hard coral	32.5	6.88
		Hard substrate	0.6	0.40
		Macroalgae	13.1	2.61
		Other benthic invertebrates	0.6	0.40
		Sand and sediment	45.8	8.08
		Turf	7.2	1.75
	SB	All other	0.0	0.00
		Ascidians	0.3	0.22
		Cyanobacteria	11.7	1.98
		Hard coral	31.1	4.15
		Hard substrate	1.3	0.40
		Macroalgae	22.2	1.91
		Other benthic invertebrates	0.6	0.10
		Sand and sediment	23.8	4.20
		Turf	9.0	2.16
	EB	All other	0.0	0.01
		Ascidians	0.0	0.02
		Cyanobacteria	12.0	1.62
		Hard coral	39.4	4.77
		Hard substrate	1.0	0.73
		Macroalgae	15.4	1.64
		Other benthic invertebrates	0.9	0.21
		Sand and sediment	23.3	2.90
		Turf	7.9	1.03
	CB	All other	0.0	0.00
		Ascidians	3.8	1.68
		Cyanobacteria	10.8	1.37
		Hard coral	28.2	8.64
		Hard substrate	1.2	0.32
		Macroalgae	16.6	3.02
		Other benthic invertebrates	0.7	0.37
		Sand and sediment	31.6	6.05
		Turf	7.0	0.85

**Table S3.** Odds ratios, standard errors (SE), z-ratios, p-values, and asymptotic lower (LCL) and upper (UCL) confidence limits for contrasts assessing changes in ascidian percent cover across sites and time points. Notable comparisons explore variations in the rate of change between different sites (Cemetery Bay (CB); Emily Bay (EB); Slaughter Bay (SB)) and years (April 2021 (21), April 2022 (22), and April 2023 (23)).

Contrast	Odds Ratio	SE	Z-Ratio	P Value	Asymp LCL	Asymp UCL
CB 22-21 v. CB 23-22	0.028	0.035	-2.855	0.03	0.001	0.795784
EB 22-21 v. EB 23-22	1.163	1.107	0.159	1	0.092	14.77954

SB 22-21 v. SB 23-22	1.469	1.013	0.557	0.985	0.233	9.275957
CB 22-21 v. EB 22-21	0.471	0.405	-0.875	0.905	0.047	4.694792
CB 23-22 v. EB 23-22	19.45	17.982	3.21	0.009	1.645	230.0459
CB 22-21 v. SB 22-21	0.25	0.202	-1.719	0.389	0.029	2.155743
CB 23-22 v. SB 23-22	13.053	9.746	3.441	0.005	1.775	95.99089
EB 22-21 v. SB 22-21	0.532	0.353	-0.951	0.873	0.09	3.140549
EB 23-22 v. SB 23-22	0.671	0.532	-0.503	0.99	0.081	5.582052

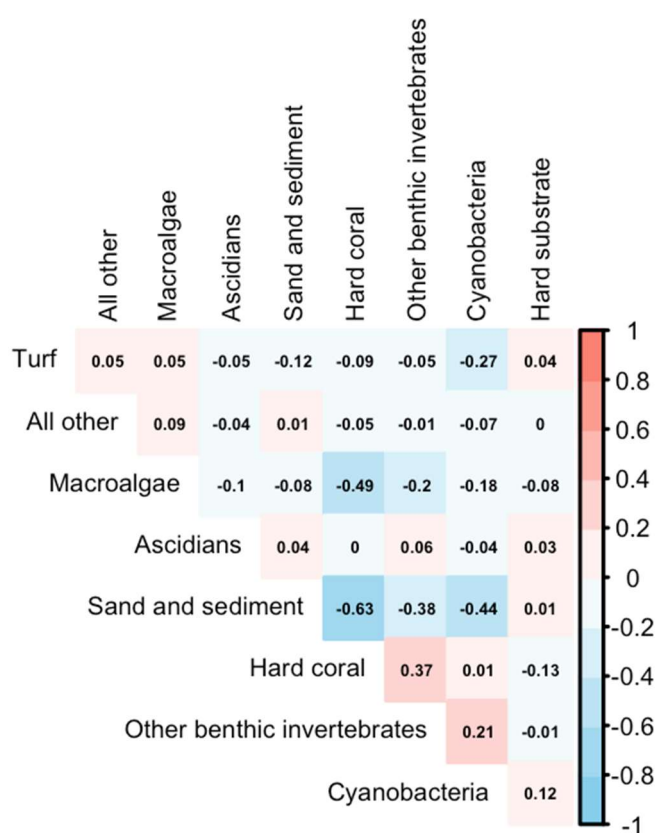
**Table S4.** Percentage of ascidians that covered each substrate type at each site (CB = Cemetery Bay; EB = Emily Bay; SB = Slaughter Bay) averaged over three time points. No. of ascidian units represents counts of how many ascidian units were found on each substrate per site. Results rounded to two decimal points.

Site	Substrate type	No. of ascidian units	Ascidians growing on substrate (%)
SB	Cyanobacteria	2	4.35
	Hard substrate	2	4.35
	Macroalgae	3	6.52
	Sand and sediment	33	71.74
	Turf	6	13.04
EB	Cyanobacteria	6	16.67
	Hard coral	2	5.56
	Macroalgae	4	11.11
	Sand and sediment	16	44.44
	Turf	8	22.22
CB	Cyanobacteria	1	3.23
	Hard coral	6	19.35
	Hard substrate	1	3.23
	Macroalgae	2	6.45
	Sand and sediment	19	61.29
	Turf	2	6.45

**Table S5.** Percentage of ascidians that interacted with/were bordered by different benthic organisms at each site (CB = Cemetery Bay; EB = Emily Bay; SB = Slaughter Bay) averaged over three time points. No. of ascidian units represents counts of how many ascidian units were found to interact with each benthic organism or substrate. Results rounded to two decimal points.

Site	Interaction partner	No. of ascidian units	Ascidians undergoing interaction (%)
SB	Cyanobacteria	8	17.39
	Hard coral	1	2.17
	Hard substrate	1	2.17
	Macroalgae	8	17.39
	Sand and sediment	10	21.74

	Turf	18	39.13
EB	Cyanobacteria	11	30.56
	Hard coral	2	5.56
	Macroalgae	4	11.11
	Sand and sediment	8	22.22
	Turf	11	30.56
CB	Cyanobacteria	6	19.35
	Hard coral	2	6.45
	Macroalgae	6	19.35
	Sand and sediment	3	9.68
	Turf	14	45.16



**Figure S3.** Correlation matrix illustrating the pairwise relationships between various benthic groups. Correlation coefficients range from -1 to 1, with warmer colors indicating stronger positive correlations (towards 1) and cooler colors indicating stronger negative correlations (towards -1). Values near 0 represent weaker or no correlation.