Table S1. Size structure of *Centrostephanus rodgersii* and *Heliocidaris erythrogramma* communities determined by hapazardly measuring 100 urchins in Wollongong, Bass Point, Bendalong and Jervis Bay. Ranges and means for urchin size (Test Diameter, TD, mm) is shown with the associated standard error (SE). The largest *C. rodgersii* were found at Bendalong, Jervis Bay, Wollongong and Bass Point and the largest *H. erythrogramma* were found at Jervis Bay, Bendalong, Bass Point and Wollongong.

Urchin species	Location	TD mean	TD range	± SE
C. rodgersii	Wollongong	88.4	45–120	1.0
C. rodgersii	Bass Point	63.4	40–82	0.9
C. rodgersii	Jervis Bay	97.3	69–121	0.4
C. rodgersii	Bendalong	99.6	69–116	0.8
H. erythrogramma	Wollongong	54.3	32–83	0.9
H. erythrogramma	Bass Point	55.4	30–82	1.3
H. erythrogramma	Jervis Bay	70.8	34–93	0.7
H. erythrogramma	Bendalong	59.8	31–101	0.9

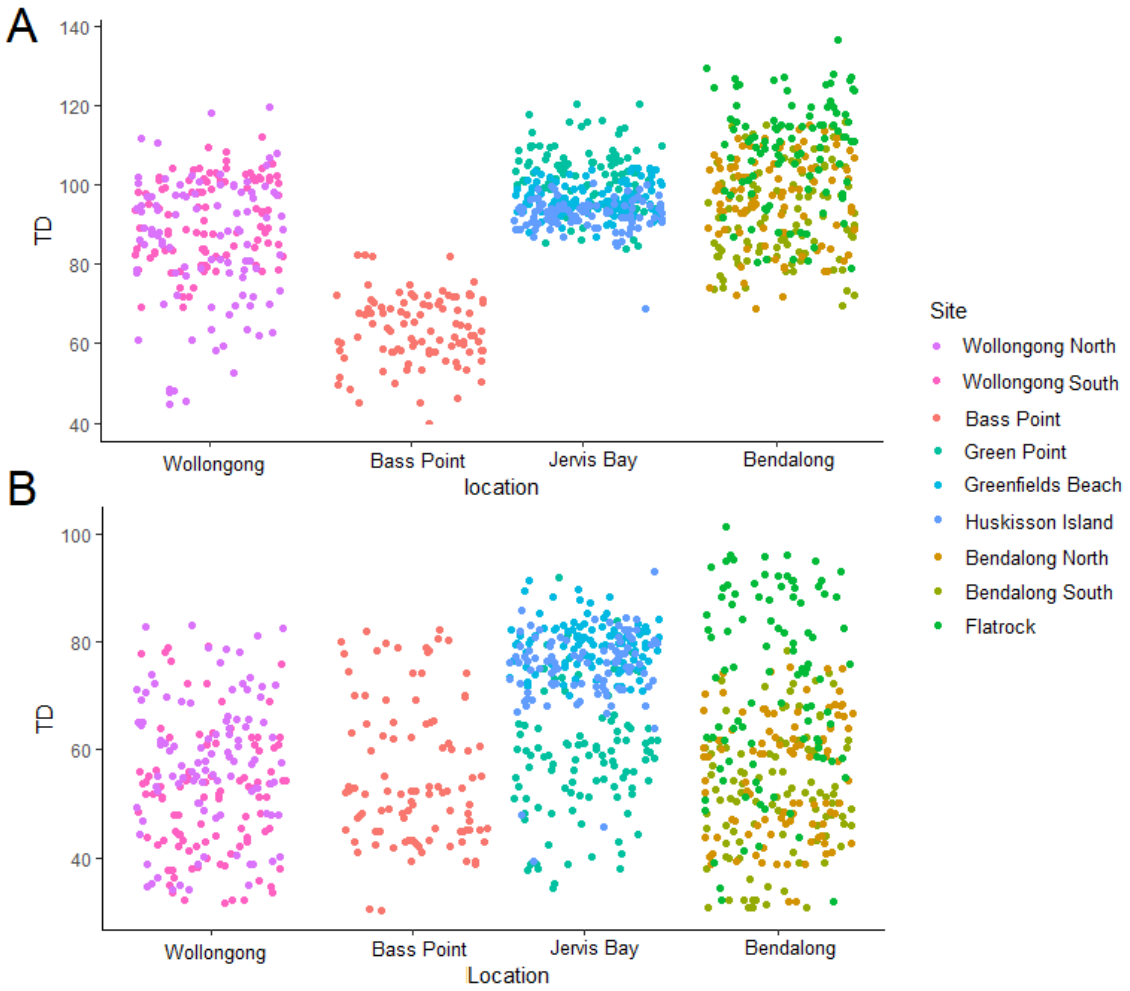

Fig. S1. Scatterplot showing test diameter (TD, mm) for A. *Centrostephanus rodgersii* and B. *Heliocidaris erythrogramma* from surveys conducted in Wollongong, Bass Point, Jervis Bay and Bendalong. Plots are colored to show how the size structure of urchin populations differed within locations.

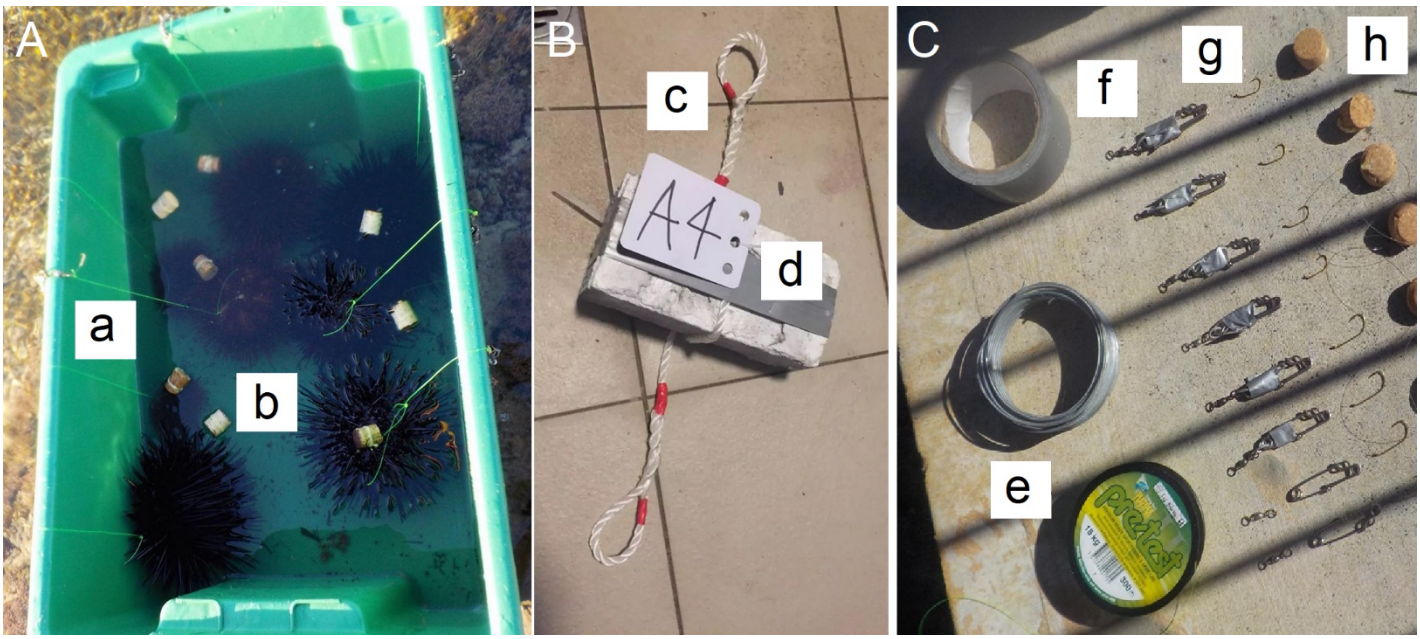

Fig. S2. Tethering and tagging method. A. Urchins with monofilament fishing line (a) with metal swivels and cork tags (b) visible. B. Urchins were individually attached to either side of tethering bricks by attaching shark clips to eyes (c) of spliced rope. Tethering bricks were labelled (d) for easy identification in the field. C. To construct tethers, 15kg monofilament fishing line (e) and 3mm galvanised steel was used to attach size 1.0 brass fishing swivels (f) to 60mm shark clips. To tag urchins, size 2.0 and 1.0 baitholder fishing hooks (g) were used for small and large urchins, respectively. The fishing hooks securely attached (h) identifying sections of cork to urchin tests.

Fig. S3. Pilot studies showing tethered A. *Centrostephanus rodgersii* and B. *Heliocidaris erythrogramma* in aquaria, C. and D. two *Sagmariasus verreauxi* (eastern rock lobster) exposed to tethered *C. rodgersii* in aquaria, and cork-tagged *H. erythrogramma* and *C. rodgersii* in the field shown from E. benthic and F. aerial views.

Table S2. Raw data from tethering experiments. Location, site, tethering brick number and habitat type are shown by urchin size (Test Diameter, TD, mm) size class ('small' or 'large') and species (*Centrostephanus rodgersii* or *Heliocidaris erythrogramma*. Mortality recorded (Y/N) at each inspection period (Day 3–4, Day 5–7, Day 12–14) is shown with Damage Index (DI) observed at each period.

Location	Site	Tether	Habitat	TD	Species	Day 3–4	Day 5–7	Day 12–14	DI
Bass Point	BP1	1	Barrens-mosaic	36	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP1	1	Barrens-mosaic	81	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP1	2	Barrens-mosaic	88	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP1	2	Barrens-mosaic	30	*H. erythrogramma*	Y	Y	ND	DI3
Bass Point	BP1	3	Barrens-mosaic	50	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP1	3	Barrens-mosaic	79	*H. erythrogramma*	Y	Y	ND	DI2
Bass Point	BP1	4	Barrens-mosaic	73	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP1	4	Barrens-mosaic	47	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP2	1	Barrens-mosaic	66	*H. erythrogramma*	N	N	Y	DI2
Bass Point	BP2	1	Barrens-mosaic	58	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP2	2	Barrens-mosaic	78	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP2	2	Barrens-mosaic	62	*C. rodgersii*	Y	Y	ND	DI2
Bass Point	BP2	3	Barrens-mosaic	55	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP2	3	Barrens-mosaic	81	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP2	4	Barrens-mosaic	49	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP2	4	Barrens-mosaic	88	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP3	1	Macroalgae	68	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP3	1	Macroalgae	60	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP3	2	Macroalgae	70	*C. rodgersii*	Y	Y	ND	DI1
Bass Point	BP3	2	Macroalgae	85	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP3	3	Macroalgae	90	*C. rodgersii*	Y	Y	ND	DI2
Bass Point	BP3	3	Macroalgae	48	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP3	4	Macroalgae	40	*H. erythrogramma*	Y	Y	ND	DI1
Bass Point	BP3	4	Macroalgae	57	*C. rodgersii*	Y	Y	ND	DI1
Wollongong	NW1	1	Barrens-mosaic	102	*C. rodgersii*	Y	ND	ND	DI2
Wollongong	NW1	1	Barrens-mosaic	83	*H. erythrogramma*	N	Y	ND	DI1
Wollongong	NW1	2	Barrens-mosaic	114	*C. rodgersii*	N	N	Y	DI1
Wollongong	NW1	2	Barrens-mosaic	32	*H. erythrogramma*	N	Y	ND	DI1
Wollongong	NW1	3	Barrens-mosaic	63	*H. erythrogramma*	Y	ND	ND	DI1
Wollongong	NW1	3	Barrens-mosaic	55	*C. rodgersii*	Y	ND	ND	DI1
Wollongong	NW1	4	Barrens-mosaic	75	*C. rodgersii*	Y	ND	ND	DI1
Wollongong	NW1	4	Barrens-mosaic	40	*H. erythrogramma*	Y	ND	ND	DI1
Wollongong	NW2	1	Barrens-mosaic	81	*C. rodgersii*	N	N	Y	DI1
Wollongong	NW2	1	Barrens-mosaic	49	*H. erythrogramma*	N	N	Y	DI1
Wollongong	NW2	2	Barrens-mosaic	45	*C. rodgersii*	N	N	Y	DI1
Wollongong	NW2	2	Barrens-mosaic	65	*H. erythrogramma*	N	N	Y	DI1
Wollongong	NW2	3	Barrens-mosaic	122	*C. rodgersii*	N	N	Y	DI1
Wollongong	NW2	3	Barrens-mosaic	63	*H. erythrogramma*	N	N	Y	DI1
Wollongong	NW2	4	Barrens-mosaic	61	*C. rodgersii*	N	N	Y	DI1
Wollongong	NW2	4	Barrens-Mosaic	34	*H. erythrogramma*	N	N	Y	DI3
Wollongong	SW	1	Macroalgae	117	*C. rodgersii*	N	N	Y	DI2
Wollongong	SW	1	Macroalgae	69	*H. erythrogramma*	N	N	Y	DI1
Wollongong	SW	2	Macroalgae	98	*C. rodgersii*	N	N	Y	DI1
Wollongong	SW	2	Macroalgae	36	*H. erythrogramma*	N	N	Y	DI1
Wollongong	SW	3	Macroalgae	64	*H. erythrogramma*	N	N	Y	DI1
Wollongong	SW	3	Macroalgae	65	*C. rodgersii*	Y	ND	ND	DI1
Wollongong	SW	4	Macroalgae	48	*C. rodgersii*	N	Y	ND	DI1
Wollongong	SW	4	Macroalgae	39	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	GF	1	Macroalgae	125	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GF	1	Macroalgae	69	*H. erythrogramma*	Y	ND	ND	DI2
Jervis Bay	GF	2	Macroalgae	118	*C. rodgersii*	N	Y	ND	DI1
Jervis Bay	GF	2	Macroalgae	47	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	GF	3	Macroalgae	81	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	GF	3	Macroalgae	82	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GF	4	Macroalgae	89	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GF	4	Macroalgae	45	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	HI	1	Barrens-mosaic	101	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	HI	1	Barrens-mosaic	109	*C. rodgersii*	Y	ND	ND	DI1

Location	Site	Tether	Habitat	TD	Species	Day 3–4	Day 5–7	Day 12–14	DI
Jervis Bay	HI	2	Barrens-mosaic	119	*C. rodgersii*	Y	ND	ND	DI3
Jervis Bay	HI	2	Barrens-mosaic	35	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	HI	3	Barrens-mosaic	71	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	HI	3	Barrens-mosaic	48	*H. erythrogramma*	Y	ND	ND	DI3
Jervis Bay	HI	4	Barrens-mosaic	67	*H. erythrogramma*	Y	ND	ND	DI3
Jervis Bay	HI	4	Barrens-mosaic	81	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GP	1	Macroalgae	100	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GP	1	Macroalgae	66	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	GP	2	Macroalgae	45	*H. erythrogramma*	Y	ND	ND	DI3
Jervis Bay	GP	2	Macroalgae	124	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GP	3	Macroalgae	77	*H. erythrogramma*	Y	ND	ND	DI1
Jervis Bay	GP	3	Macroalgae	89	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GP	4	Macroalgae	87	*C. rodgersii*	Y	ND	ND	DI1
Jervis Bay	GP	4	Macroalgae	51	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	EB	1	Barrens-mosaic	95	*C. rodgersii*	Y	ND	ND	DI2
Bendalong	EB	1	Barrens-mosaic	70	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	EB	2	Barrens-mosaic	94	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	EB	2	Barrens-mosaic	59	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	EB	3	Barrens-mosaic	81	*H. erythrogramma*	Y	ND	ND	DI3
Bendalong	EB	3	Barrens-mosaic	50	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	EB	4	Barrens-mosaic	82	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	EB	4	Barrens-mosaic	45	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	WB	1	Macroalgae	98	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	WB	1	Macroalgae	58	*C. rodgersii*	Y	ND	ND	DI3
Bendalong	WB	2	Macroalgae	90	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	WB	2	Macroalgae	35	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	WB	3	Macroalgae	65	*H. erythrogramma*	Y	ND	ND	DI2
Bendalong	WB	3	Macroalgae	33	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	WB	4	Macroalgae	45	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	WB	4	Macroalgae	60	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	FL	1	Macroalgae	89	*C. rodgersii*	Y	ND	ND	DI3
Bendalong	FL	1	Macroalgae	70	*H. erythrogramma*	Y	ND	ND	DI1
Bendalong	FL	2	Macroalgae	46	*H. erythrogramma*	Y	ND	ND	DI3
Bendalong	FL	2	Macroalgae	85	*C. rodgersii*	Y	ND	ND	DI2
Bendalong	FL	3	Macroalgae	81	*H. erythrogramma*	Y	ND	ND	DI3
Bendalong	FL	3	Macroalgae	59	*C. rodgersii*	Y	ND	ND	DI2
Bendalong	FL	4	Macroalgae	56	*C. rodgersii*	Y	ND	ND	DI1
Bendalong	FL	4	Macroalgae	50	*H. erythrogramma*	Y	ND	ND	DI1

Table S3. Results of model selection within a Generalized Linear Mixed Model (GLMM) using Aikake's Information Criterion corrected for reduced sample sizes (AICc). Outcomes are shown for urchin mortality recorded at the first checkup interval (Day 3-4). Contributions of fixed effects (R^2m) and fixed plus random effects (R^2c) are displayed. Models are shown ranked from the lowest AICc to the highest. The model with the lowest AICc is shown in **bold.** Models within ± 2 AICc of the lowest AICc model are significant. This preliminary modelling included effects of tethering brick ('tether') to test whether the position of tethered urchins of different sizes and species affected the variables tested.

Model	df	AICc	ΔAICc	Weight	Log. Lik	R^2m	R^2c
Mortality ~ Location + (1|Site)	**6**	**39.7**	**0.00**	**0.798**	**–13.36**	**0.52**	**0.64**
Mortality ~ (1|Site) (NULL)	3	44.6	4.92	0.068	–19.16	0	0.64
Mortality ~ Location + Habitat + (1|Site)	7	44.6	4.98	0.066	–14.69	0.51	0.65
Mortality ~ Location + Species + (1|Site)	7	46.0	6.29	0.034	–15.34	0.52	0.64
Mortality ~ Habitat + (1|Site)	4	47.9	8.21	0.013	–19.72	0.02	0.66
Mortality ~ Location + Tether + (1|Site)	9	48.9	9.26	0.008	–14.41	0.54	0.66
Mortality ~ Species + (1|Site)	4	50.7	11.06	0.003	–21.14	0.01	0.64
Mortality ~ Location + Habitat + Species + (1|Site)	8	51.0	11.3	0.003	–16.67	0.51	0.64
Mortality ~ Location + Size + (1|Site)	7	51.6	11.94	0.002	–18.16	0.53	0.65
Mortality ~ Location + Habitat + Location * Habitat + (1|Site)	10	53.4	13.70	0.001	–15.38	0.46	0.69