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Supplementary information

Individual species provide multifaceted contributions to the stability of ecosystems

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Individual species provide multifaceted contributions to the stability of ecosystems

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Supplementary Tables 1-4

Supplementary Table 1. Results of SIMPER analyses identifying species that contributed most to pairwise dissimilarities in macroalgal assemblage structure in response to grazer species loss [all groups differ significantly from each other (*P* < 0.02, *n* = 8) in every case]. Comparisons are between: (a) *Patella* and *Gibbula* removals (mean dissimilarity = 57.3%); (b) *Littorina* and *Patella* removals (mean dissimilarity = 56.5%); (c) *Gibbula* and *Littorina* removals (mean dissimilarity = 51.4%); (d) *Gibbula* removals and treatments with all grazers present (mean dissimilarity = 48.1%); (e) *Littorina* removals and treatments with all grazers present (mean dissimilarity = 40%) and (f) *Patella* removals and treatments with all grazers present (mean dissimilarity = 52.6%), all in unperturbed plots at the end of the experiment.

Species	**Mean Biomass (g)**		**Contribution (%)**
(a)	***-Gibbula***	***-Patella***	
Rhizoclonium riparium	21.88	37.89	21.54
Cladophora rupestris	14.84	19.92	14.49
Corallina officinalis	36.33	43.75	12.31
Lithothamnium	23.44	5.86	12.24
(b)	***-Littorina***	***-Patella***	
Rhizoclonium riparium	14.45	37.89	17.82
Corallina officinalis	43.36	43.75	14.42
Lithothamnium	27.34	5.86	13.43
Cladophora rupestris	0.78	19.92	11.8
(c)	***-Gibbula***	***-Littorina***	
Rhizoclonium riparium	21.88	14.45	15.22
Lithothamnium	23.44	27.34	14.48
Corallina officinalis	36.33	43.36	13.05
Ceramium nodulosum	8.2	22.27	12.19

(d)	***-Gibbula***	**+All Grazers**	
Rhizoclonium riparium	21.88	14.84	17.58
Lithothamnium	23.44	18.75	15.41
Cladophora rupestris	14.84	2.73	11.21
Corallina officinalis	36.33	46.48	9.7
(e)	***-Littorina***	**+All Grazers**	
Corallina officinalis	43.36	46.48	16.89
Lithothamnium	27.34	18.75	16.46
Ceramium nodulosum	22.27	12.11	14.34
Fucus serratus	14.84	0	12.13
(f)	***-Patella***	**+All Grazers**	
Rhizoclonium riparium	37.89	14.84	20.01
Corallina officinalis	43.75	46.48	14.89
Cladophora rupestris	19.92	2.73	13.35
Lithothamnium	5.86	18.75	8.77

Supplementary Table 2. The effects of grazer removal on functional and compositional stability responses of macroalgal assemblages. Functional stability responses were based on total macroalgal cover, whereas compositional stability responses were based on macroalgal community composition. Significant (ANOVA; $P < 0.05$, $n = 20$) terms are highlighted in bold. Linear mixed models were used for analyses of spatial variability, which included month as a random factor.

Stability component			**Functional stability**			**Compositional stability**		
	Source of Var	DF	MS	*F*	*P*	MS	*F*	*P*
Temporal variability	Grazer loss	4	0.002	1.11	0.39	0.002	2.74	0.068
	Residual	15	0.002			0.001		
Spatial variability	Month	10	0.441	1.48	0.18	0.005	5.56	**<0.001**
	Grazer loss	4	0.131	0.44	0.78	0.016	16.88	**<0.001**
	Residual	49	0.285			0.001		
Resistance	Grazer loss	4	0.101	1.96	0.15	0.171	3.33	**0.039**
	Residual	15	0.052			0.051		
Reactivity	Grazer loss	4	0.016	1.59	0.23	0.052	3.56	**0.031**
	Residual	15	0.010			0.014		
Resilience	Grazer loss	4	0.026	3.37	**0.037**	0.010	0.86	0.51
	Residual	15	0.008			0.012		
Recovery time	Grazer loss	4	15.88	7.38	**0.002**	13.93	1.5	0.25
	Residual	15	2.150			9.3		

Supplementary Table 3. Results of SIMPER analyses identifying species that contributed most to pairwise dissimilarities in macroalgal assemblage structure in response to our experimentally imposed pulse perturbation (mean dissimilarity = 52.1%). Comparisons are between perturbed and unperturbed plots immediately following the perturbation in plots from which (a) *Patella*, (b) *Littorina*, and (c) *Gibbula* were removed in isolation, plots from which (d) all three grazer taxa were removed and (e) no grazers were removed.

	Species	**Mean cover (%)**		**Contribution (%)**
		Unperturbed	**Perturbed**	
(a) *Patella* removed	***Corallina officinalis***	75.39	32.03	32.63
	Cladophora rupestris	27.34	6.10	16.92
	Ulva compressa	20.31	3.51	13.65
	Lithothamnium	12.5	11.71	6.81
(b) *Littorina* removed	***Corallina officinalis***	70.70	29.69	27.87
	Ceramium nodulosum	35.55	7.42	19.21
	Ulva compressa	22.66	39.84	14.61
	Lithothamnium	2.34	17.58	10.01
(c) *Gibbula* removed	***Corallina officinalis***	70.70	38.67	27.07
	Lithothamnium	23.05	19.92	12.93
	Ulva compressa	17.97	0.00	12.86
	Cladophora rupestris	16.02	8.20	12.22
	Rhizoclonium riparium	9.77	6.25	8.63
(d) All grazers removed	***Corallina officinalis***	77.73	40.23	25.16
	Cladophora rupestris	29.69	5.72	16.40
	Lithothamnium	4.69	14.45	8.19
	Ceramium nodulosum	15.63	11.33	8.02
	Fucus serratus	1.95	9.38	6.92
	Polysiphonia fucoides	77.73	40.23	6.31

(e) No grazers removed	***Corallina officinalis***	75.00	36.72	33.49
	Ceramium nodulosum	12.36	8.20	11.17
	Ulva compressa	7.03	8.59	8.96
	Fucus serratus	9.77	0.00	8.62
	Lithothamnium	20.70	19.14	8.25

Supplementary Table 4. The effects of experimental cages on functional and compositional stability responses of macroalgal assemblages. Significant (ANOVA; *P* < 0.05, *n* = 8) terms are highlighted in bold.

Stability component			**Functional stability**			**Compositional stability**		
	Source of Var	DF	MS	*F*	*P*	MS	*F*	*P*
Temporal variability	Cage	1	0.008	3.88	0.096	0.0006	1.45	0.27
	Residual	6	0.002			0.0004		
Spatial variability	Month	10	0.003	8.54	**0.001**	0.002	4.69	**0.011**
	Cage	1	0.000	0.06	0.82	0.000	0.1	0.76
	Residual	10	0.002			0.001		
Resistance	Cage	1	0.036	1.17	0.32	0.013	0.46	0.52
	Residual	6	0.03			0.028		
Reactivity	Cage	1	0.005	0.46	0.52	0.003	0.8	0.41
	Residual	6	0.01			0.004		
Resilience	Cage	1	0.000	0.03	0.87	0.001	0.93	0.37
	Residual	6	0.016			0.001		
Recovery time	Cage	1	2	0.26	0.63	2	1.6	0.25
	Residual	6	7.67			1.25		