Table 1. 13 water quality parameters. Values within the East/West columns are annual mean value (June 2021-June 2022) of different sites, and values within the treatment columns are the annual mean value (June 2021-June 2022) of the three treatment types across east and west. *p*-values adjusted using the Benjamini-Hochberg procedure, with **bold numbers** indicating statistical significance ($p < 0.05$, all model df = 3,63).

Mean environmental data by site (top), by treatment (bottom), and the adjusted p value from linear models

	East				West				Adj *p* Value
	TPC	SK	CI	Mean	CDA	LM	PC	Mean	East ~ West
Total Inorganic Nitrogen (mg/l)	0.04	0.05	0.09	0.06	0.08	0.17	0.33	0.20	**2.32E-06**
Ammonia Nitrogen (mg/l)	0.03	0.03	0.05	0.03	0.03	0.06	0.11	0.06	**1.27E-04**
Nitrite Nitrogen (mg/l)	0.002	0.001	0.011	0.004	0.011	0.028	0.038	0.026	**8.74E-03**
Nitrate Nitrogen (mg/l)	0.009	0.013	0.028	0.017	0.043	0.084	0.186	0.104	**7.74E-05**
Orthophosphate Phosphorus (mg/l)	0.003	0.004	0.007	0.005	0.006	0.009	0.012	0.009	7.52E-02
E. coli (cfu/100ml)	0.65	12.27	205.00	72.64	1.54	550.74	424.36	325.55	1.86E-01
Faecal Coliforms (cfu/100ml)	1.90	145.27	555.50	234.22	2.09	1021.34	760.96	594.80	4.15E-01
Chlorophyll a (µg/L)	2.27	2.40	4.15	2.94	2.94	3.69	5.92	4.18	4.15E-01
Phaeo pigments (µg/L)	0.22	0.41	1.48	0.70	0.80	0.80	1.82	1.14	7.52E-02
Dissolved Oxygen (mg/L)	6.04	5.79	5.29	5.71	6.10	5.67	5.45	5.74	4.15E-01
Dissolved Oxygen saturation (% of saturation)	85.35	81.73	74.83	80.64	86.03	79.80	77.09	80.97	4.15E-01
Suspended Solids (mg/L)	2.88	5.65	3.65	4.06	2.95	3.52	7.03	4.50	**4.71E-02**
Turbidity (NTU)	13.77	5.85	5.86	8.49	6.76	6.41	9.60	7.59	2.95E-01

	by Treatment			Adj *p* Value	
	MPA	Marieculture	Sewage	Mariculture ~ MPA	Sewage ~ MPA
Total Inorganic Nitrogen (mg/l)	0.06	0.11	0.21	4.71E-01	**3.82E-07**
Ammonia Nitrogen (mg/l)	0.03	0.04	0.08	9.49E-01	**2.28E-08**
Nitrite Nitrogen (mg/l)	0.006	0.014	0.025	9.29E-01	**3.70E-03**
Nitrate Nitrogen (mg/l)	0.026	0.048	0.107	4.18E-01	**4.30E-04**
Orthophosphate Phosphorus (mg/l)	0.004	0.007	0.010	9.29E-01	**3.99E-03**
E. coli (cfu/100ml)	1.10	281.51	314.68	1.35E-01	**1.79E-07**
Faecal Coliforms (cfu/100ml)	1.99	583.31	658.23	**3.71E-02**	**2.73E-08**
Chlorophyll a (µg/L)	2.60	3.04	5.03	9.49E-01	**1.65E-02**
Phaeo pigments (µg/L)	0.51	0.61	1.65	7.72E-01	**6.33E-06**
Dissolved Oxygen (mg/L)	6.07	5.73	5.37	3.37E-01	**2.32E-02**
Dissolved Oxygen saturation (% of saturation)	85.69	80.76	75.96	3.40E-01	5.07E-02
Suspended Solids (mg/L)	2.91	4.59	5.34	3.37E-01	**6.94E-04**
Turbidity (NTU)	10.27	6.13	7.73	4.71E-01	9.83E-01

Table 2. Benjamini-Hochberg adjusted *p*-values and adjusted R^2 values from linear models (all models: df = 1, 132) testing associations between species richness and environmental metrics. All chemical indicators (ammonia nitrogen, TIN etc.), and bioindicators (faecal coliforms, phaeo Pigments) showed significant correlations with species richness.

Adjusted p value and adjusted R square value (richness ~ indicators)

Indicator	Adj *p* value	Adj R^2
Ammonia Nitrogen (mg/l)	**7.85E-19**	46.64%
Total Inorganic Nitrogen (mg/l)	**8.69E-18**	44.10%
E. coli (cfu/100ml)	**3.63E-13**	34.04%
Faecal Coliforms (cfu/100ml)	**1.92E-12**	32.08%
Nitrate Nitrogen (mg/l)	**6.57E-11**	28.17%
Phaeo pigments (µg/L)	**3.46E-10**	26.18%
Nitrite Nitrogen (mg/l)	**6.23E-09**	22.77%
Orthophosphate Phosphorus (mg/l)	**2.22E-06**	15.62%
Chlorophyll a (µg/L)	**4.74E-04**	8.66%
Suspended Solids (mg/L)	**7.15E-03**	4.98%
Dissolved Oxygen saturation (% of saturation)	**3.33E-02**	2.87%
Dissolved Oxygen (mg/L)	6.36E-02	1.94%
Turbidity (NTU)	1.51E-01	0.81%

Table S1. Treatment sites, their corresponding water monitoring stations and the GPS coordinates.

Treatment Sites and Corresponding Water Monitoring Stations

	Site	Treatment	Latitude	Longitude	Monitoring Station	Latitude	Longitude
West	CDA	MPA	22.20683	114.25672	SM1	22.21230	114.23140
	CDA	MPA	22.20683	114.25672	MM8	22.20035	114.32240
	LM	Mariculture	22.22025	114.12764	SM3	22.22545	114.14970
	LM	Mariculture	22.22025	114.12764	SM4	22.21263	114.13860
	PC	Sewage	22.28992	114.03442	SM9	22.27367	114.06707
	PC	Sewage	22.28992	114.03442	SM10	22.30208	114.03198
	PC	Sewage	22.28992	114.03442	SM11	22.25738	114.01797
East	TPC	MPA	22.54292	114.43717	MM5	22.52055	114.39388
	SK	Mariculture	22.36983	114.32403	PM4	22.38233	114.31365
	CI	Sewage	22.43725	114.22183	TM4	22.43273	114.21960

Table S2. Total species richness (top) and unique species (bottom) by fractions and by ARMS.

Total OTUs and Unique OTUs by fractions and by ARMS

		Phase I: Seeding, 12 months		Phase II: Resistance, 24 months						Phase III: Resilience, 30 months					
Total OTUs		MPA: CDA		MPA: CDA		Mariculture: LM		Sewage: PC		MPA: CDA		Mariculture: LM		Sewage: PC	
West	ARMS No.	**89**	**90**	**79**	**81**	**83**	**57**	**88**	**61**	**77**	**78**	**84**	**58**	**87**	**62**
	106 µm	659	814	775	656	756	765	545	554	436	535	575	640	759	498
	500 µm	153	256	385	234	262	252	222	362	216	170	184	253	200	492
	Sessile	626	565	529	604	544	386	426	408	356	466	626	683	515	488
	By ARMS	1209	1340	1249	1136	1136	1046	826	893	704	857	1078	1200	1137	1027
		MPA: TPC		MPA: TPC		Mariculture: SK		Sewage: CI		MPA: TPC		Mariculture: SK		Sewage: CI	
East	ARMS No.	**55**	**56**	**69**	**70**	**65**	**75**	**80**	**67**	**71**	**72**	**66**	**76**	**82**	**68**
	106 µm	771	799	747	829	855	967	605	735	581	592	754	665	603	686
	500 µm	329	436	349	376	565	613	482	454	385	272	402	166	237	287
	Sessile	572	611	696	295	281	439	349	386	541	349	494	384	480	273
	By ARMS	1327	1432	1309	1124	1215	1428	968	1073	1101	914	1204	948	974	943

		Phase I: Seeding, 12 months		Phase II: Resistance, 24 months						Phase III: Resilience, 30 months					
Unique OTUs		MPA: CDA		MPA: CDA		Mariculture: LM		Sewage: PC		MPA: CDA		Mariculture: LM		Sewage: PC	
West	ARMS No.	**89**	**90**	**79**	**81**	**83**	**57**	**88**	**61**	**77**	**78**	**84**	**58**	**87**	**62**
	106 µm	93	52	45	81	71	765	58	50	17	24	48	50	96	39
	500 µm	9	14	40	17	3	252	8	30	10	5	12	16	21	24
	Sessile	26	71	36	68	34	386	28	18	21	37	49	59	48	33
	By ARMS	129	142	123	171	112	111	100	105	50	67	110	126	176	99
		MPA: TPC		MPA: TPC		Mariculture: SK		Sewage: CI		MPA: TPC		Mariculture: SK		Sewage: CI	
East	ARMS No.	**55**	**56**	**69**	**70**	**65**	**75**	**80**	**67**	**71**	**72**	**66**	**76**	**82**	**68**
	106 µm	49	53	96	95	103	116	57	89	27	30	63	55	34	58
	500 µm	12	25	20	19	40	62	64	41	18	13	34	5	7	8
	Sessile	64	83	79	14	9	29	16	23	41	23	24	25	47	14
	By ARMS	125	161	198	136	156	217	145	162	89	68	127	88	89	81

Table S3. Z-scores and adjusted *p* values from Negative Binomial model to study community succession. Bold value highlighted in adjusted *p* indicated significant trends ($p < 0.05$ after Benjamini-Hochberg adjustment).

Z score and adjusted *p* - value from Negative Binomial model to assess succession

phylum	MPA	slope	z score	Adj *P* value
Arthropoda	CDA	-3.04E-02	-3.92	**4.05E-04**
Annelida	CDA	-2.86E-02	-3.65	**7.46E-04**
Mollusca	CDA	-2.29E-02	-1.49	1.46E-01
Bacillariophyta	CDA	-3.94E-02	-1.59	1.30E-01
Rhodophyta	CDA	-2.77E-02	-3.13	**3.27E-03**
Porifera	CDA	-2.69E-02	-3.12	**3.27E-03**
Total richness	CDA	-2.37E-02	-3.11	**3.27E-03**
Arthropoda	TPC	-3.44E-02	-7.83	**6.64E-14**
Annelida	TPC	-2.71E-02	-5.19	**1.47E-06**
Mollusca	TPC	-3.16E-02	-2.94	**4.72E-03**
Bacillariophyta	TPC	2.79E-02	2.93	**4.72E-03**
Rhodophyta	TPC	1.12E-02	1.79	9.40E-02
Porifera	TPC	8.39E-03	1.05	2.92E-01
Total richness	TPC	-1.64E-02	-3.68	**7.46E-04**

Table S4. Mean values of all 13 environmental parameters over the study period (Jun 20 ~ Dec 22) from two marine park (CDA, TPC), and adjusted *p*, adjusted R^2 value from linear model (all df = 1,131). Parameters showed significant site differences were highlighted in blue ($p < 0.05$ after Benjamini-Hochberg adjustment).

30 months' mean environmental parameters of two MPA, and the Adj *p* value and Adj R2

	CDA	TPC	Adj *P* value	AdjR2
Nitrite Nitrogen (mg/l)	0.012	0.004	**3.51E-03**	8.98%
Total Inorganic Nitrogen (mg/l)	0.092	0.048	**5.07E-03**	7.59%
Nitrate Nitrogen (mg/l)	0.055	0.018	**8.48E-03**	6.37%
Orthophosphate Phosphorus (mg/l)	0.007	0.005	**3.97E-02**	3.97%
Phaeo pigments (µg/L)	0.75	0.36	5.86E-02	3.18%
Suspended Solids (mg/L)	4.08	2.90	1.32E-01	1.91%
Chlorophyll a (µg/L)	3.16	1.77	2.98E-01	0.75%
Dissolved Oxygen (mg/L)	5.92	5.76	5.77E-01	-0.25%
Turbidity (NTU)	5.91	7.39	5.77E-01	-0.13%
E. coli (cfu/100ml)	1.38	0.70	5.77E-01	-0.31%
Dissolved Oxygen saturation (% of saturation)	84.89	83.46	6.83E-01	-0.52%
Faecal Coliforms (cfu/100ml)	2.99	1.91	7.34E-01	-0.63%
Ammonia Nitrogen (mg/l)	0.023	0.024	7.60E-01	-0.69%