

Interannual variation and spatial distribution of decapod larvae in a region of persistent coastal upwelling

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Table S1. Distance-based linear model (DISTLM) marginal tests for all environmental variables considered. UI: Bakun's upwelling index; SOI: Southern Oscillation Index; SST: sea surface temperature; SSS: sea surface salinity; SSH: sea surface height; NPGO: North Pacific Gyre Oscillation.

Variable	SS	Pseudo- <i>F</i>	<i>p</i>	<i>R</i> ²
Temperature	19188	5.8226	0.001	0.0138
Flourescence	41304	12.739	0.001	0.0298
Salinity	16644	5.041	0.001	0.0120
Thermocline depth	7639.4	2.2987	0.025	0.0055
Alongshore wind	8894.8	2.6789	0.011	0.0064
SST	10958	3.3053	0.007	0.0079
SSS	9933.3	2.9939	0.005	0.0072
SSH	6593.7	1.9826	0.049	0.0048
Chl- <i>a</i>	29005	8.8649	0.001	0.0209
PDO	11326	3.4172	0.002	0.0082
SOI	17060	5.1686	0.001	0.0123
NPGO	18119	5.4938	0.001	0.0131
UI	25540	7.7861	0.001	0.0184

Table S2. Results for Caridea negative binomial regression model. *n* = 417, likelihood ration $\chi^2 = 0.000$, pseudo $R^2 = 0.048$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

Variable	Coefficient	SE	95% CI lower	95% CI upper	<i>z</i>	<i>p</i>
Year						
2005	3.75	0.74	2.29	5.20	5.03	< 0.0001
2006	0.27	0.79	-1.28	1.82	0.34	0.736
2007	3.13	0.77	1.62	4.65	4.06	< 0.0001
2008	3.03	0.74	1.57	4.49	4.07	< 0.0001
2009	2.07	0.79	0.53	3.62	2.63	0.009
2010	0.80	0.78	-0.72	2.32	1.03	0.301
2011	-0.56	0.92	-2.37	1.24	-0.61	0.541
Month	4.85	1.22	2.46	7.24	3.97	< 0.0001
Month ²	-0.29	0.09	-0.47	-0.12	-3.34	0.001
Thermocline depth	0.03	0.01	0.01	0.06	2.50	0.012
Salinity	4.03	0.92	2.23	5.84	4.38	< 0.0001
Fluorescence	0.33	0.08	0.18	0.49	4.13	< 0.0001
Fluorescence ²	-0.01	0.00	-0.01	0.00	-3.33	< 0.0001
UI	0.10	0.03	0.05	0.15	3.75	< 0.0001
UI ²	0.00	0.00	0.00	0.00	-4.24	< 0.0001

Table S3. Results for *Emerita analoga* negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 148.44$, pseudo $R^2 = 0.113$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	1.26	0.80	-0.31	2.83	1.57	0.117
2006	3.14	1.06	1.06	5.21	2.96	0.003
2007	1.06	0.78	-0.46	2.59	1.37	0.172
2008	4.88	1.44	2.05	7.70	3.38	0.001
2009	0.93	1.22	-1.47	3.32	0.76	0.448
2010	3.27	0.92	1.46	5.07	3.55	< 0.0001
2011	4.48	1.35	1.82	7.13	3.31	0.001
Month	-4.08	1.15	-6.34	-1.83	-3.55	< 0.0001
Month ²	0.35	0.08	0.20	0.50	4.48	< 0.0001
Temperature	-0.71	0.21	-1.12	-0.30	-3.37	0.001
UI(3)	0.01	0.01	0.00	0.02	2.24	0.025
Chl- <i>a</i>	0.63	0.30	0.04	1.22	2.10	0.036
SOI(3)	-0.49	0.11	-0.72	-0.27	-4.32	< 0.0001
PDO(1)	1.52	0.42	0.71	2.34	3.66	< 0.0001
PDO(1) ²	0.96	0.24	0.50	1.43	4.07	< 0.0001

Table S4. Results for Majidae negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 106.99$, Prob > $\chi^2 = 0.000$, pseudo $R^2 = 0.0807$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	-1.34	0.90	-3.10	0.42	-1.49	0.136
2006	-2.29	1.17	-4.58	0.00	-1.96	0.050
2007	-4.06	1.27	-6.55	-1.57	-3.20	0.001
2008	-4.96	1.39	-7.69	-2.23	-3.57	< 0.0001
2009	-7.54	1.53	-10.55	-4.53	-4.91	< 0.0001
2010	-54.36	4.08E+07	-8.00E+07	8.00E+07	0.00	1.000
2011	-13.46	4.12	-21.53	-5.39	-3.27	0.001
Month	1.10	1.68	-2.18	4.39	0.66	0.511
Month ²	-0.14	0.12	-0.38	0.09	-1.19	0.236
Fluorescence	0.29	0.06	0.18	0.41	5.03	< 0.0001
UI(1)	0.24	0.05	0.14	0.33	4.97	< 0.0001
UI(1) ²	0.00	0.00	0.00	0.00	-5.04	< 0.0001
SOI(1)	1.53	0.40	0.76	2.31	3.87	< 0.0001
SOI(1) ²	-1.03	0.34	-1.70	-0.37	-3.05	0.002

Table S5. Results for Pinnotheridae negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 63.31$, $\text{prob} > \chi^2 = 0.000$, pseudo $R^2 = 0.091$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	-9.071503	5.40	-19.66	1.51	-1.68	0.093
2006	-5.576867	3.25	-11.94	0.79	-1.72	0.086
2007	-4.090255	3.23	-10.43	2.25	-1.27	0.206
2008	-11.46472	6.39	-23.98	1.05	-1.80	0.073
2009	-5.208546	3.32	-11.72	1.30	-1.57	0.117
2010	-20.66151	8.26	-36.85	-4.48	-2.50	0.012
2011	-14.13269	5.53	-24.97	-3.30	-2.56	0.011
Month	-2.967484	3.39	-9.61	3.68	-0.88	0.381
Month ²	.0637526	0.25	-0.42	0.55	0.26	0.796
Fluorescence	.6578045	0.32	0.04	1.28	2.08	0.037
Fluorescence ²	-.0299099	0.01	-0.06	0.00	-2.19	0.028
UI(1)	.0339338	0.02	0.00	0.06	2.26	0.024
SSH	.3899747	0.33	-0.25	1.03	1.20	0.232
SSH ²	-.1860979	0.08	-0.35	-0.02	-2.23	0.026
NPGO(2)	.5677674	2.55	-4.43	5.57	0.22	0.824
NPGO(2) ²	3.60019	1.74	0.18	7.02	2.06	0.039
Shelf	3.121039	1.08	0.99	5.25	2.88	0.004

Table S6. Results for Porcellanidae negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 32.24$, probability $> \chi^2 = 0.001$, pseudo $R^2 = 0.120$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	-16.30	6.18	-28.41	-4.19	-2.64	0.008
2006	-2.72	4.24	-11.03	5.60	-0.64	0.522
2007	11.31	6.04	-0.53	23.15	1.87	0.061
2008	27.66	12.79	2.60	52.72	2.16	0.031
2009	-25.54	47667.32	-93451.77	93400.68	0.00	1.000
2010	-2.62	3.73	-9.94	4.70	-0.70	0.483
2011	-15.01	121007.60	-237185.60	237155.60	0.00	1.000
Month	-12.88	10.07	-32.61	6.86	-1.28	0.201
Month ²	0.89	0.73	-0.53	2.32	1.23	0.219
PDO	15.83	5.66	4.74	26.93	2.80	0.005
Gulf	4.74	1.89	1.03	8.45	2.51	0.012

Table S7. Results for *Cangon spp.* negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 95.60$, probability $> \chi^2 = 0.000$, pseudo $R^2 = 0.179$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	2.87	3.83	-4.62	10.37	0.75	0.452
2006	-3.00	2.37	-7.65	1.64	-1.27	0.205
2007	-7.90	2.78	-13.35	-2.46	-2.84	0.004
2008	-3.50	3.43	-10.23	3.22	-1.02	0.307
2009	-7.44	2.39	-12.13	-2.74	-3.11	0.002
2010	-2.15	2.46	-6.97	2.68	-0.87	0.383
2011	-21.21	934.13	-1852.08	1809.65	-0.02	0.982
Month	-6.71	2.91	-12.41	-1.02	-2.31	0.021
Month ²	0.42	0.19	0.04	0.80	2.19	0.029
Fluorescence	0.94	0.28	0.40	1.48	3.39	0.001
Fluorescence ²	-0.03	0.01	-0.05	-0.01	-3.17	0.002
NPGO(2)	-0.18	2.05	-4.20	3.84	-0.09	0.932
NPGO(2) ²	-3.25	1.11	-5.43	-1.07	-2.92	0.004
Shelf	4.15	0.76	2.66	5.64	5.45	< 0.0001
Gulf	2.64	0.85	0.97	4.32	3.10	0.002

Table S8. Results for Hippolytidae negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 140.20$, probability $> \chi^2 = 0.000$, pseudo $R^2 = 0.206$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	-50.77	478.22	-988.07	886.52	-0.11	0.915
2006	-15.47	3.87	-23.05	-7.89	-4.00	< 0.0001
2007	-18.85	4.91	-28.48	-9.22	-3.84	< 0.0001
2008	4.03	4.11	-4.03	12.09	0.98	0.327
2009	-3.34	1.19	-5.67	-1.00	-2.80	0.005
2010	8.95	3.38	2.32	15.57	2.65	0.008
2011	12.01	3.63	4.90	19.11	3.31	0.001
Month	-4.32	3.00	-10.19	1.56	-1.44	0.150
Month ²	0.32	0.20	-0.07	0.71	1.61	0.107
Fluorescence	0.47	0.14	0.19	0.74	3.33	0.001
Fluorescence ²	-0.01	0.00	-0.02	0.00	-3.07	0.002
SOI(2)	-1.14	0.44	-2.00	-0.28	-2.60	0.009
NPGO(2)	-13.08	3.68	-20.29	-5.87	-3.56	< 0.0001
Shelf	2.71	0.68	1.38	4.04	3.99	< 0.0001

Table S9. Results for *Neotrypaea spp.* negative binomial regression model. n = 417, likelihood ratio $\chi^2 = 130.04$, probability $> \chi^2 = 0.000$, pseudo $R^2 = 0.160$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	-73.32	18.41	-109.41	-37.23	-3.98	< 0.0001
2006	-42.10	10.77	-63.20	-21.00	-3.91	< 0.0001
2007	12.02	5.79	0.68	23.36	2.08	0.038
2008	11.66	7.80	-3.62	26.94	1.50	0.135
2009	-24.07	6.02	-35.86	-12.28	-4.00	< 0.0001
2010	-36.25	9.66	-55.18	-17.32	-3.75	< 0.0001
2011	-26.23	8.98	-43.84	-8.62	-2.92	0.004
Month	61.30	16.08	29.80	92.81	3.81	< 0.0001
Month ²	-3.61	0.96	-5.50	-1.72	-3.74	< 0.0001
Temperature	-3.95	0.95	-5.81	-2.09	-4.17	< 0.0001
Fluorescence	1.82	0.42	0.99	2.64	4.32	< 0.0001
Fluorescence ²	-0.05	0.02	-0.08	-0.02	-3.53	< 0.0001
SOI(2)	7.72	2.56	2.69	12.74	3.01	0.003
PDO(1)	-6.57	2.23	-10.93	-2.20	-2.95	0.003
PDO(1) ²	8.98	2.62	3.84	14.11	3.43	0.001
NPGO(1)	-41.06	10.65	-61.93	-20.19	-3.86	< 0.0001
UI(2)	0.07	0.09	-0.09	0.24	0.87	0.383
UI(2) ²	0.00	0.00	0.00	0.00	-2.22	0.027
Shelf	6.85	1.36	4.19	9.51	5.04	< 0.0001
Gulf	4.93	1.26	2.46	7.40	3.91	< 0.0001

Table S10. Results for Paguridae negative binomial regression model. $n = 417$, likelihood ratio $\chi^2 = 92.19$, probability $> \chi^2 = 0.000$, pseudo $R^2 = 0.126$. Abbreviations are the same as those used in Table S1, and time lags are indicated by the number of months of the lag in parentheses.

	Coefficient	SE	95% CI lower	95% CI upper	z	p
Year						
2005	5.90	3.60	-1.14	12.95	1.64	0.101
2006	-0.09	3.05	-6.07	5.89	-0.03	0.977
2007	-6.81	3.58	-13.82	0.20	-1.90	0.057
2008	-0.45	3.91	-8.11	7.21	-0.11	0.909
2009	-6.12	3.96	-13.87	1.64	-1.55	0.122
2010	-14.43	9.59	-33.23	4.38	-1.50	0.133
2011	6.31	5.65	-4.76	17.37	1.12	0.264
Month	-1.89	2.69	-7.15	3.38	-0.70	0.482
Month ²	0.26	0.21	-0.14	0.67	1.28	0.199
Thermocline depth	0.34	0.14	0.06	0.62	2.37	0.018
Thermocline depth ²	0.00	0.00	0.00	0.01	2.17	0.030
Fluorescence	1.12	0.33	0.48	1.77	3.42	0.001
Fluorescence ²	-0.03	0.01	-0.05	-0.01	-2.72	0.006
SSH	-1.55	0.55	-2.62	-0.47	-2.82	0.005
SOI	-3.16	1.52	-6.14	-0.19	-2.08	0.037
SOI ²	0.98	0.41	0.17	1.78	2.39	0.017
Shelf	3.52	0.99	1.57	5.47	3.55	< 0.0001

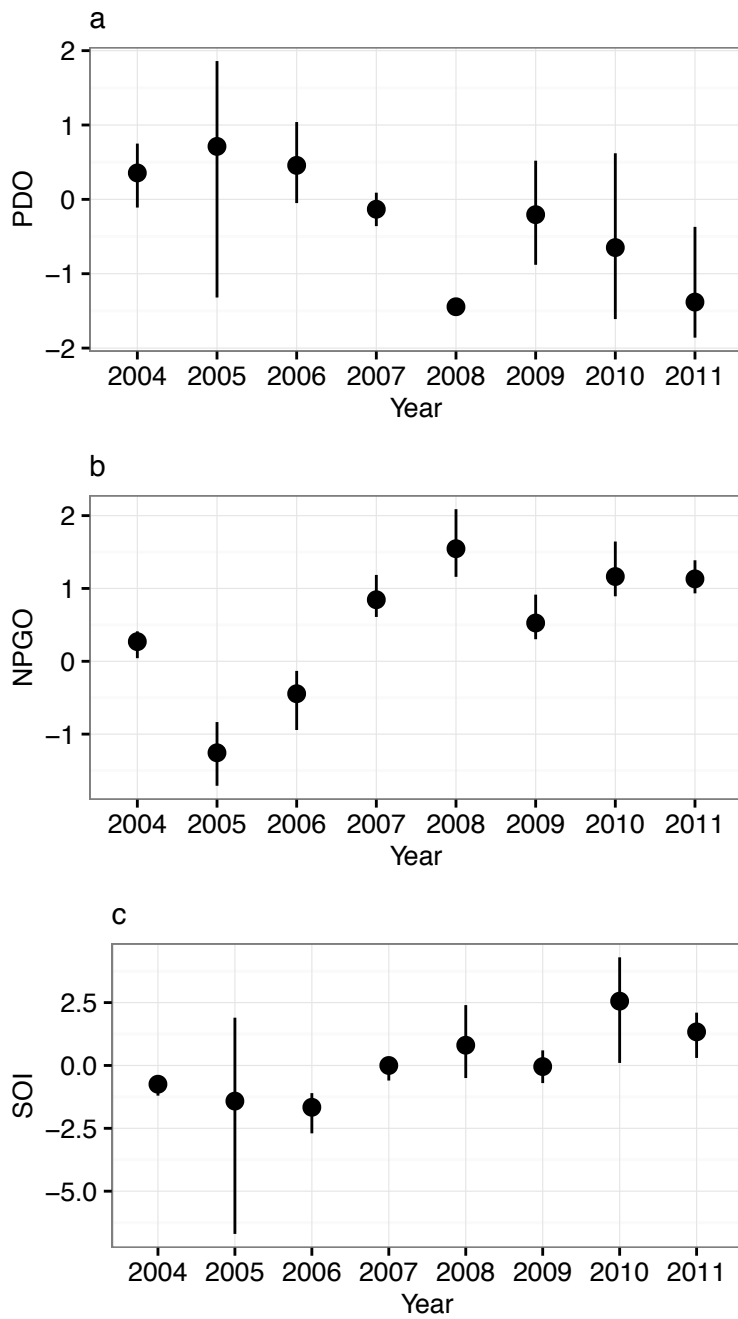


Fig. S1. Basin-scale environmental variables across years. The dot represents the average and the whiskers represent the range of values across the 3-5 cruise-months per year for (a) the Pacific Decadal Oscillation index, (b) North Pacific Gyre Oscillation index, and (c) Southern Oscillation Index.

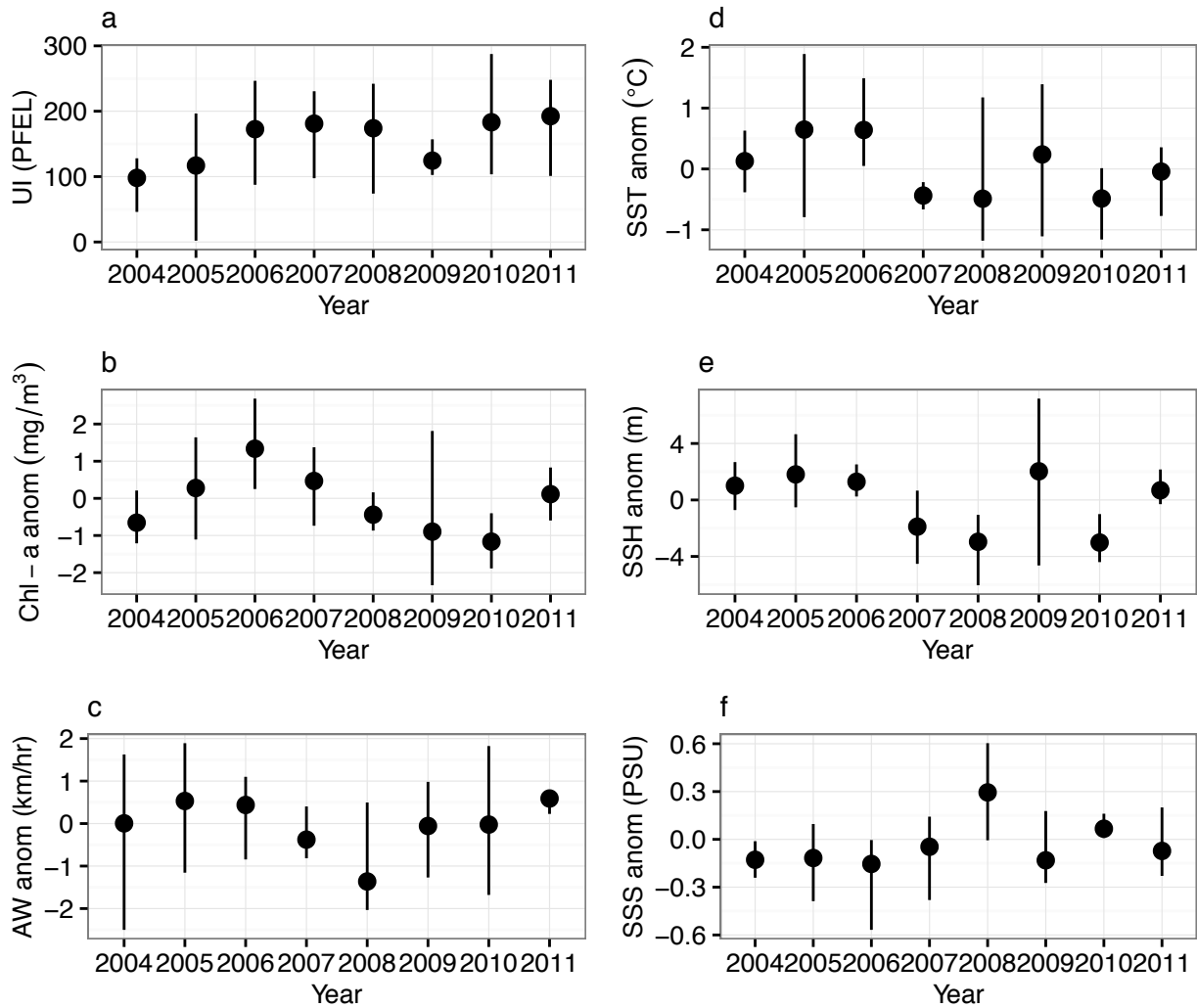


Fig. S2. Regional environmental variables across years. The dot represents the average and the whiskers represent the range of values across the 3-5 cruise-months per year for (a) Upwelling Index, (b) Chlorophyll *a* anomalies, (c) alongshore wind velocity anomalies, (d) sea surface temperature anomalies, (e) sea surface height anomalies, and (f) sea surface salinity anomalies.

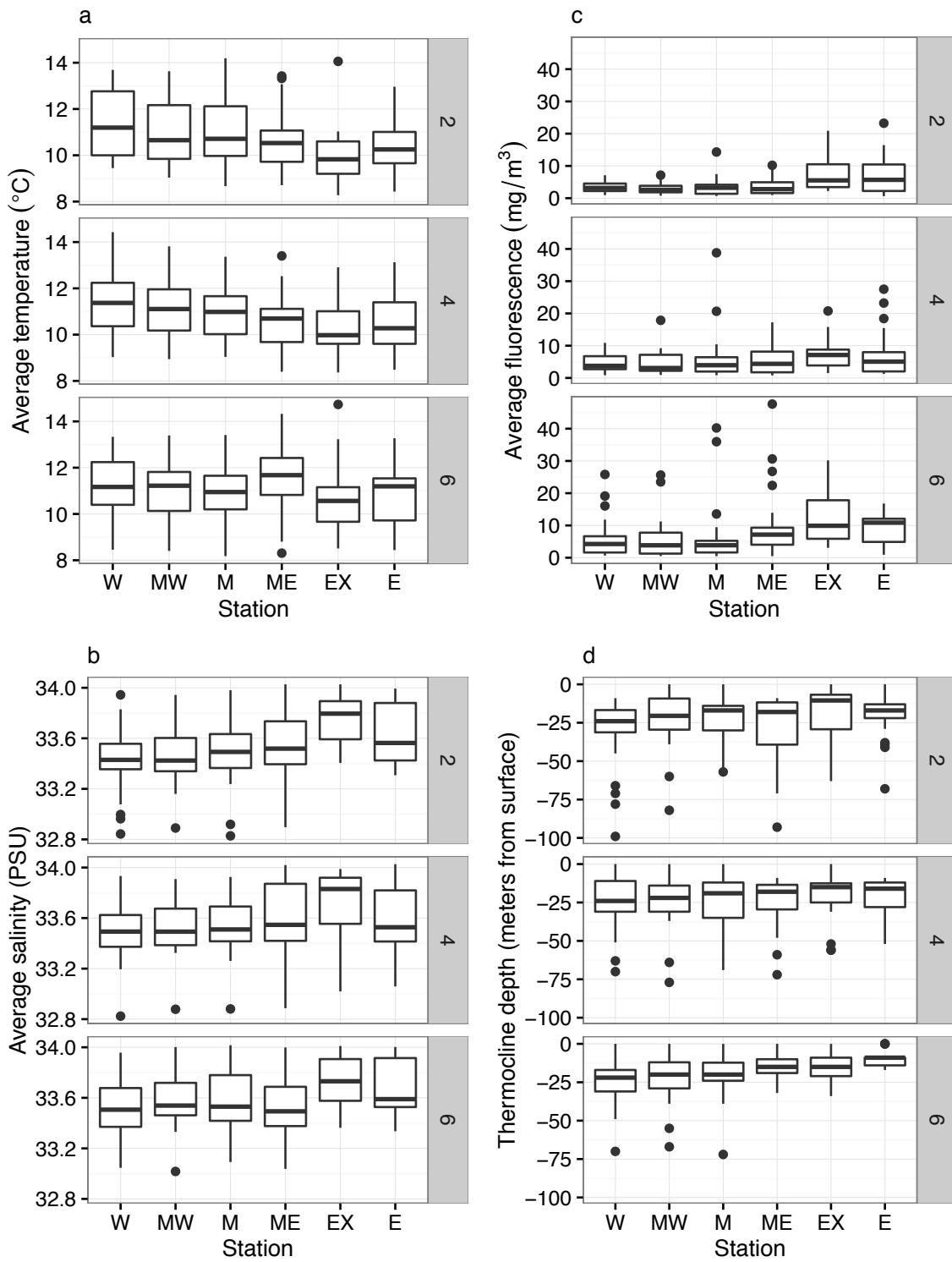


Fig. S3. Local environmental variables across space. Boxplots of (a) temperature, (b) salinity, (c) fluorescence, and (d) thermocline depth depict the distribution of values at each station (W, MW, M, ME, EX, E) along each line (2, 4, 6).

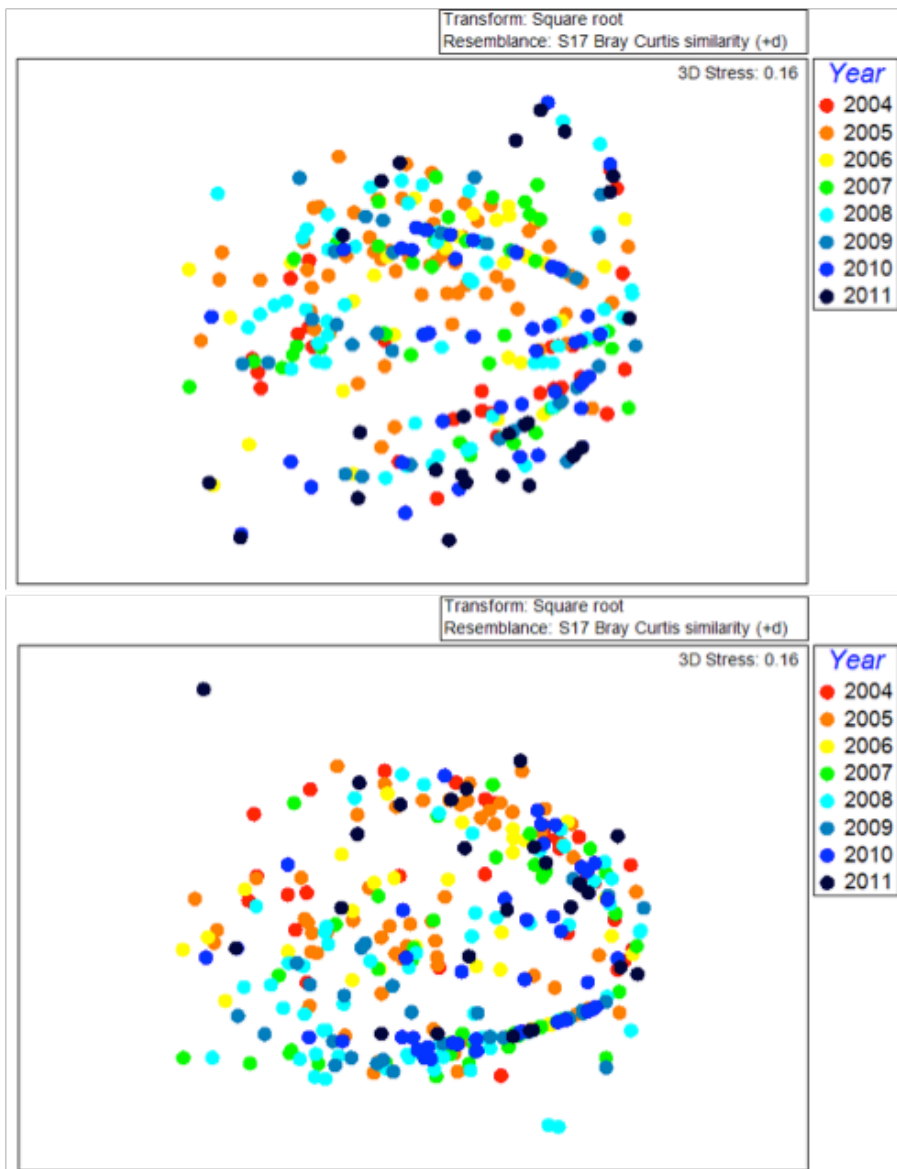


Fig. S4. Three-dimensional non-metric multidimensional scaling plots of decapod larvae taxonomic assemblages are depicted as: Top, Axis 1 vs. Axis 2; Bottom, Axis 1 vs. Axis 3. Samples are color-coded by year: warm colors correspond with warm regime years, and cool colors correspond with cold regime years. Plots are derived from Bray-Curtis similarity matrices on square-root transformed larval concentration data.