Trophic interactions modify the temperature dependence of community biomass and ecosystem function.

Supplementary File: Expanded statistical results

Jessica Garzke, Stephanie J. Connor, Ulrich Sommer and Mary I O'Connor

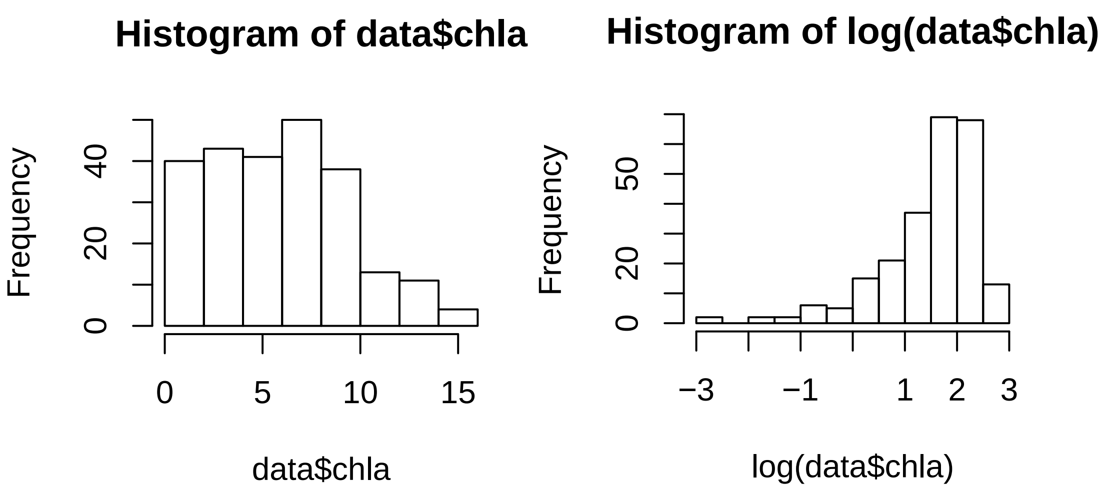
today

Results in Main text.

Code in Markdown file, printed here are supplemental results. I could imagine a second version of this file for the appendix in which this first section is omitted, or posted for the sake of reproducibility.

1. Results: Phytoplankton abundance (for Figure 2, Table 1 main text)

Figure S2. 2: Trophic Cascade strength by temperature and week



1.1 Biomass (Mb) candidate models

1.2 Biomass model results

Table S2. 4: Model selection results for Phytoplankton (Chl a) for linear mixed effects model

	Int	Z_j	T_{wj}	T_M	T_{wj}*Z_j	T_M*Z_j	T_M*T_{wj}	df	logLik	AICc	d	w
modPBF	2.05	+	-0.52	1.30	1.34	+	+	12	-155.37	336.11	0.00	9.982260e-01
modPB8	2.05	+	-0.66	1.30	NA	+	+	11	-162.86	348.87	12.76	1.690617e-03
modPB7	2.05	+	-0.96	1.30	NA	NA	+	9	-168.05	354.89	18.78	8.342130e-05
modPB4	1.50	NA	-0.96	1.70	0.96	NA	NA	6	-207.94	428.24	92.13	9.830504e-21
modPB6	1.91	+	-0.66	NA	NA	+	NA	8	-206.58	429.79	93.68	4.538012e-21
modPB3	1.50	NA	-0.96	1.71	NA	NA	NA	5	-211.73	433.72	97.62	6.341539e-22
modPB5	1.91	+	-0.96	NA	NA	NA	NA	6	-211.45	435.26	99.16	2.937427e-22
modPB2	1.50	NA	-0.96	NA	NA	NA	NA	4	-218.40	444.97	108.87	2.287011e-24
modPB1	1.90	+	NA	NA	NA	NA	NA	5	-257.21	524.68	188.57	1.124143e-41
modPB0	1.49	NA	NA	NA	NA	NA	NA	3	-264.15	534.41	198.30	8.684503e-44

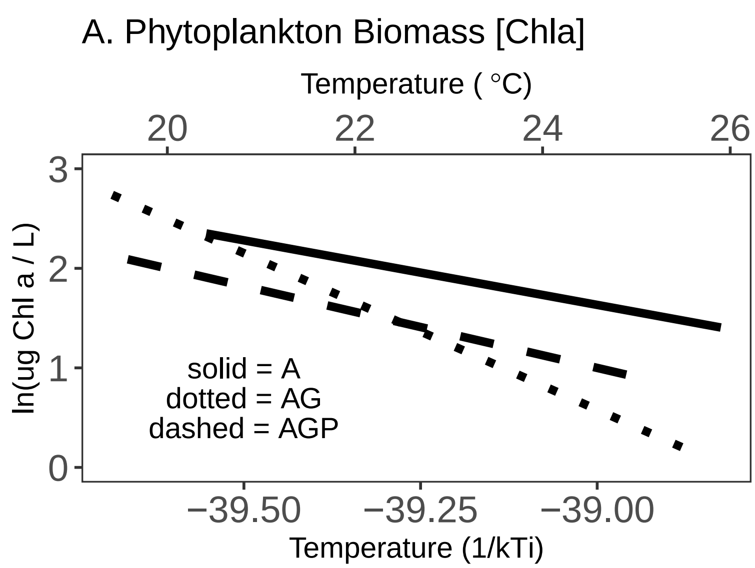
1.3 Biomass (Mb) Ea estimates Table 1 and Figure 2A

Table S2. 10:

	Ea	lower	upper
A	1.30	0.85	1.74
AG	3.14	2.77	3.52
AGP	1.64	1.20	2.08

1.4 Biomass (Mb) temperature dependence across systems, Fig 2A

Figure S2. 4: Chlorophyll a concentration



1.5 Biomass (Mb) within and among systems

2. Results: Trophic Cascade Results

These results support Table 1 and Figure 2, Main text. We defined the trophic cascade (TC) as log(AGP/AG) for Chlorophyll a.

Full model for trophic cascade strength:

lme(log(TC) ~ 1 + I(invTavg-mean(invTavg))*week, random = ~ 1|power, data=TCchla, method="ML", na.action=na.omit)

Following Equation 5 in the main text, we modeled the strength of the trophic cascade (TC) against inverse temperature (1/kT) centered on the mean temperature and experimental week (2-8). We allowed the intercept to vary randomly with the 'power' of the heater applied, which varied from 0 - 450 watts in 50 watt increments.

Figure with model predictions from best model (the full model), fit with REML. Model predictions here include random effects of 'power'; Figure 2 in the main text shows model estimated fixed effects without random effects.

Figure S2. 7:

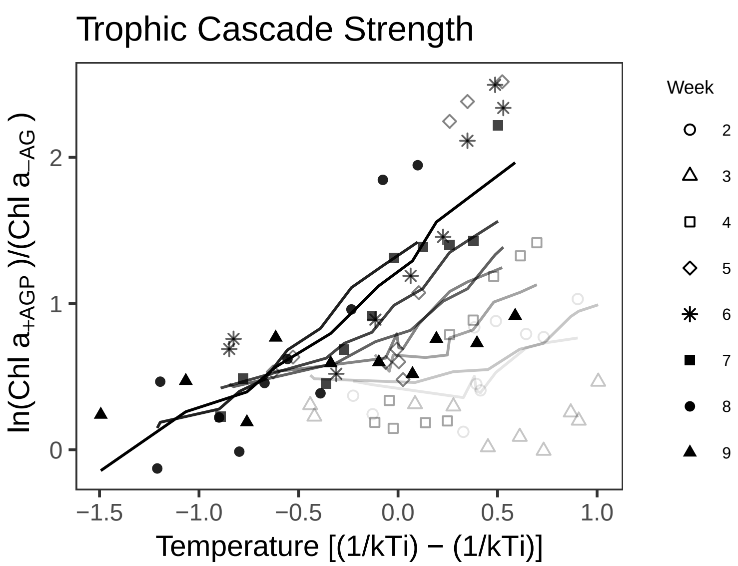
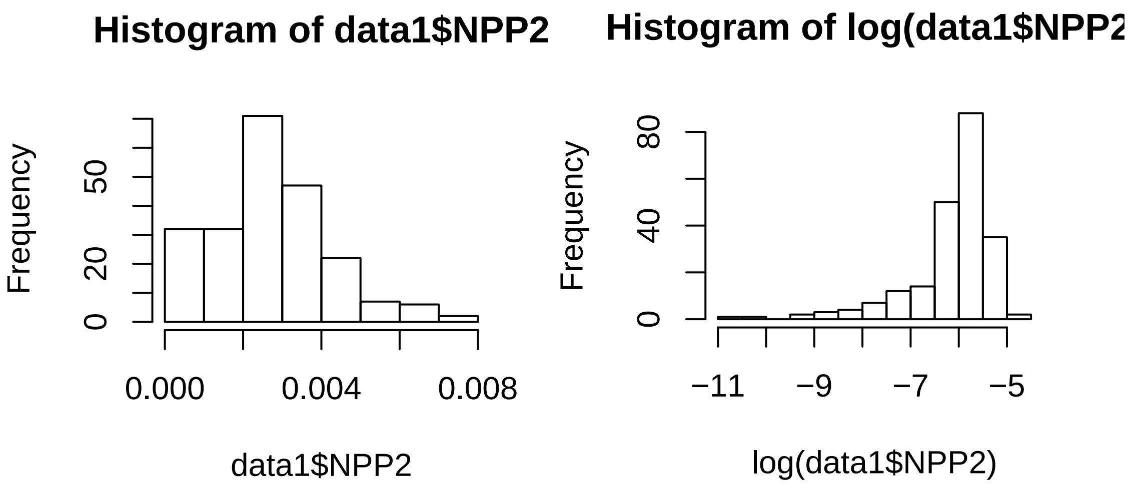


Table S2. 11:

	Int	T_{wj}	Wk	T_{wj}*Wk	df	logLik	AICc	d	w
TCFull	0.19	-0.01	0.12	0.11	6	-60.78	134.73	0.00	0.769299027
TCmodc	0.02	0.74	0.14	NA	5	-63.26	137.33	2.60	0.209484257
TCmode	0.56	NA	0.04	NA	4	-67.36	143.27	8.54	0.010776915
TCmodf	0.79	NA	NA	NA	3	-68.80	143.92	9.19	0.007786805
TCmodd	0.79	-0.05	NA	NA	4	-68.76	146.07	11.34	0.002652997

Summary of best model: trophic cascade strength - Full Model.

3. RESULTS: Net ecosystem oxygen production (NEP)



3.1 NEP candidate models

3.2 NEP model results

Table S2. 12:

	Int	Z_j	T_{wj}	T_M	$T_{wj}*Z_j$	T_M*Z_j	$T_{wj}*T_M$	df	logLik	AICc	d	w
modNEP8	-6.42	+	0.29	-1.40	NA	+	+	11	-266.47	556.21	0.00	3.878747e-01
modNEPF	-6.42	+	0.37	-1.42	0.84	+	+	12	-265.54	556.60	0.39	3.192963e-01
modNEP7	-6.41	+	0.03	-1.39	NA	NA	+	9	-269.68	558.22	2.01	1.421535e-01
modNEP3	-6.15	NA	0.02	-0.96	NA	NA	NA	5	-274.36	559.01	2.80	9.557409e-02
modNEP4	-6.15	NA	0.02	-0.96	0.61	NA	NA	6	-273.86	560.12	3.91	5.487563e-02
modNEP0	-6.15	NA	NA	NA	NA	NA	NA	3	-283.15	572.41	16.20	1.179389e-04
modNEP2	-6.15	NA	0.03	NA	NA	NA	NA	4	-283.13	574.44	18.23	4.265400e-05
modNEP1	-6.26	+	NA	NA	NA	NA	NA	5	-282.25	574.78	18.57	3.596974e-05
modNEP6	-6.26	+	0.27	NA	NA	+	NA	8	-279.83	576.34	20.13	1.647426e-05
modNEP5	-6.26	+	0.03	NA	NA	NA	NA	6	-282.23	576.85	20.64	1.278556e-05

3.3 NEP Ea estimates Table 2 and Figure 3A

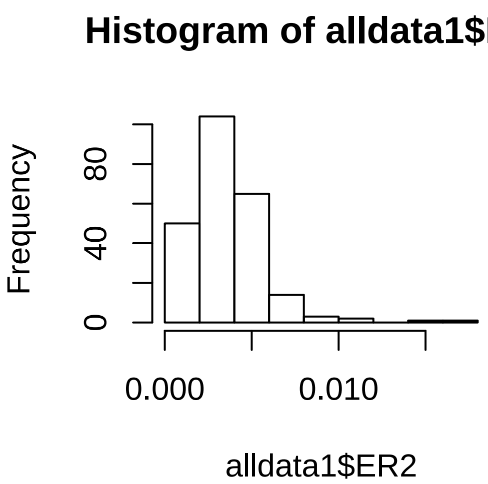
Table S2. 13:

	Ea	lower	upper
A	-1.41	-2.24	-0.58
AG	-1.21	-2.36	-0.07
AGP	-0.99	-2.10	0.12

3.4 NEP temperature dependence across systems, Figure 3A

3.5 NEP temperature dependence within and across systems, Figure 5

4. RESULTS: Net ecosystem oxygen consumption (ER)



4.1 ER candidate models

4.2 ER model results

Table S2. 14:

	Int	Z_j	T_{wj}	T_M	T_{wj}*T_M	T_{wj}*Z_j	T_M*Z_j	df	logLik	AICc	d	w
modER7	-6.09	+	0.11	-1.32	NA	NA	+	9	-185.88	390.54	0.00	6.013204e-01
modER8	-6.09	+	0.02	-1.32	NA	+	+	11	-184.58	392.31	1.77	2.479721e-01
modERF	-6.09	+	0.06	-1.32	0.42	+	+	12	-183.97	393.31	2.77	1.506867e-01
modER3	-5.79	NA	0.11	-0.67	NA	NA	NA	5	-201.37	413.00	22.46	7.978045e-06
modER4	-5.79	NA	0.11	-0.68	0.50	NA	NA	6	-200.45	413.27	22.73	6.977684e-06
modER1	-5.94	+	NA	NA	NA	NA	NA	5	-202.46	415.18	24.64	2.685333e-06
modER5	-5.94	+	0.11	NA	NA	NA	NA	6	-201.75	415.85	25.31	1.916292e-06
modER6	-5.94	+	0.02	NA	NA	+	NA	8	-200.49	417.60	27.06	8.013775e-07
modER0	-5.79	NA	NA	NA	NA	NA	NA	3	-207.04	420.17	29.63	2.211271e-07
modER2	-5.79	NA	0.11	NA	NA	NA	NA	4	-206.32	420.82	30.28	1.602501e-07

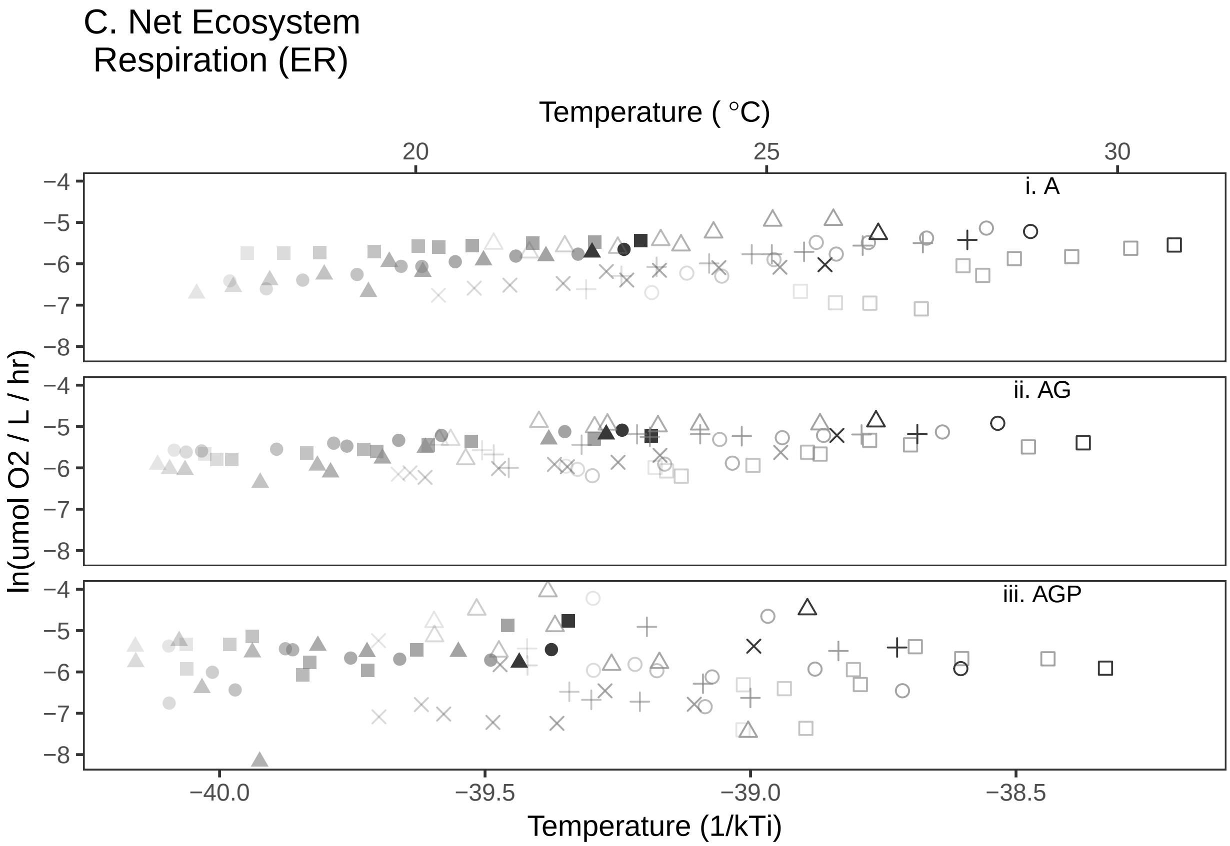
4.3 ER Ea estimates Table 3 and Figure 3b

Table S2. 15:

	Ea	lower	upper
A	-1.3150573	-1.8189019	-0.8112127
AG	-0.9065681	-1.3325385	-0.4805977
AGP	-0.3177815	-0.8197504	0.1841874

4.4 ER temperature dependence across systems

4.5 ER temperature dependence within and across systems xmin = -40.2, xmax = -38.2



5. COMBINED RESULTS:

5.1 coefficient plot

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## pdf
##   2
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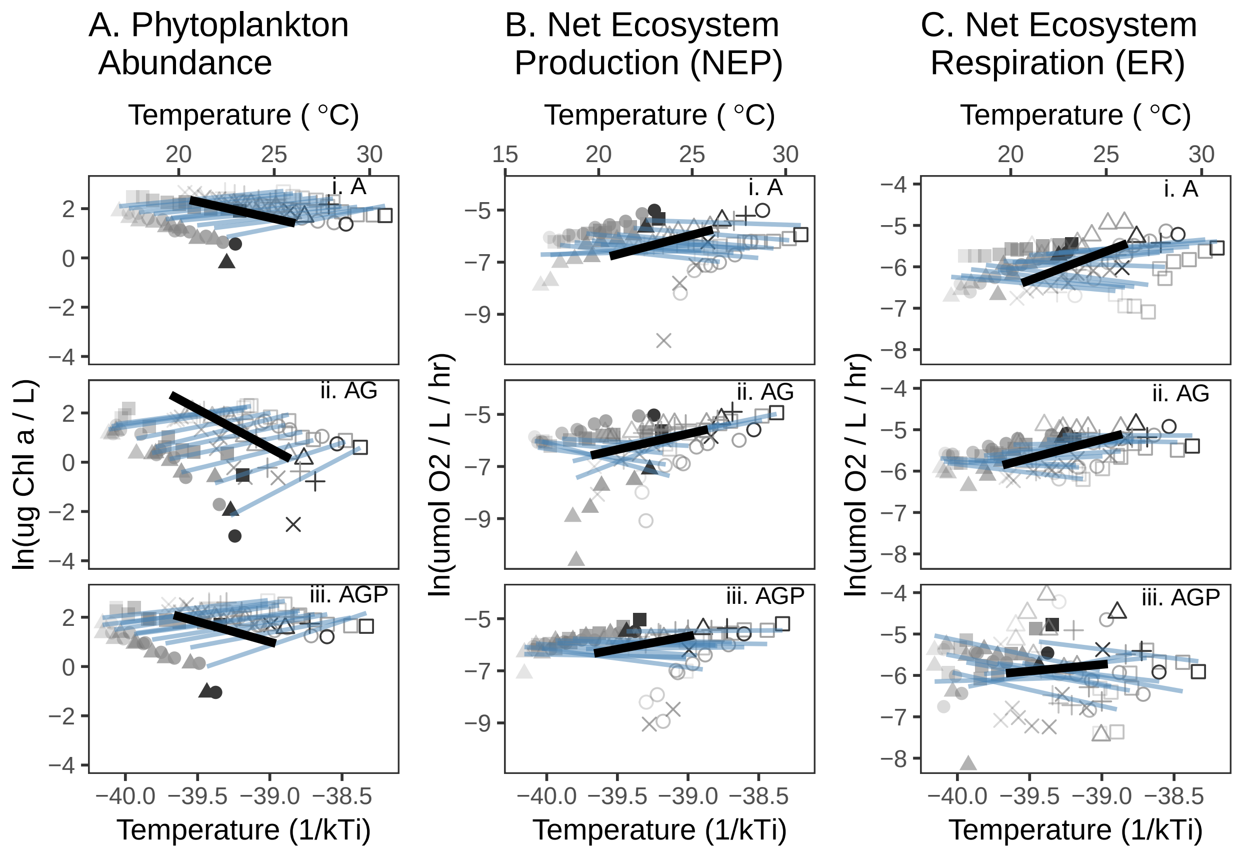
testing ER < NEP, per reviewer question

5.2 Figure 5 (Full)

Figure S2. 8:


A. Phytoplankton Abundance
B. Net Ecosystem Production (NEP)
C. Net Ecosystem Respiration (ER)
Temperature (°C)
i. A
ii. AG
iii. AGP
ln(ug Chl a / L)
ln(umol O2 / L / hr)
Temperature (1/kTi)

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## pdf
##   2
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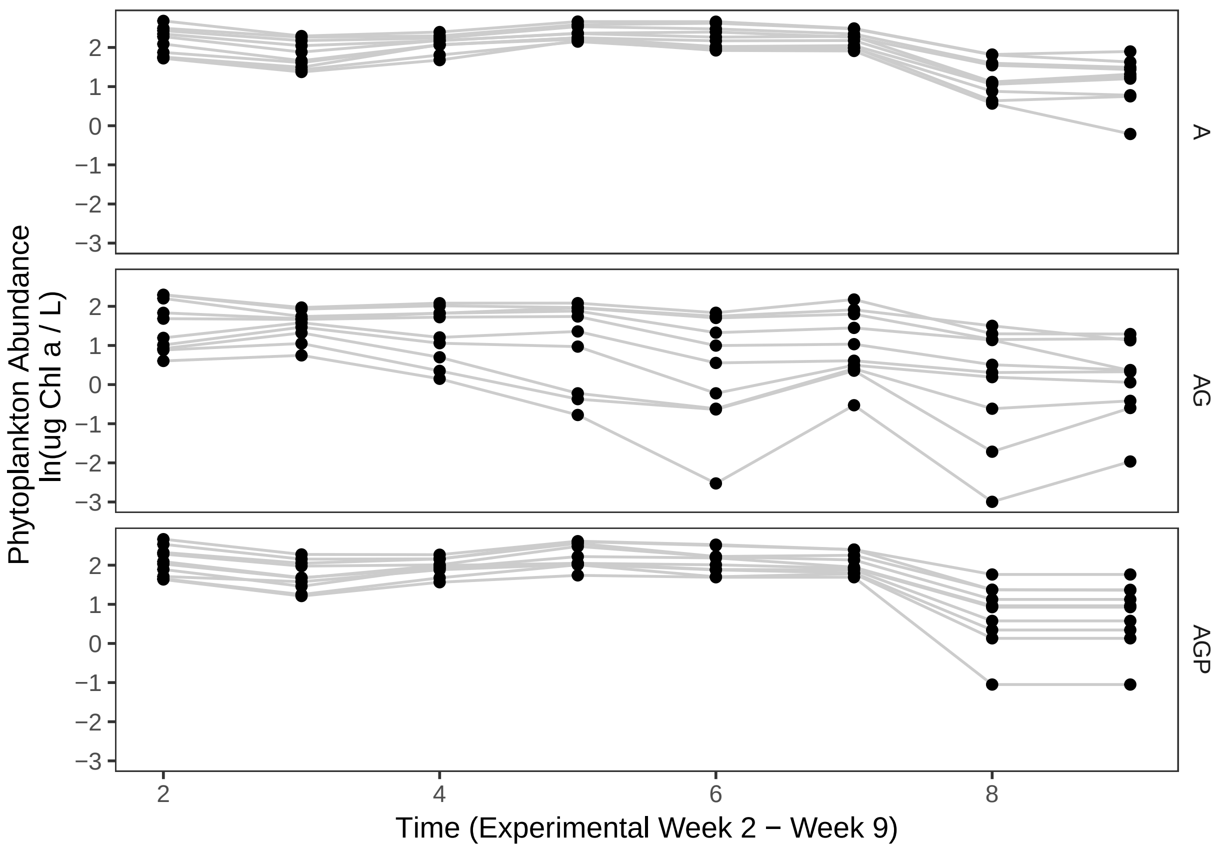
6. Appendix Results: Temporal patterns ## 6.1. Chlorophyll over time (8 weeks)

Figure S2. 1: Chlorophyll a concentration over time. Phytoplankton biomass, estimated as concentration of chlorophyll a pigment, for weekly sampling dates between July 3, 2012 (week 2) and August 28, 2012 (week 9). Experimental ecosystems were subjected to one of three trophic structure treatments: phytoplankton only (P), phytoplankton + zooplankton grazers (PZ), and phytoplankton, zooplankton grazers + predatory Notonectids (PZN). Tanks were sampled once per week, and gray lines connect repeated measurements of each tank (1 - 30).



Full model: lme(I(log(chla)) ~ week*trophic.level, random = ~ 1 | Tank, data=alldata, method="ML", na.action=na.omit)

Chlorophyll concentration (ln[Chla]) declined over time and varied with trophic treatment. There was a signficant temperature*week interaction (Table S1.1). When we re-run the model using weeks 2-7, we see evidence of a slight increase in chlorophyll concentration over time (Table S1.2). Together these results suggest the negative trend in chlorophyll is drive by the drop in week 8, across all treatments. This is concurrent with a cooling event and a large storm.

Table S2. 1: Model selection results: Chlorophyll a variation over time and with trophic treatment, weeks 2-9.

	Int	TrophicLev	Week	TL*Wk	df	logLik	AICc	d	w
CT1	2.54	+	-0.12	+	8	-194.72	406.06	0.00	9.224069e-01
CT2	2.82	+	-0.17	NA	6	-199.33	411.02	4.97	7.698761e-02
CT3	2.41	NA	-0.17	NA	4	-206.27	420.71	14.66	6.054409e-04
CT4	1.49	NA	NA	NA	3	-264.15	534.41	128.35	1.240275e-28

Table S2. 2: Model selection results: Chlorophyll a variation over time and with trophic treatment, weeks 2-7.

	Int	TrophicLev	Week	TL*Wk	df	logLik	AICc	d	w
CT1s	1.91	+	0.05	+	8	-83.30	183.44	0.00	1.000000e+00
CT2s	2.28	+	-0.03	NA	6	-108.23	228.94	45.50	1.319628e-10
CT3s	1.90	NA	-0.03	NA	4	-117.12	242.47	59.03	1.517267e-13
CT4s	1.76	NA	NA	NA	3	-119.11	244.36	60.92	5.905315e-14

	Weeks 2-9	Weeks 2-7
A	-0.12	0.05
AG	-0.21	-0.18
AGP	-0.17	0.03