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

Supplementary File: Expanded statistical results

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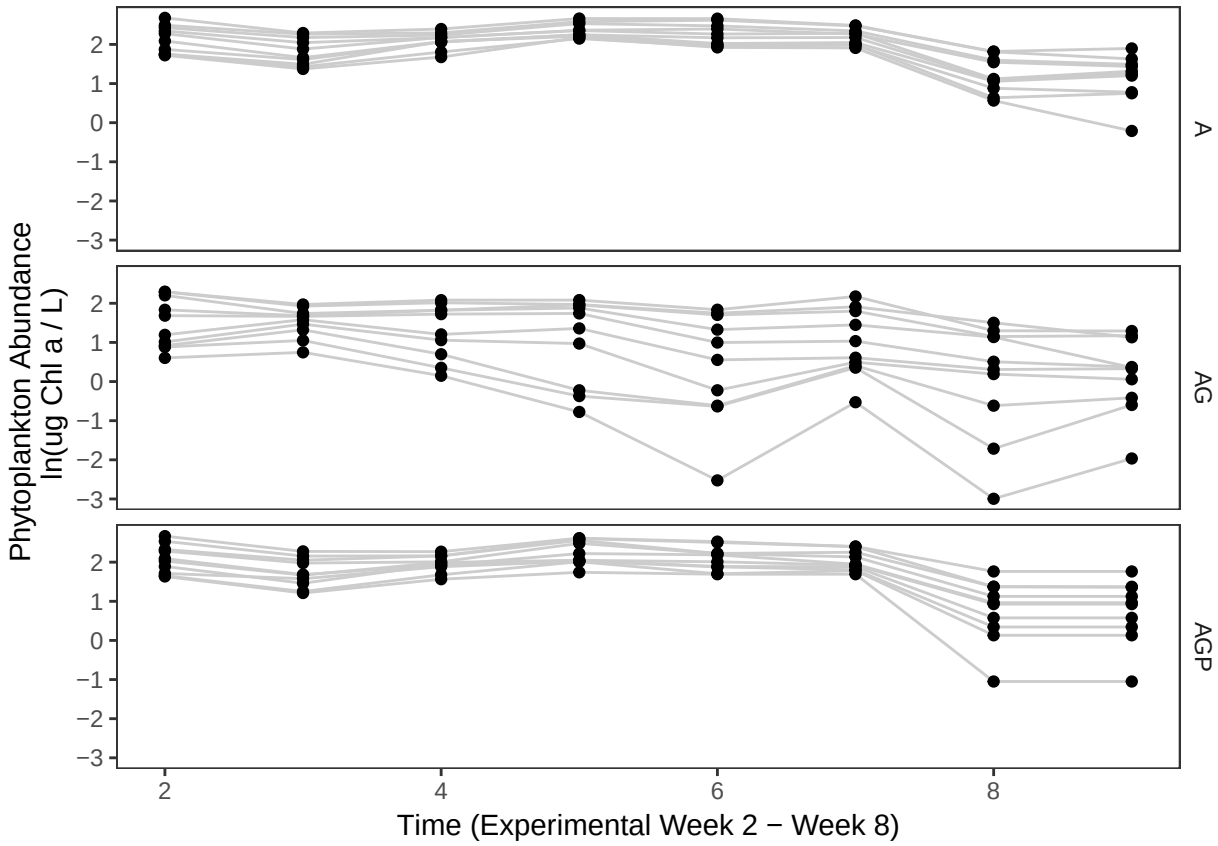
today

1. Results: Temporal patterns

1.1. 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

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. 2: Trophic Cascade strength by temperature and week

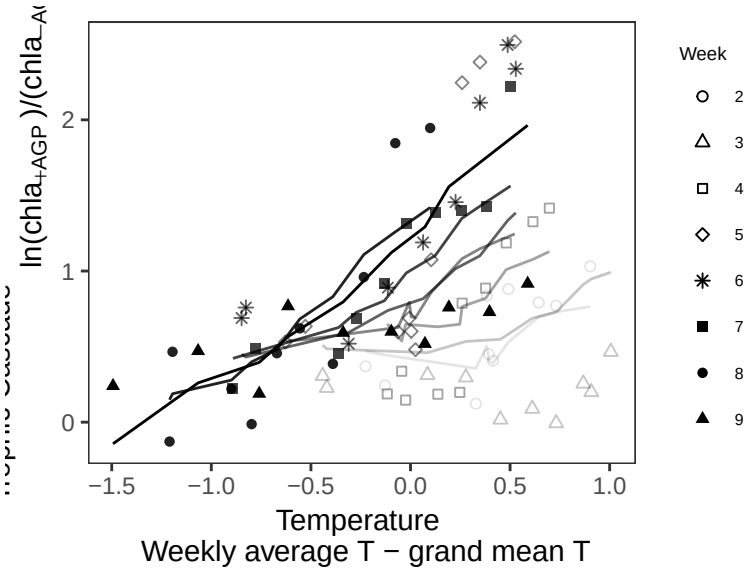


Table S2. 3: Model selection results for Trophic Cascade strength (Chl a) for linear mixed effects model

	Int	T	Wk	T*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.

```
## Linear mixed-effects model fit by REML
##  Data: TCchla
##        AIC      BIC    logLik
##   148.6345 162.5394 -68.31724
##
## Random effects:
##  Formula: ~1 | power
##         (Intercept)  Residual
## StdDev:   0.1986087 0.5114714
##
## Fixed effects: log(TC) ~ 1 + I(-(invTavg - mean(invTavg))) * week
##                                       Value Std.Error DF    t-value
## (Intercept)                       0.3080029 0.2174818 66  1.4162241
## I(-(invTavg - mean(invTavg)))    -0.2011684 0.3666985 66 -0.5485936
## week                              0.1025726 0.0344448 66  2.9778816
## I(-(invTavg - mean(invTavg))):week  0.1198250 0.0488956 66  2.4506293
##                                    p-value
## (Intercept)                         0.1614
## I(-(invTavg - mean(invTavg)))       0.5851
## week                                0.0041
## I(-(invTavg - mean(invTavg))):week  0.0169
```

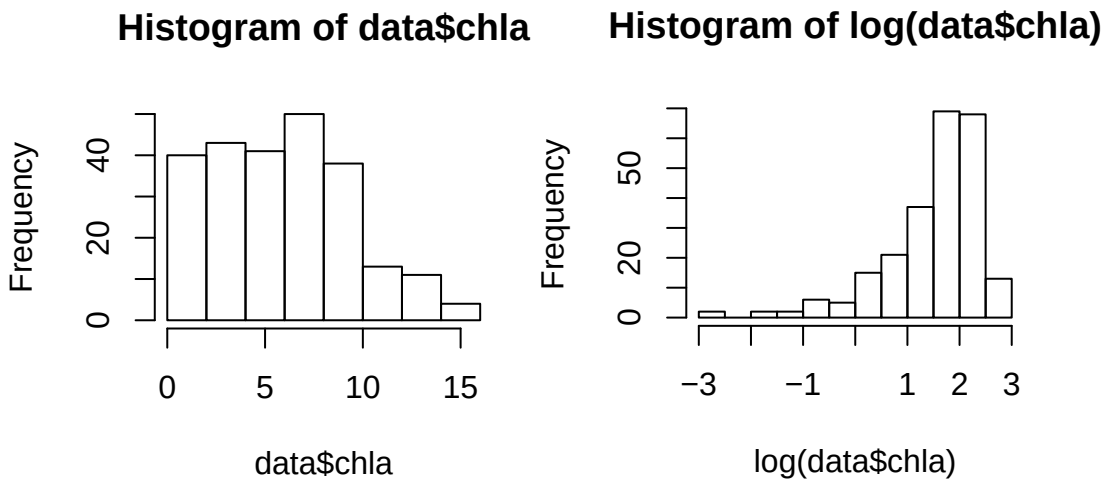
```
##  Correlation:
##                                   (Intr) I(-(nT-m(T))) week
## I(-(invTavg - mean(invTavg)))      -0.575
## week                               -0.907  0.497
## I(-(invTavg - mean(invTavg))):week  0.350 -0.886        -0.219
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -2.04781634 -0.46134585 -0.05746518  0.50402288  2.48582704
##
## Number of Observations: 79
## Number of Groups: 10
```

```
## Approximate 95% confidence intervals
##
##  Fixed effects:
##                                         lower       est.     upper
## (Intercept)                        -0.12621342  0.3080029 0.7422192
## I(-(invTavg - mean(invTavg)))      -0.93330566 -0.2011684 0.5309688
## week                                0.03380130  0.1025726 0.1713440
## I(-(invTavg - mean(invTavg))):week  0.02220178  0.1198250 0.2174483
## attr(,"label")
## [1] "Fixed effects:"
##
##  Random Effects:
##   Level: power
##                       lower      est.    upper
## sd((Intercept)) 0.02372111 0.1986087 1.662882
##
##  Within-group standard error:
##     lower      est.     upper
## 0.4149172 0.5114714 0.6304945
```

Figure S2. 5:

3. Results: Phytoplankton abundance (for Figure 3, Table 2 main text)

Figure S2. 3: Chlorophyll a concentration



3.1.1 Phytoplankton abundance candidate models

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

	Int	TL	Tw	Tt	Tw*Tt	Tw*TL	Tt*TL	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

Table S2. 5: Parameter estimates from model PB8 (Table S2.1) for Phytoplankton (Chl a) for linear mixed effects model

	Ea	lower	upper
P	1.30	0.85	1.74
PZ	3.14	2.77	3.52
PZN	1.64	1.20	2.08

“‘{r}

tring to plot with visreg

modPBp <- lme(logChla ~ 1 + trophic.level*I(invTi - invTT) + trophic.level*Tcenter, random = ~ 1 | Tank, data=data, method=“ML”, na.action=na.omit) library(visreg)

to get this to work, i think i have to make the temp term one term in the dataframe.

PP.plot3 <- visreg(modPBp, “Tcenter”, by = “trophic.level”, type = “contrast”, overlay = TRUE, gg = TRUE) visreg(modPBp, “week”, “Tank”) ggsave(“PPplot3.png”, device = “png”, width = 5, height = 3)

```
#```{r}
#### tring to plot with sjplot
modPBp <- lme(logChla ~ 1 + trophic.level*I(invTi - invTT) + trophic.level*Tcenter, random = ~ 1 | Tank
library(sjPlot)

## to get this to work, i think i have to make the temp term one term in the dataframe.
PP.plot3 <- plot_model(modPBp, type = "eff", terms = c("Tcenter"))
visreg(modPBp, "week", "Tank")
ggsave("PPplot3.png", device = "png", width = 5, height = 3)
```

3.1.2 Net ecosystem oxygen production

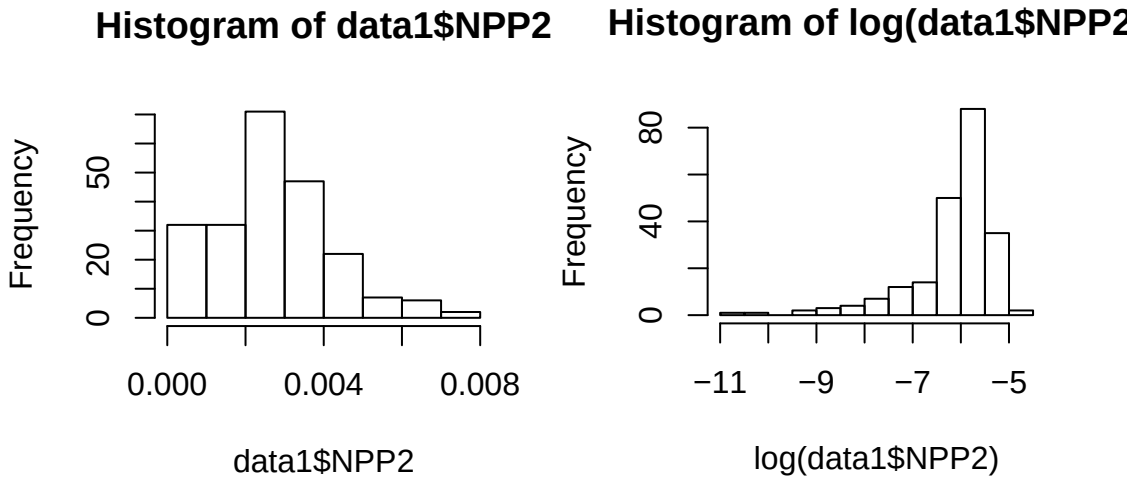


Table S2. 6: Model selection results for Net Ecosystem Oxygen Production, with 1|Tank as a random effect. Model terms are: intercept (Int), trophic treatment (TL), Temperature - weekly average (Tw), temperature - expt average (Tt), interaction terms and statistical estimates

	Int	TL	Tw	Tt	Tw*Tt	Tw*TL	Tt*TL	df	logLik	AICc	d	w
modNPP8	-6.42	+	0.29	-1.40	NA	+	+	11	-266.47	556.21	0.00	3.878747e-01
modNPPF	-6.42	+	0.37	-1.42	0.84	+	+	12	-265.54	556.60	0.39	3.192963e-01
modNPP7	-6.41	+	0.03	-1.39	NA	NA	+	9	-269.68	558.22	2.01	1.421535e-01
modNPP3	-6.15	NA	0.02	-0.96	NA	NA	NA	5	-274.36	559.01	2.80	9.557409e-02
modNPP4	-6.15	NA	0.02	-0.96	0.61	NA	NA	6	-273.86	560.12	3.91	5.487563e-02
modNPP0	-6.15	NA	NA	NA	NA	NA	NA	3	-283.15	572.41	16.20	1.179389e-04
modNPP2	-6.15	NA	0.03	NA	NA	NA	NA	4	-283.13	574.44	18.23	4.265400e-05
modNPP1	-6.26	+	NA	NA	NA	NA	NA	5	-282.25	574.78	18.57	3.596974e-05
modNPP6	-6.26	+	0.27	NA	NA	+	NA	8	-279.83	576.34	20.13	1.647426e-05
modNPP5	-6.26	+	0.03	NA	NA	NA	NA	6	-282.23	576.85	20.64	1.278556e-05

NPP Coefficients

Table S2. 7: Parameter estimates from model NPP8 (Table S2.3) for Net Ecosystem Oxygen Productivity (NEP) for linear mixed effects model(For MS Figure 3)

	Ea	lower	upper
P	-1.41	-2.24	-0.58
PZ	-1.21	-2.36	-0.07
PZN	-0.99	-2.10	0.12

3.1.3 Net ecosystem oxygen consumption (ER)

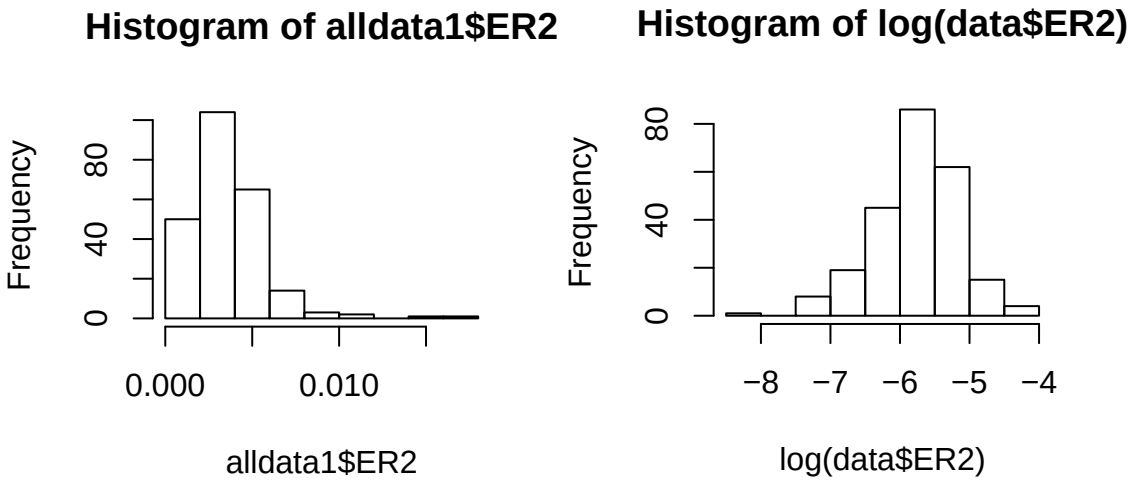


Table S2. 8: Model selection results for Net Ecosystem Respiration, with 1|Tank as a random effect. Model terms are: intercept (Int), trophic treatment (TL), Temperature - weekly average (Tw), temperature - expt average (Tt), interaction terms and statistical estimates

	Int	TL	Tw	Tt	Tw*Tt	Tw*TL	Tt*TL	df	logLik	AICc	d	w
modER7	-6.09	+	0.11	-1.32	NA	NA	+	9	-185.88	390.54	0.00	6.849070e-01
modER8	-6.09	+	0.02	-1.32	NA	+	+	11	-184.58	392.31	1.77	2.824415e-01
modERF	-6.04	+	0.06	-0.85	0.43	+	NA	10	-187.83	396.63	6.09	3.262787e-02
modER3	-5.79	NA	0.11	-0.67	NA	NA	NA	5	-201.37	413.00	22.46	9.087033e-06
modER4	-5.79	NA	0.11	-0.68	0.50	NA	NA	6	-200.45	413.27	22.73	7.947617e-06
modER1	-5.94	+	NA	NA	NA	NA	NA	5	-202.46	415.18	24.64	3.058608e-06
modER5	-5.94	+	0.11	NA	NA	NA	NA	6	-201.75	415.85	25.31	2.182667e-06
modER6	-5.94	+	0.02	NA	NA	+	NA	8	-200.49	417.60	27.06	9.127731e-07
modER0	-5.79	NA	NA	NA	NA	NA	NA	3	-207.04	420.17	29.63	2.518649e-07
modER2	-5.79	NA	0.11	NA	NA	NA	NA	4	-206.32	420.82	30.28	1.825257e-07

ER coefficients

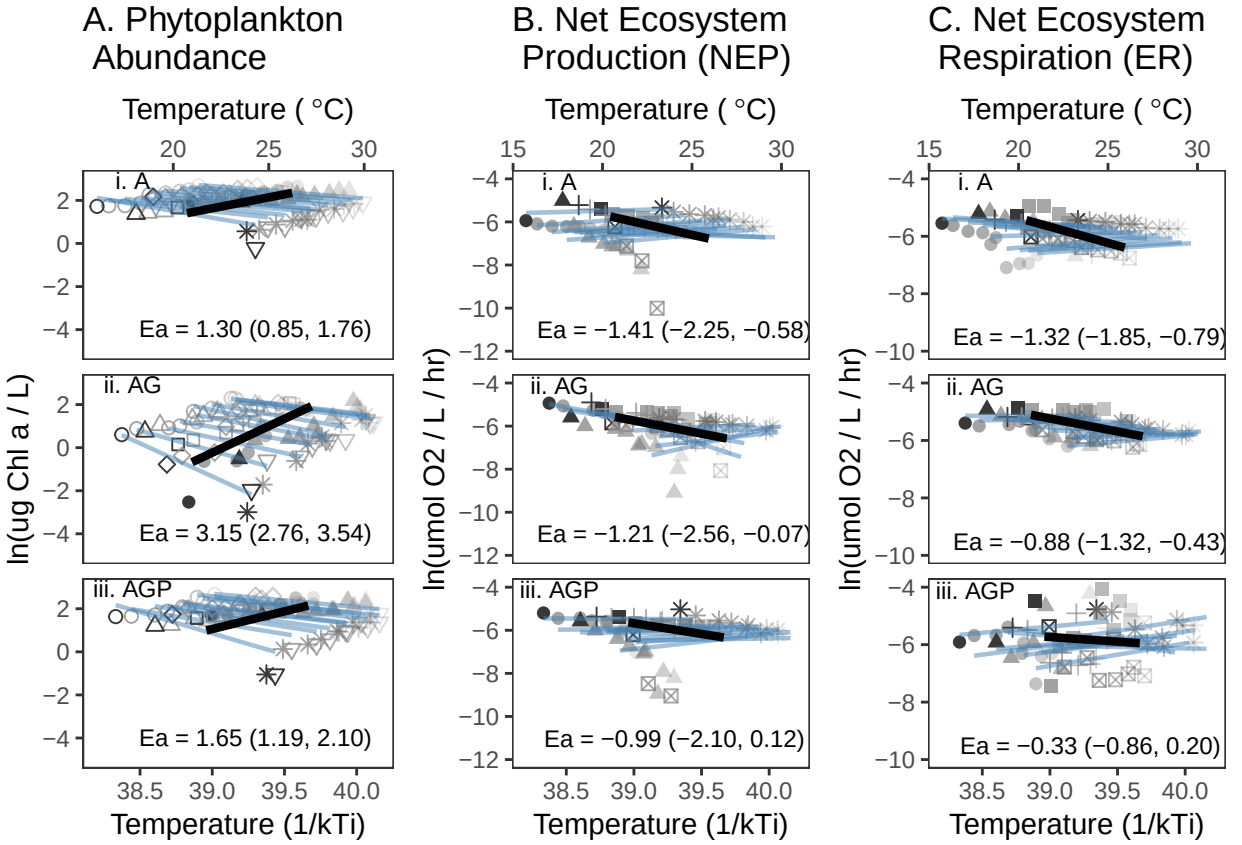
Table S2. 9: Confidence intervals for model ER7 (Table S2.5) (For MS Figure 3

	Ea	lower	upper
P	-1.3150573	-1.8189019	-0.8112127
PZ	-0.9065681	-1.3325385	-0.4805977

	Ea	lower	upper
PZN	-0.3177815	-0.8197504	0.1841874

Figure 3 (Full)

Figure S2. 4: Manuscript figure 3: Effects of temperature on oxygen flux and phytoplankton standing stock

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