Statistical Analysis to Support the Cerco Algal Growth Rate Model Proposed for the MBM and MTMs

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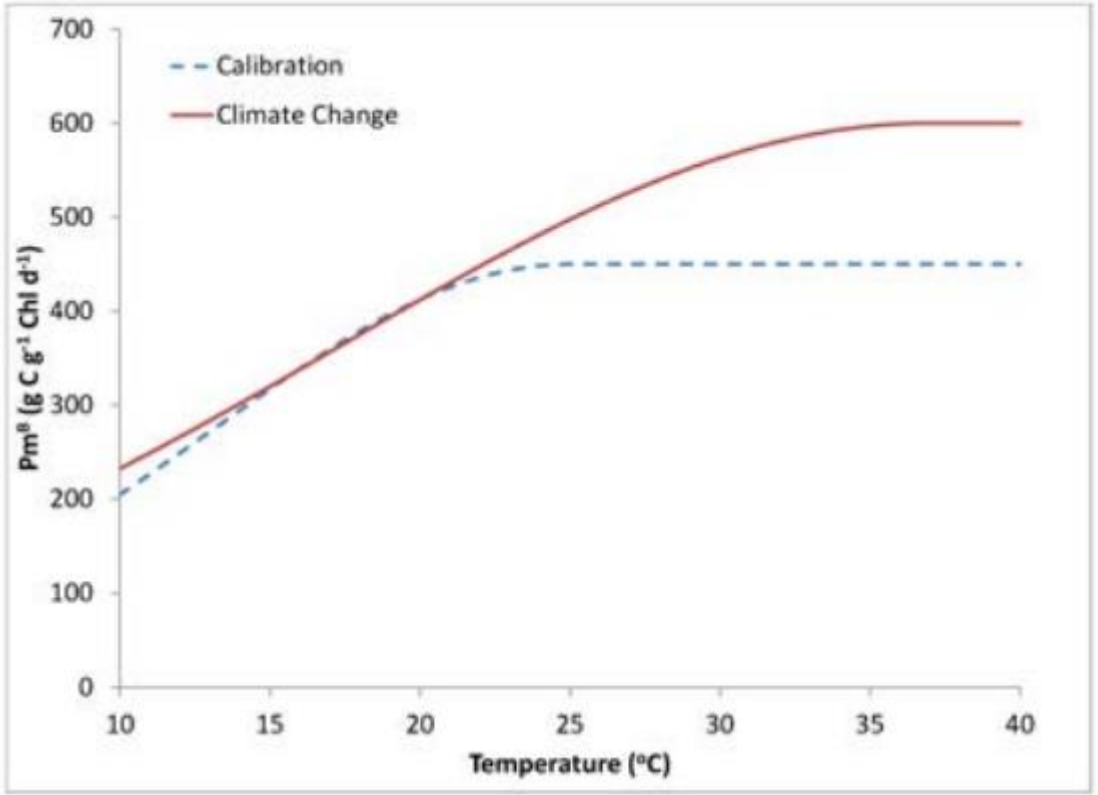
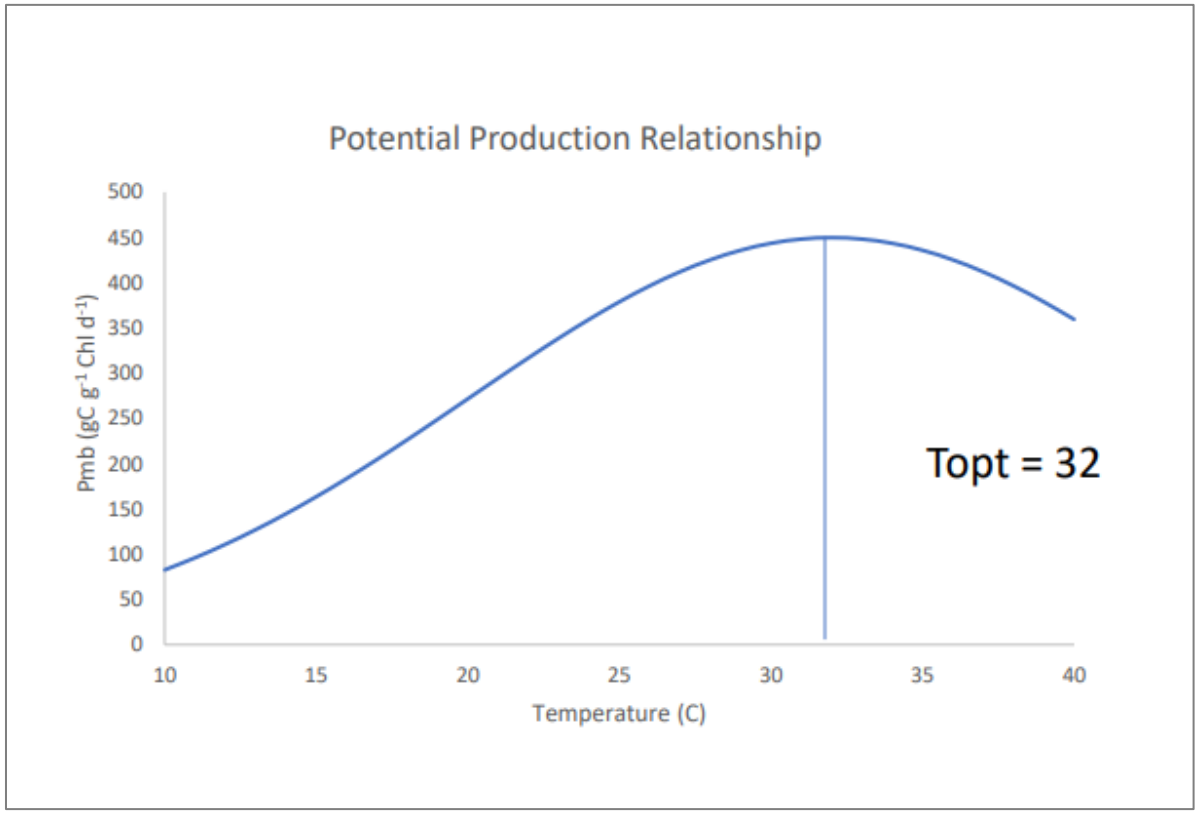
Phase 6



Proposed for Phase 7



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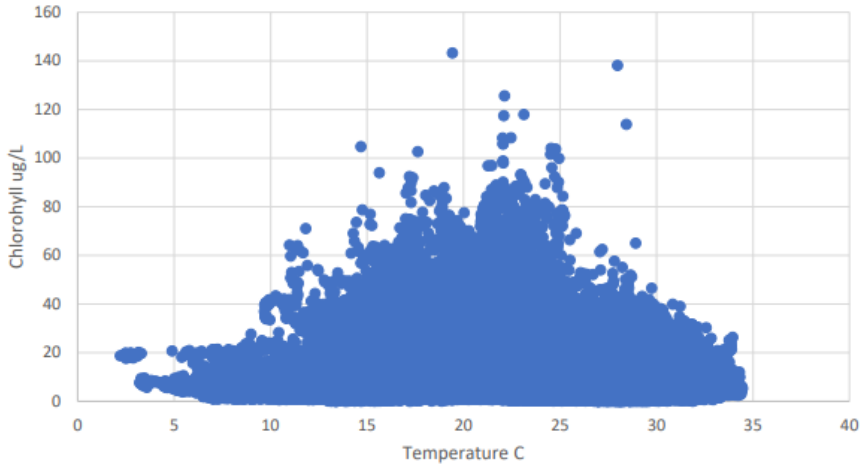
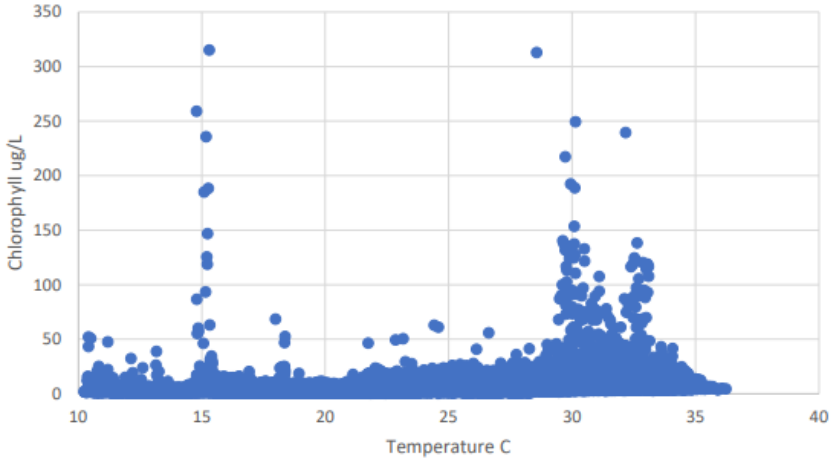
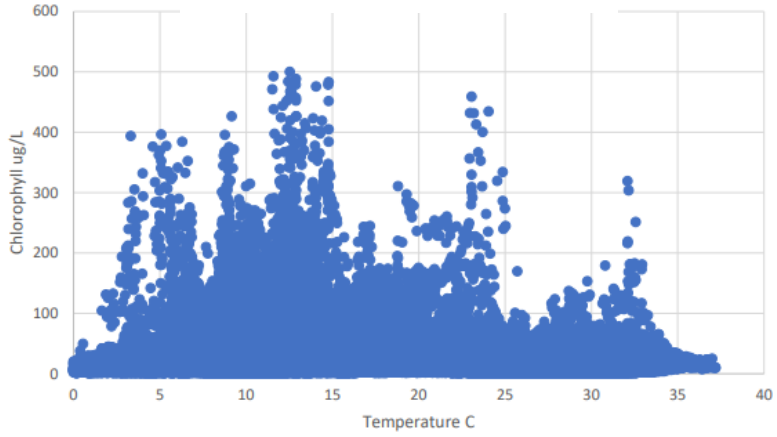
Piscataway, Potomac River



Osborne Landing, James River

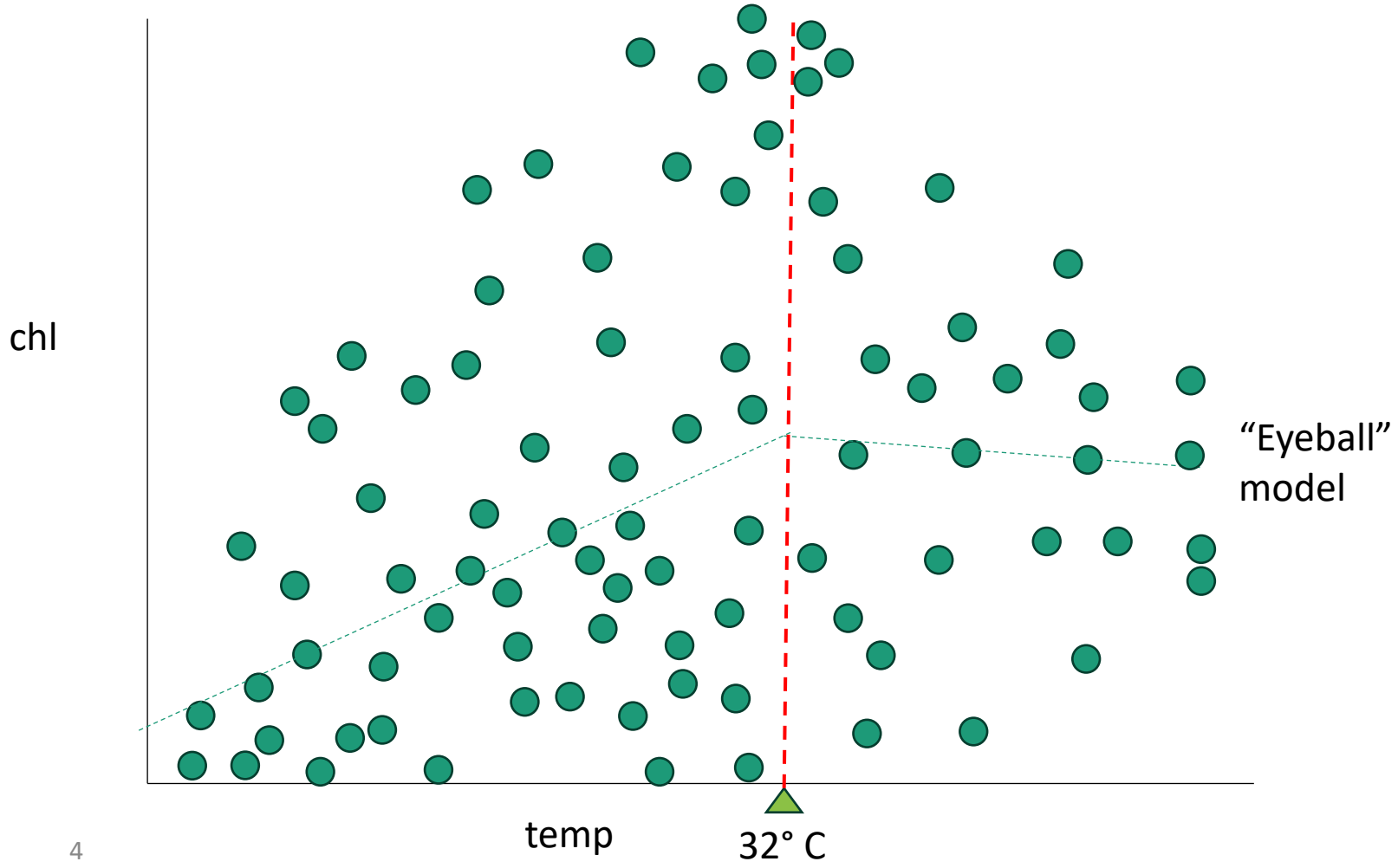


Otter Pt, Bush River

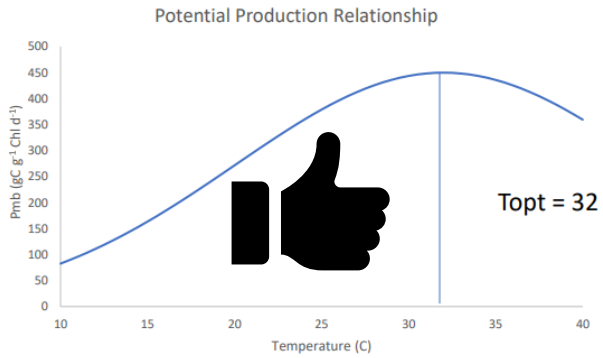


Visually the monitoring data seem to support the assumptions of the proposed algal growth model. But are we sure they do?

Eyeball interpretation: The average chlorophyll concentration flattens out or decreases at high temperatures.



Proposed for Phase 7



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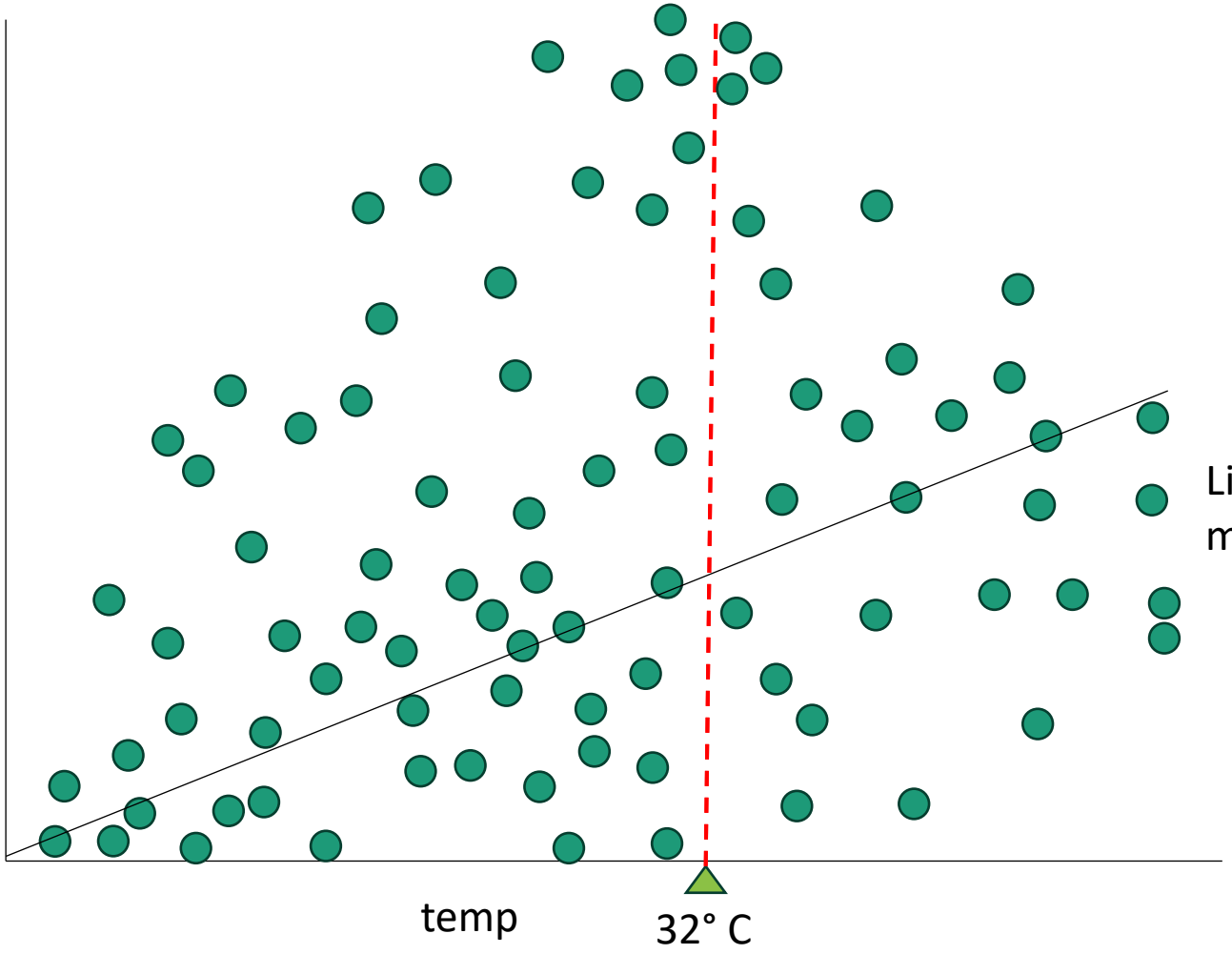
But it is possible that a statistical model would show something different.



Linear regression model (mean)

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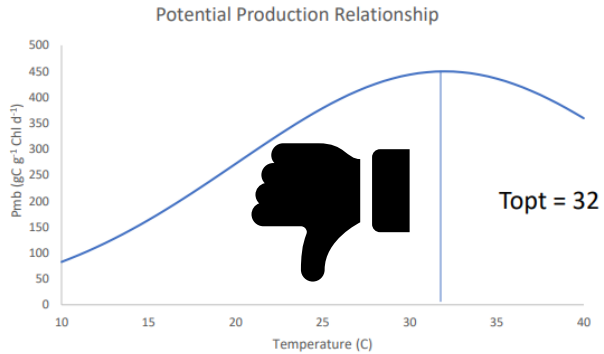

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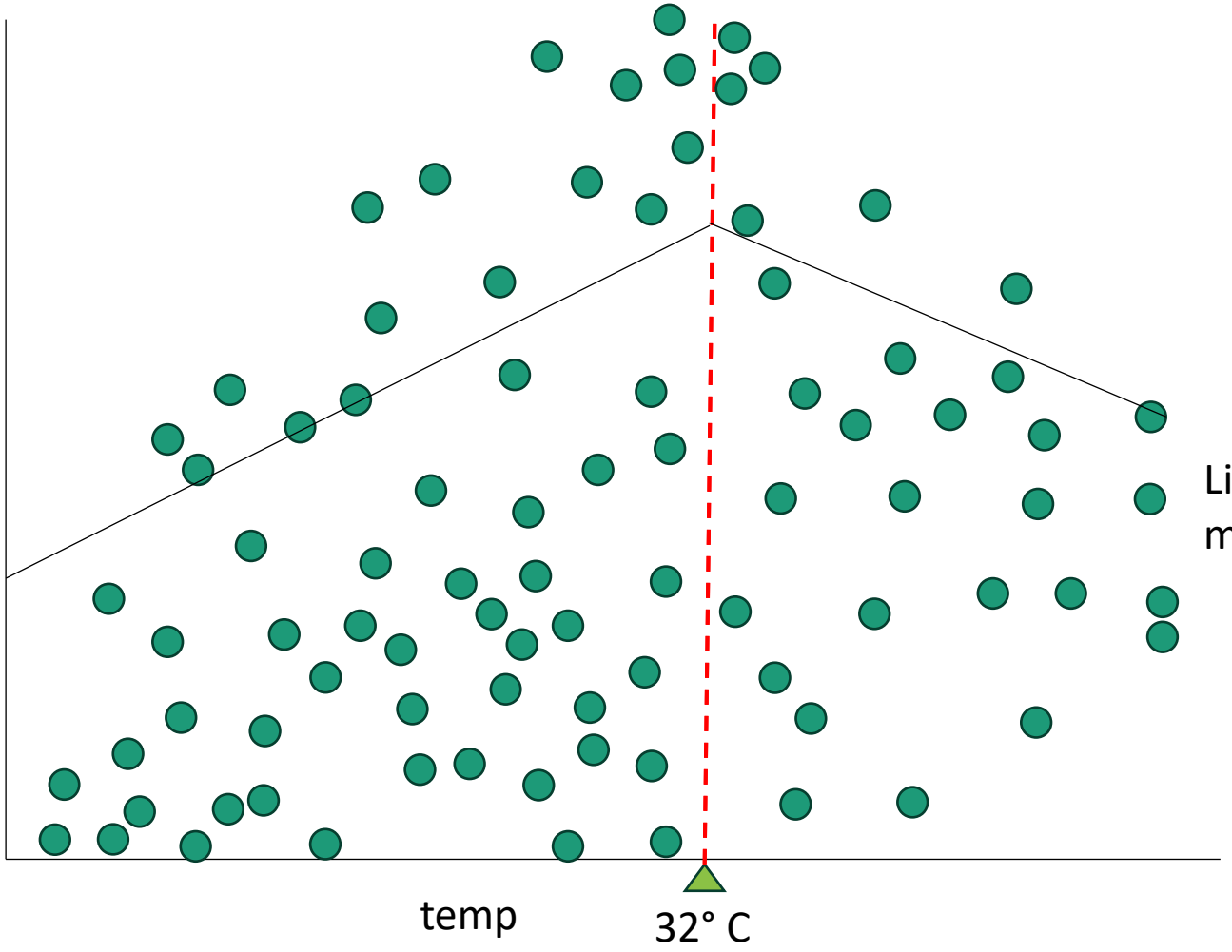
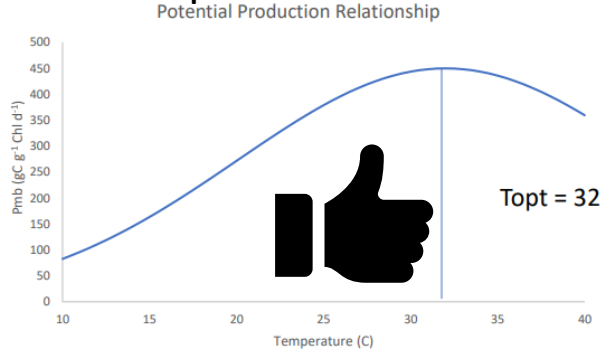
Or maybe a statistical model does corroborate your eyeballs but in a place you weren't expecting.



Linear regression model (90th percentile)

Proposed for Phase 7



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Quantile Regression

- Models the relationship between an independent variable(s) and a response variable, at specified quantiles of the latter.

- The more commonly used ordinary least squares regression simulates the conditional mean of the response variable to the independent variable(s). But sometimes we are curious about more than just the mean response.

- Quantile regression allows us to discern the effect of an independent variable even when this variable does not elicit an average response. This is important in ecology, since ecological effects are often the result of complex interactions with limiting factors that may only be abundant some of the time.

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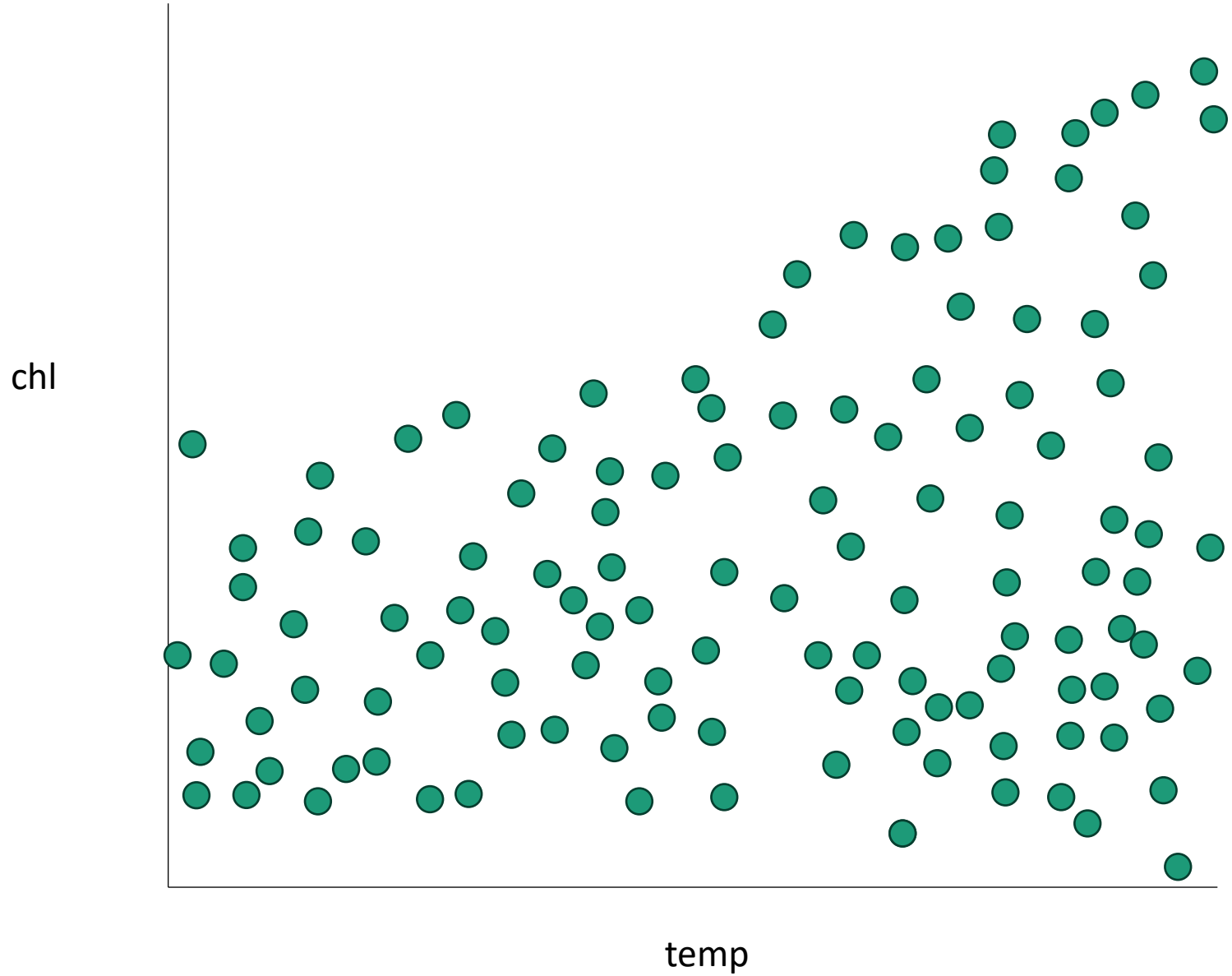
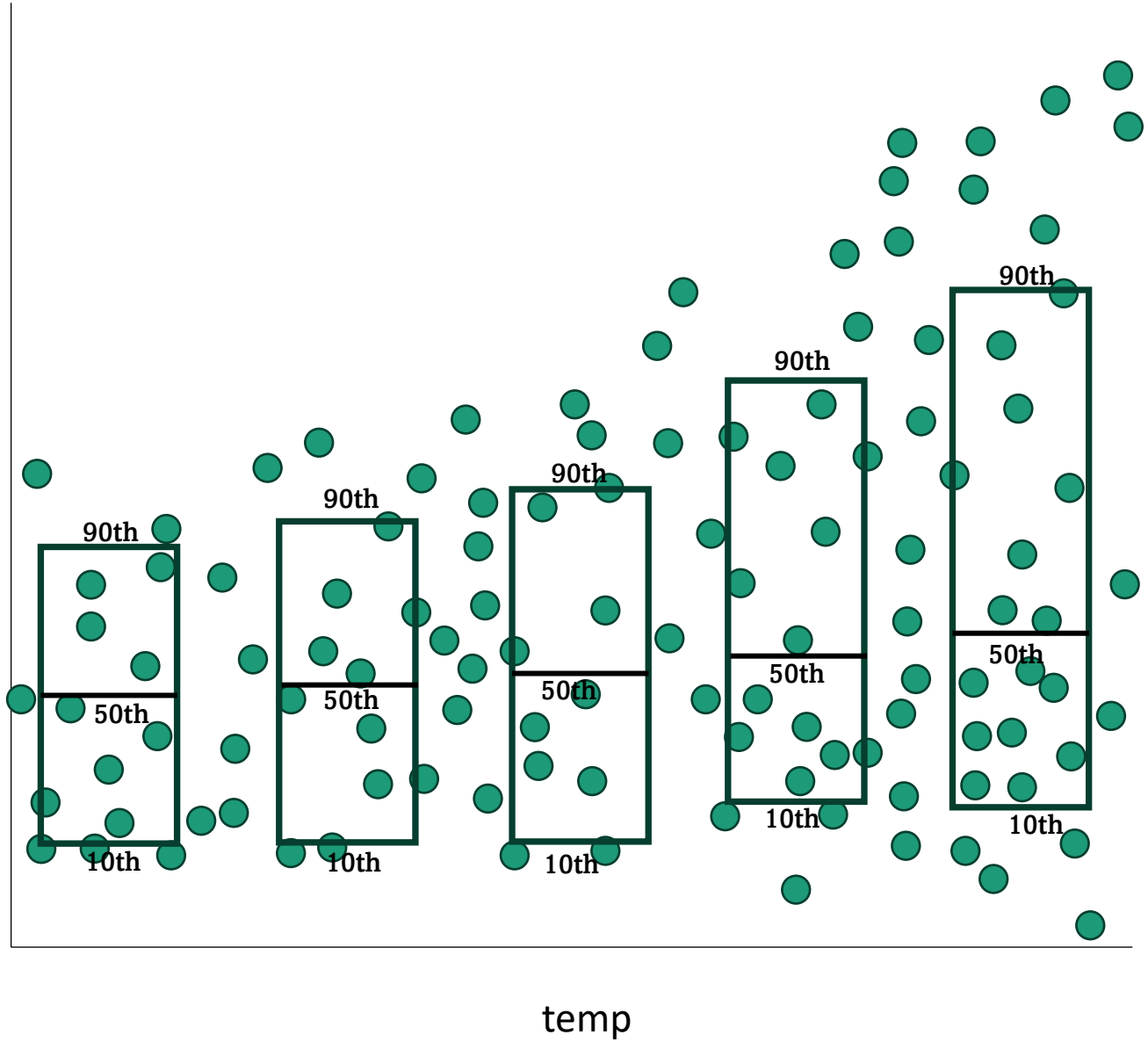
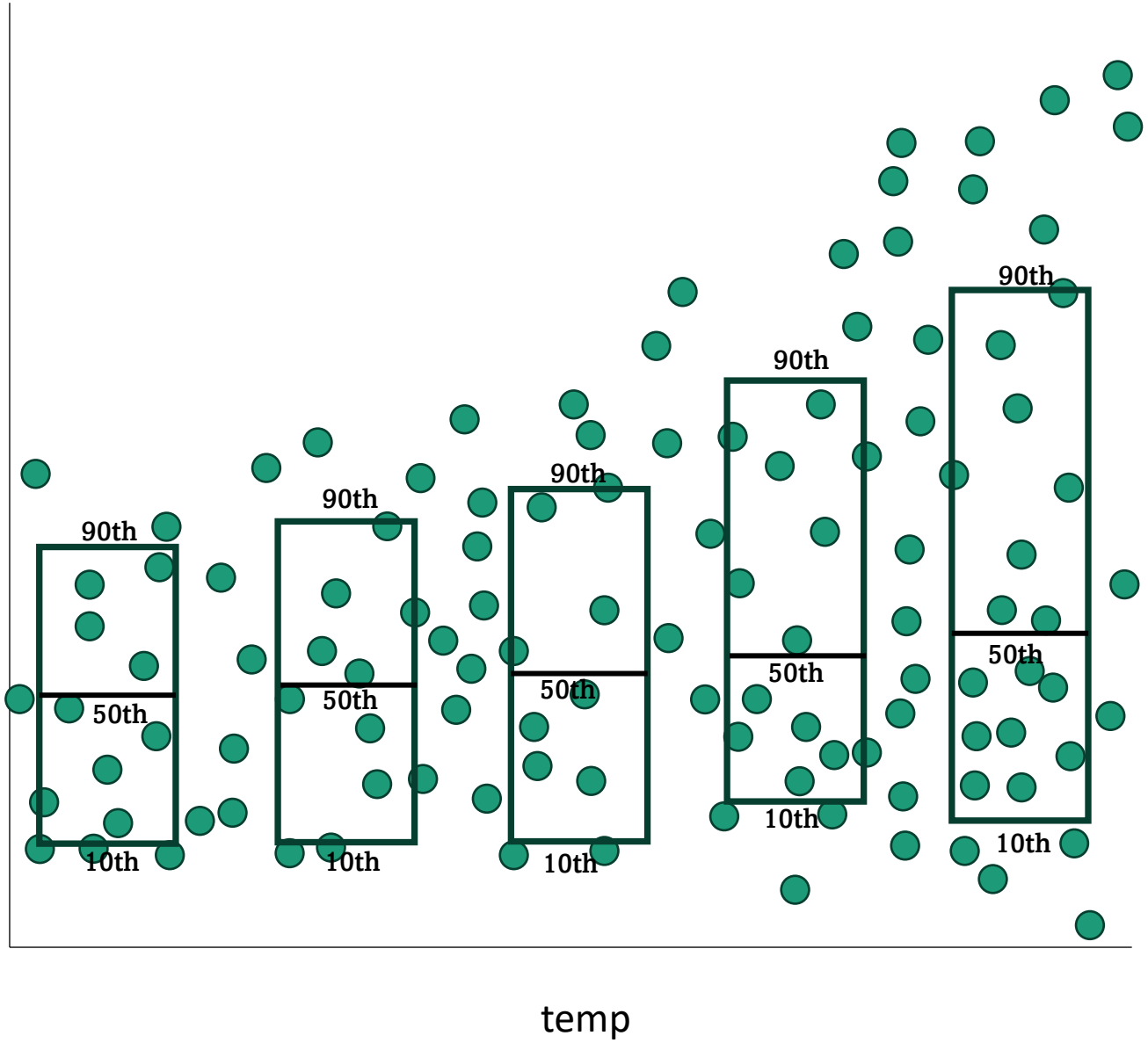

chl
temp

Heteroscedascity is a not a problem with quantile regression.

Heteroscedascity is the term for unequal variance over different ranges of X. Note the different sizes of the boxes.





In this hypothetical, the average response of chlorophyll to temp is weak. But we see a strong positive relationship with temperature at the upper end of the chlorophyll distribution.

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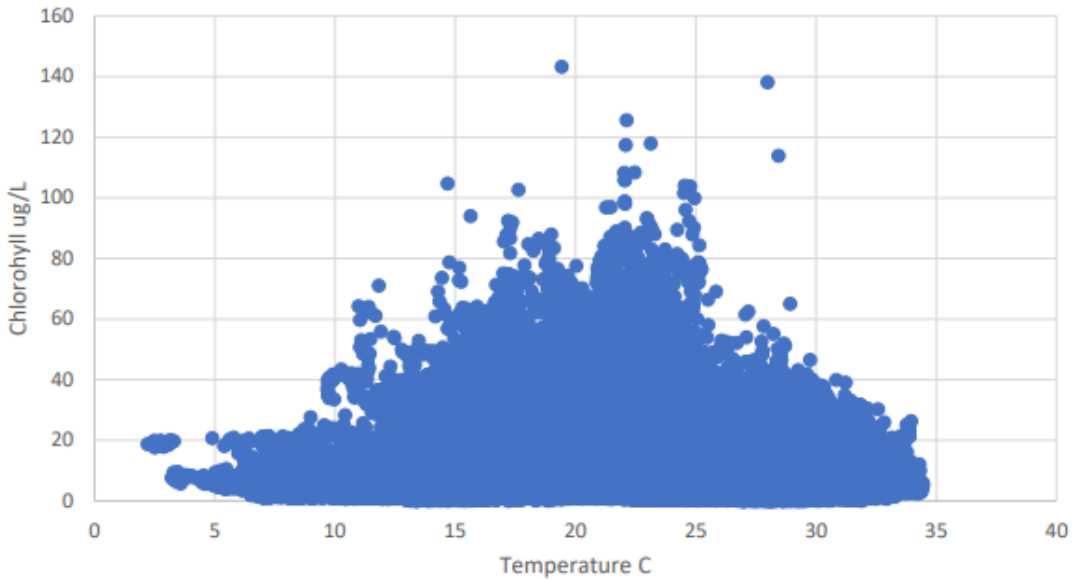
Piscataway, Potomac River



Quantile regression can help us understand the relationships buried in this dense cloud of data!

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Method

- 20 continuous monitoring datasets collected in MD and VA Bay and tribs were compiled, each dataset meeting the following conditions:
    - At least 50 observations at temps greater than 32°C.
    - A maximum temperature observation of at least 33.5°C
- Piecewise quantile regression was used to model the conditional 50^{th} and conditional 90^{th} percentile responses with respect to a breakpoint of 32°C.
- The signs and p-values of the resulting 80 slopes were used to make an inference about the weight of evidence for or against the Cerco algal growth rate model.

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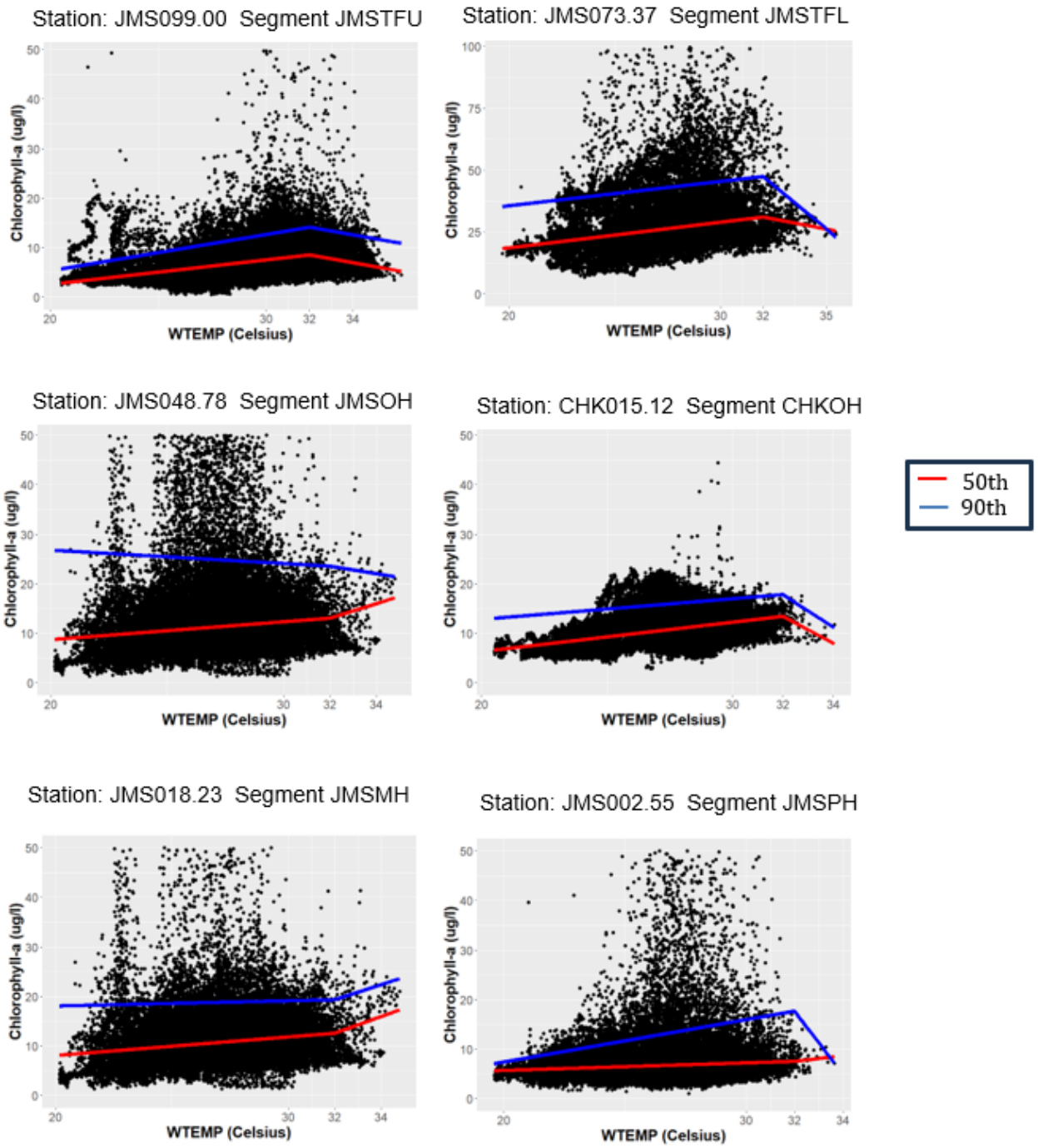
James River datasets



Results

Plus signs (highlighted in green) indicate positive relationships between chlorophyll-a and temperature, while negative signs indicate negative relationships. ns = Slope is not statistically significant (p > 0.1). All statistically significant results had a p-value less than 0.05.

Station	Segment	Year Range	Relationship at temps <= 32°C		Relationship at temps > 32°C		Sample size >32°C	Maximum temperature observed (°C)
			50th	90th	50th	90th		
JMS099.00	JMSTFU	2006-2008	+	+	-	-	5181	36.2
JMS073.37	JMSTFL	2006-2008	+	+	-	-	675	35.5
JMS048.78	JMSOH	2006-2008	+	-	ns	ns	426	34.8
CHK015.12	CHKOH	2006-2008	+	+	-	-	121	34.0
JMS018.23	JMSMH	2006-2008	+	+	ns	+	426	34.8
JMS002.55	JMSPH	2006-2008	+	+	+	-	55	33.6
HUN001.29	POCMH	2013-2015	ns	+	-	-	196	34.6
BBY002.74	LYNPH	2019-2020	+	+	ns	-	79	33.5
OCH001.60	CB7PH	2016-2018	-	-	ns	+	398	33.9
TSK000.23	YRKMH	2020-2022	+	+	-	-	1201	35.1
Bush River-Otter Cr	BSHOH	2010-2022	ns	-	+	ns	5570	37.2
Wicomico-Little Monie Cr	WICMH	2010-2022	+	+	+	+	3124	35.2
Patuxent R.	PAXTF	2010-2022	+	+	ns	-	125	33.5
Back R. - Riverside	BACOH	2014-2022	+	+	-	-	317	34.2
Bush R. -Church Pt	BSHOH	2008-2010	+	-	ns	-	250	34.2
Susquehanna Flats	CB1TF	2007-2017	+	+	-	-	773	34.2
Gratitude Marine	CB3MH	2009-2011	+	+	-	-	201	34.0
Tilgman Island	CB4MH	2017-2019	-	-	+	+	115	33.7
Chester R. - Deep Landing	CHSTF	2003-2006	+	+	+	-	620	34.4
Choptank R. - Mulberry Pt	CHOMH1	2001-2003	+	+	-	-	399	35.3

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Results

- The monitoring datasets show that chlorophyll tends to increase with increasing temperature up 32°C. This is true for both percentiles.
- At temperatures greater than 32°C, chlorophyll is more likely to decrease or show no trend with increasing temperature. This is true for both percentiles.
- These results support the proposed Cerco algal growth rate model.
- Non-statistically significant slopes were more likely to be found in the 50th percentile than the 90th percentile, which suggests that algal blooms respond more strongly to temperature than phytoplankton under non-bloom conditions.

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Limitations of this analysis

- Continuous monitoring data are highly autocorrelated.
- Few observations at and above 35°C.
- Datasets were only collected in shallow, nearshore environments.

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Questions?

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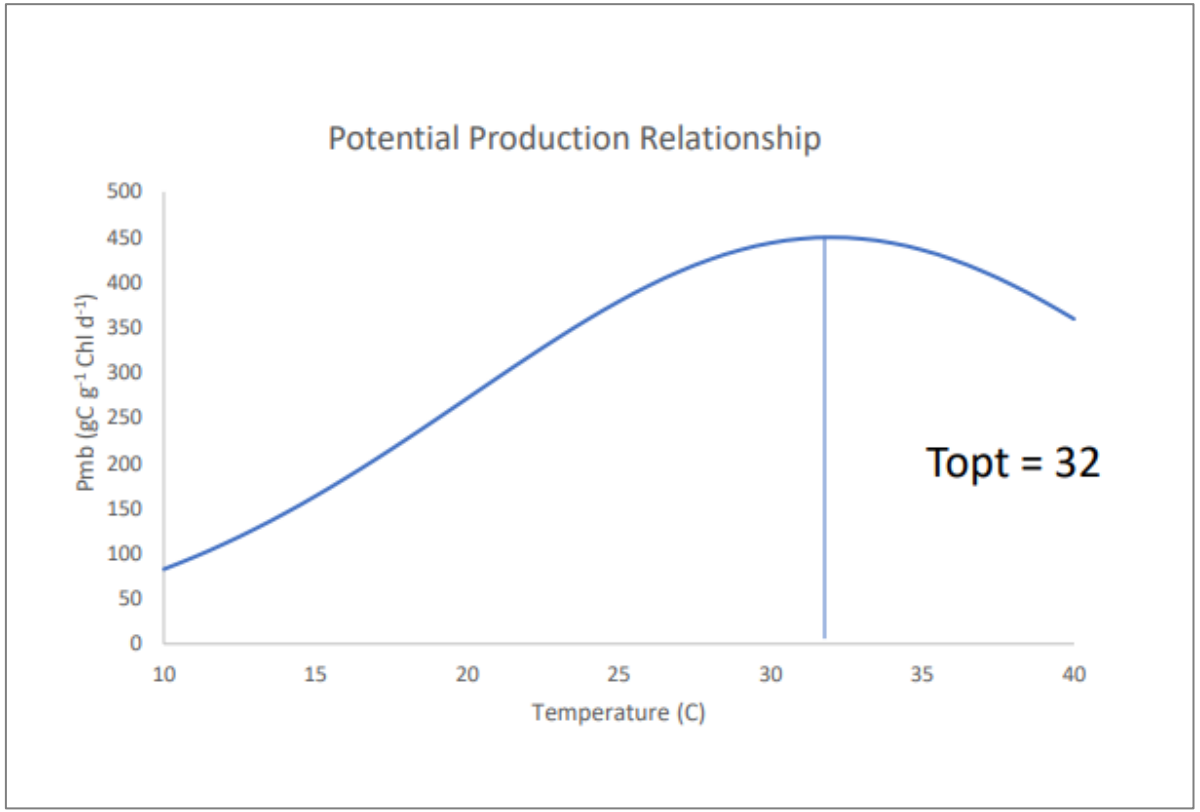

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