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Oklahoma Scenic Rivers Joint Phosphorus Study: Interim Report, 10 August 2016

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Joint Study Committee Members:

Brian Haggard; Co-Chair (University of Arkansas)
Marty Matlock (University of Arkansas)
Ryan Benefield (Arkansas Natural Resources Commission)

Derek Smithee; Co-Chair (Oklahoma Water Resources Board)
Shellie Chard-McClary (Oklahoma Dept. of Environmental Quality)
Shanon Philips (Oklahoma Conservation Commission)

CRASR
Center for Reservoir & Aquatic Systems Research

Study Framework

"to determine the total phosphorus threshold response level....at which any statistically significant shift occurs in

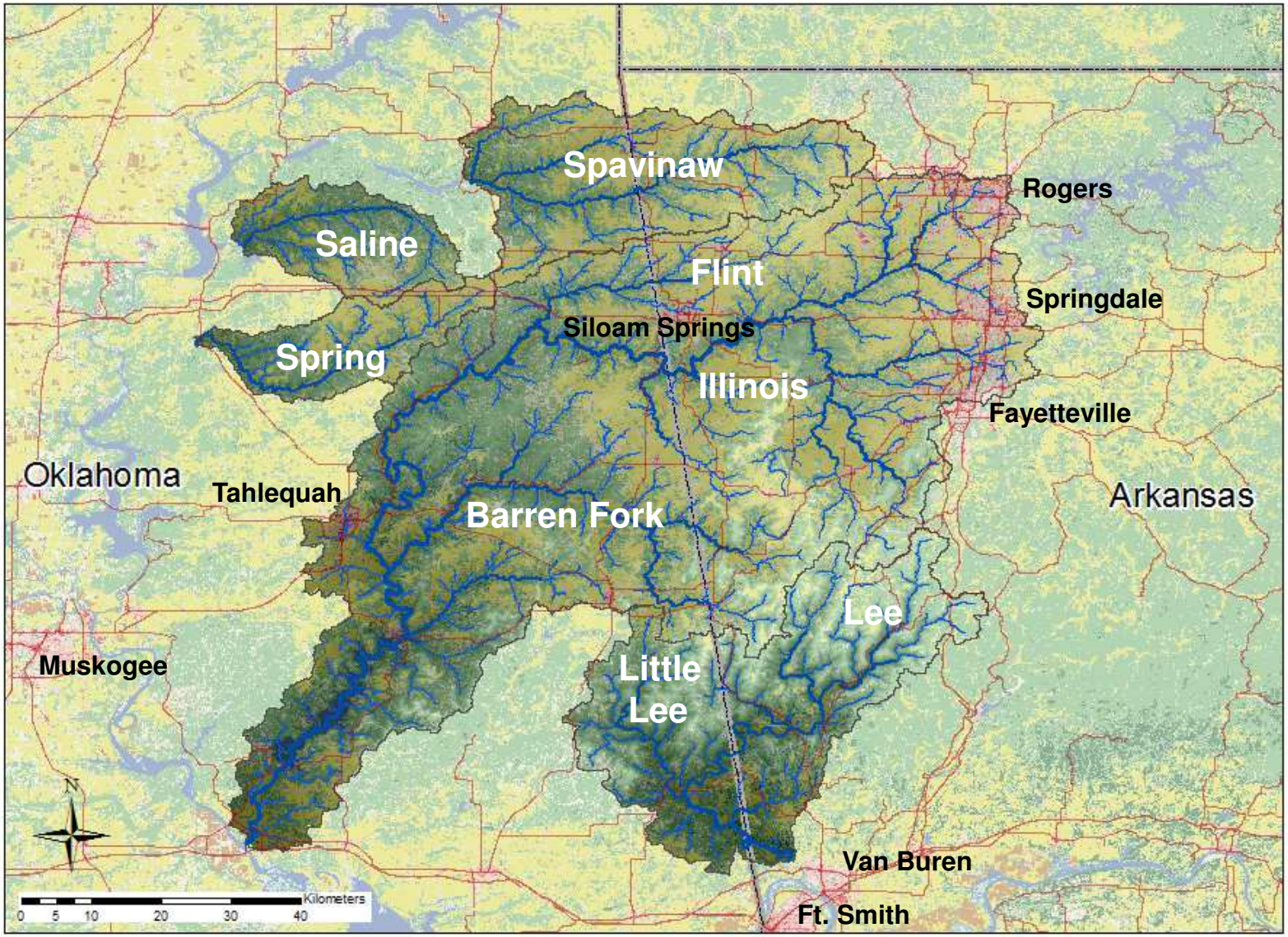
1. algal species composition OR
2. algal biomass production

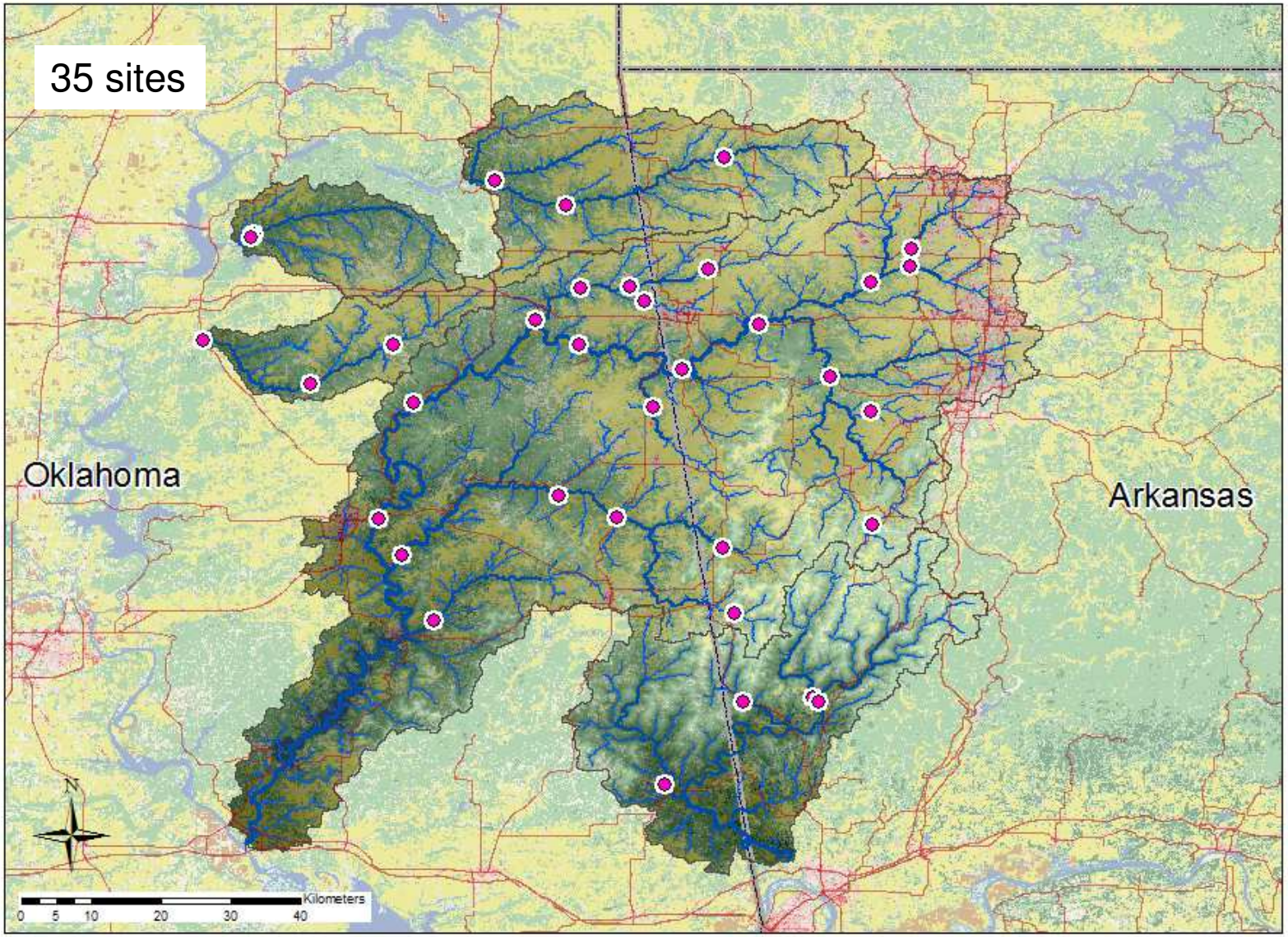
...resulting in undesirable

1. aesthetic OR
2. water quality

...conditions in the Designated Scenic Rivers."

Second Statement of Joint Principles and Actions, p.2, Mandatory Study Components


Spavinaw
Saline
Flint
Spring
Siloam Springs
Illinois
Barren Fork
Lee
Little
Lee
Rogers
Springdale
Fayetteville
Tahlequah
Muskogee
Van Buren
Ft. Smith
Oklahoma
Arkansas
N
0 5 10 20 30 40
Kilometers


35 sites
Oklahoma
Arkansas
N
Kilometers
0 5 10 20 30 40

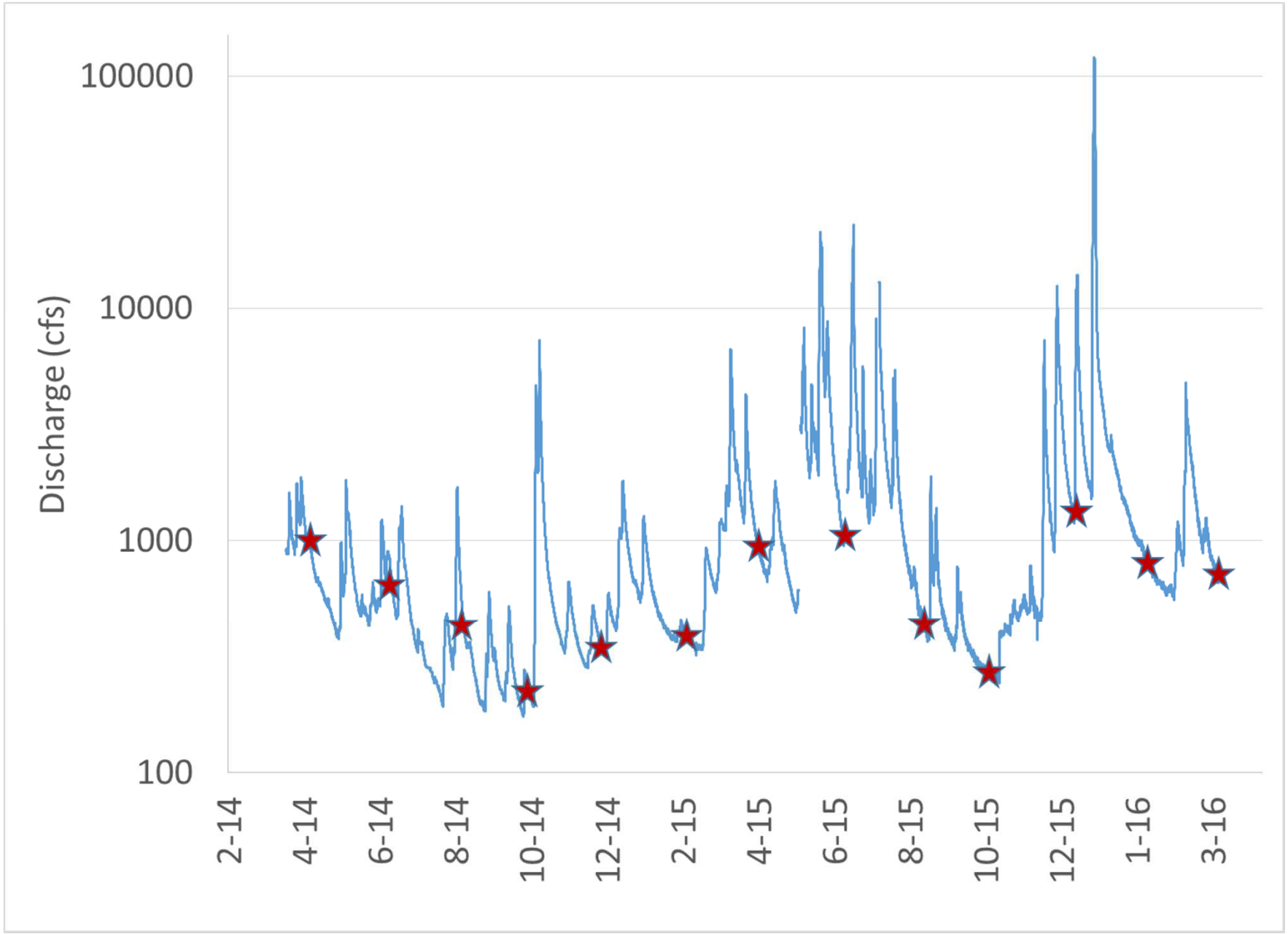
Schedule

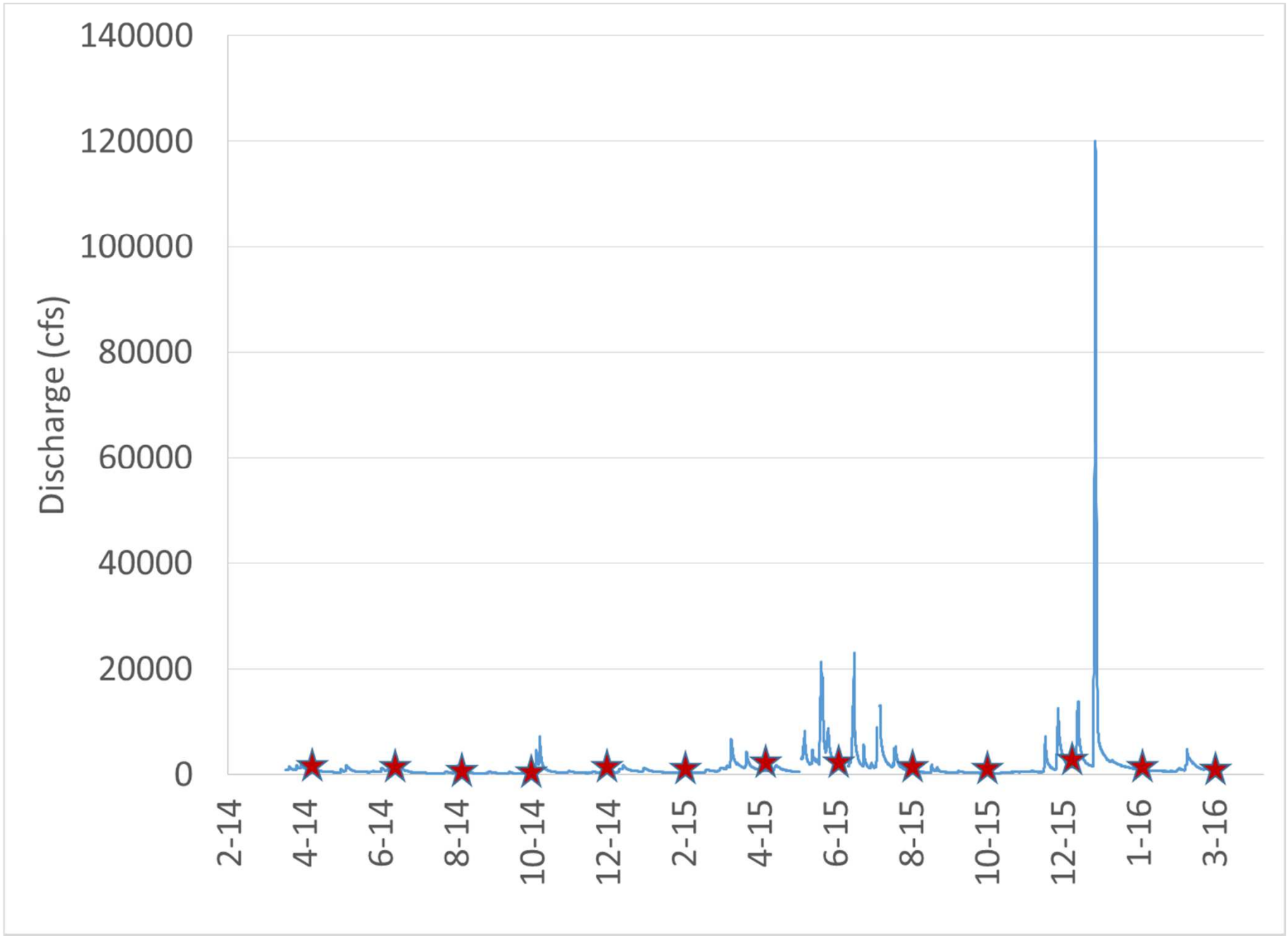
Sampling scheduled bimonthly. Proposed sampling was to result in 12 events in 2 years. All 12 sampling events have been completed.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014				**Site selection**		**X**		**X**		**X**		**X**
2015		**X**		**X**		**X**		**X**		**X**		**X**
2016		**X**		**X**	Final analyses & report writing							

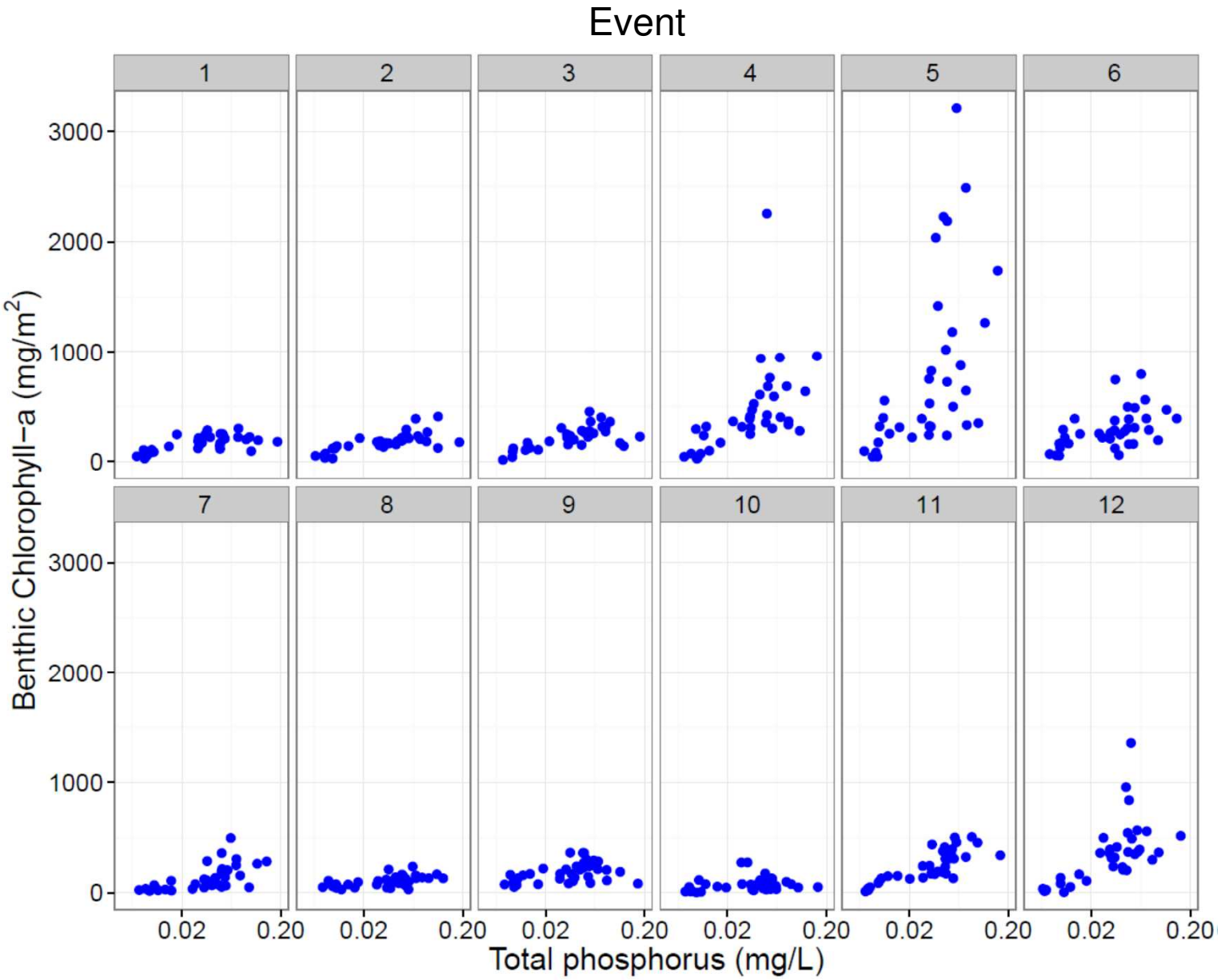
Data status report

Event	TP	TN, DOC, DNP	Benthic CHLA/ AFDM	Sestonic CHLA/ TSS	Ben -thic CNP	Soft spp.	Dia- tom spp.	Hess	Diel DO
Jun-14	X	X	X	X	X	X	X	X	N/A
Aug-14	X	X	X	X	X	N/A	N/A	X	X
Oct-14	X	X	X	X	X	X	X	X	N/A
Dec-14	X	X	X	X	X	N/A	N/A	X	N/A
Feb-15	X	X	X	X	X	X	N/A	X	N/A
Apr-15	X	X	X	X	X	X	X	X	N/A
Jun-15	X	X	X	X	X	N/A	N/A	X	N/A
Aug-15	X	X	X	X	X	N/A	N/A	X	X
Oct-15	X	X	X	X	X	**X**	**X**	X	N/A
Dec-15	X	X	X	X	X	N/A	N/A	X	N/A
Feb-16	X	X	X	X	X	N/A	N/A	X	N/A
Apr-16	X	X	X	X	X	**X**	**X**	X	N/A

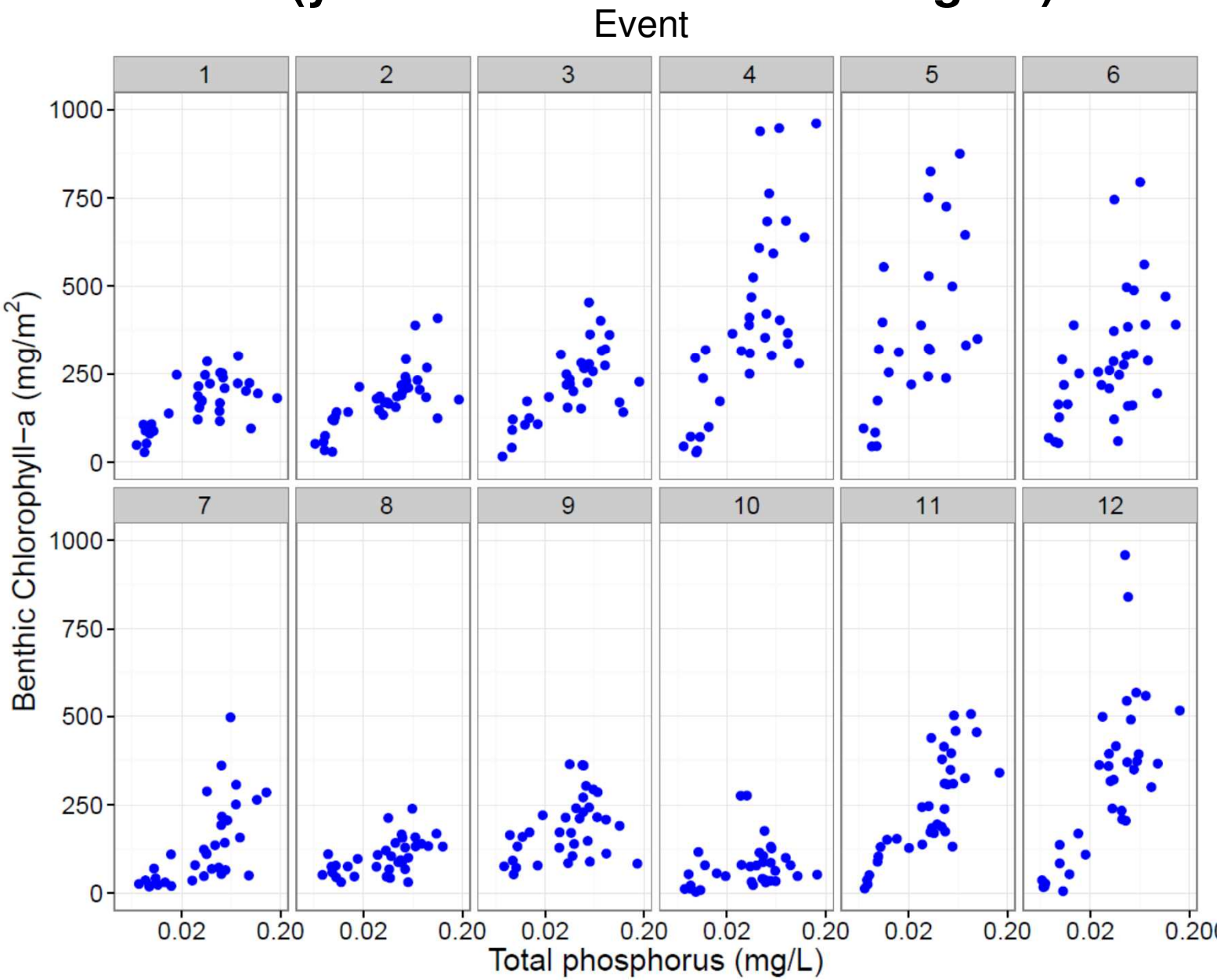

100000
10000
1000
100
Discharge (cfs)
2-14
4-14
6-14
8-14
10-14
12-14
2-15
4-15
6-15
8-15
10-15
12-15
1-16
3-16


140000
120000
100000
80000
60000
40000
20000
0
Discharge (cfs)
2-14
4-14
6-14
8-14
10-14
12-14
2-15
4-15
6-15
8-15
10-15
12-15
1-16
3-16

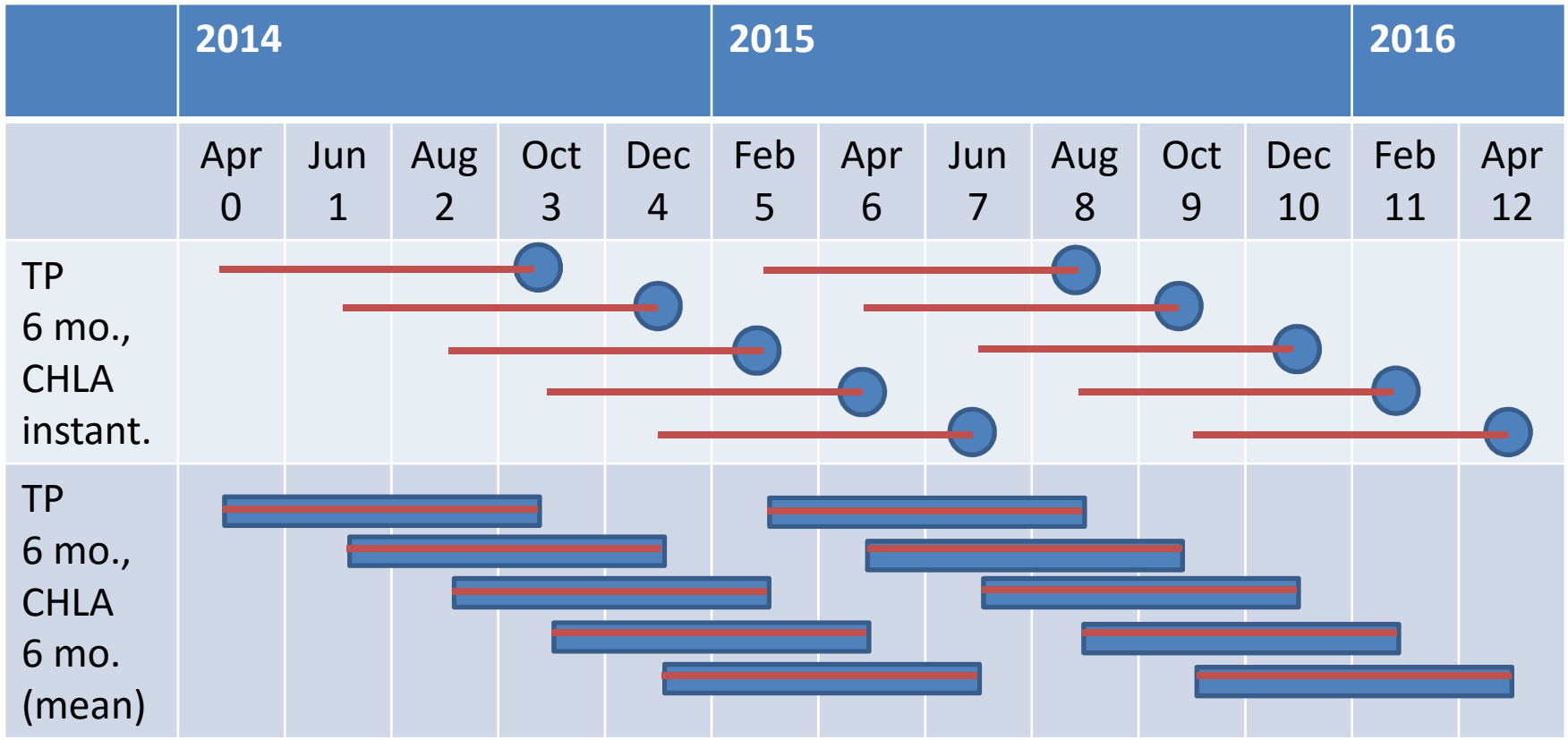
Benthic (Periphyton) Chlorophyll-*a* (mg/m^2) vs TP



Benthic (Periphyton) Chlorophyll-*a* vs TP (y-axis truncated at 1000 mg/m^2)



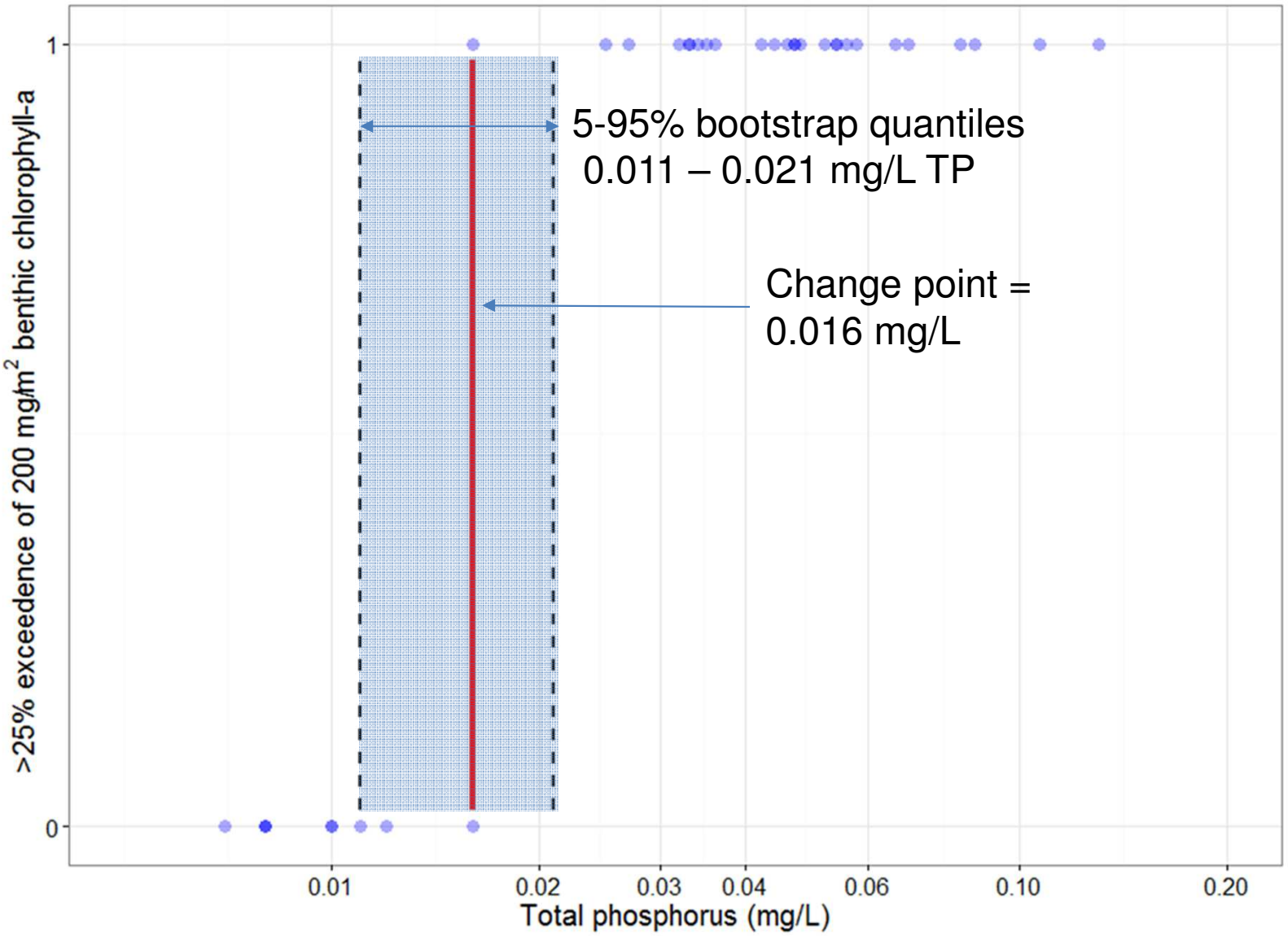
Duration of exposure (TP) vs. instantaneous/cumulative response (CHLA)



Change point analysis

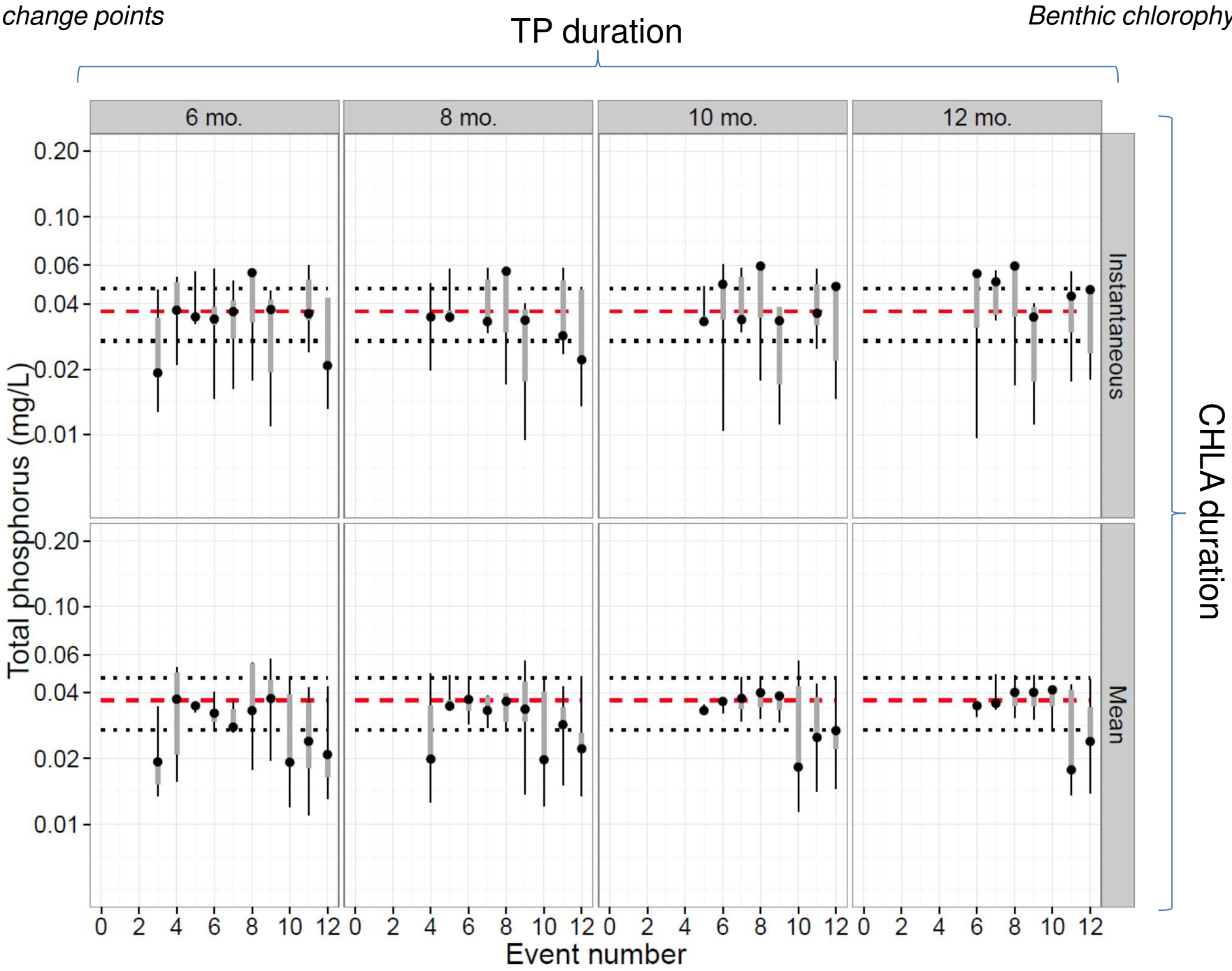
- “What value of TP splits the data into two groups with the largest difference in mean chlorophyll-a?”
- More technically, “what value of the predictor (x axis variable) results in the greatest reduction in variance (deviance) by splitting the response data into two groups.”

Change point analysis

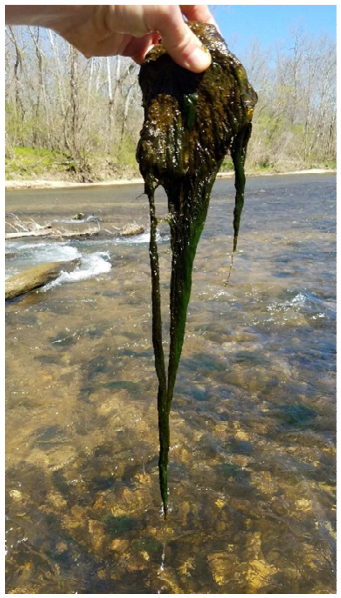


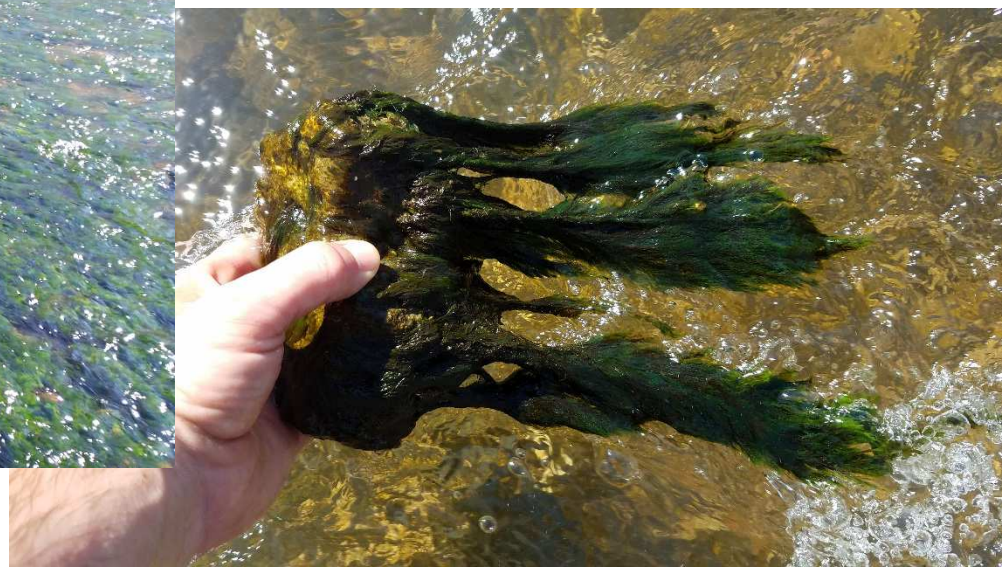
Change point analysis

- Deviance is calculated differently based on the appropriate probability distribution for each variable
  - Normal and lognormal distributions were used for benthic chlorophyll-a analyses
  - Poisson distribution was used for *Cladophora* biovolume (biovolume is converted from counts, hence Poisson or neg. binomial is appropriate)
  - Binomial distribution was used for proportion of biovolume as nuisance taxa


TP change points
TP duration
Benthic chlorophyll-a
6 mo.
8 mo.
10 mo.
12 mo.
Instantaneous
Mean
CHLA duration
Total phosphorus (mg/L)
0.20
0.10
0.06
0.04
0.02
0.01
0 2 4 6 8 10 12
Event number

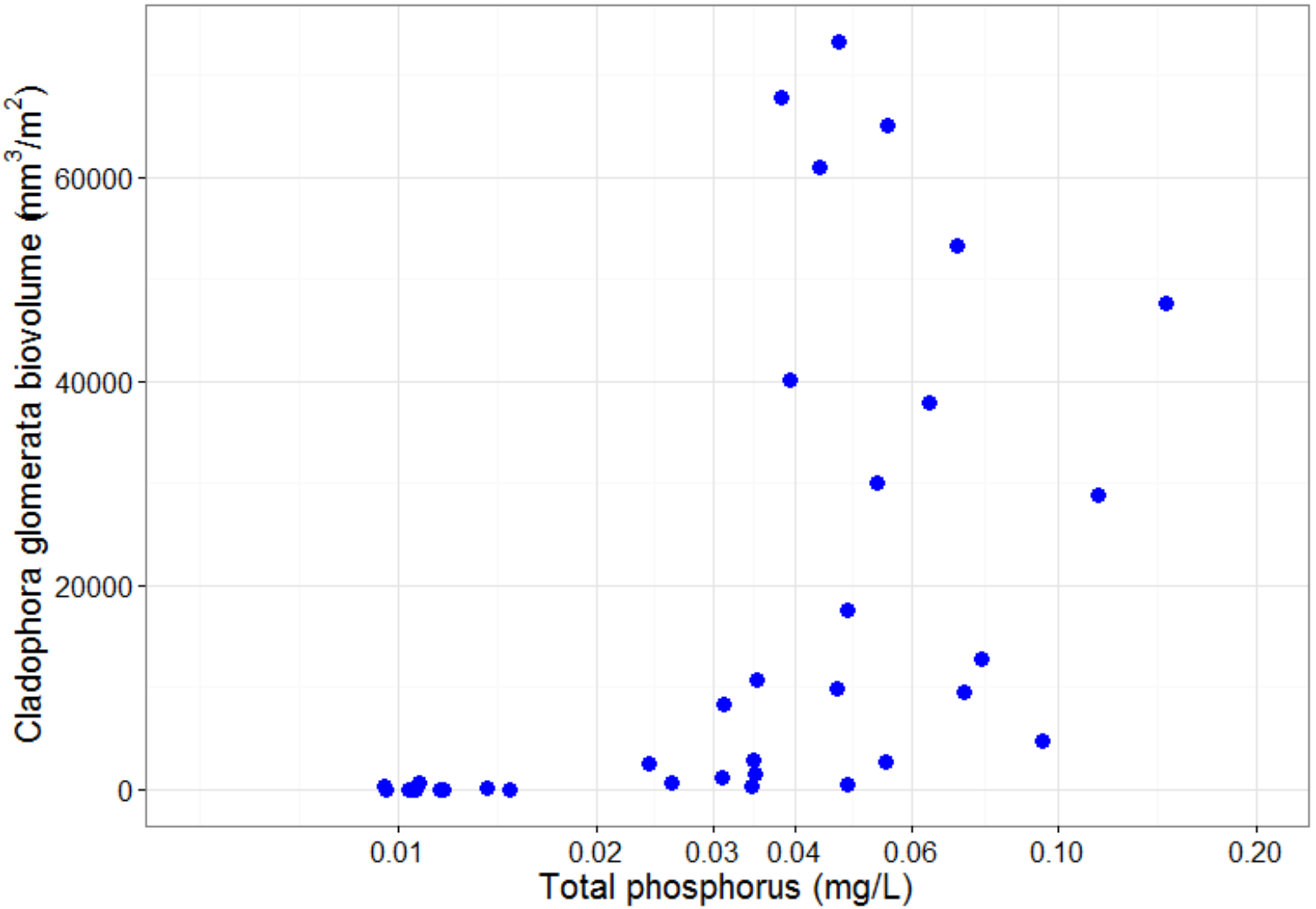
Cladophora glomerata biovolume (mm^3/m^2) vs TP





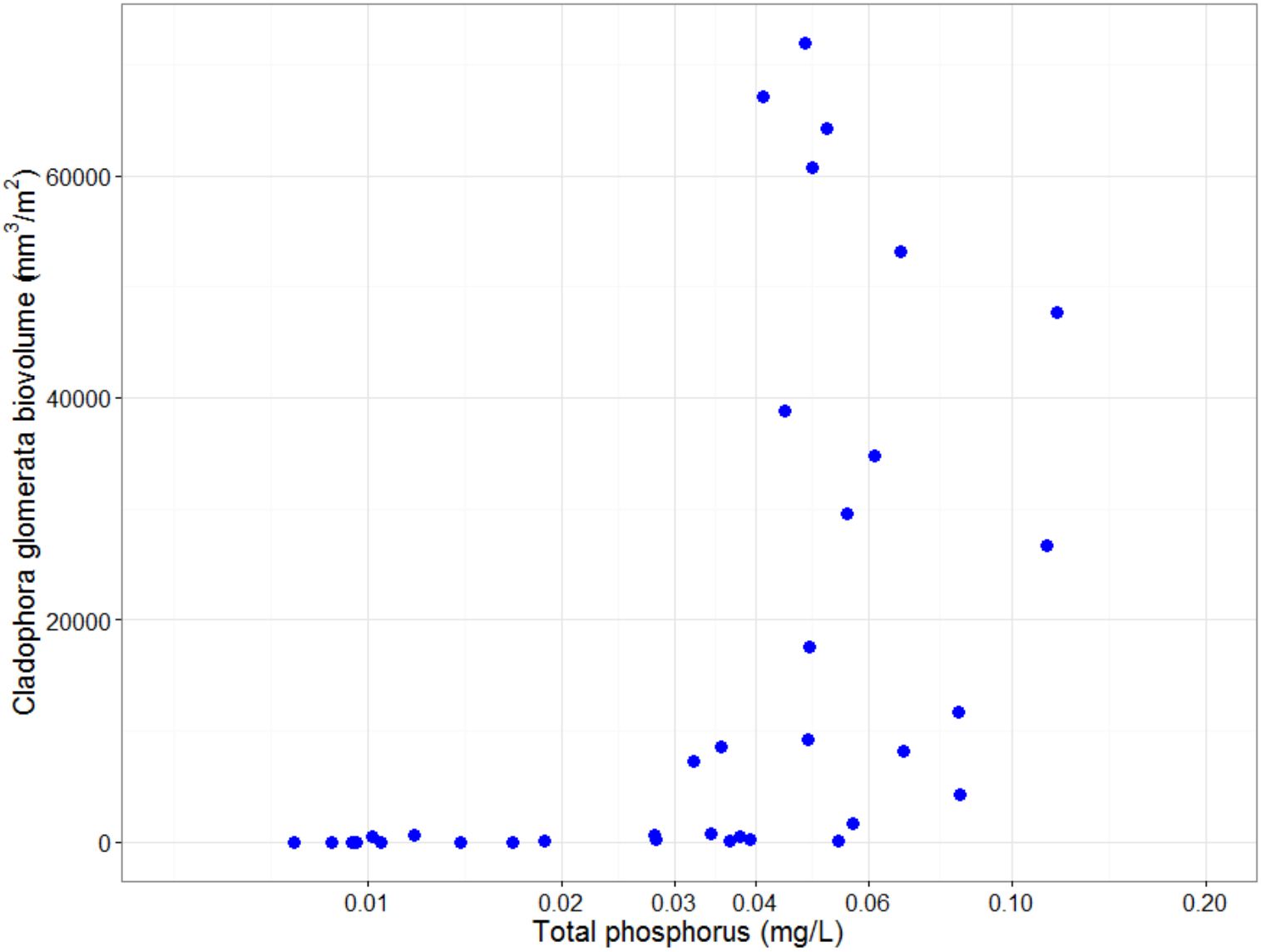
Cladophora glomerata biovolume vs TP

12 month TP, Mean *Cladophora* biovolume
June 2014 – April 2015



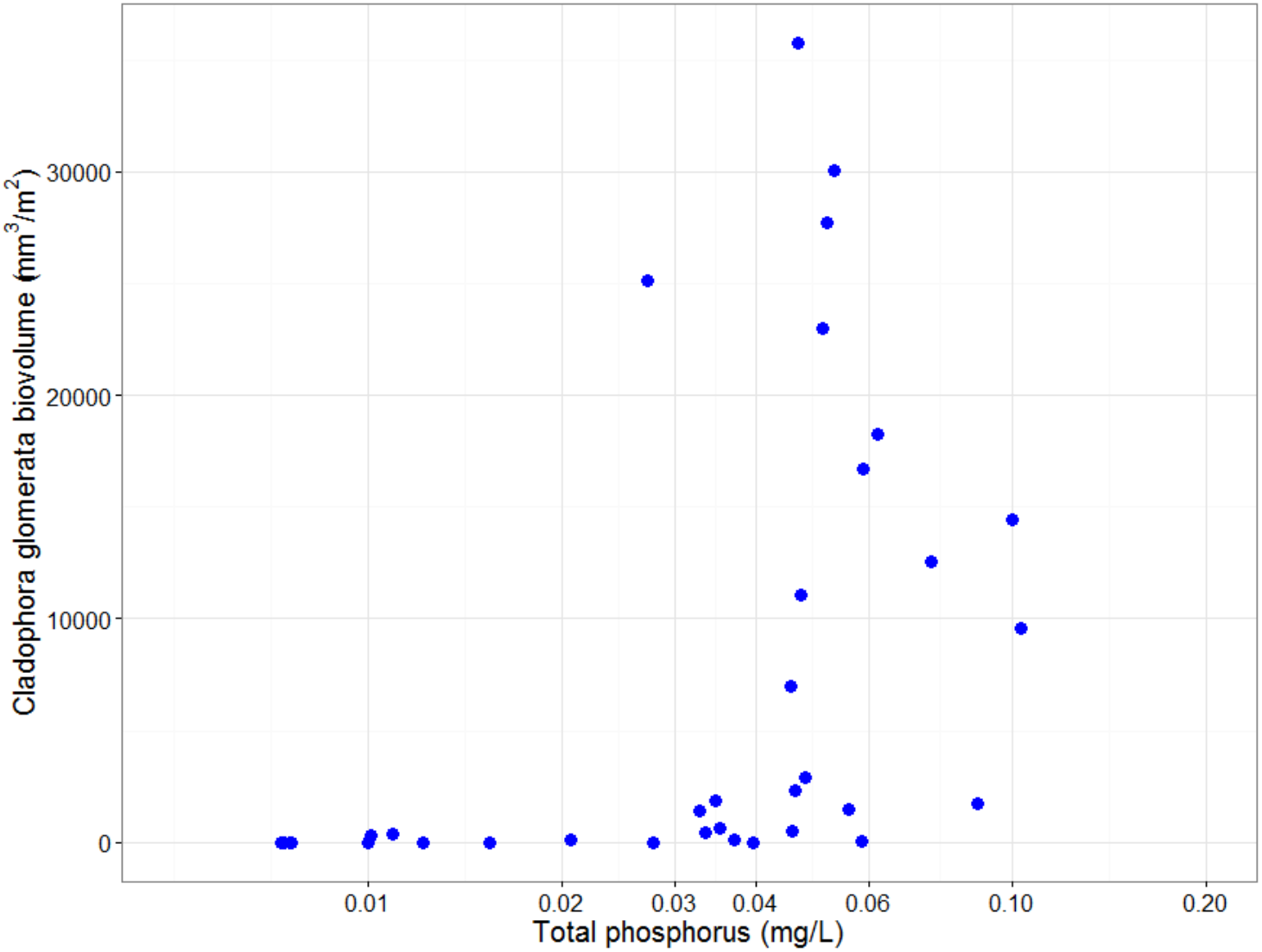
Cladophora glomerata biovolume vs TP

12 month TP, Mean *Cladophora* biovolume
October 2014-October 2015



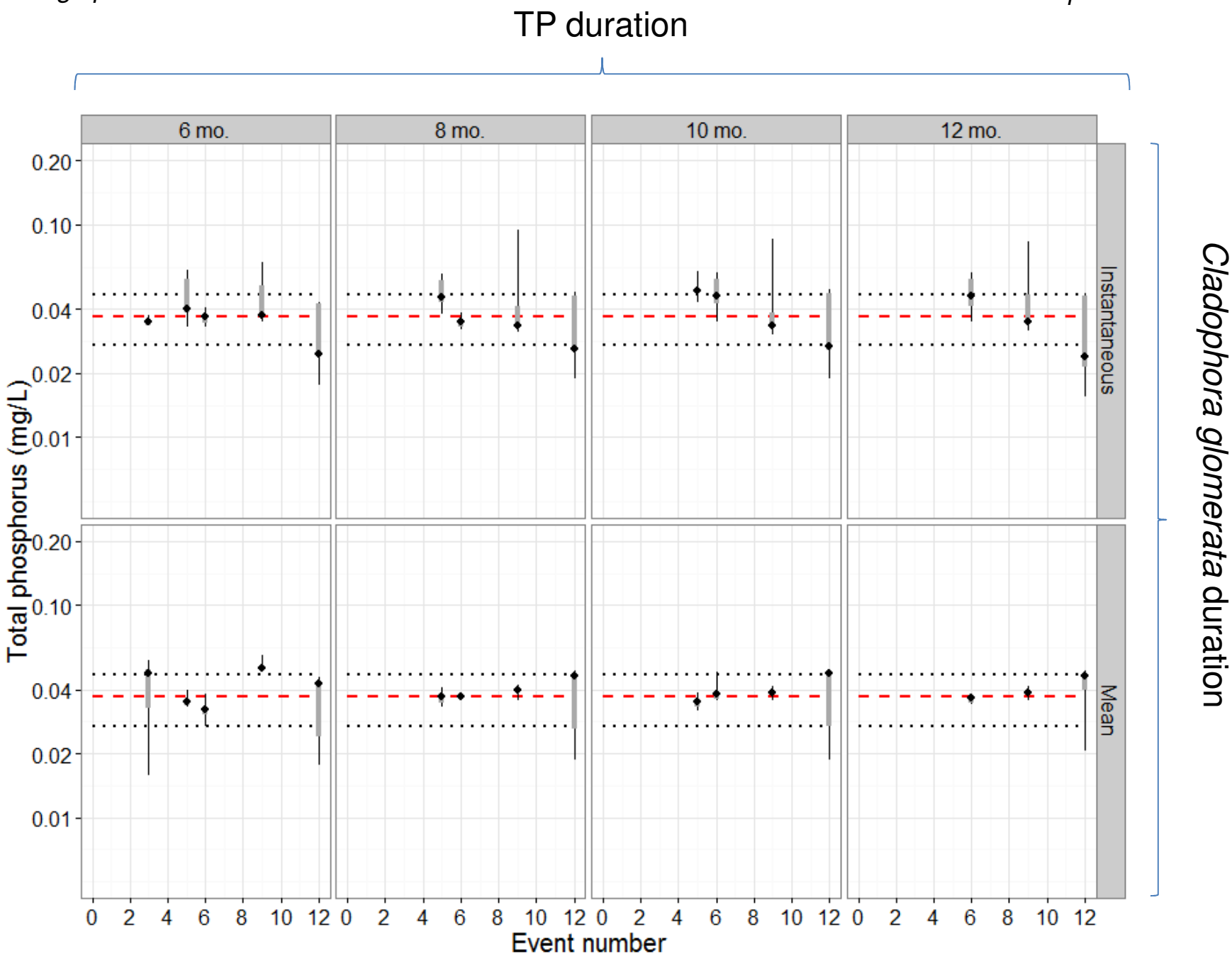
Cladophora glomerata biovolume vs TP

12 month TP, Mean *Cladophora* biovolume
April 2015-April 2016



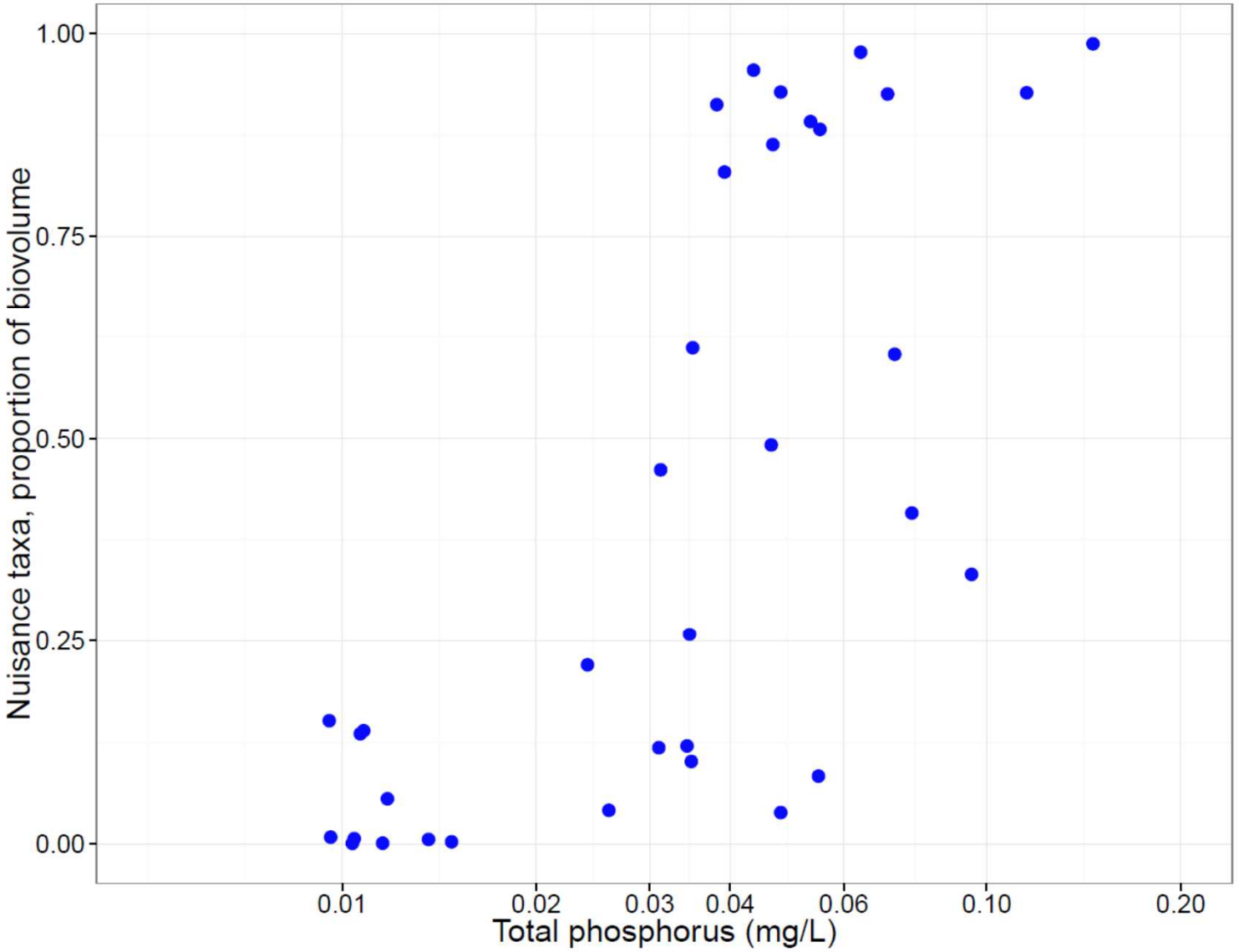
TP change points: Poisson distribution

Cladophora biovolume



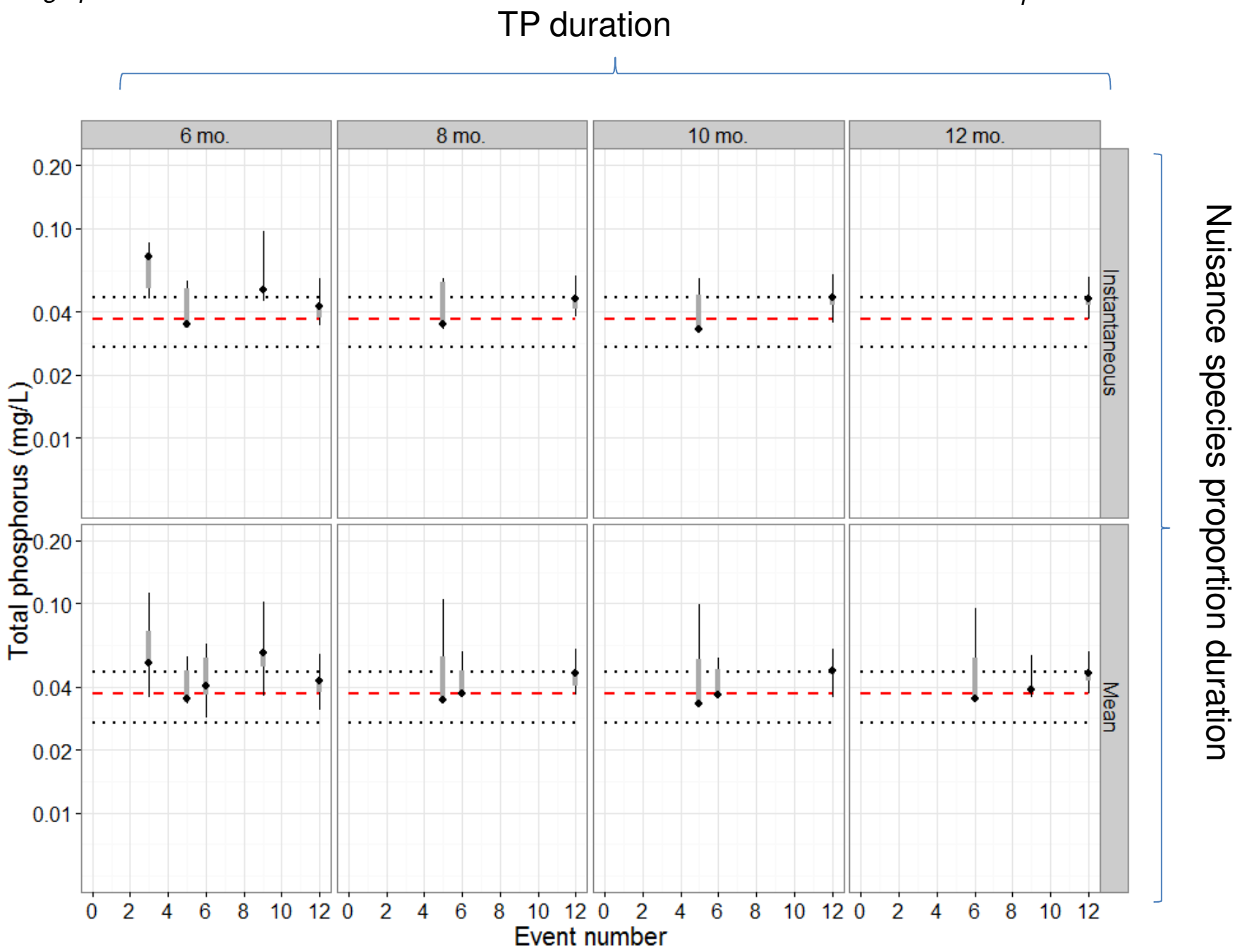
Nuisance taxa proportion vs TP

12 month TP, Mean nuisance taxa biovolume
June 2014 – April 2015



TP change points: binomial distribution

Prop. Nuisance taxa

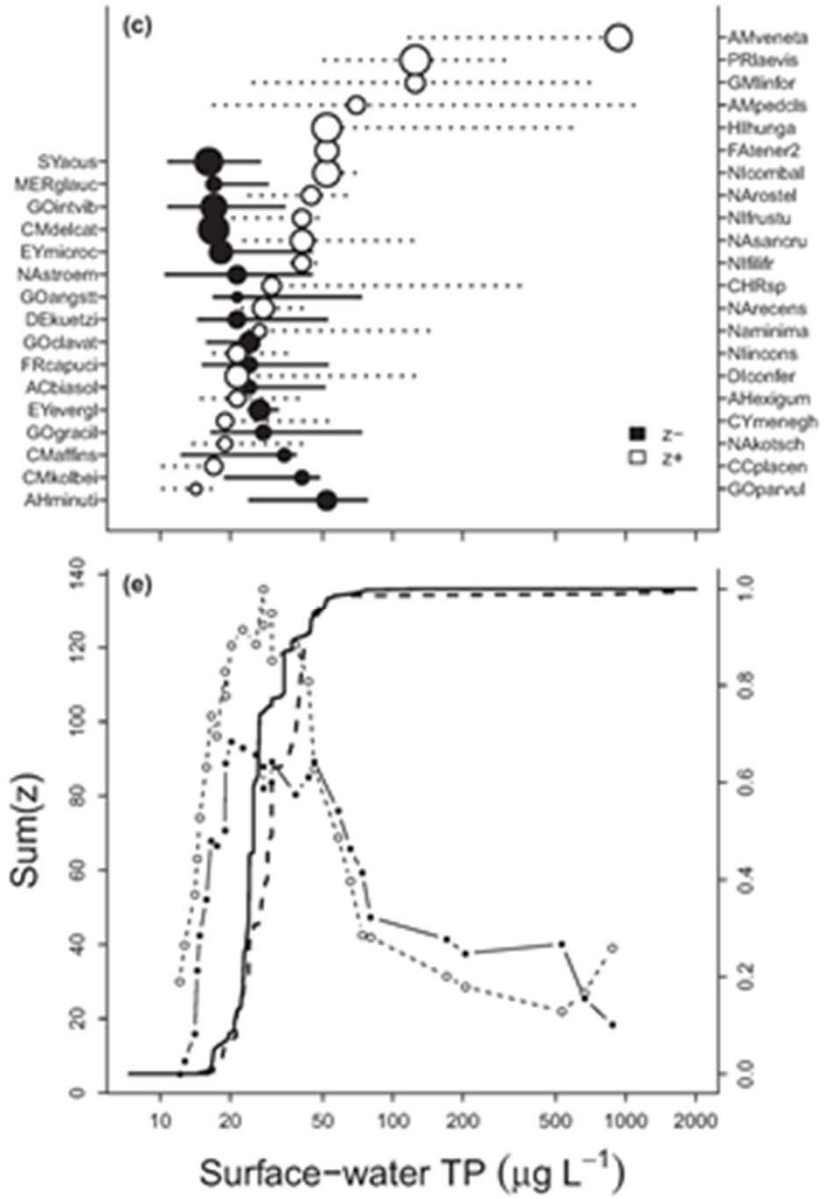


Threshold Indicator Taxa Analysis (TITAN)

TITAN identifies change points in species that decline (-) or increase (+) and distinguishes these two groups.

In this Texas example, negative species responses sharply peaked at 0.021 (0.016-0.052) whereas positive responses peaked at 0.028 (0.018-0.048) mg/L TP.

Both results are indicative of a significant shift in species composition between ~0.02-0.05 mg/L TP.



Taylor, King, et al. 2014. *Freshwater Biology*

TITAN taxa change points

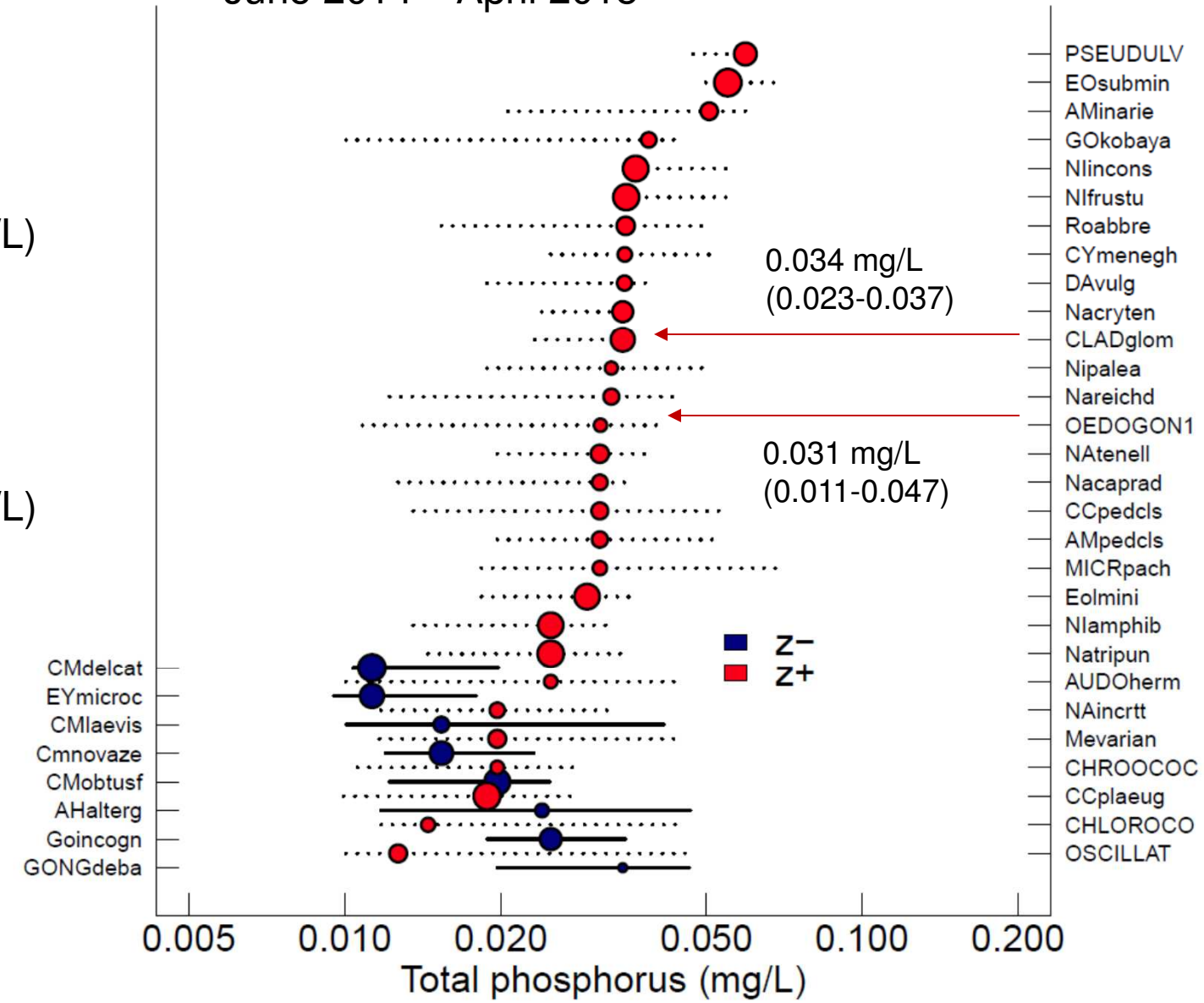
TITAN

12 month TP, Mean taxa biovolume

June 2014 – April 2015

z- change point:
0.0197 mg/L
(0.0119-0.0232 mg/L)

z+ change point:
0.0249 mg/L
(0.0189-0.0349 mg/L)

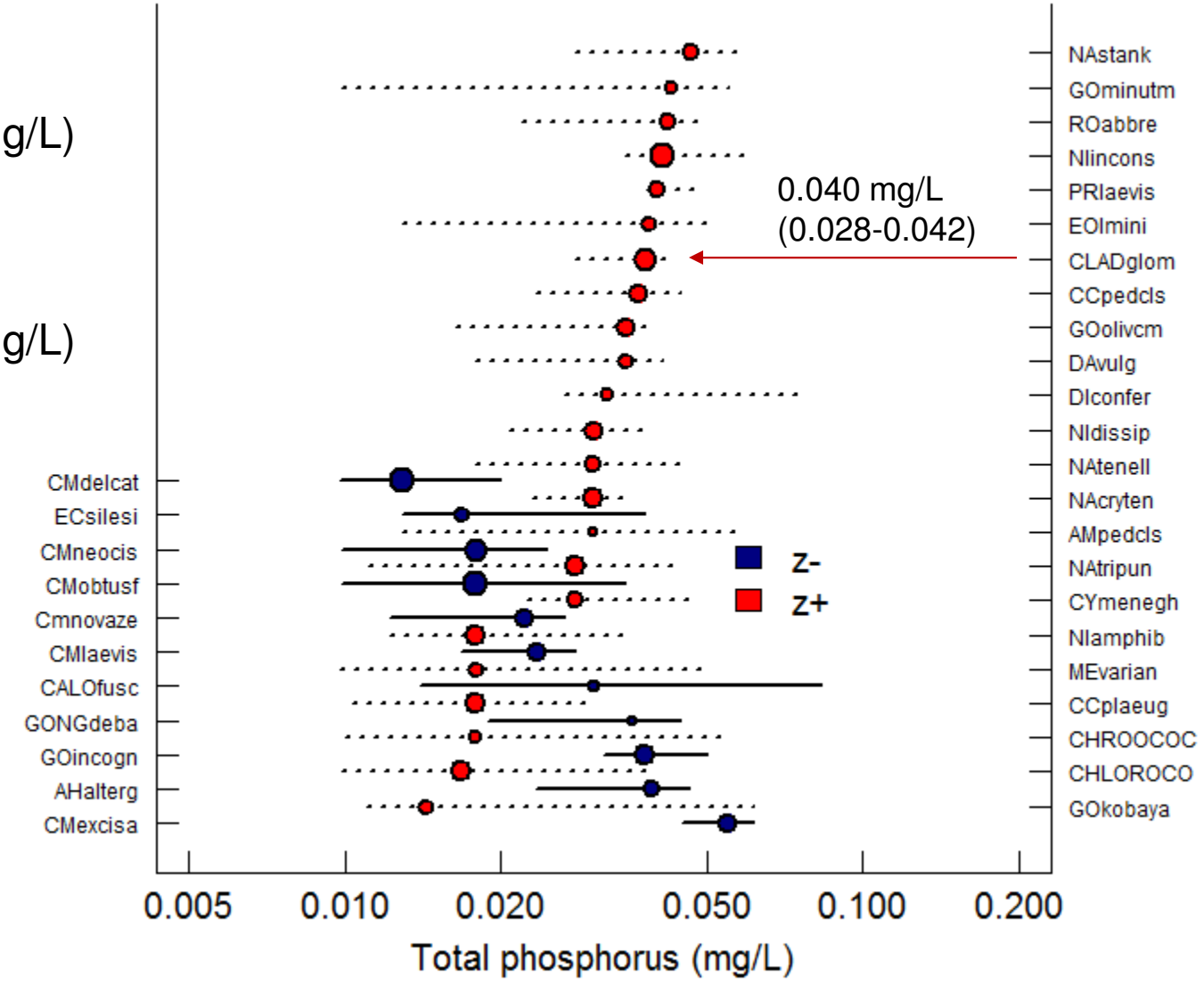


TITAN

12 month TP, Mean taxa biovolume
October 2014 to October 2015

z- change point:
0.0233 mg/L
(0.0129-0.0254 mg/L)

z+ change point:
0.0279 mg/L
(0.0178-0.0419 mg/L)

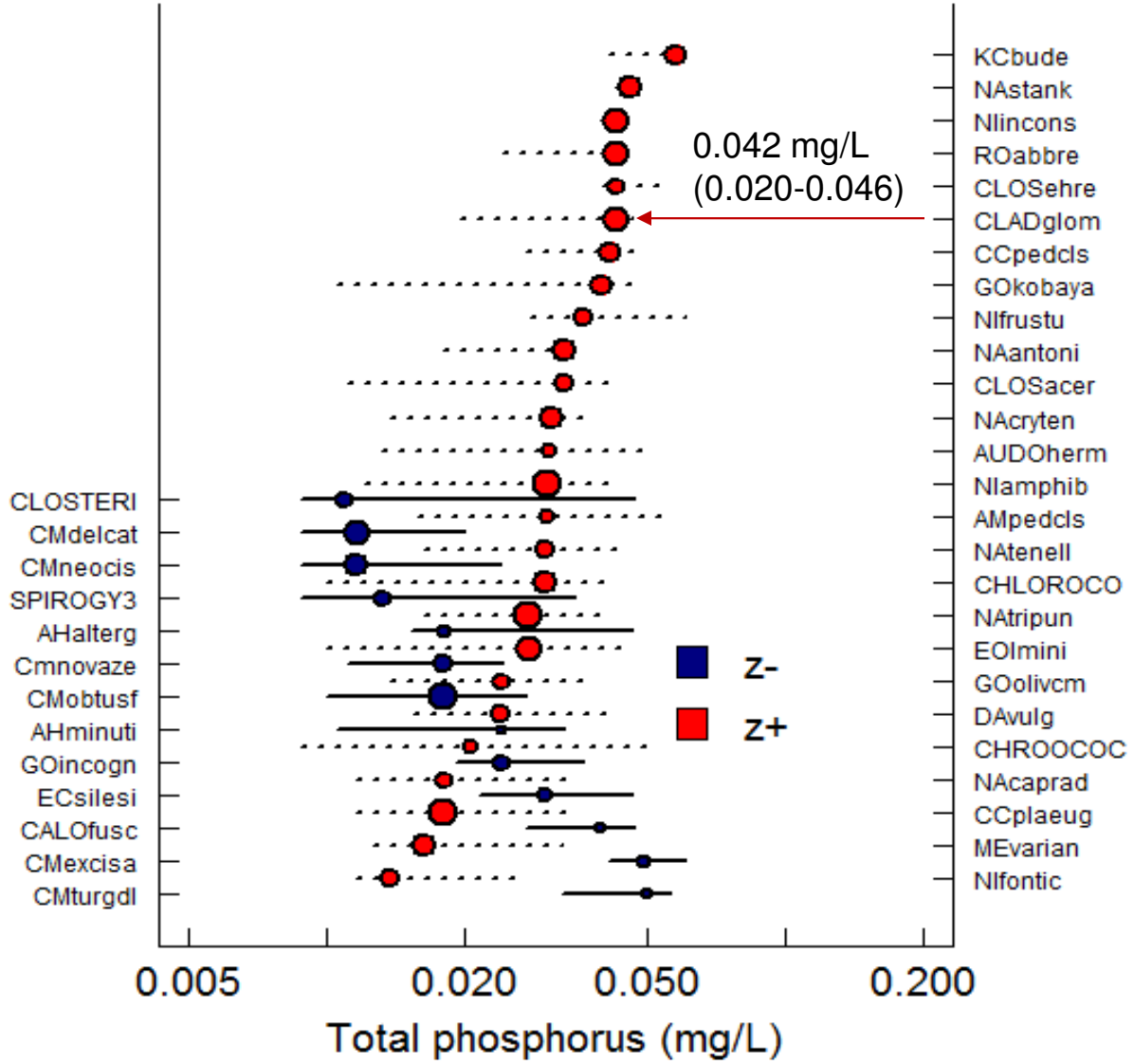


TITAN

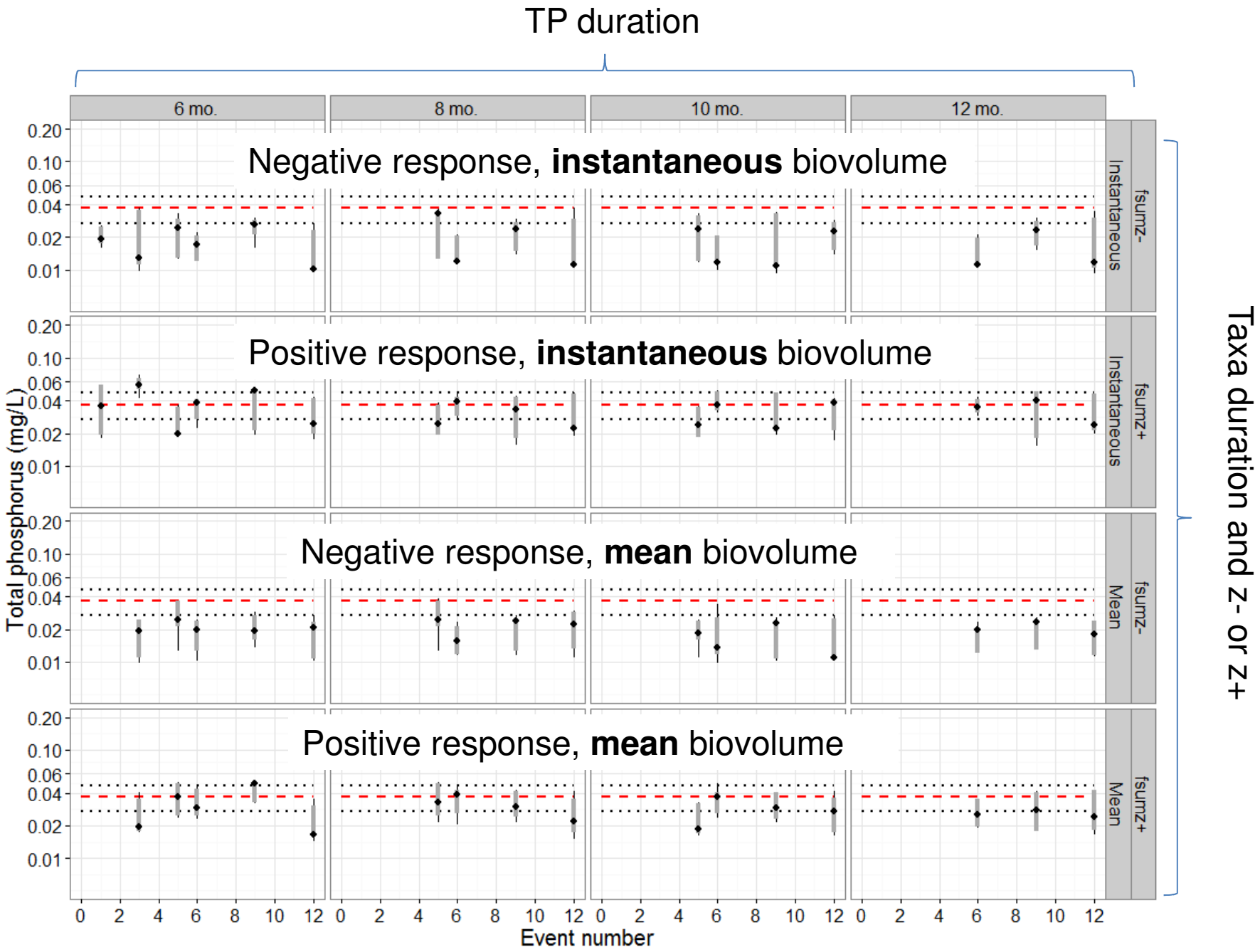
12 month TP, Mean taxa biovolume
April 2015 to April 2016

z- change point:
0.0180 mg/L
(0.0111-0.0242 mg/L)

z+ change point:
0.0239 mg/L
(0.0164-0.0424 mg/L)



TITAN community change points



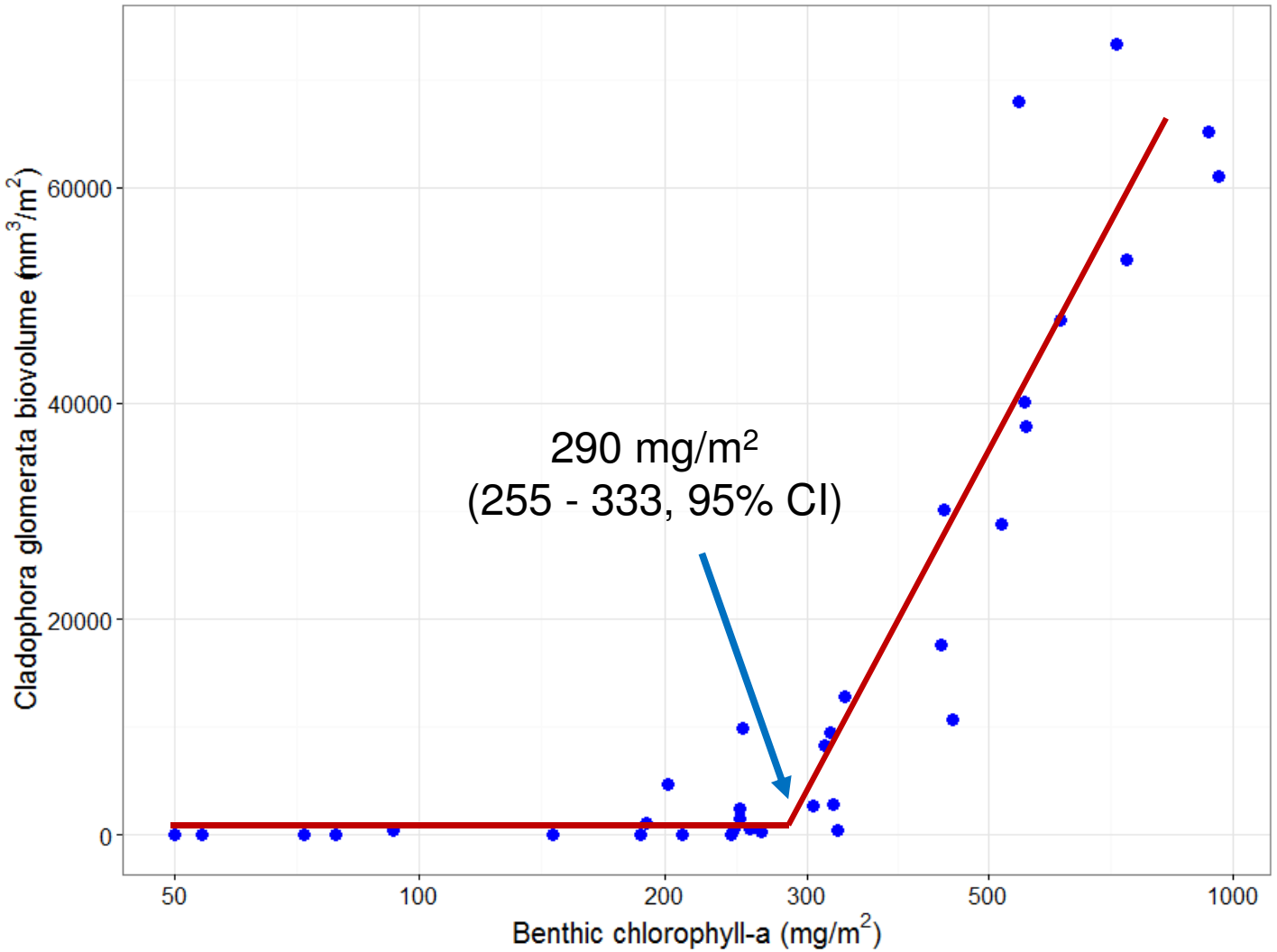
What is a nuisance level of benthic chlorophyll-a?

- 200 mg/m^2 is supported in literature as a nuisance level
  - May not apply to Ozark Highland rivers
  - Methods used to derive this number have been subjective
  - Sampling protocols used to select substrata, remove attached algae, and measure chlorophyll also may differ slightly from our study

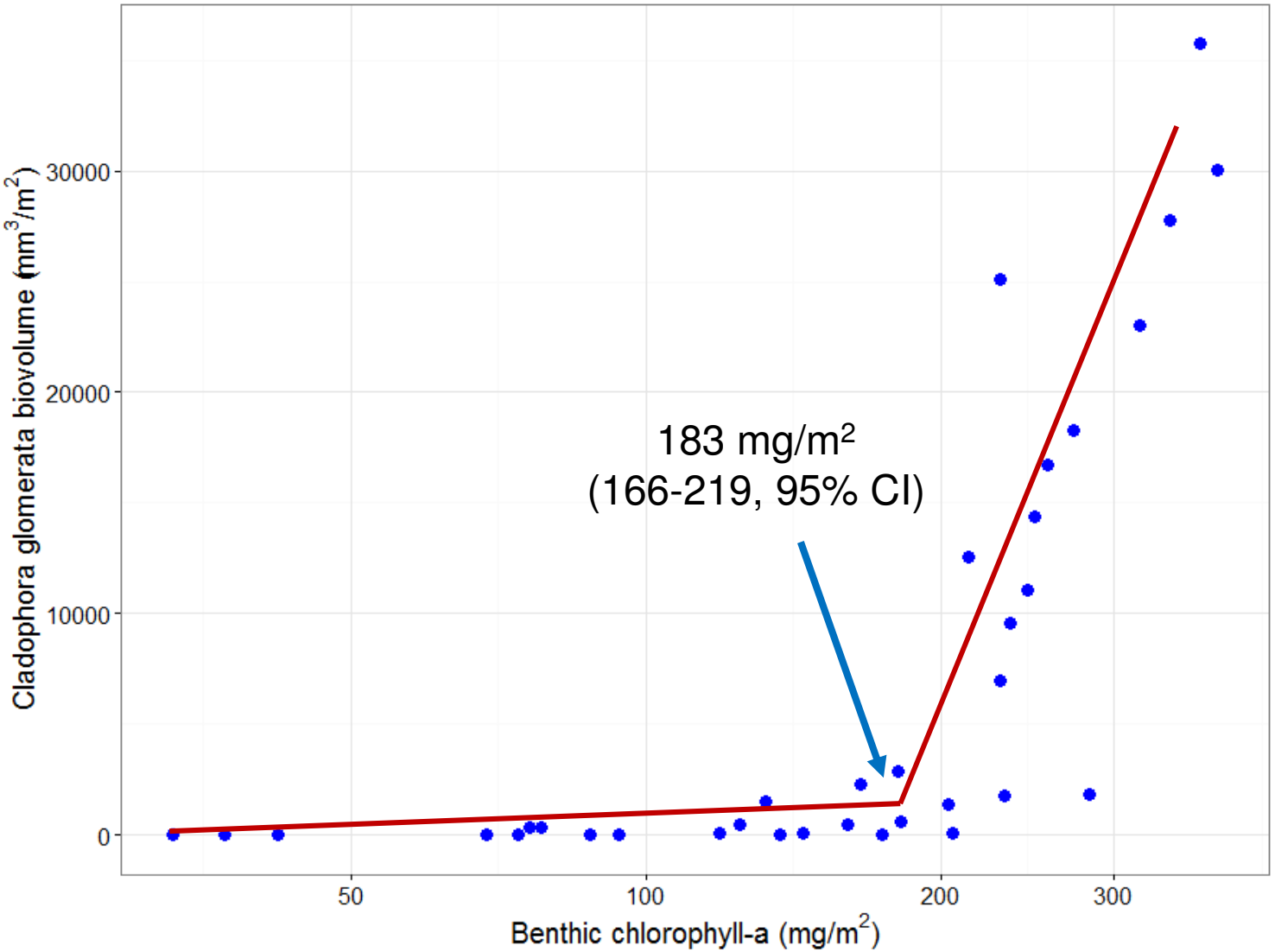
What is a nuisance level of benthic chlorophyll-a?

- *Cladophora glomerata* is the dominant nuisance filamentous species
  - What level of TP leads to increases in *Cladophora* (we've looked at this already)
  - What level(s) of benthic chlorophyll-a corresponds to blooms of *Cladophora* in our data set? **
- Segmented regression

Mean chlorophyll vs. *Cladophora* biovolume, Year 1 (June 2014-April 2015)

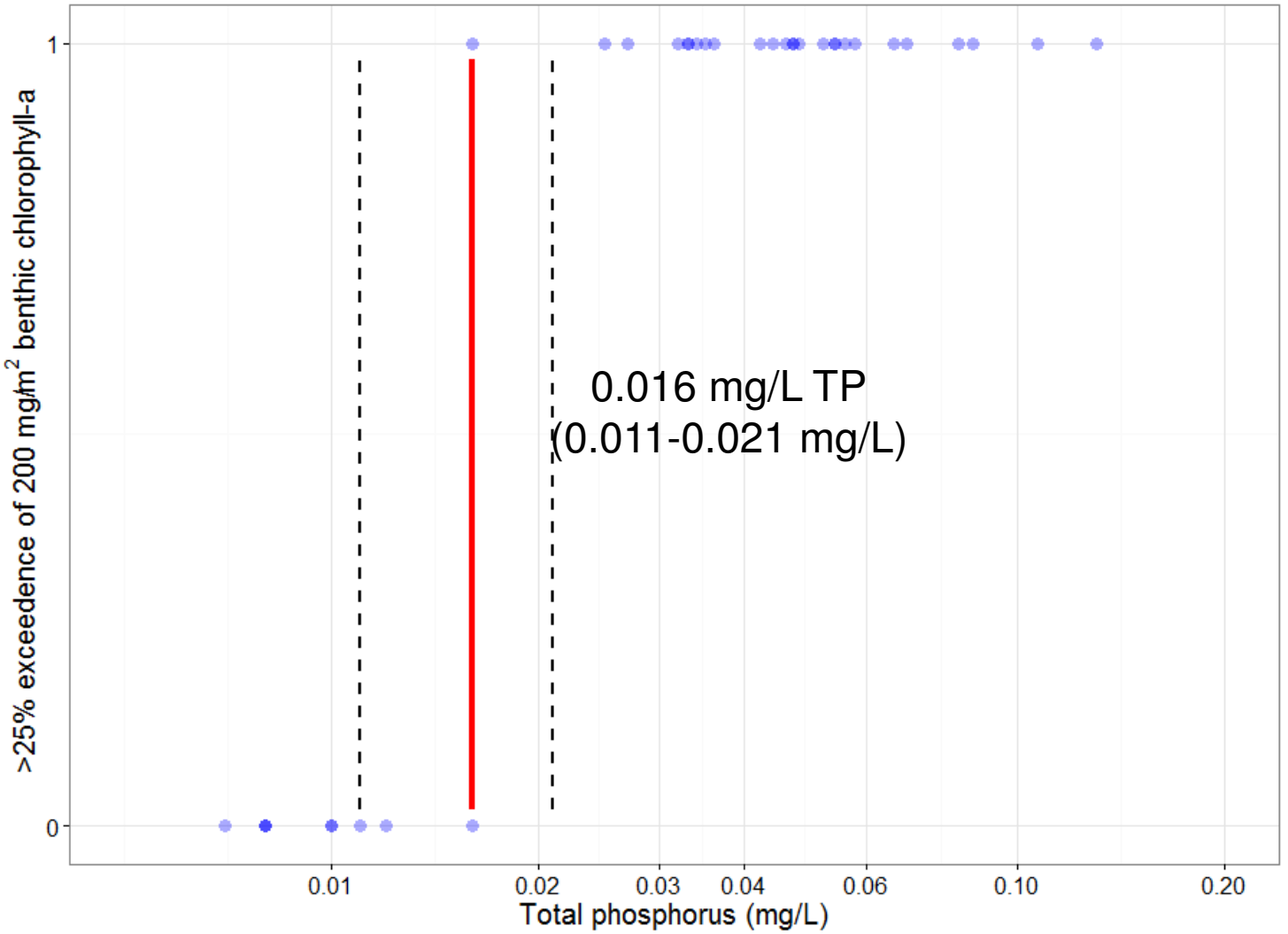


Mean chlorophyll vs. *Cladophora* biovolume, Year 2 (April 2015- April 2016)



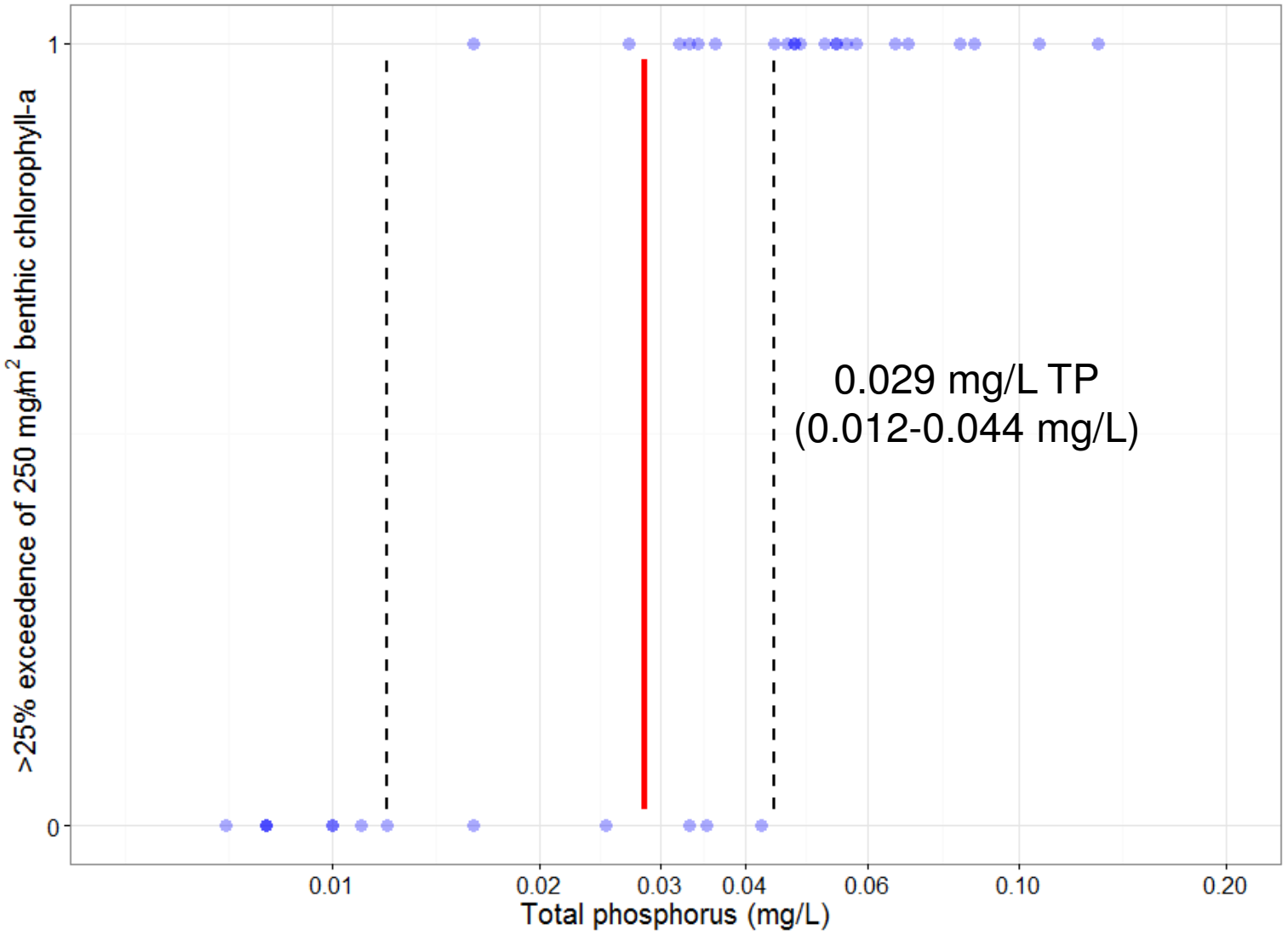
TP change point *Binomial response*

> 25% Exceedance of 200 mg/m^2 CHLA



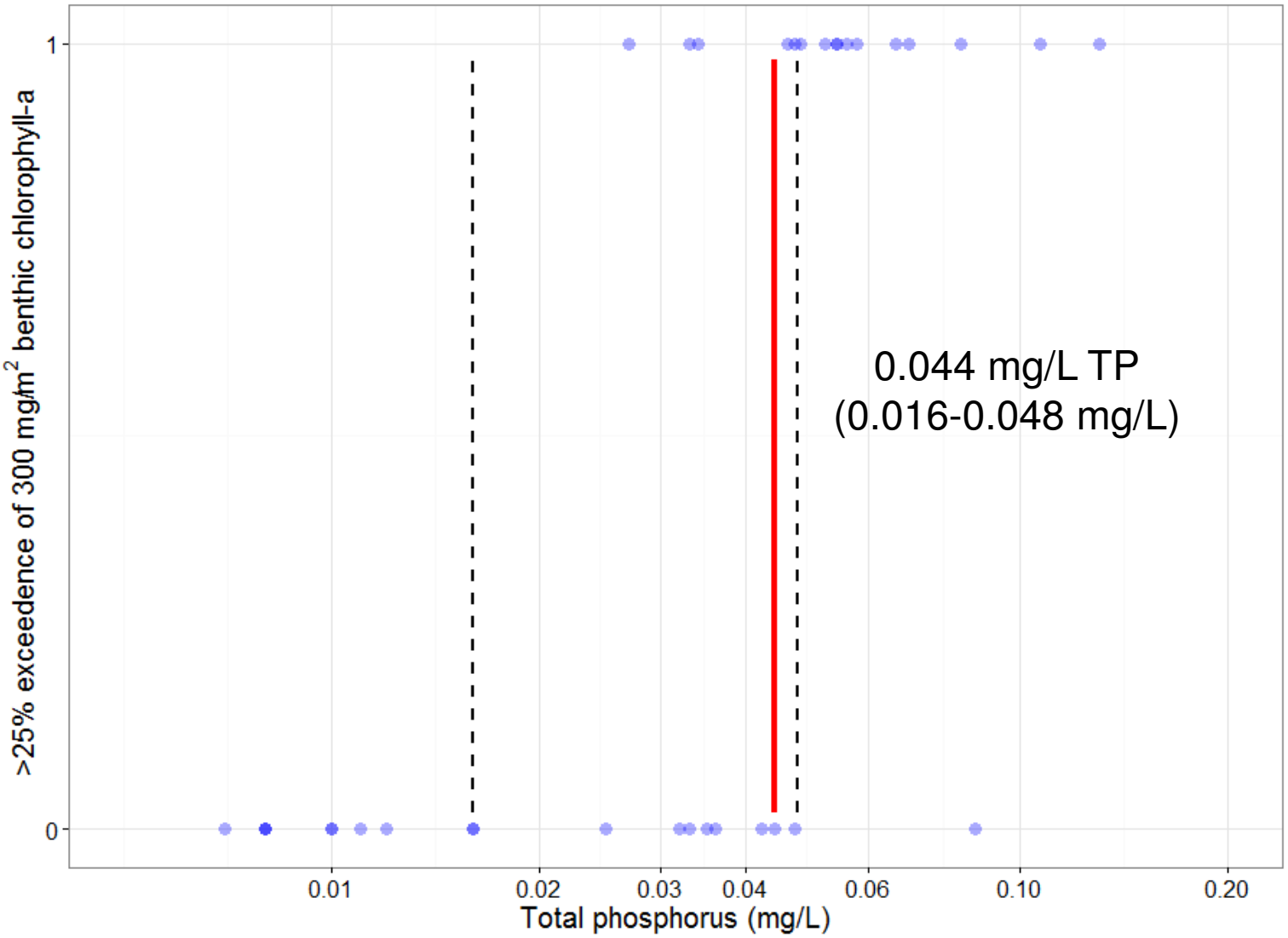
TP change point *Binomial response*

> 25% Exceedance of 250 mg/m^2 CHLA



TP change point *Binomial response*

> 25% Exceedance of 300 mg/m^2 CHLA



Next steps?

- What additional analyses/variables does the the committee wish included in final report?
- Deadline for delivering first draft of final report?
- Deadline for completion of summary report by committee with recommendation(s)?
- Next public meeting?

Acknowledgments

- Baylor SRJS core team:
  - Dr. Jeffrey Back, instrument specialist and research associate
  - Morgan Bettcher, research technician (UNC '14)
  - Stephen Elser, research technician (ND '14)
  - Katherine Hooker, research technician (BU '14)
  - Stephen Cook, Ph.D. student, BU (2013- .)
  - Lauren Housley, M.S. student, BU (2014- .)
  - Caleb Robbins, Ph.D. student, BU (2012- .)
- Taxonomists
  - Dr. Stephen Porter (soft algae)
  - Dr. Barbara Winsborough (diatoms)