Chlorophyll maxima and chlorophyll : total phosphorus ratios in Missouri reservoirs

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The Missouri Department of Natural Resources

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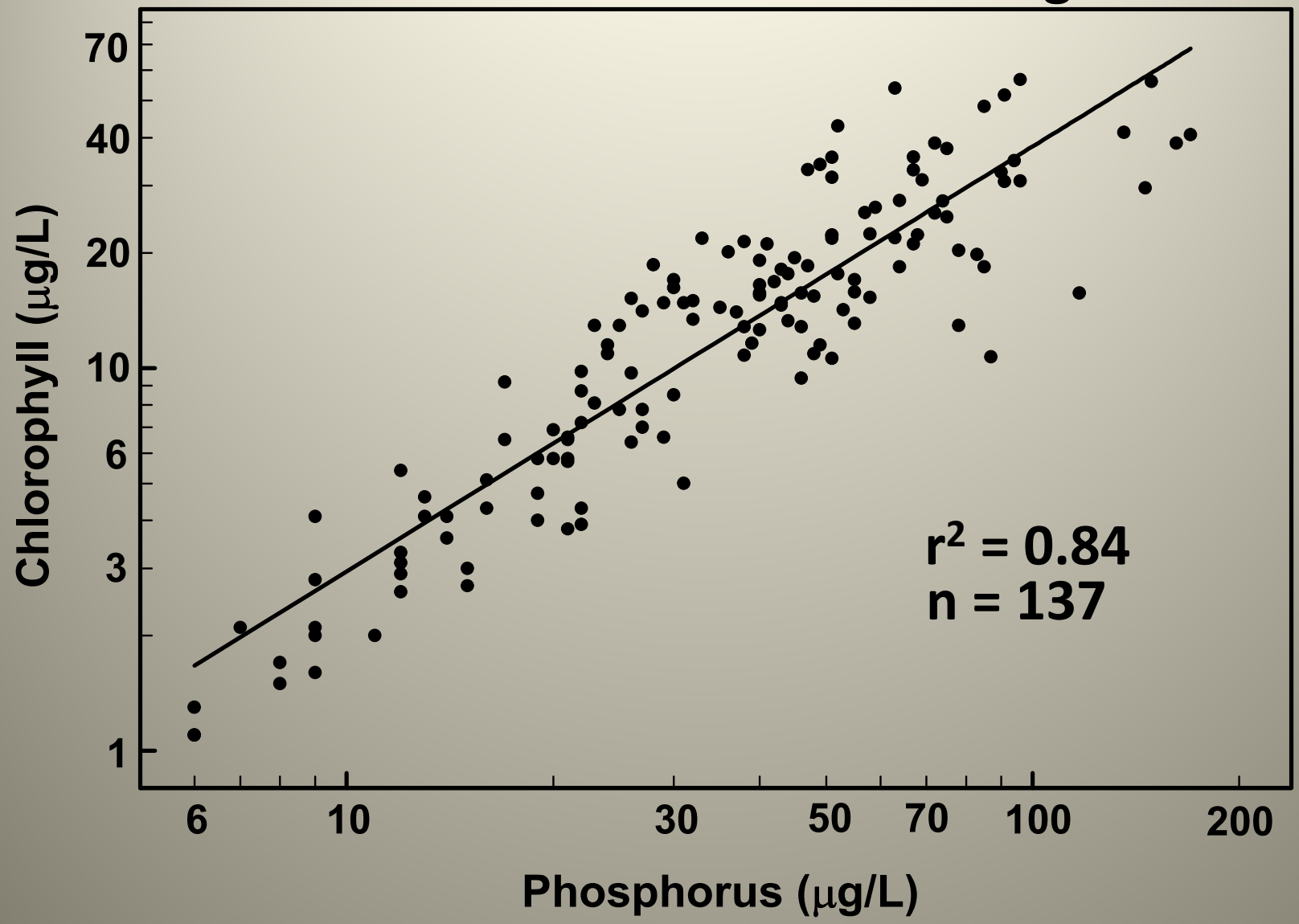
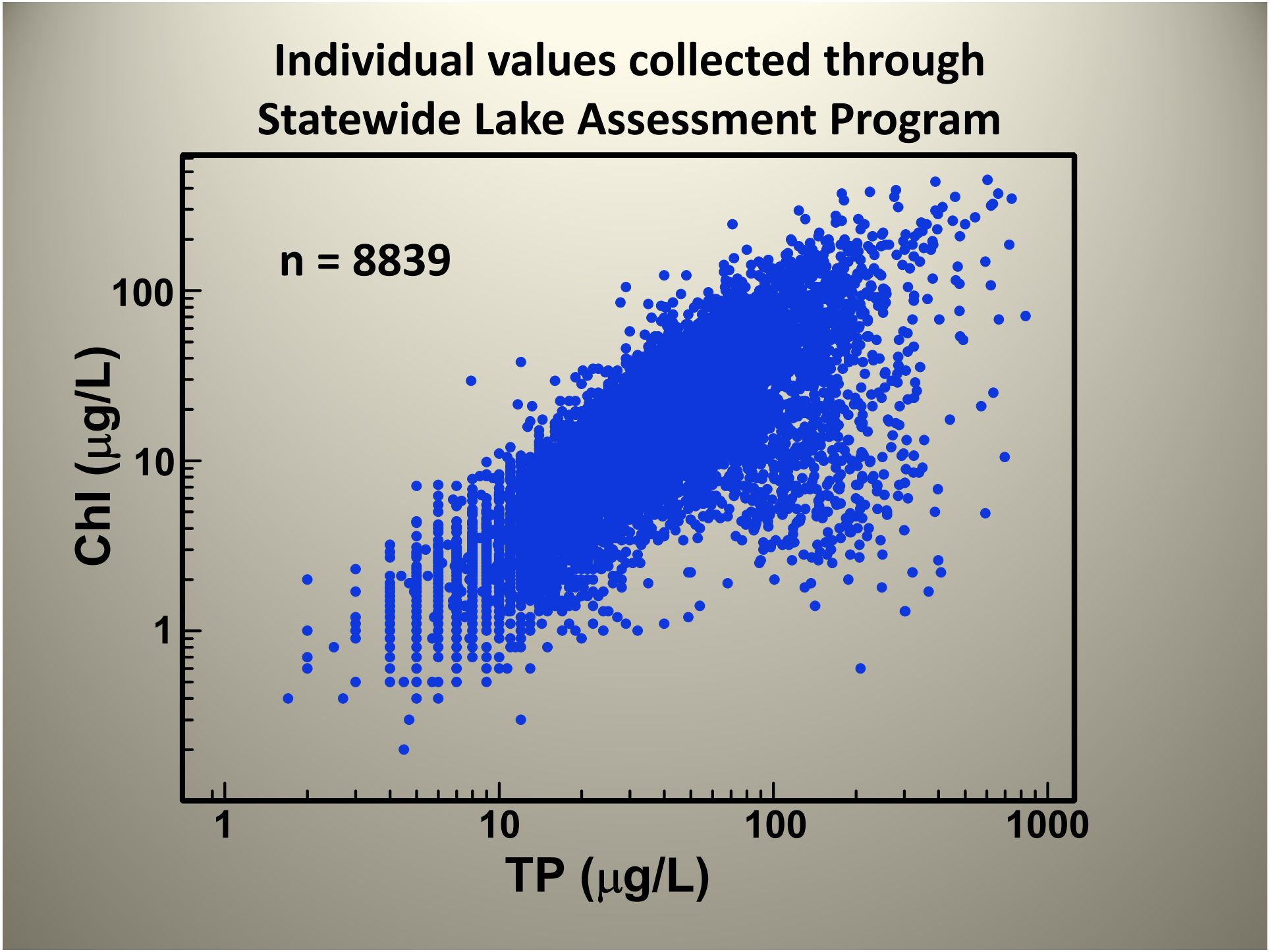
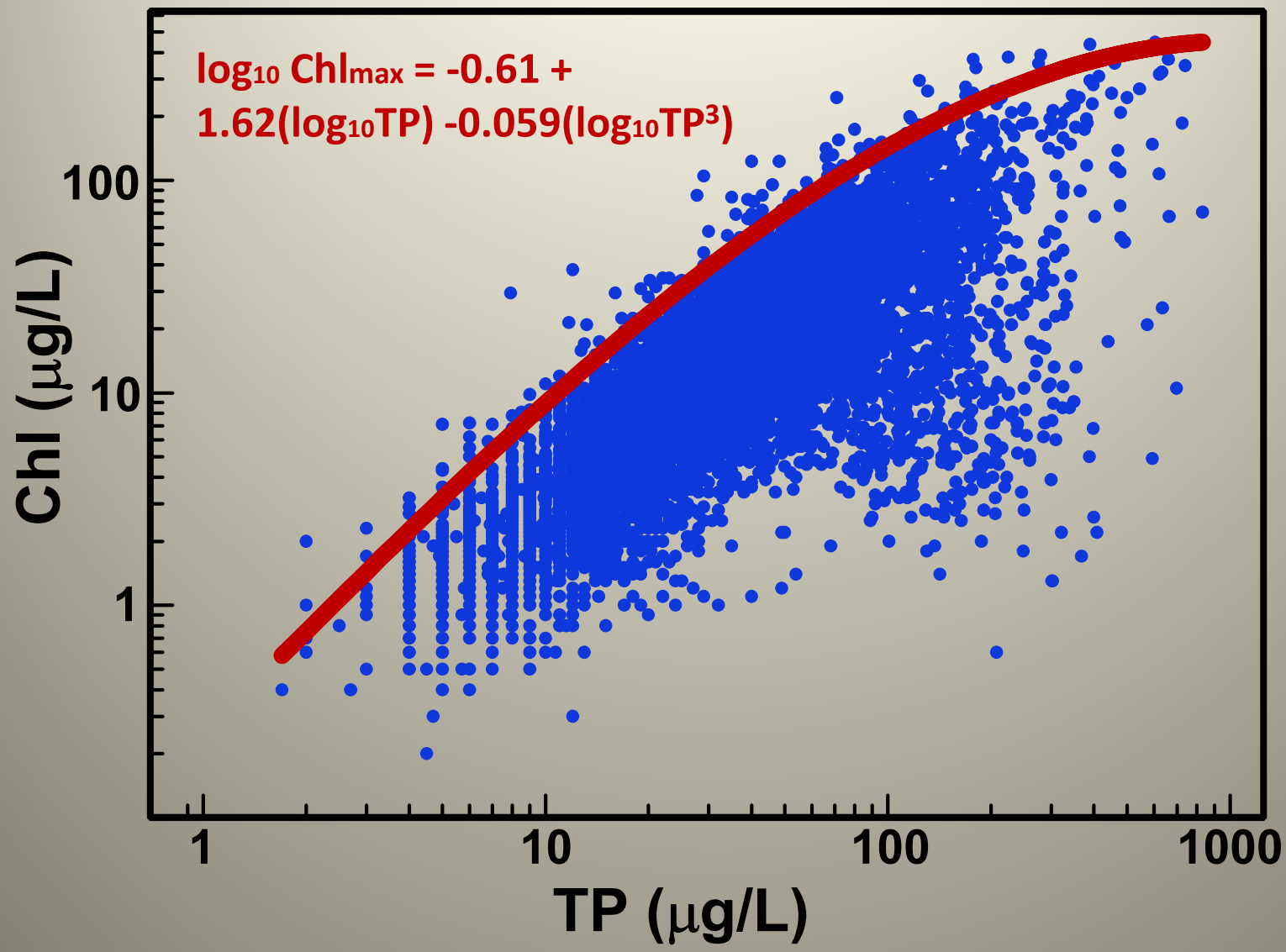
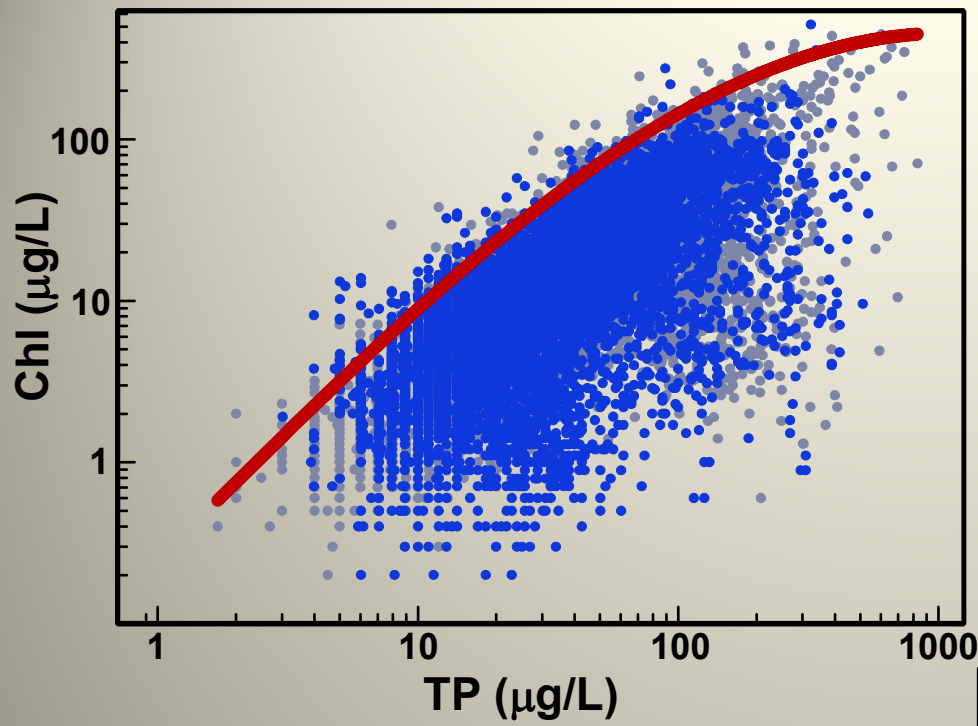
Long-term mean values collected through Statewide Lake Assessment Program



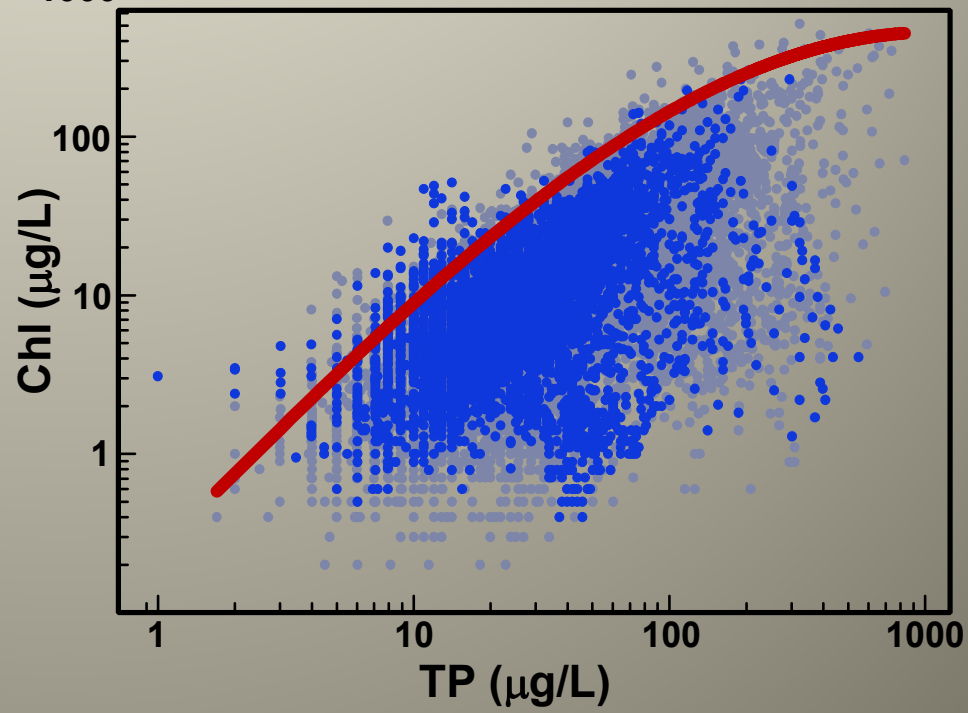

Individual values collected through
Statewide Lake Assessment Program
n = 8839
Chl (μg/L)
100
10
1
1
10
100
1000
TP (μg/L)

Individual values collected through Statewide Lake Assessment Program





Lakes of Missouri Volunteer Program
n = 8188

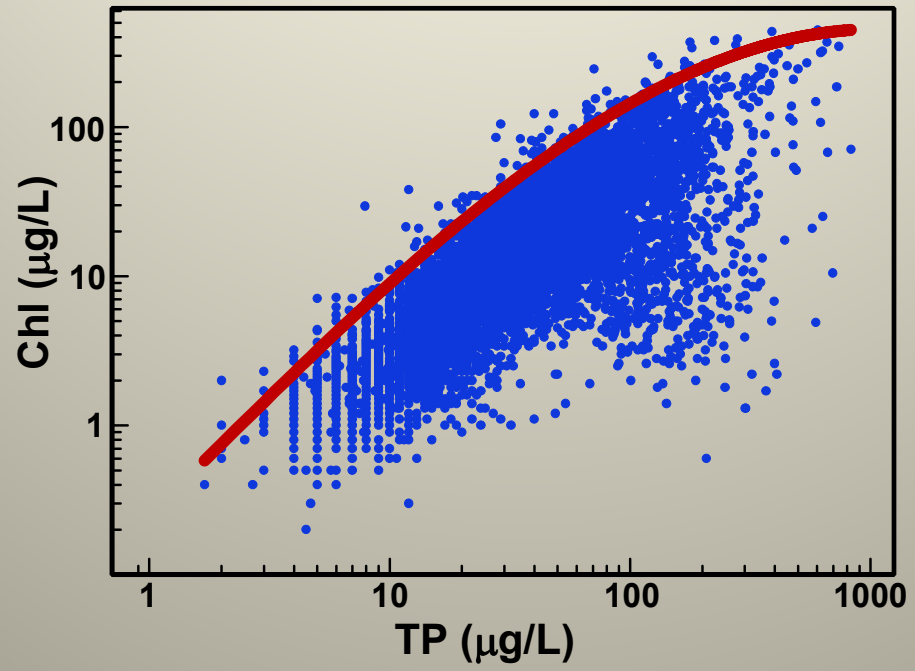


Misc Data
n = 5151

Upper boundary is not distinct

- 1.4% of Chl_{obs} exceeded Chl_{max}

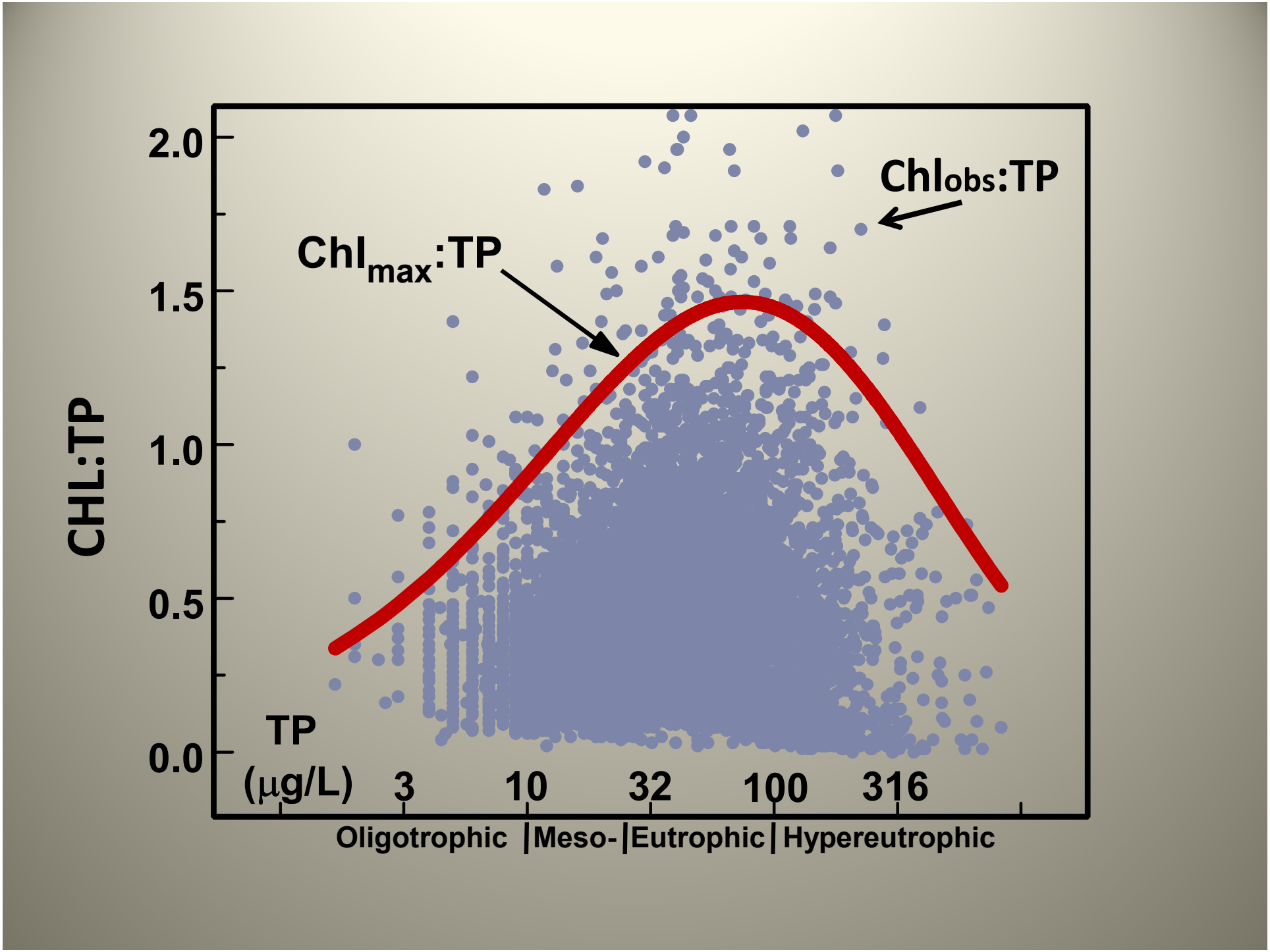
- similar to findings in FL



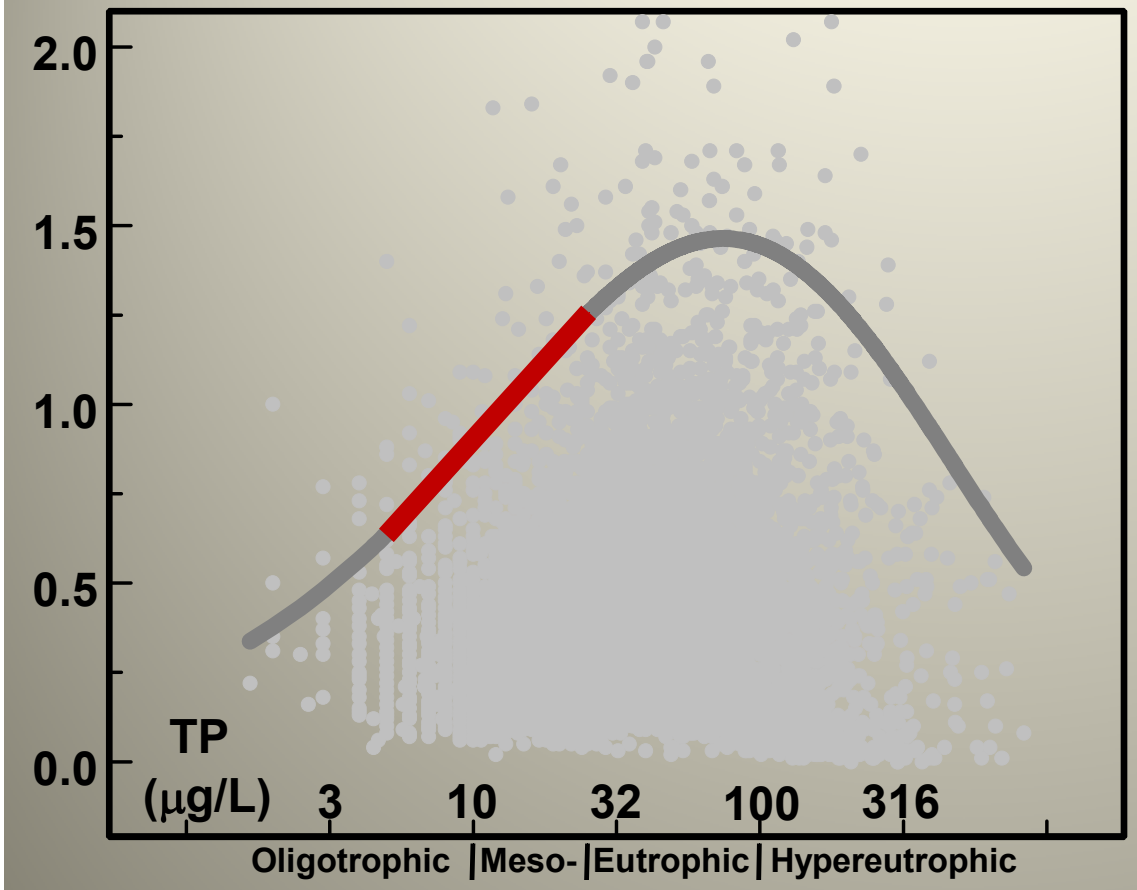
Median Chl_{obs}:Chl_{max} = 0.31

Interquartile range = 0.22 – 0.44

The expression of algal biomass relative to phosphorus concentrations can be gauged by looking at Chl:TP ratios.


2.0
1.5
1.0
0.5
0.0
CHL:TP
Chlobs:TP
Chlmax:TP
TP
(μg/L)
3
10
32
100
316
Oligotrophic
Meso-
Eutrophic
Hypereutrophic

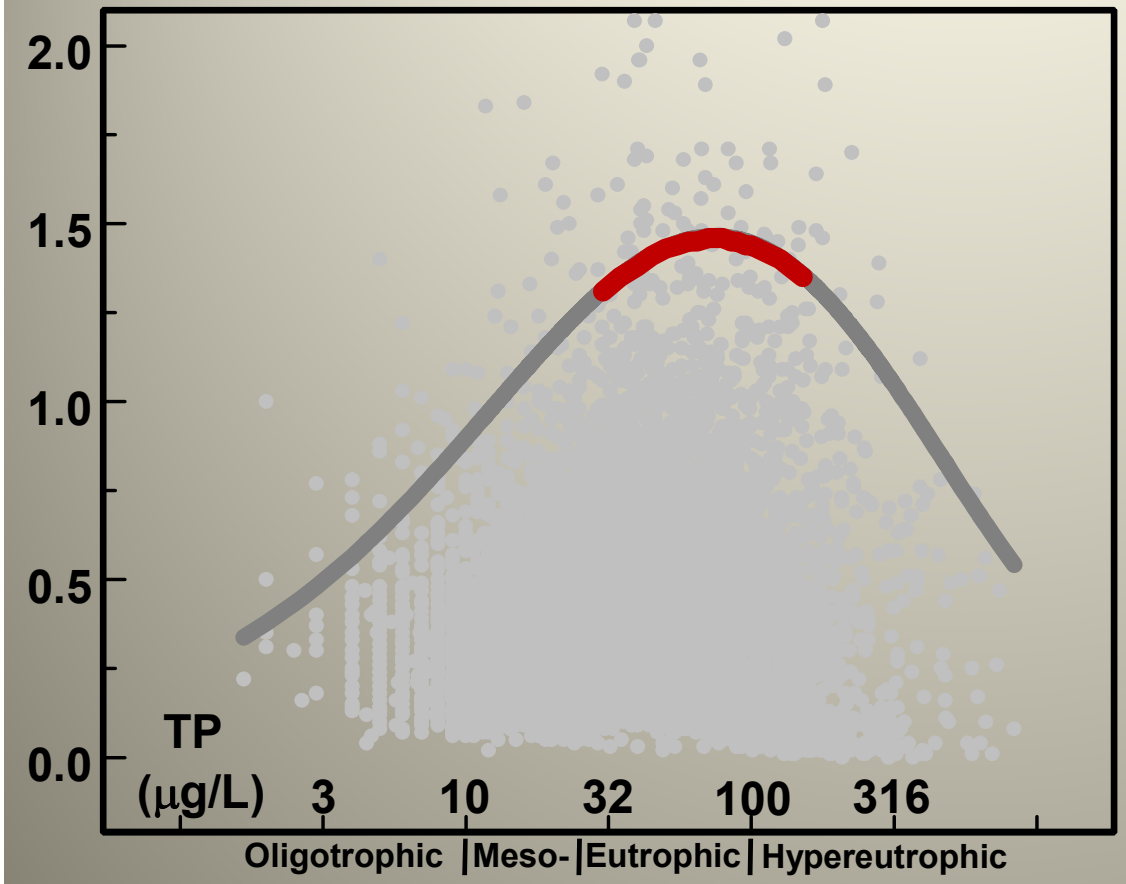
Chl_{max}:TP ratio increases rapidly across oligotrophic and mesotrophic range



TP	Chl_{max}:TP	CHL_{max}
5	0.64	3.2
13	1.00	13.0
25	1.25	31.2

A five-fold increase in TP results in a ten-fold increase in Chl_{max}

Chl_{max}:TP ratio forms a dome across the eutrophic range and into the hypereutrophic range



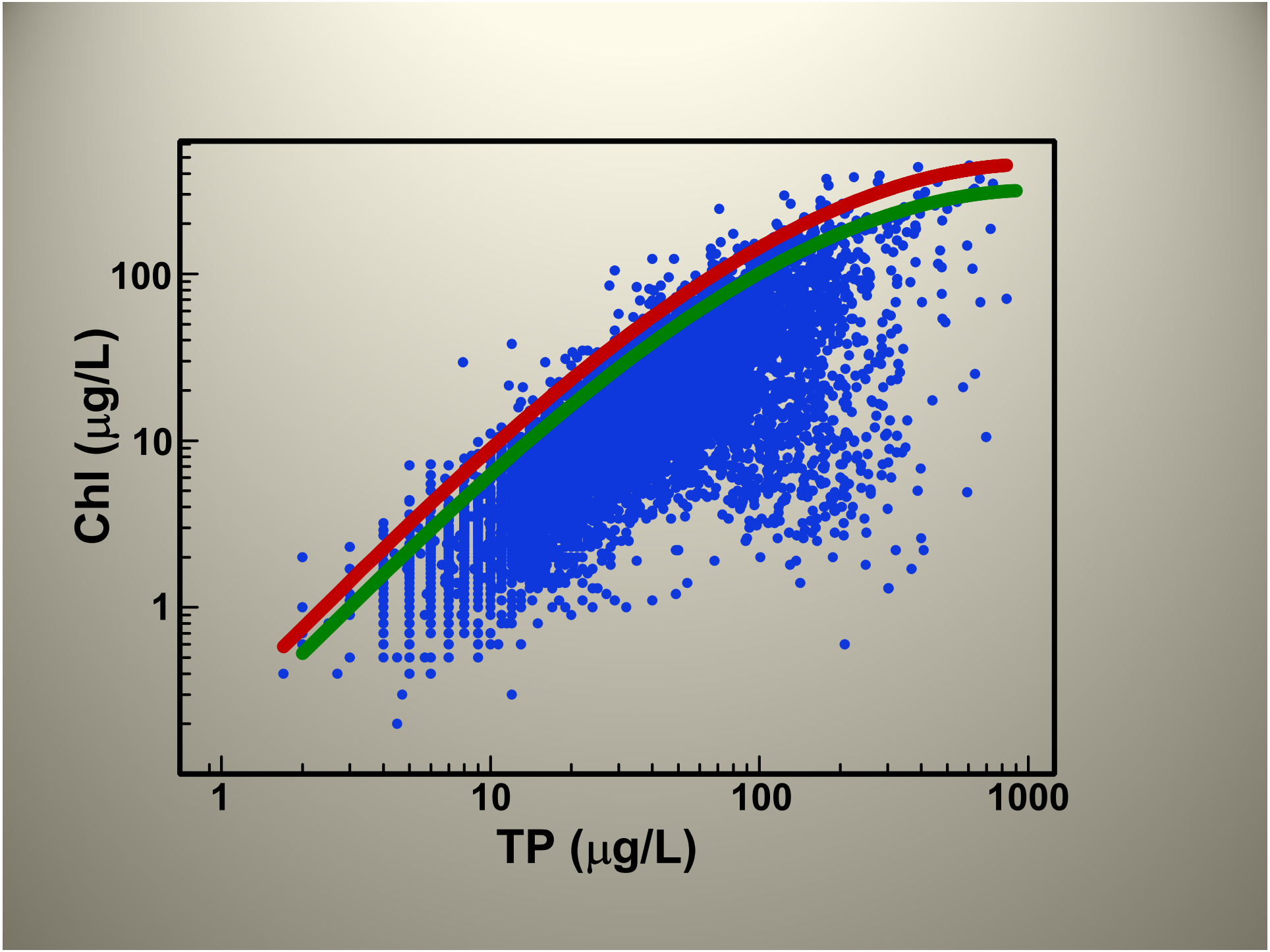
TP	Chl_{max}:TP	CHL_{max}
30	1.31	39.2
90	1.45	130.5
150	1.35	202.9

A five-fold increase in TP results in a five-fold increase in CHL_{max}

The reduction in Chl_{max} associate with a given reduction in TP is dependant on location within the trophic gradient

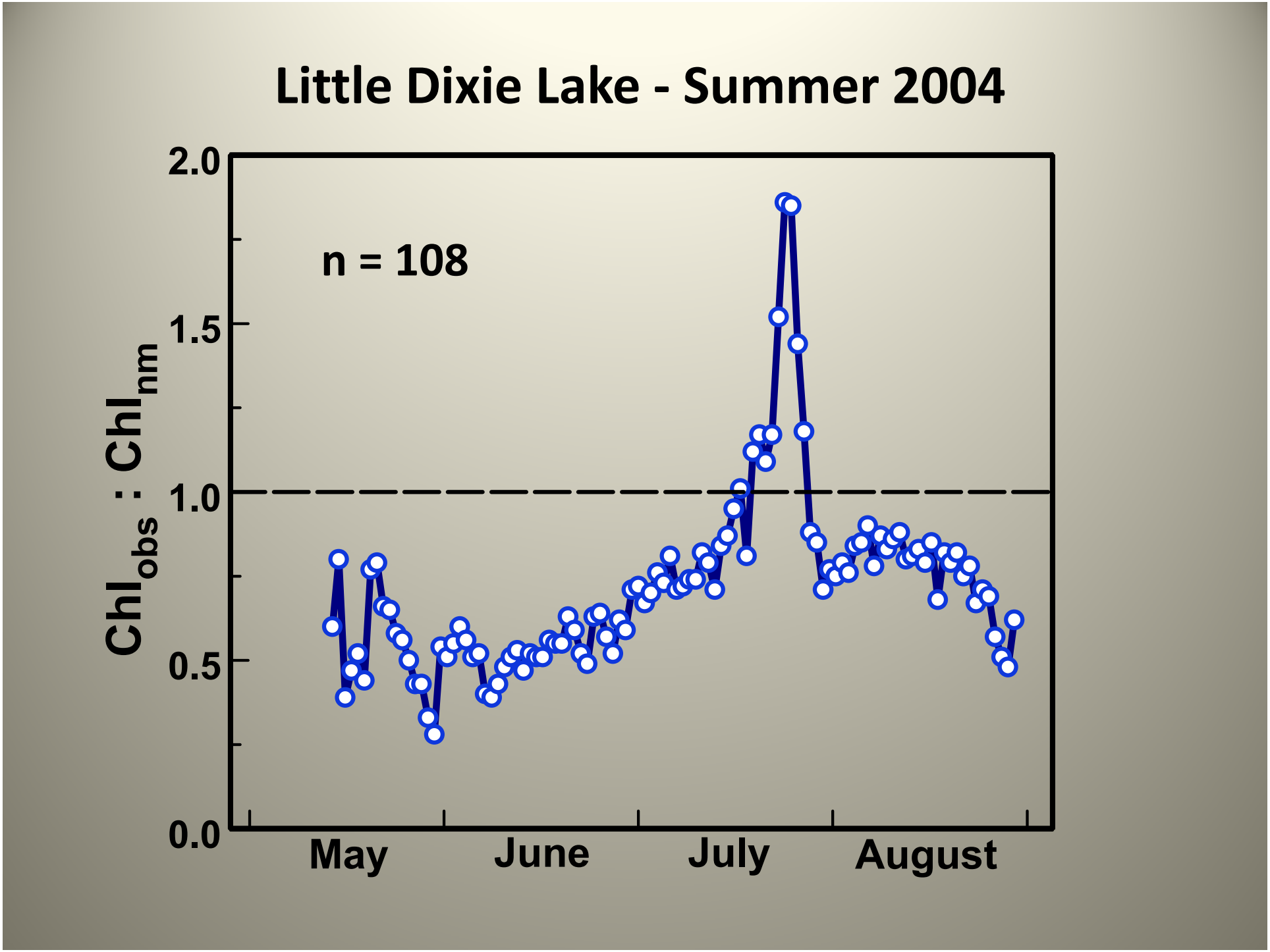
In an attempt to identify near-maximum algal biomass, the upper 95% confidence interval was calculated for each of the 38 phosphorus bins used to generate the maximum line.

The pattern using this approach matched 70% of Chl_{max}, and serves as a provisional limit for identifying near-maximum chlorophyll (Chl_{nm}).


100
10
1
Chl (μg/L)
1
10
100
1000
TP (μg/L)

Approximately 5% of Chl_{obs} values were between Chl_{nm} and Chl_{max} lines

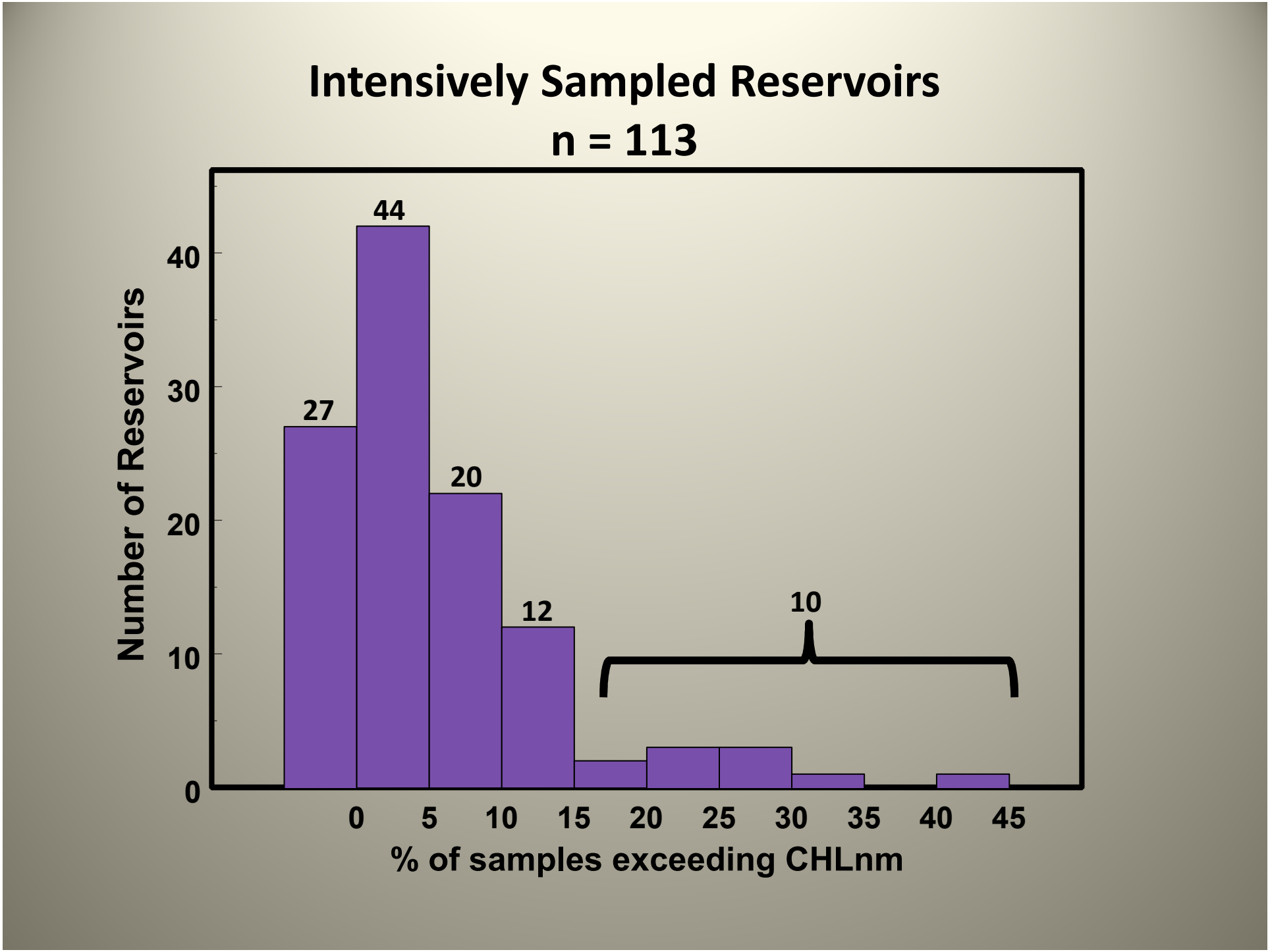
A total of 6.5% of Chl_{obs} values were >Chl_{nm} when values exceeding Chl_{max} are taken into account


Little Dixie Lake - Summer 2004
n = 108
$Chl_{obs} : Chl_{nm}$
2.0
1.5
1.0
0.5
0.0
May
June
July
August

Among our most intensively sampled reservoirs

(sampled 33 – 151 times, median 53 samples)

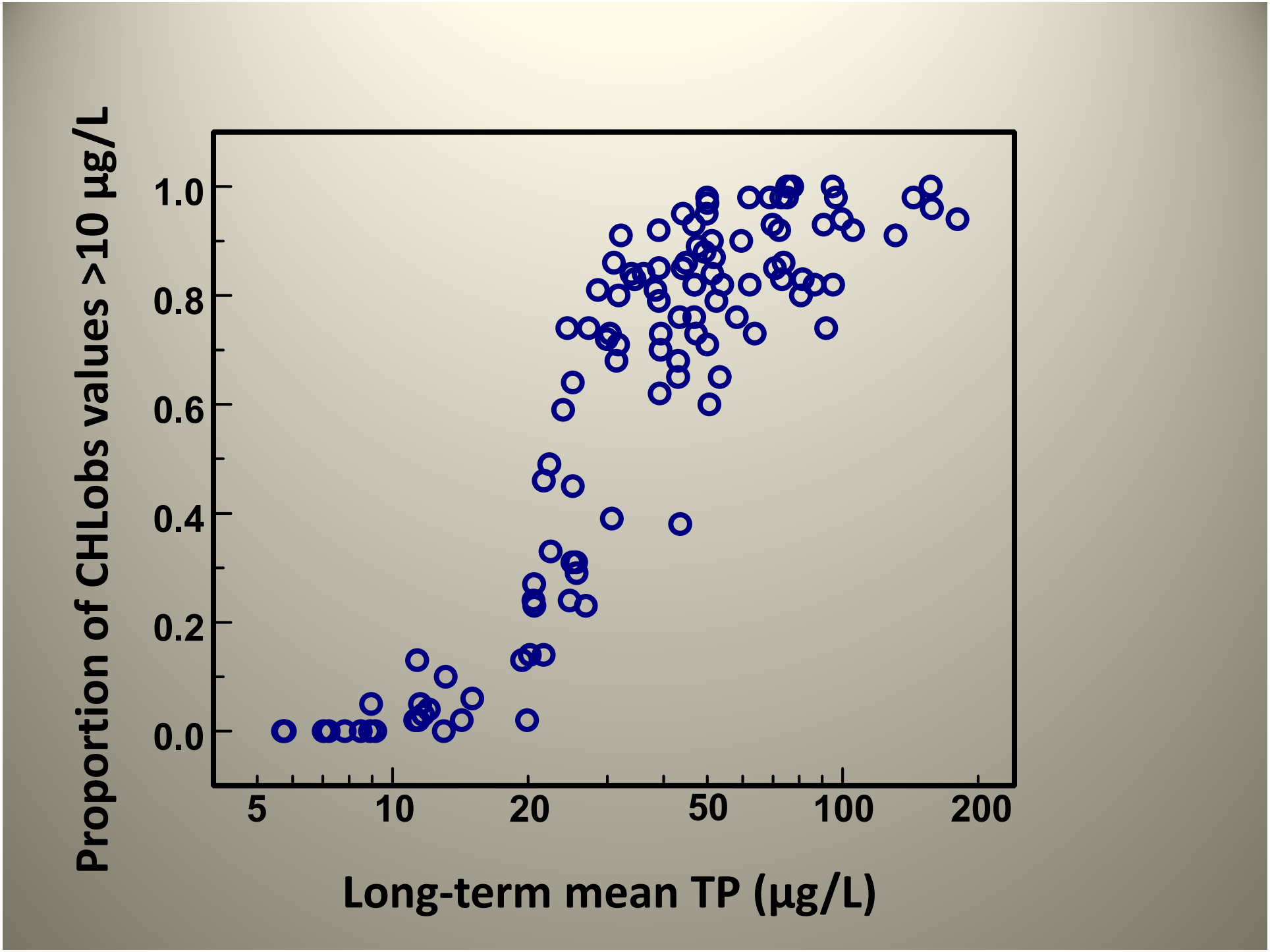
- **67% of Chl_{nm} were collected in July-Aug**
- **Individual reservoirs differ in their history to support Chl_{nm}**

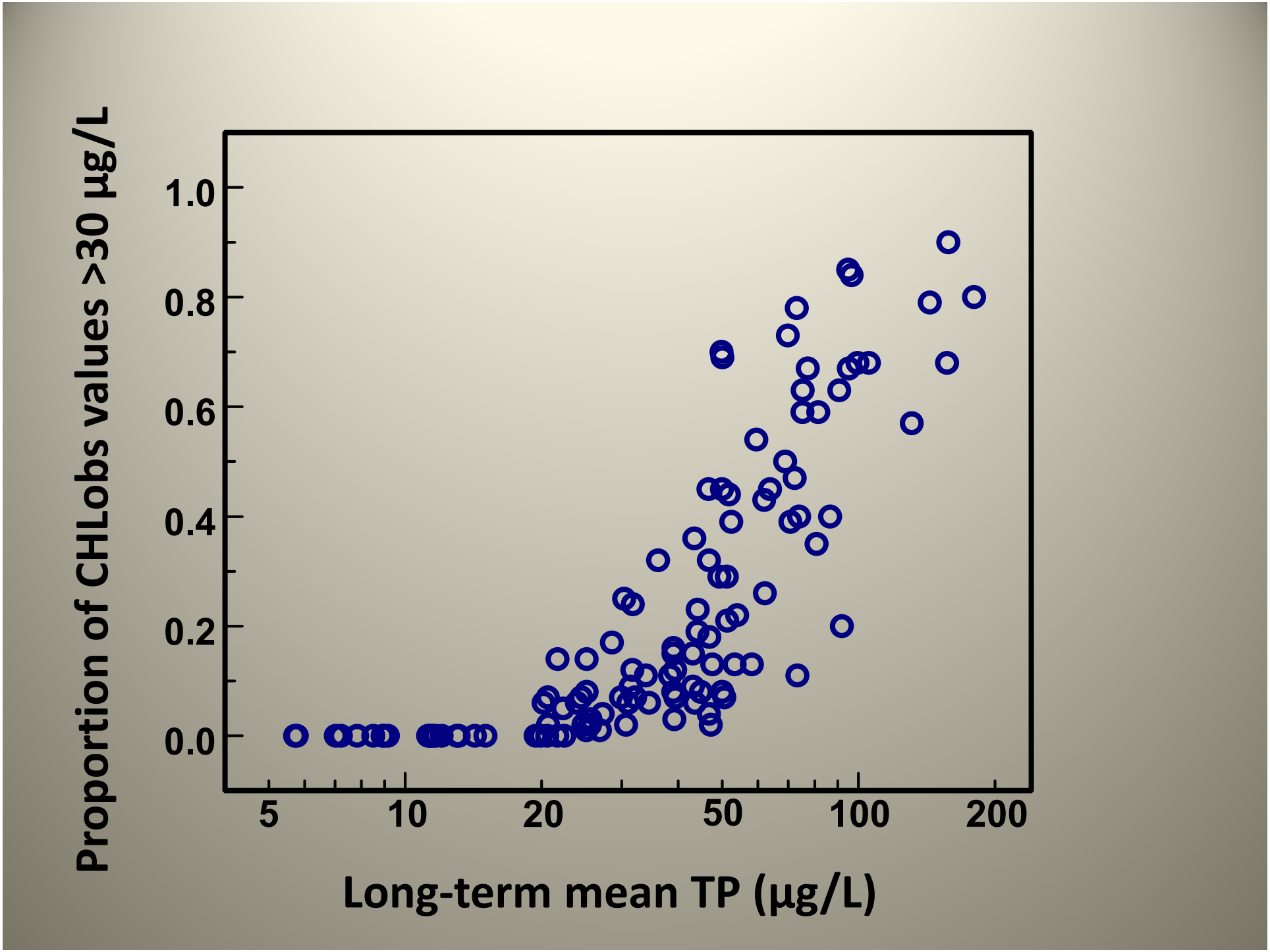

Intensively Sampled Reservoirs
n = 113
Number of Reservoirs
0
10
20
30
40
27
44
20
12
10
0
5
10
15
20
25
30
35
40
45
% of samples exceeding CHLnm

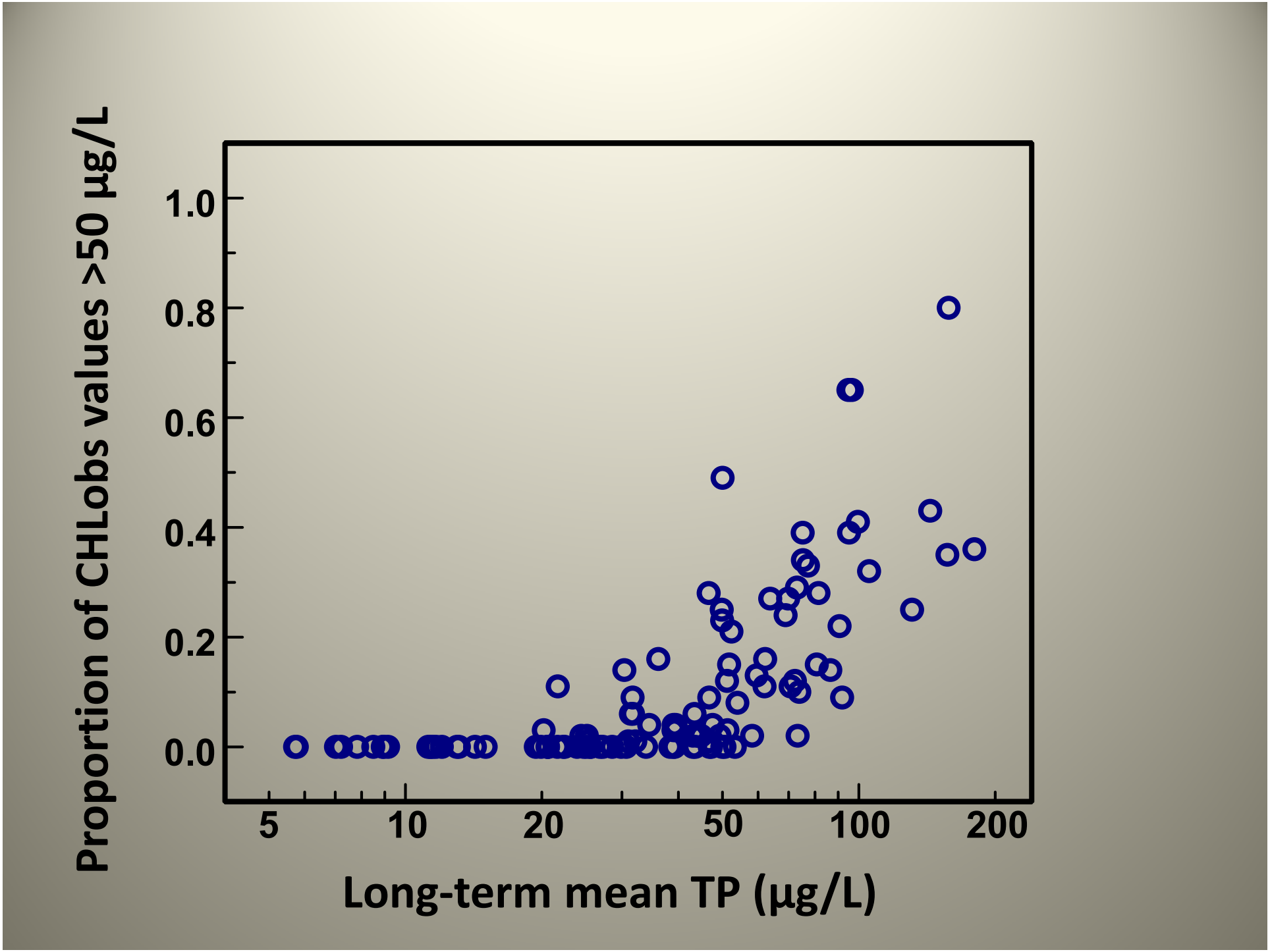
Exceeds Chlnm	Reservoir Name	Mean TP (µg/L)	Mean Chl (µg/L)
43%	Tywappity	50	38.8
33%	Stockton	11	6.0
27%	Table Rock	9	4.0
26%	Pleasant Valley	30	16.8
25%	Girardeau	47	29.9
22%	Harrison Co.	70	36.2
20%	Bilby Ranch	50	31.4
20%	Sterling Price	97	59.0
18%	Wappapello	36	21.2
18%	Hazel Hill	50	35.2

Neither trophic state nor the number of samples explains the frequency of Chl_{nm} values

Along with gauging bloom frequency lake managers might look at how often select chlorophyll concentrations are exceeded.


Proportion of CHLobs values >10 µg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100
200
Long-term mean TP (µg/L)


Proportion of CHLobs values >30 µg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100
200
Long-term mean TP (µg/L)


Proportion of CHLobs values >50 µg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100
200
Long-term mean TP (µg/L)

Summary

- There is a Chl_{max} associated with any given TP value
- Most observed Chl values are well below Chl_{max}
- Chl_{max}:TP ratios change across trophic gradient
- 70% of Chl_{max} can be used to define near max conditions
- Only 6.5% of samples reach Chl_{nm}
- Reservoirs differ in the frequency in which Chl_{nm} is supported

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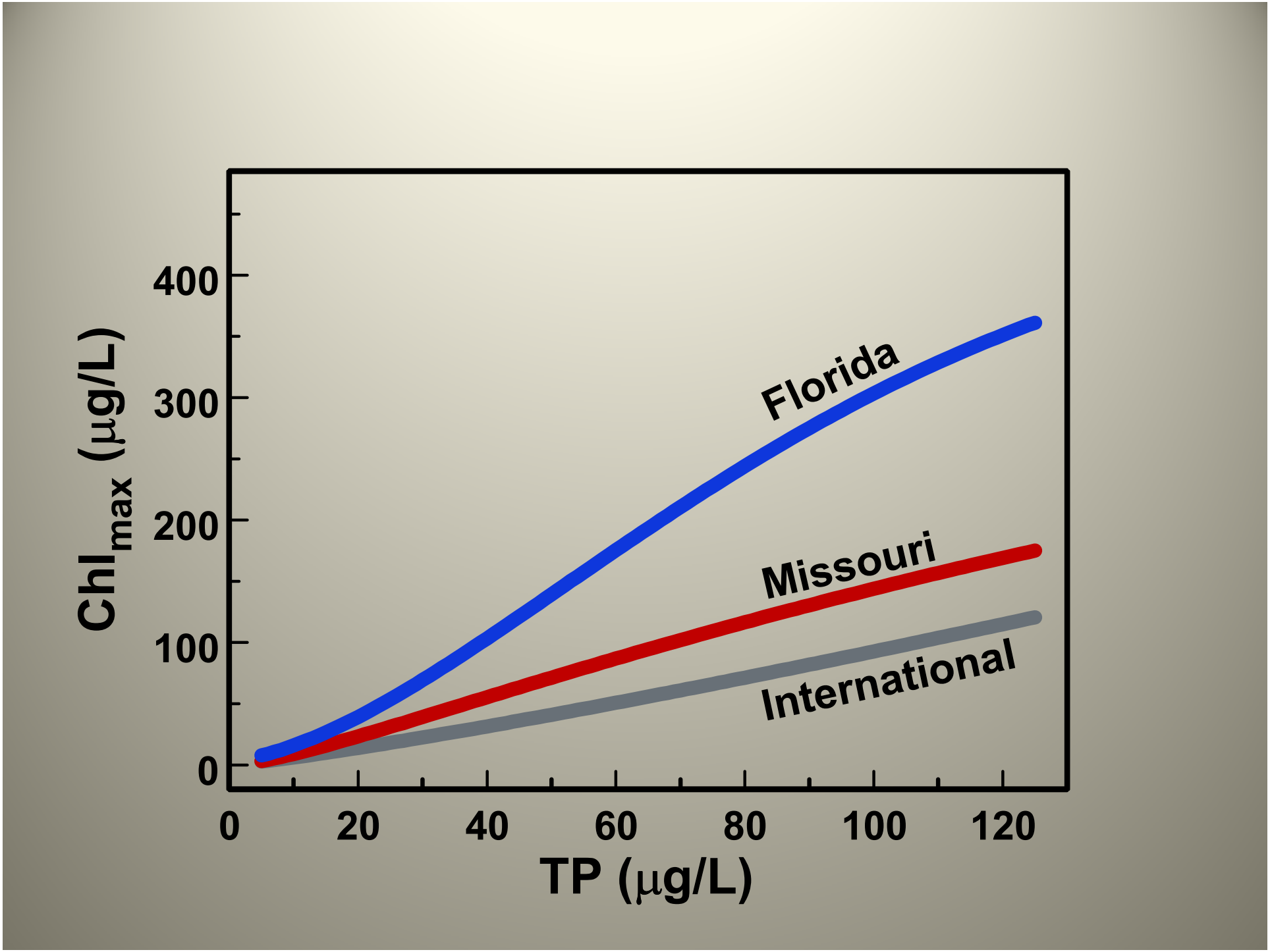
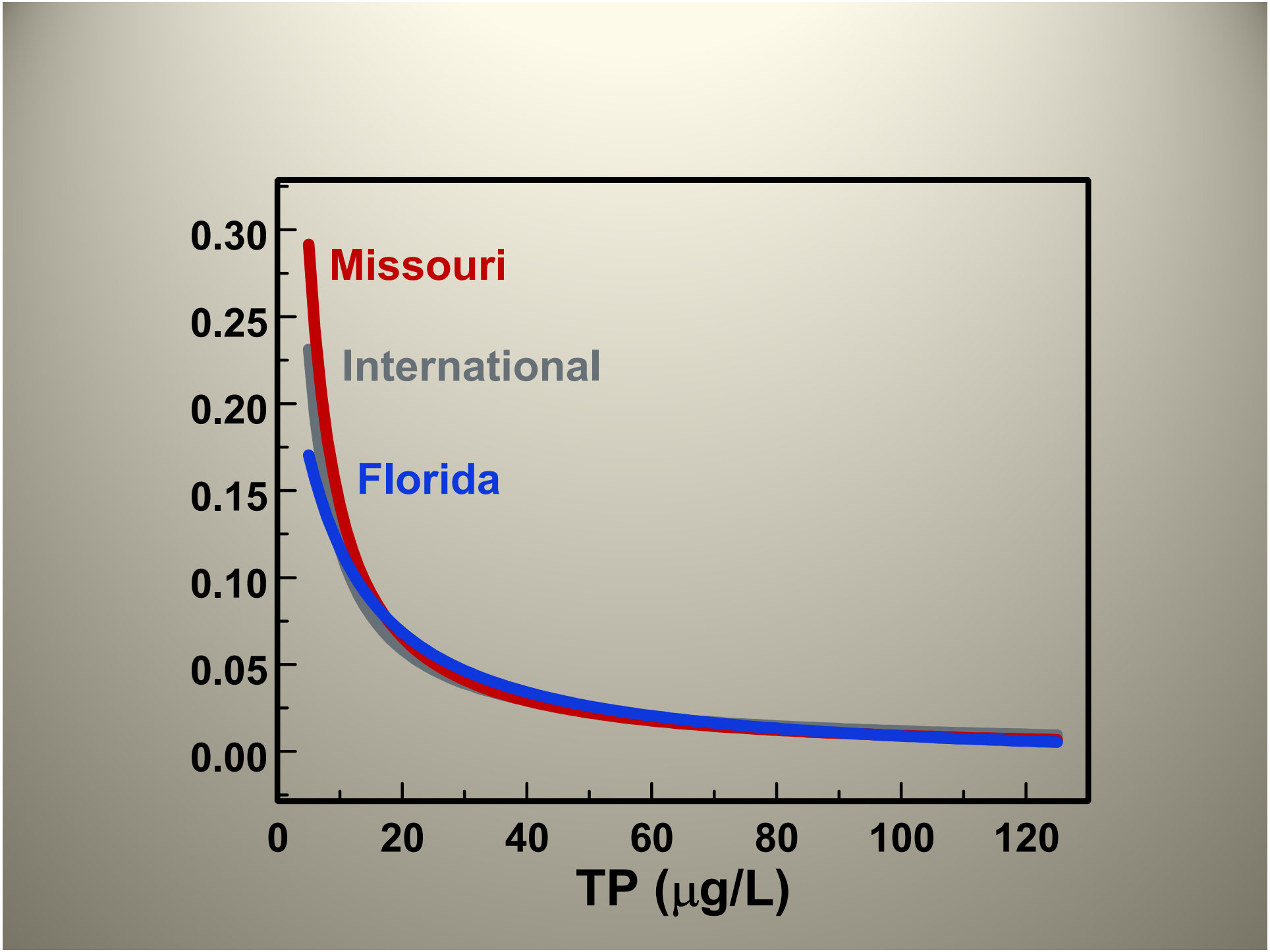
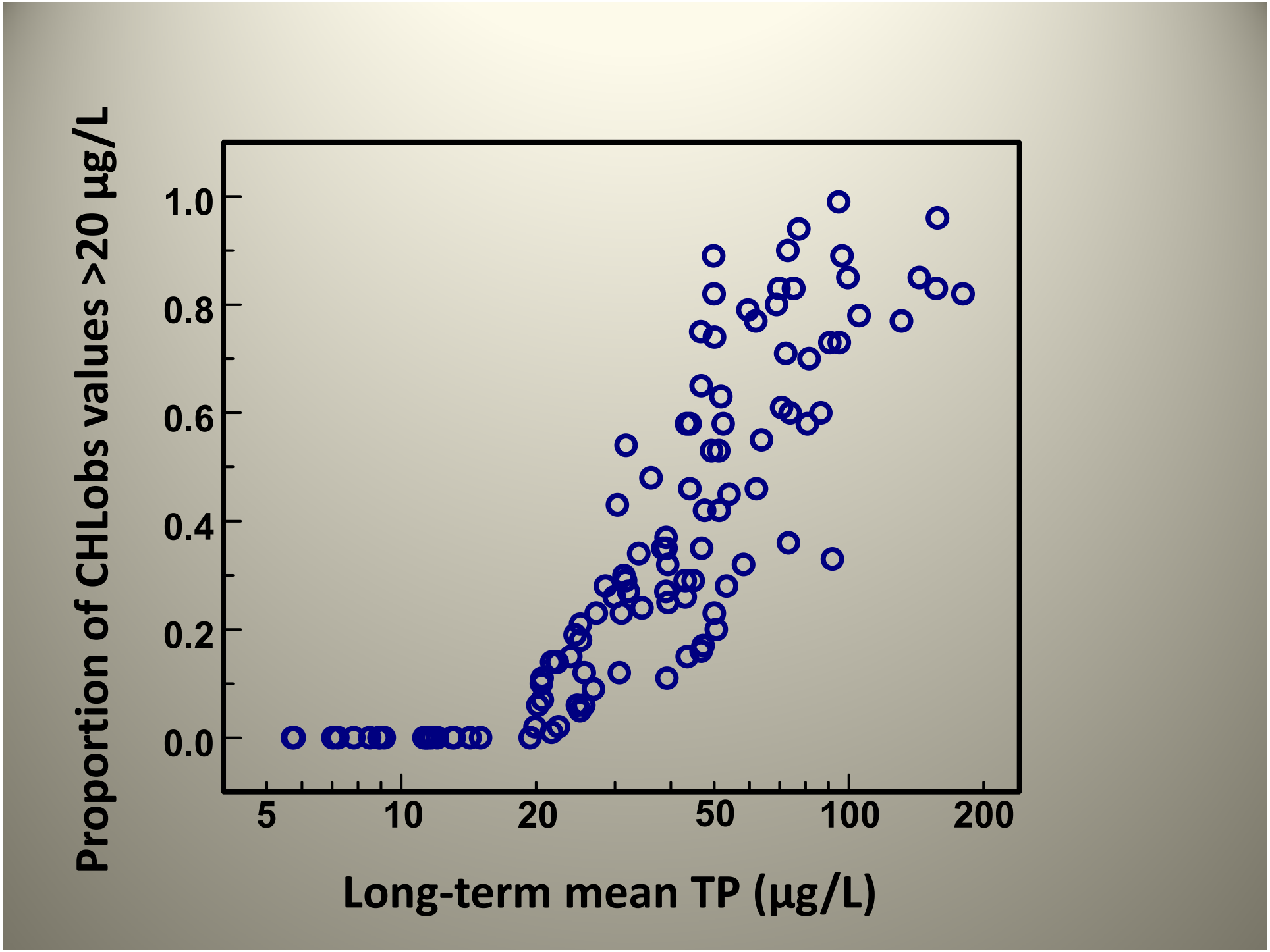
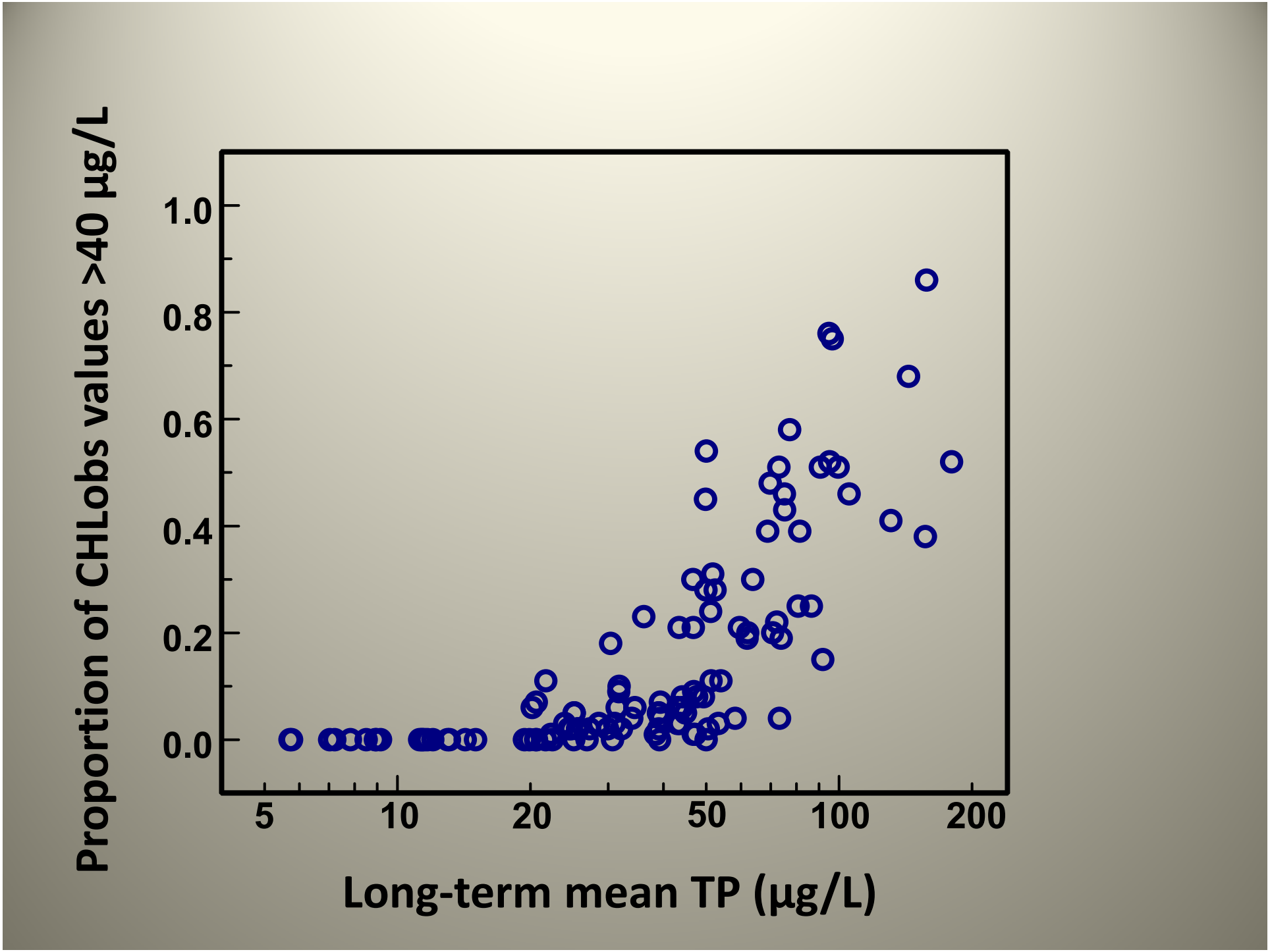
Trophic State	TP (µg/L) at upper limit of trophic state	Chl (µg/L) at upper limit of trophic state	Chl (µg/L) at maximum	Chl (µg/L) at near maximum
Oligotrophic	10	3	9	6
Mesotrophic	25	9	31	22
Eutrophic	100	40	145	100

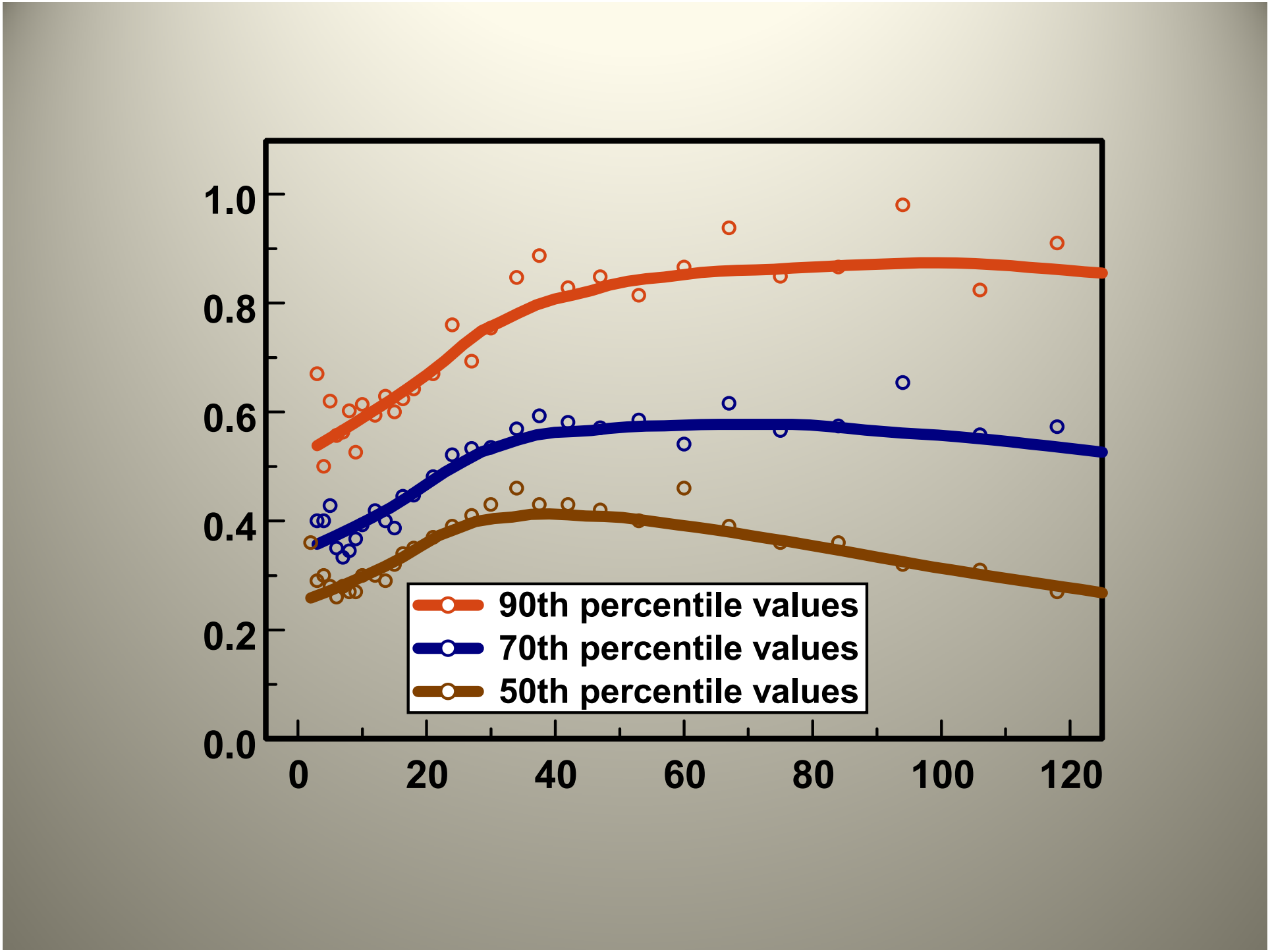
Trophic State	CHL:TP at upper limit	CHL:TP at max	CHL:TP at near max
Oligotrophic	0.30	0.90	0.62
Mesotrophic	0.36	1.25	0.86
Eutrophic	0.40	1.45	1.00

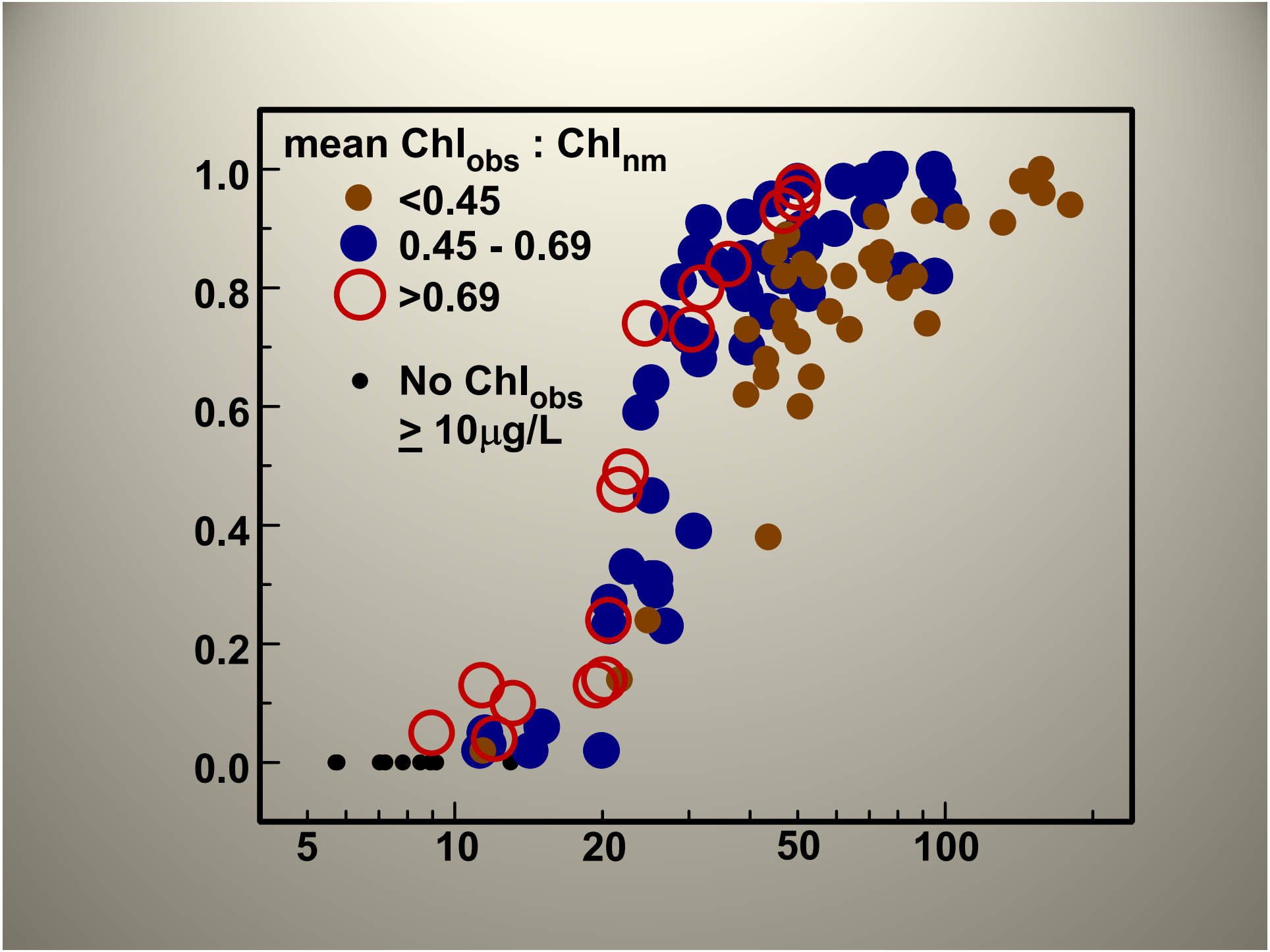

400
300
200
100
0
Chl_{max} (μg/L)
0
20
40
60
80
100
120
TP (μg/L)
Florida
Missouri
International

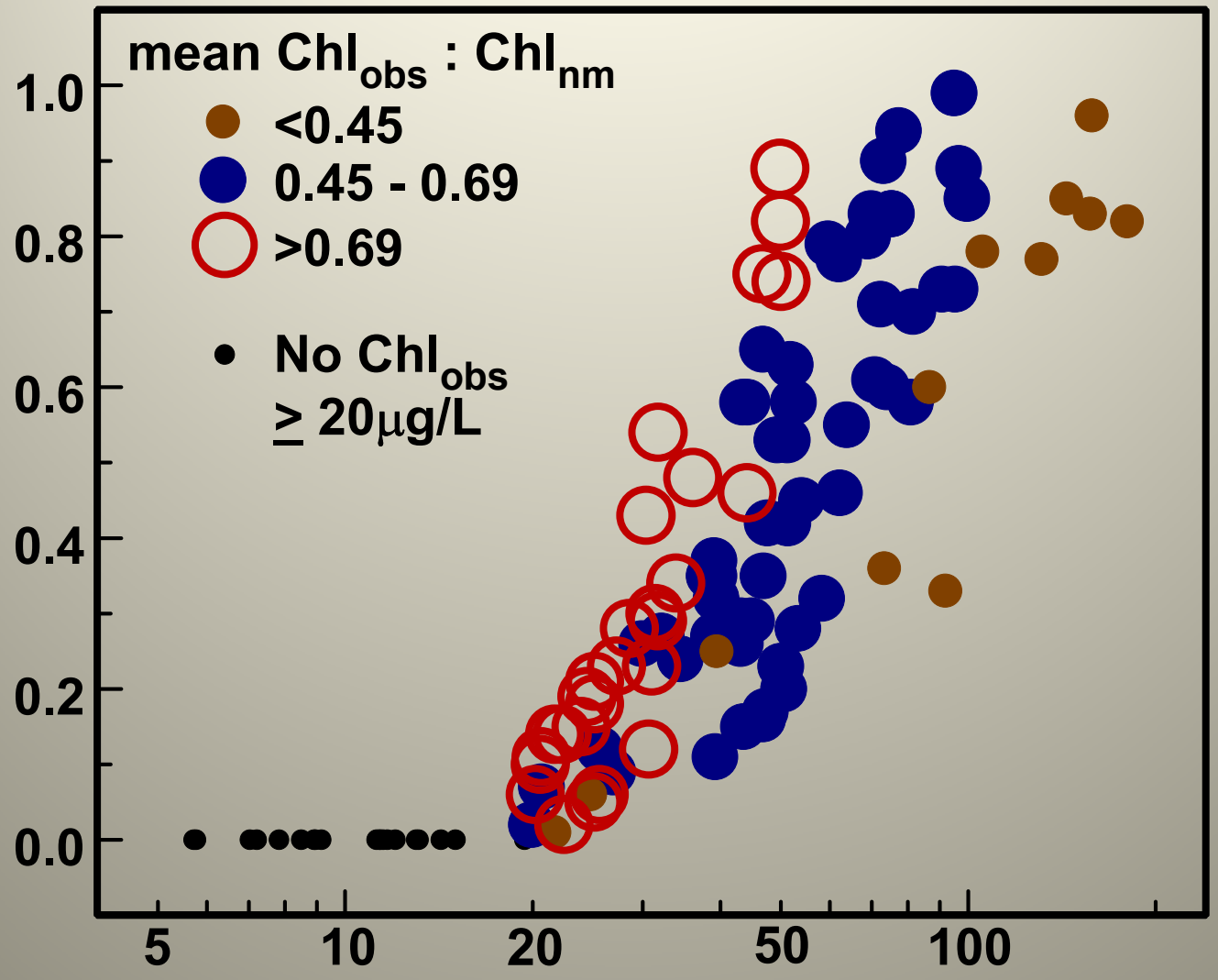

0.30
0.25
0.20
0.15
0.10
0.05
0.00
Missouri
International
Florida
0
20
40
60
80
100
120
TP (μg/L)

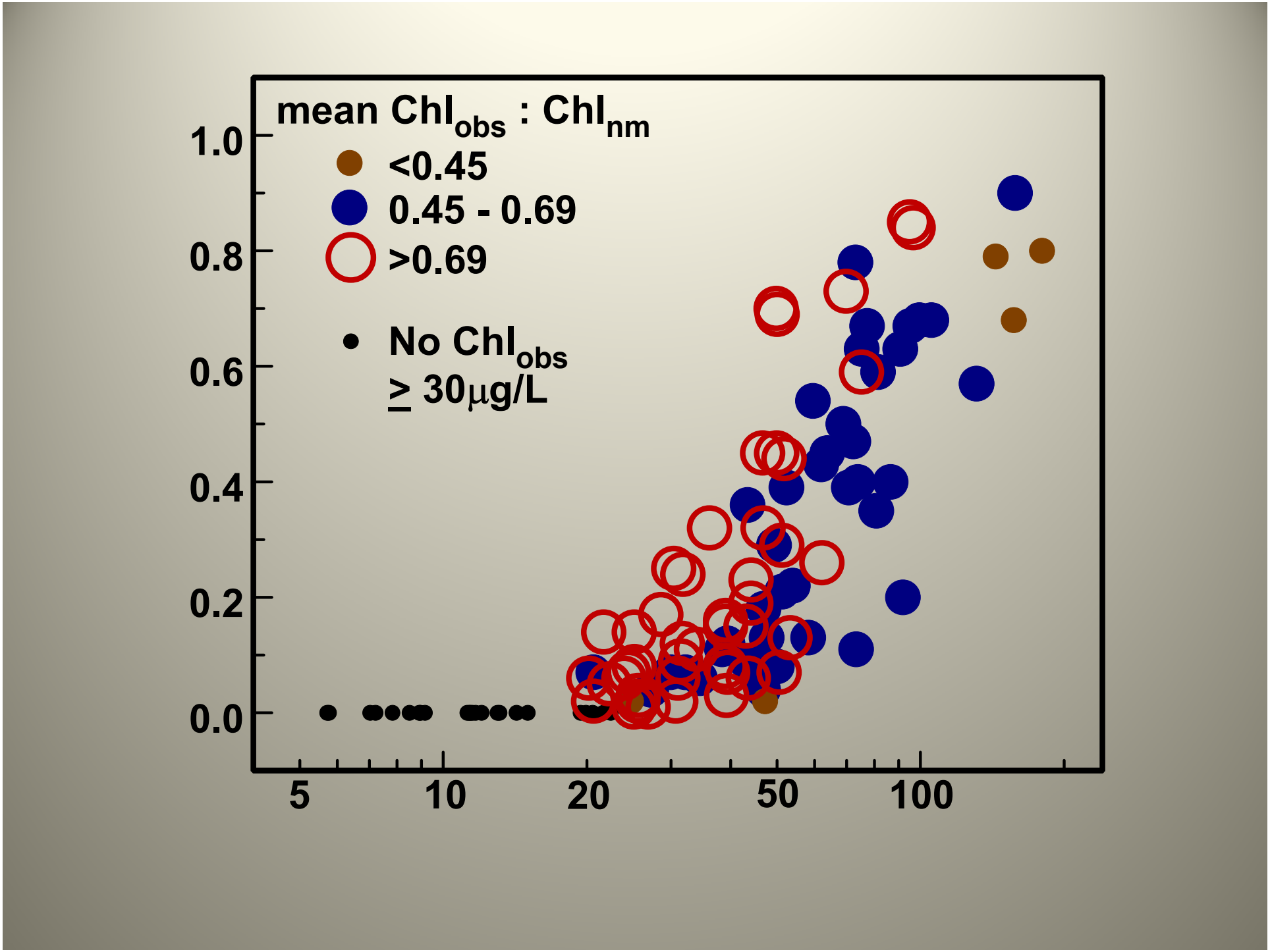

Proportion of CHLobs values >20 µg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100
200
Long-term mean TP (µg/L)


Proportion of CHLobs values >40 µg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100
200
Long-term mean TP (µg/L)


1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
90th percentile values
70th percentile values
50th percentile values


mean Chl$_{obs}$: Chl$_{nm}$
<0.45
0.45 - 0.69
>0.69
No Chl$_{obs}$
≥ 10μg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100


mean Chl$_{obs}$: Chl$_{nm}$
<0.45
0.45 - 0.69
>0.69
No Chl$_{obs}$
≥ 20μg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100


mean Chl$_{obs}$: Chl$_{nm}$
<0.45
0.45 - 0.69
>0.69
No Chl$_{obs}$
≥ 30μg/L
1.0
0.8
0.6
0.4
0.2
0.0
5
10
20
50
100