



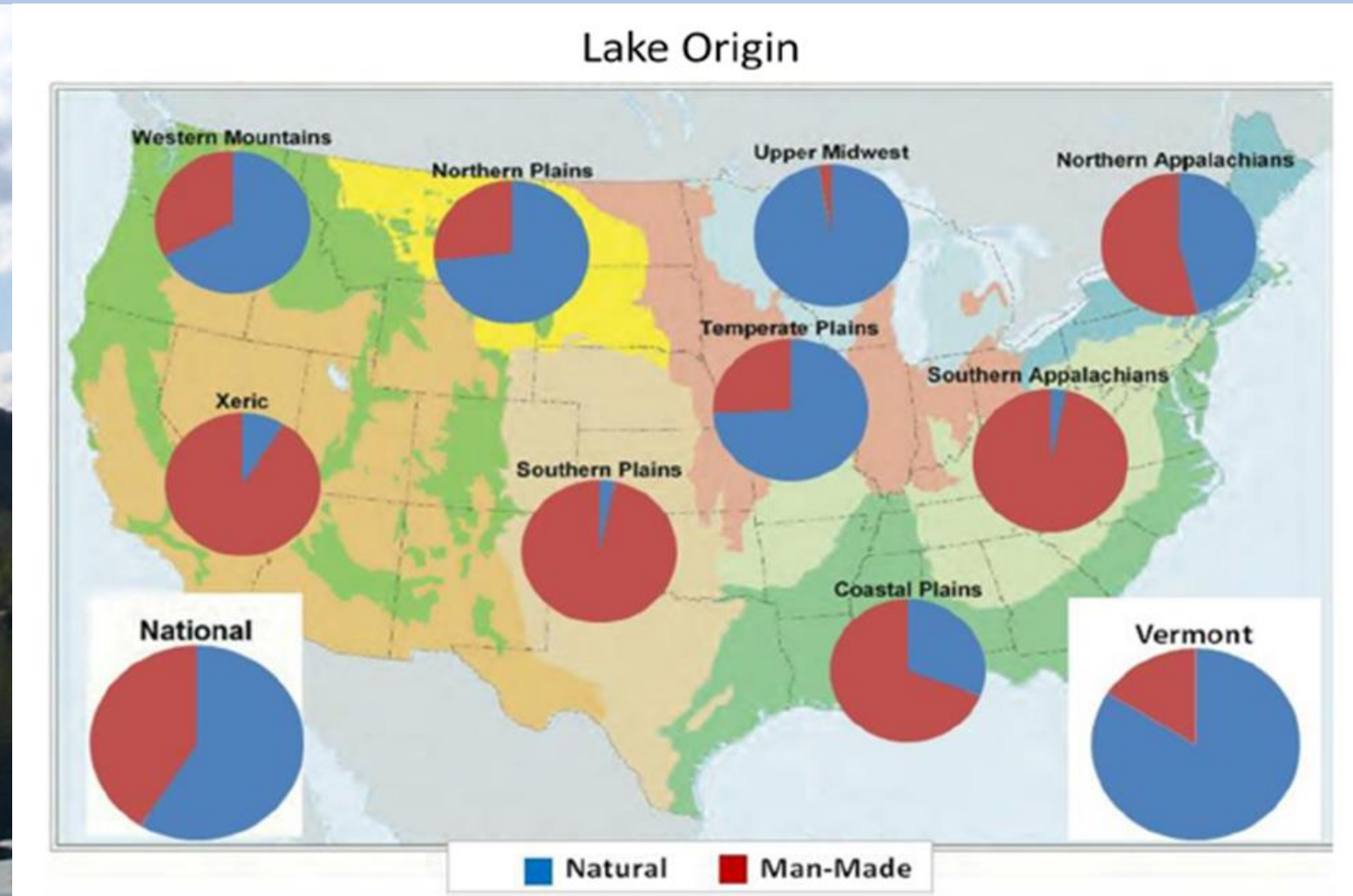
# Piloting a Strategy for Turning Significantly Increasing Phosphorus Trends Around on Vermont's Clearest Lakes

Kellie Merrell, Ben Copans and Danielle Owczarski

22 July 2019

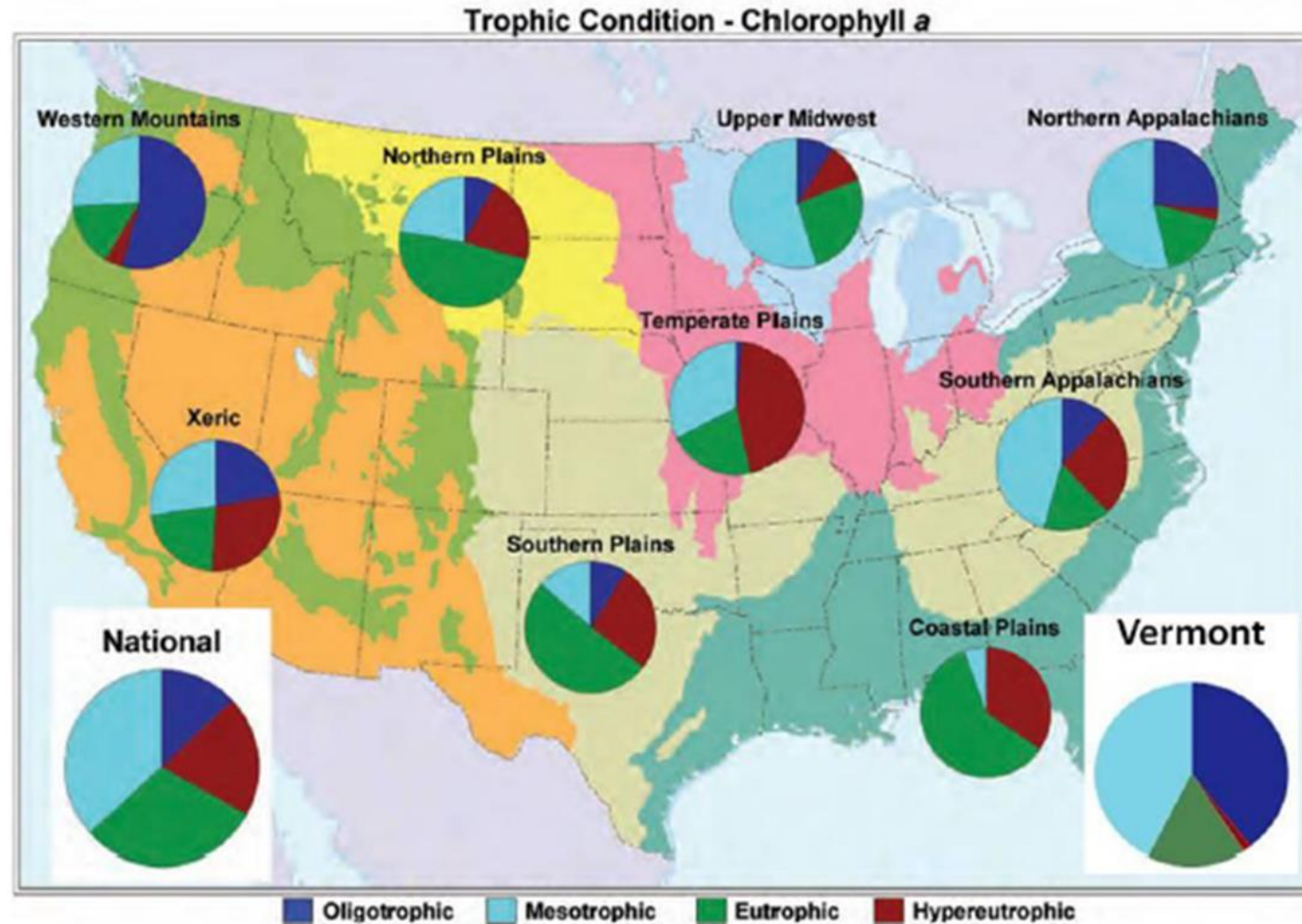
Federation of Vermont Lakes and Ponds Annual Meeting

# Vermont is Stewarding Some of the Clearest Lakes in the Nation

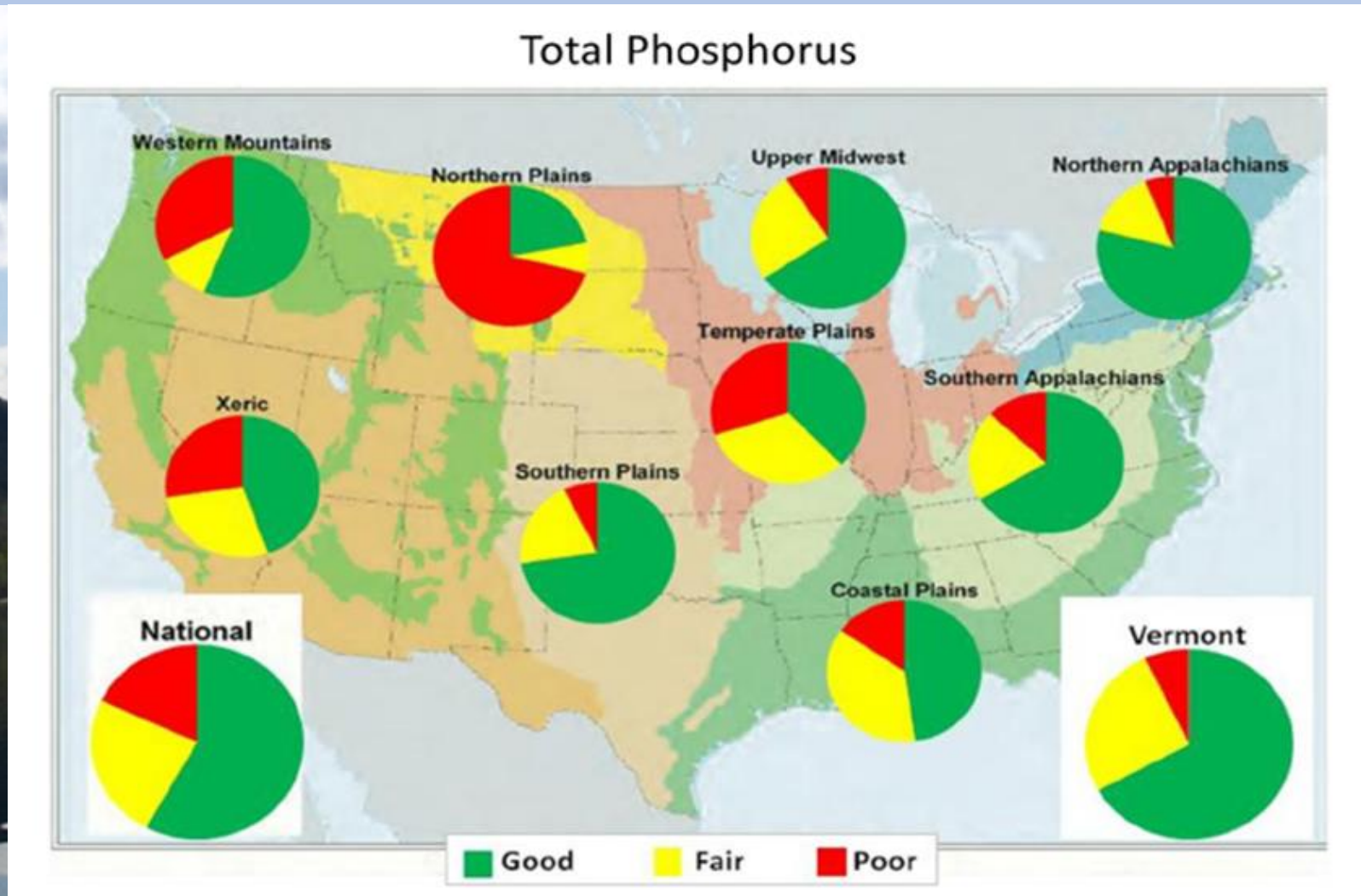




# Vermont is Stewarding Some of the Clearest Lakes in the Nation

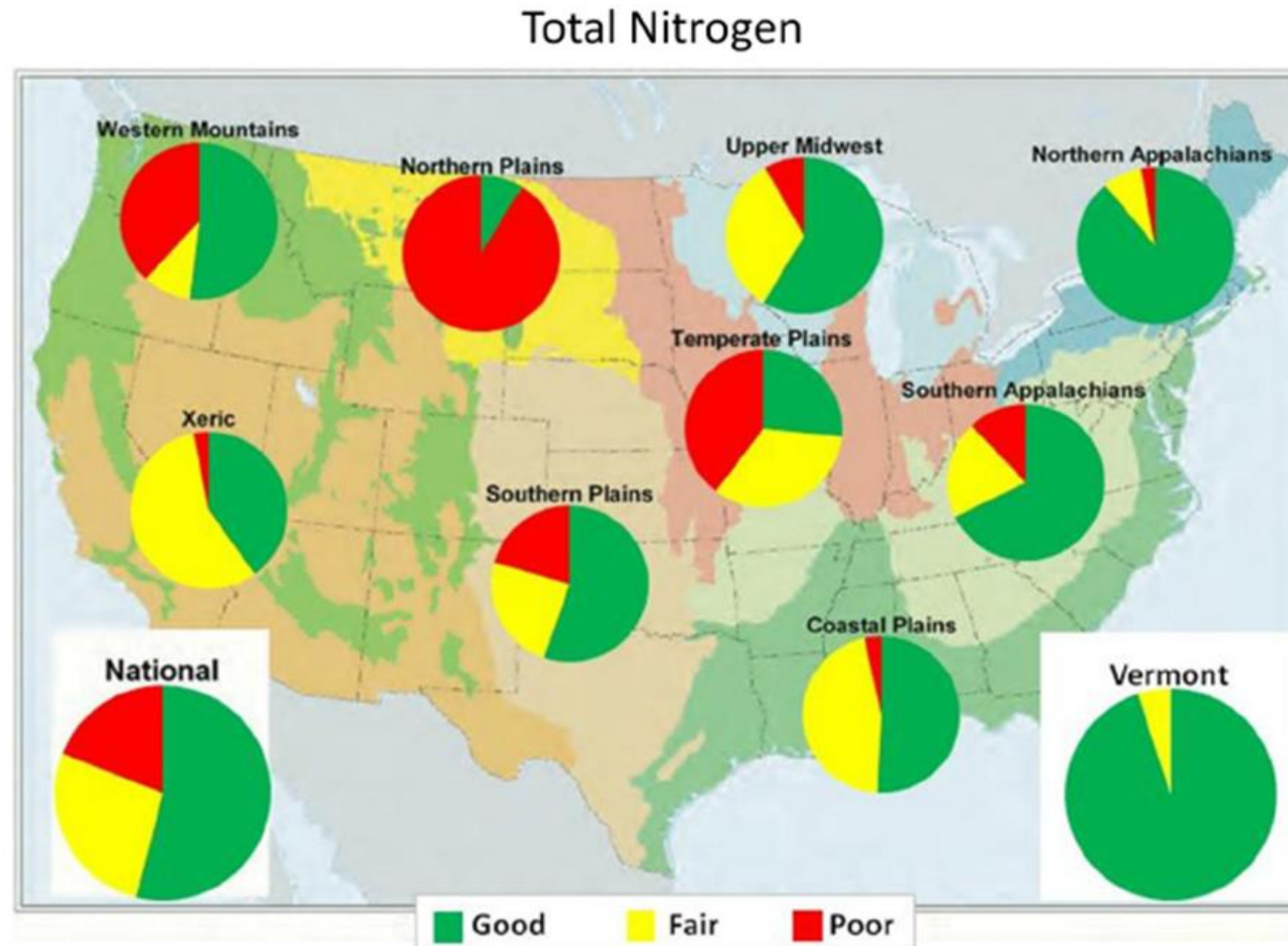


# Vermont is Stewarding Some of the Clearest Lakes in the Nation



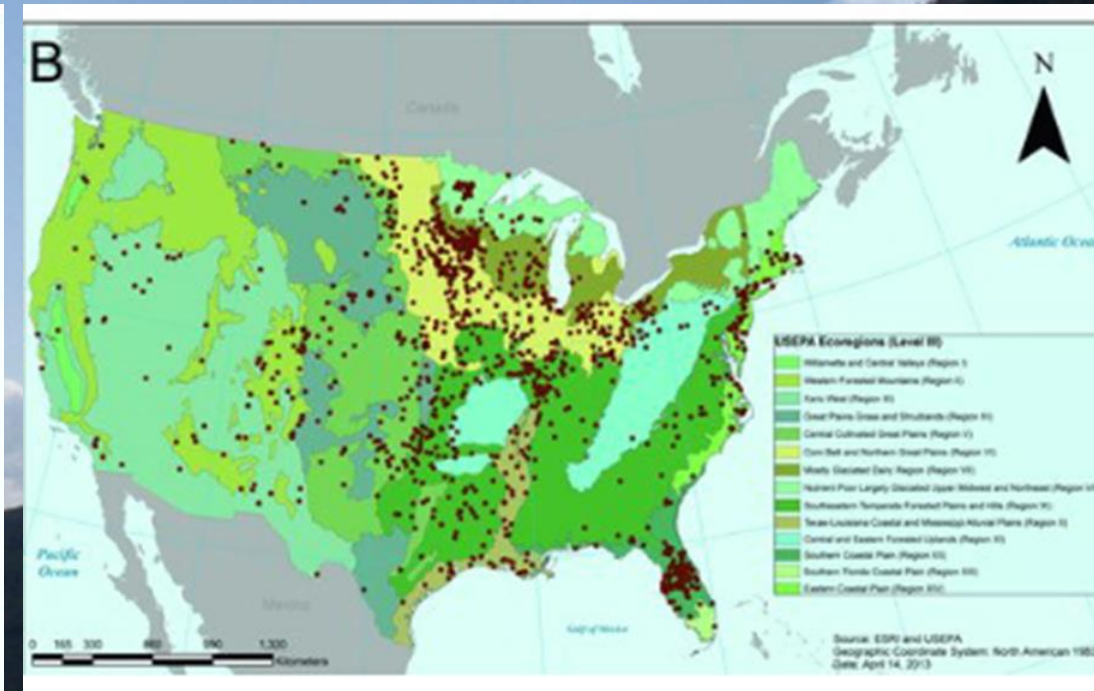
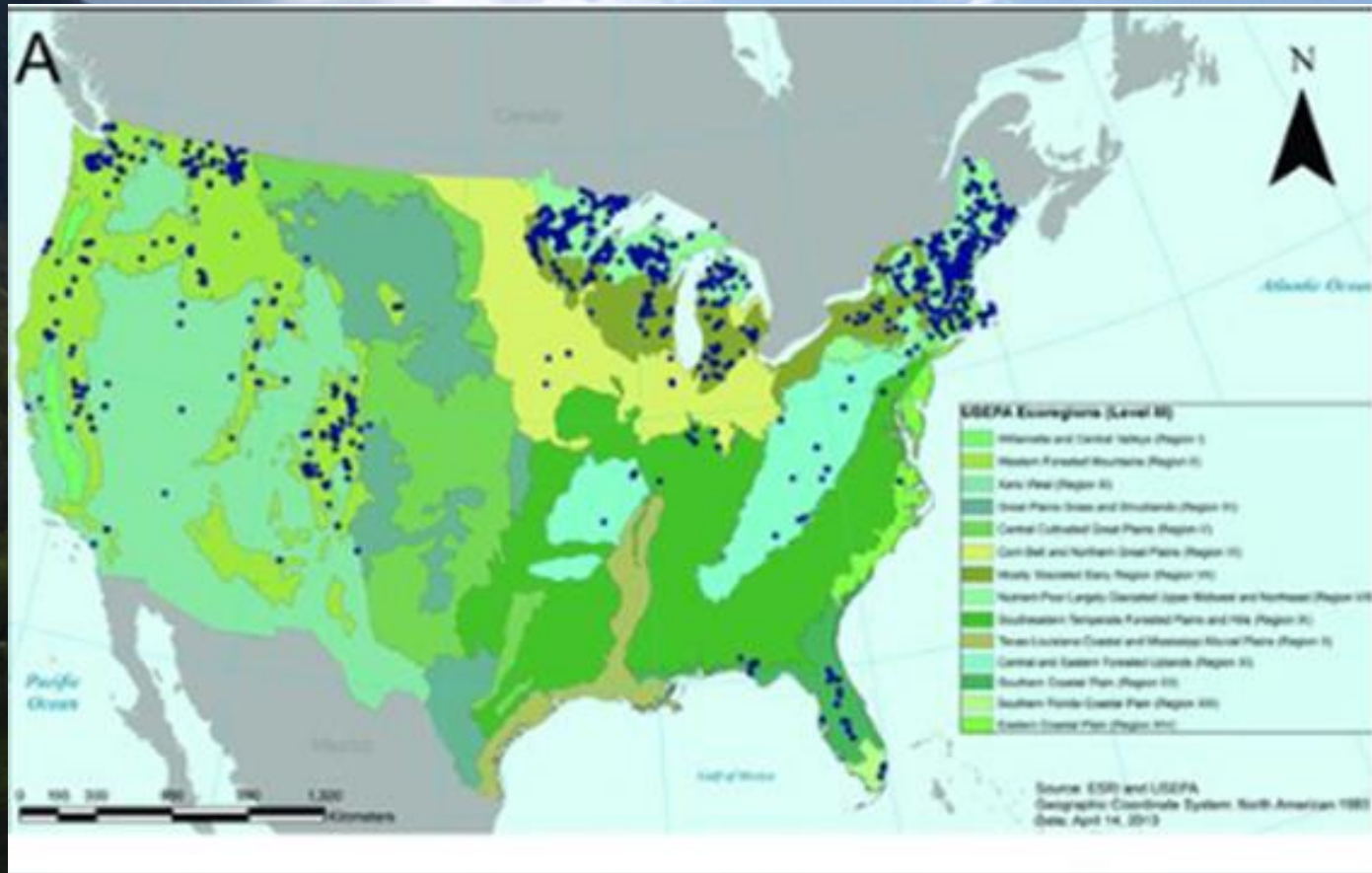


# Vermont is Stewarding Some of the Clearest Lakes in the Nation





# Vermont is Stewarding Some of the Clearest Lakes in the Nation



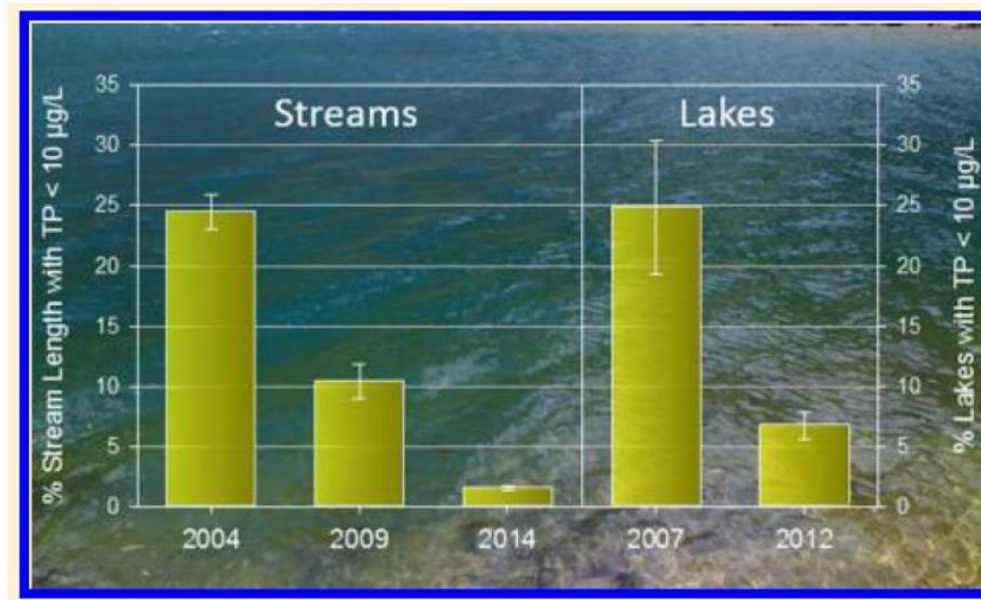
Stephens, et al., 2015



# Evidence Vermont may be Losing its Oligotrophic Lakes

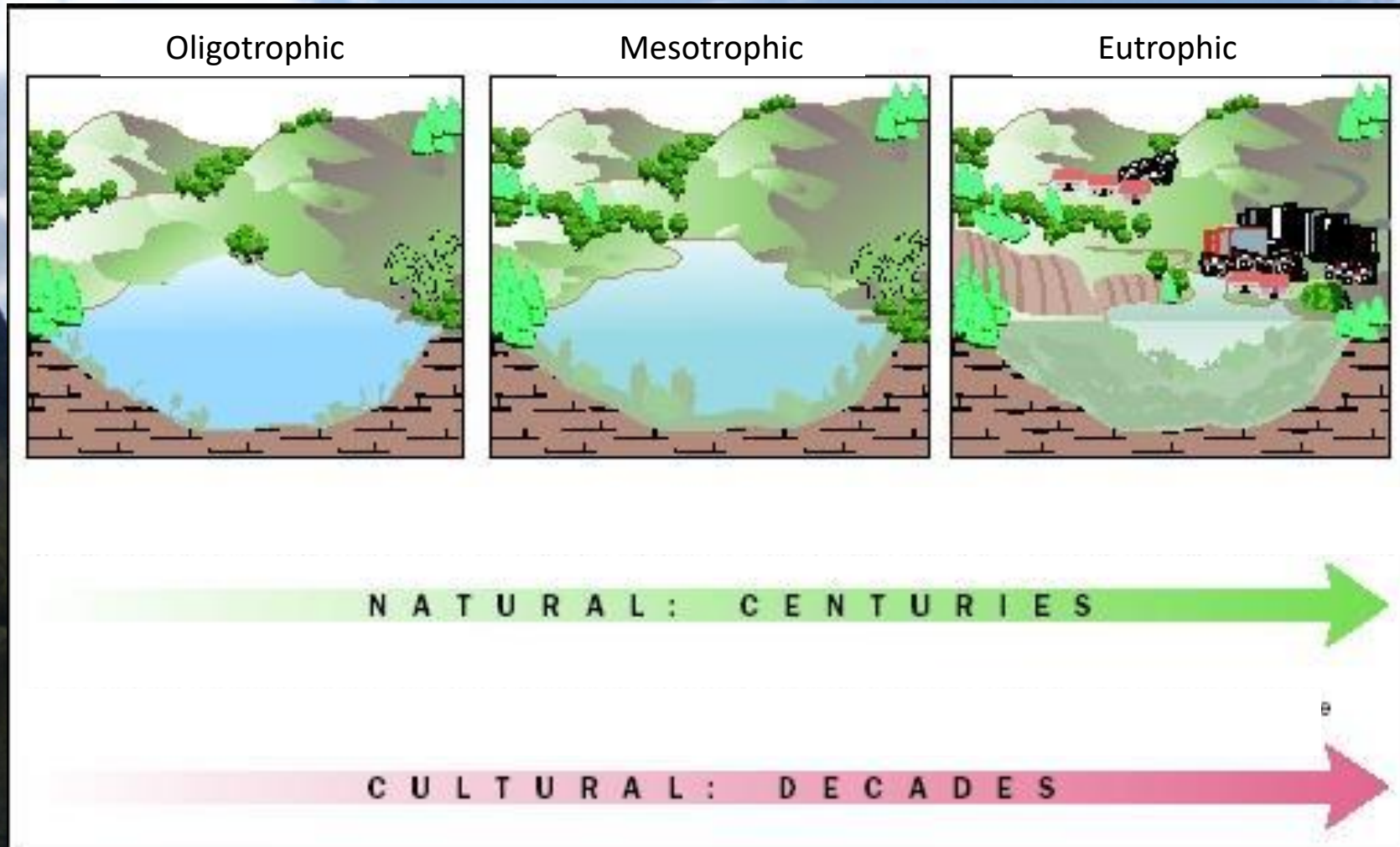
## Continental-Scale Increase in Lake and Stream Phosphorus: Are Oligotrophic Systems Disappearing in the United States?

John L. Stoddard,<sup>\*,†</sup> John Van Sickle,<sup>†,‡</sup> Alan T. Herlihy,<sup>§</sup> Janice Brahney,<sup>||</sup> Steven Paulsen,<sup>†</sup> David V. Peck,<sup>†</sup> Richard Mitchell,<sup>⊥</sup> and Amina I. Pollard<sup>⊥</sup>



Stoddard, et al., 2016

# Eutrophication in Lakes is Driven by Phosphorus





# Evidence Vermont may be Losing its Oligotrophic Lakes





# Evidence Vermont may be Losing its Oligotrophic Lakes

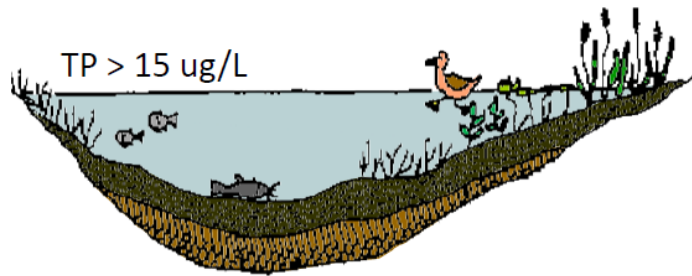
153 Lakes  $\geq$  20 acres

- \* Sampled at least 3 times (median=11)
- \* Sampled at least once in 1980s and once since 2000
- \* Trophic > Average Spring TP in the 1980s
  - 23 Oligotrophic < 7  $\mu\text{g/L}$
  - 89 Mesotrophic 7-15  $\mu\text{g/L}$
  - 41 Eutrophic > 15  $\mu\text{g/L}$



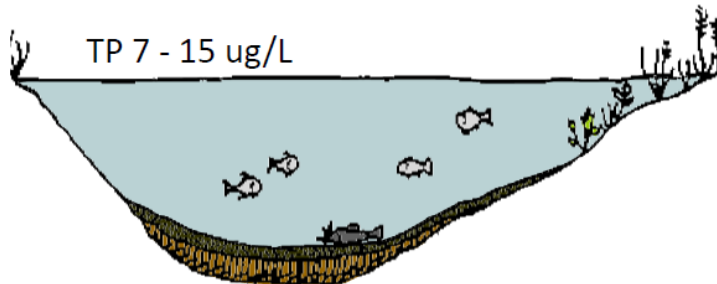
# Evidence Vermont may be Losing its Oligotrophic Lakes

## Lake Trophic Status – Average TP concentration in the 1980s



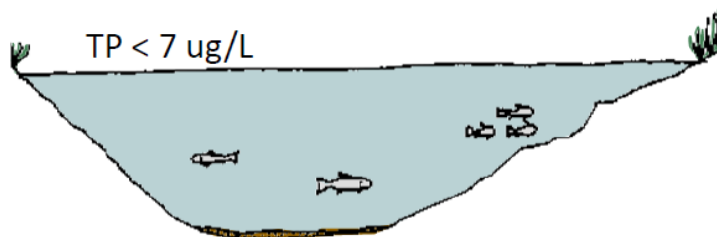
### Eutrophic n = 41

- high nutrient enrichment
- abundant algae and plant growth
- only supports warmwater fish species



### Mesotrophic n = 89

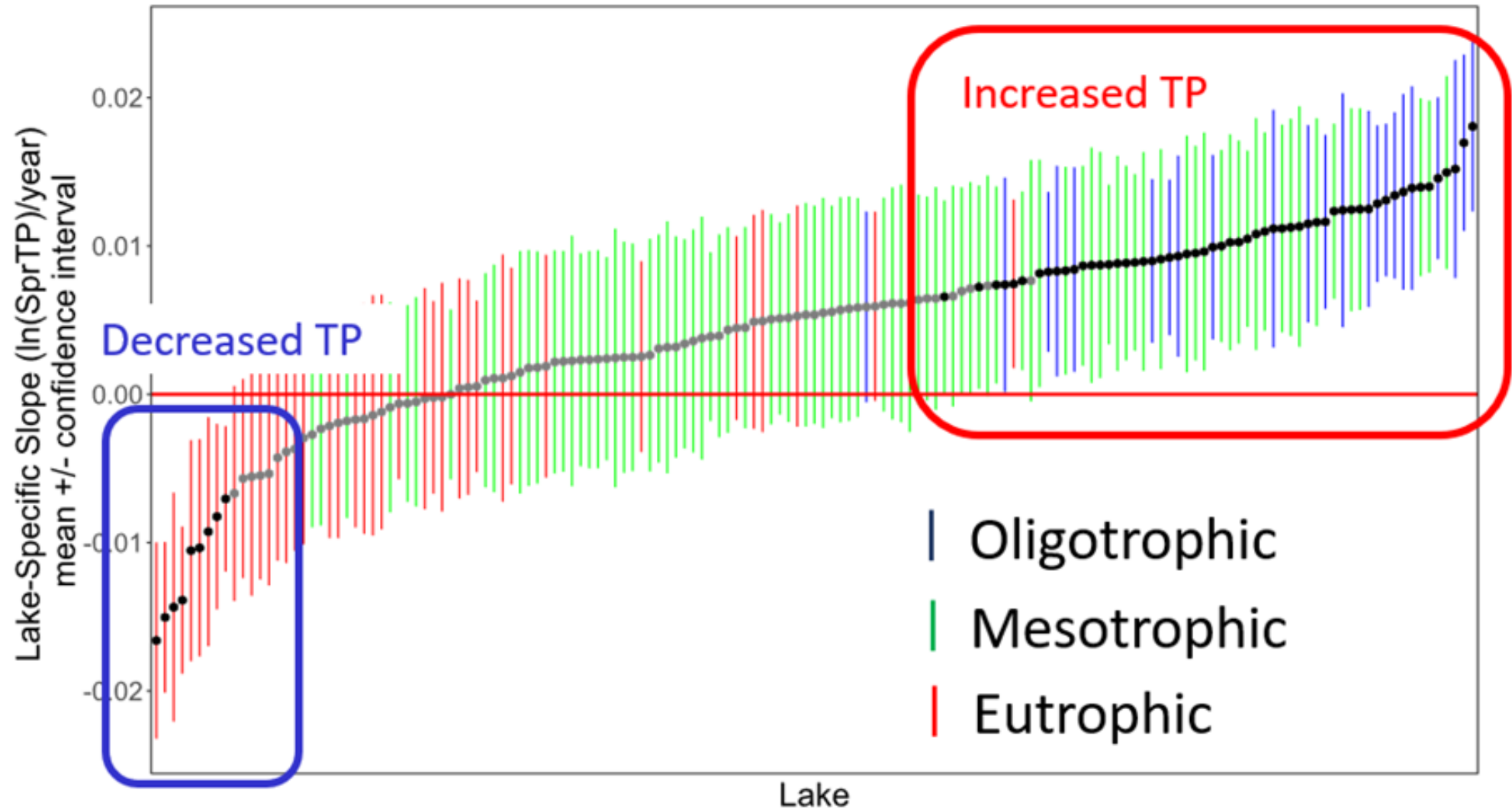
- moderate nutrient enrichment
- moderate algae and plant growth
- usually supports warmwater fish species



### Oligotrophic n = 23

- low nutrient enrichment
- deep, clear water
- well oxygenated to the bottom
- supports coldwater fish species

# Evidence Vermont may be Losing its Oligotrophic Lakes: Trends Over the Last 4 Decades





# Evidence Vermont may be Losing its Oligotrophic Lakes

Percentage of lakes for which Total Phosphorus is estimated to have increased, decreased or stayed the same over 38 years.

Trophic Status ~ 1980s	Increased %	Decreased %	No Change %
Eutrophic n=41	2	22	76
Mesotrophic n=89	38	0	62
Oligotrophic n=23	96	0	4

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

## WATERSHED MANAGEMENT DIVISION

### STRATEGIC PLAN 2016-2018

*Guiding the Division's collective work to meet our goal to  
PROTECT, MAINTAIN, ENHANCE, and RESTORE  
Vermont's surface waters*



VERMONT DEPARTMENT OF  
ENVIRONMENTAL CONSERVATION  
**WATERSHED**  
MANAGEMENT DIVISION

Top goal is to “Protect Vermont’s pristine or special waters by safeguarding these natural systems from deleterious change over the long term.”



# Evidence Vermont may be Losing its Oligotrophic Lakes

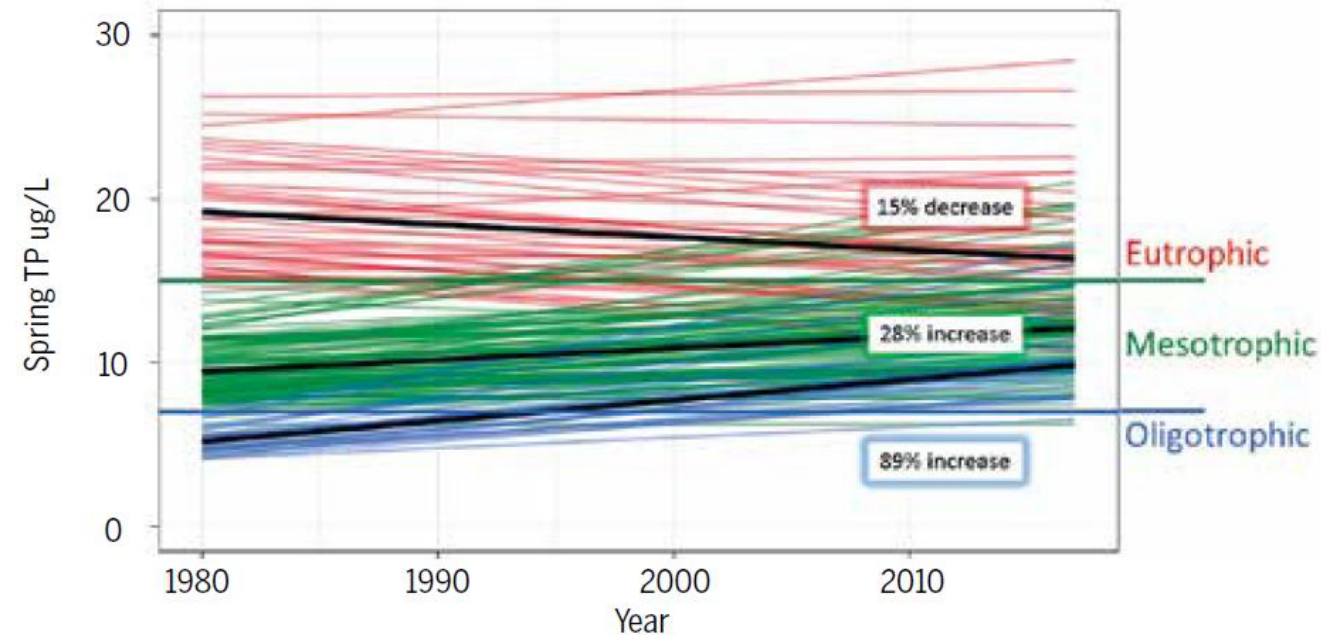


Figure 2. Linear mixed effects model showing the predicted changes in spring TP for individual lakes (solid colored lines, red = eutrophic, green = mesotrophic, blue = oligotrophic), and the overall predicted change in spring TP for each trophic category (solid black lines). Horizontal colored lines represent cut-offs between eutrophic and mesotrophic category (green), and between mesotrophic and oligotrophic category (blue).

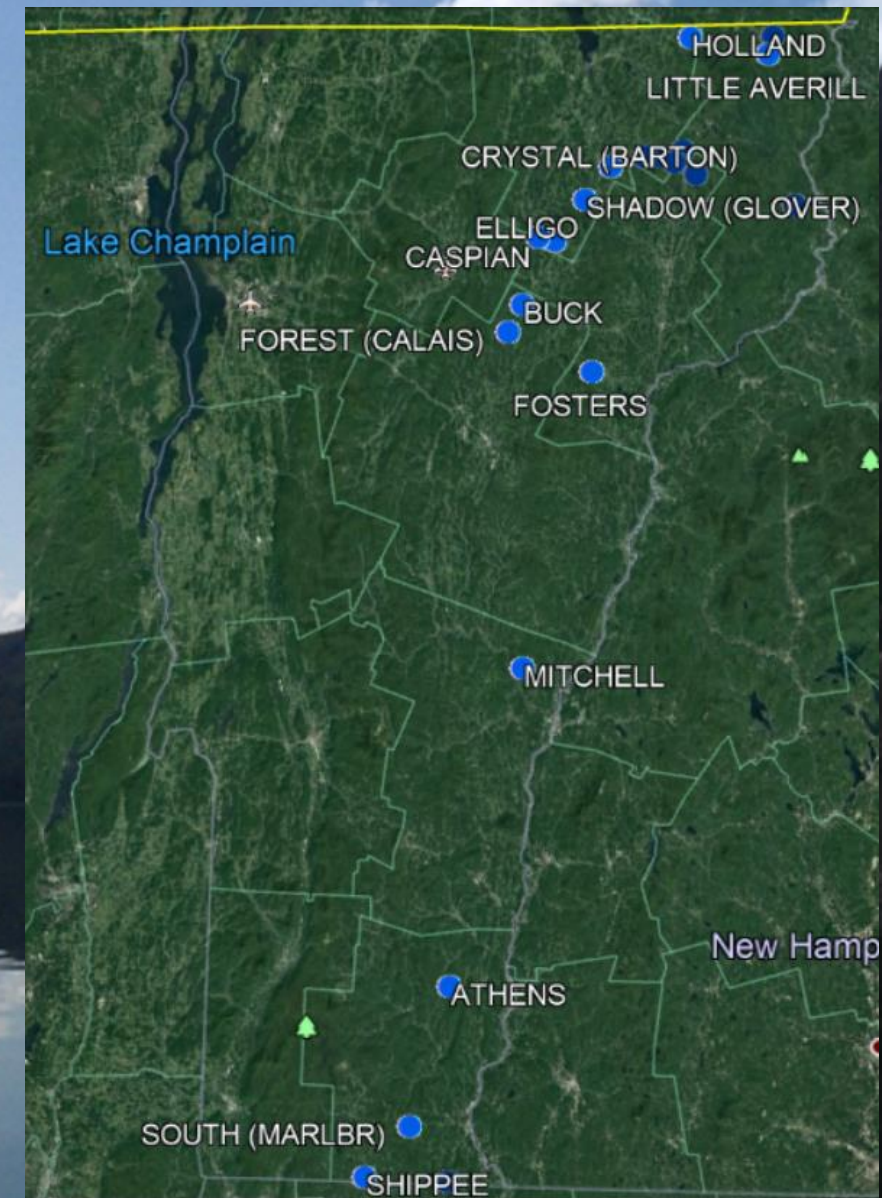
Matthews, et al., 2018



# 21 Oligotrophic Lakes with Increasing Phosphorus

Lake
Athens
Bald Hill
Buck
Caspian
Center
Crystal (Barton)
Elligo
Forest (Calais)
Fosters
Great Averill
Holland

Lake
Jobs
Little Averill
Long (Westmore)
Maidstone
Mitchell
Shadow (Glover)
Shippee
South (Marlboro)
Weatherhead Hollow
Willoughby





# 13 Lakes Targeting to Pilot a Strategy to Turn Phosphorus Trends Around on Oligotrophic Lakes

Lake	Basin	yrs	Statistical Significance P value	Spring TP 1980	Spring TP 2018	Increase
<b>FOREST (CALAIS)</b>	<b>Winooski</b>	<b>15</b>	<b>0.00101</b>	<b>4.366666667</b>	<b>10.7</b>	<b>6.3</b>
<b>FOSTERS</b>	<b>Stevens-Wells-Waits- Ompompanoosuc-CT Direct</b>	<b>10</b>	<b>0.03114</b>	<b>4.011764706</b>	<b>11.83529412</b>	<b>7.8</b>
<b>LONG (WESTMR)</b>	<b>Memphremagog</b>	<b>17</b>	<b>0.00146</b>	<b>4.948444444</b>	<b>12.18533333</b>	<b>7.2</b>
<b>WILLOUGHBY</b>	<b>Memphremagog</b>	<b>22</b>	<b>0.00153</b>	<b>4.963888889</b>	<b>6.336111111</b>	<b>1.4</b>
<b>SHADOW (GLOVER)</b>	<b>Memphremagog</b>	<b>19</b>	<b>0.00244</b>	<b>6.1</b>	<b>11.42</b>	<b>5.3</b>
<b>BALD HILL</b>	<b>Passumpsic</b>	<b>19</b>	<b>0.00097</b>	<b>5.453846154</b>	<b>11.3</b>	<b>5.8</b>
<b>HOLLAND</b>	<b>Memphremagog</b>	<b>20</b>	<b>0.00007</b>	<b>5.945483193</b>	<b>10.48792017</b>	<b>4.5</b>
<b>CASPIAN</b>	<b>Lamoille</b>	<b>18</b>	<b>0.01820</b>	<b>5.647058824</b>	<b>9</b>	<b>3.4</b>
<b>CRYSTAL (BARTON)</b>	<b>Memphremagog</b>	<b>12</b>	<b>0.00383</b>	<b>4.588383838</b>	<b>8.772222222</b>	<b>4.2</b>
<b>BUCK</b>	<b>Winooski</b>	<b>10</b>	<b>0.02543</b>	<b>6.95</b>	<b>9.713636364</b>	<b>2.8</b>
<b>MAIDSTONE</b>	<b>Upper Connecticut</b>	<b>19</b>	<b>0.00572</b>	<b>5.636</b>	<b>7.308</b>	<b>1.7</b>
<b>LITTLE AVERILL</b>	<b>Memphremagog</b>	<b>16</b>	<b>0.00459</b>	<b>4.639880952</b>	<b>7.12797619</b>	<b>2.5</b>
<b>GREAT AVERILL</b>	<b>Memphremagog</b>	<b>17</b>	<b>0.03282</b>	<b>5.663768116</b>	<b>7.793236715</b>	<b>2.1</b>

# 4 Lakes Targeting to Pilot a Strategy to Turn Phosphorus Trends Around on Oligotrophic Lakes

LakeID	Basin	yrs	P value	calcSprTP1980	calcSprTP2018	calcDiff
<b>FOREST (CALAIS)</b>	<b>Winooski</b>	<b>15</b>	<b>0.00101</b>	<b>4.366666667</b>	<b>10.7</b>	<b>6.3</b>
<b>WILLOUGHBY</b>	<b>Memphremagog</b>	<b>22</b>	<b>0.00153</b>	<b>4.963888889</b>	<b>6.336111111</b>	<b>1.4</b>
<b>CASPIAN</b>	<b>Lamoille</b>	<b>18</b>	<b>0.01820</b>	<b>5.647058824</b>	<b>9</b>	<b>3.4</b>
<b>MAIDSTONE</b>	<b>Upper Connecticut</b>	<b>19</b>	<b>0.00572</b>	<b>5.636</b>	<b>7.308</b>	<b>1.7</b>

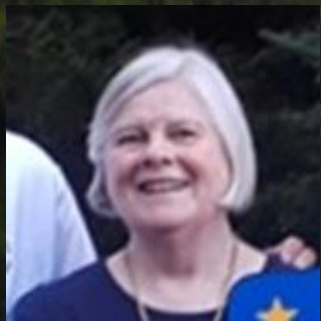


# Evidence We Can Turn These Trends Around

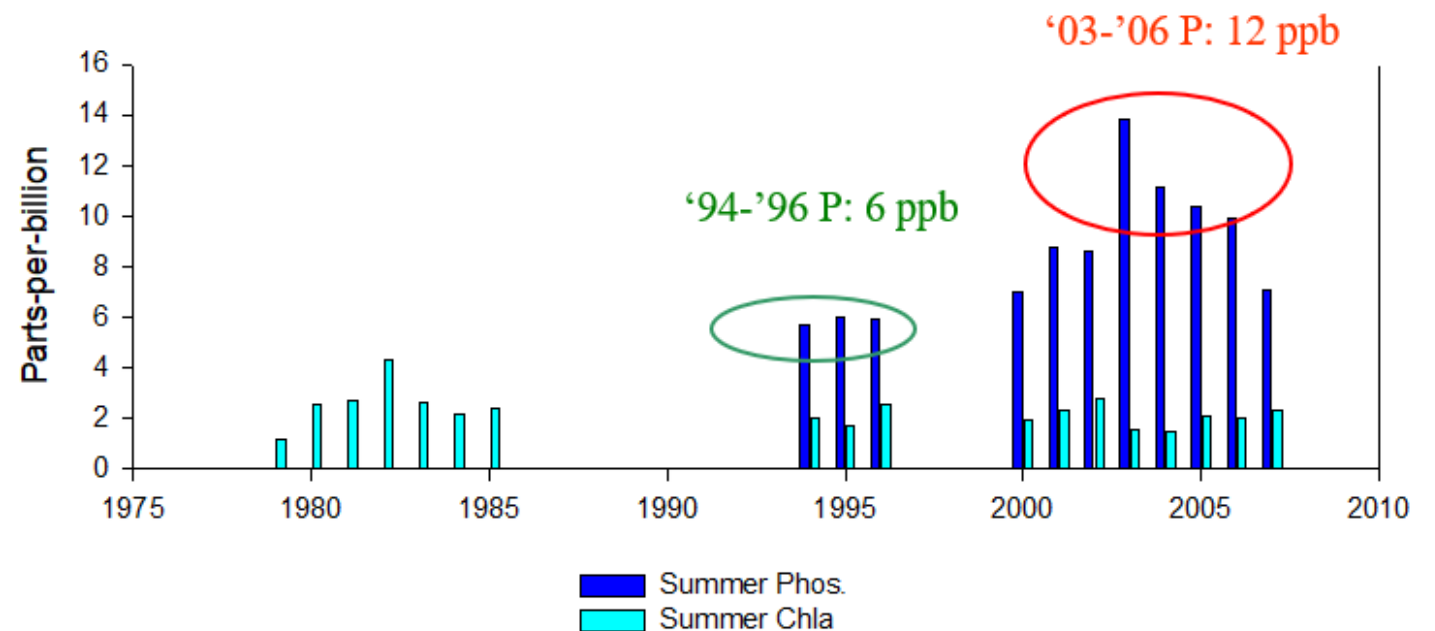
## Seymour Lake - Case Study



Amy Picotte



Water quality trends in Seymour Lake  
1980-2007  
VT Lay Lakes Monitoring Program and the VTDEC Spring Phosphorus Monitoring Program



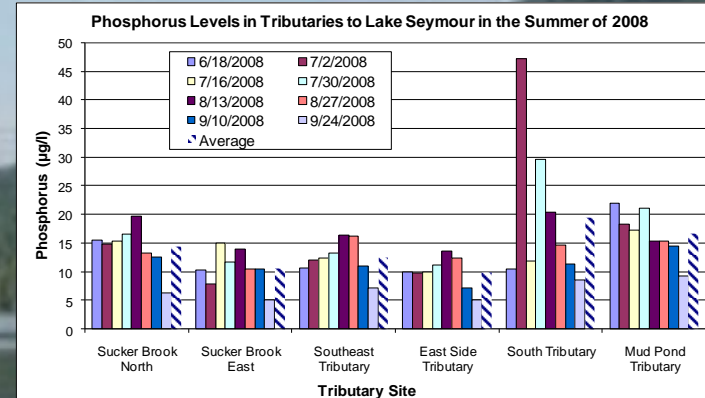
## The Lake Seymour efforts are an amazing partnership between the Lake community and technical partners:

- Local Lake Leader(s) – Someone usually several folks – who may change over time – with the energy to keep things moving and an understanding of what needs to be done.
- A Lake Association willing to support efforts with an active membership
- Support of the Town (Morgan) and Road Commissioner
- DEC staff support – Amy Picotte, Susan Warren, Neil Kamman + 8 others.
- Technical support from: Orleans County Natural Resources Conservation District, NorthWoods Stewardship Center, FOVLAP, MWA....



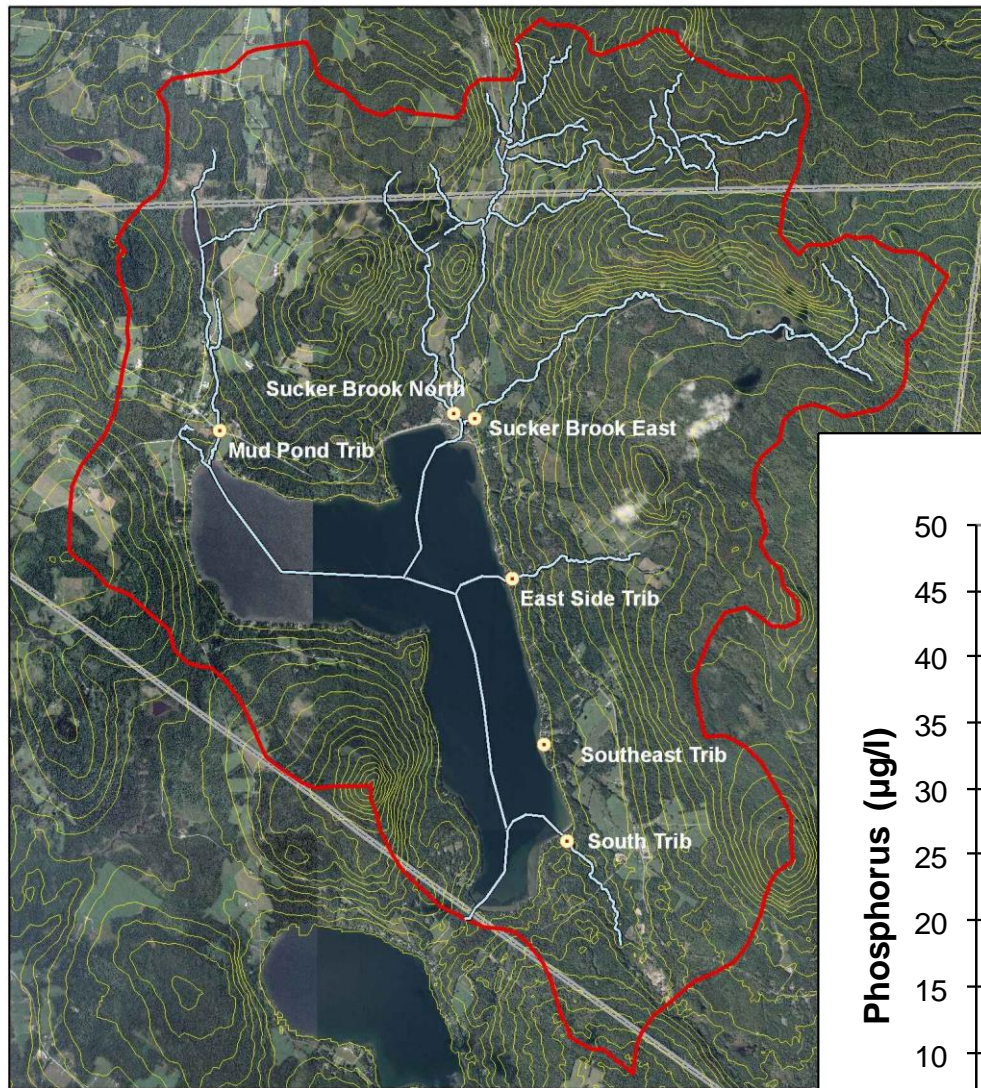
# Through these partnerships the Seymour Lake Association focused on the following areas:

- Tributary water quality sampling to ID phosphorus source areas
- Lake wise Assessments and implementation
- Road assessments and projects
- Large scale implementation projects and grants
- Community outreach - shorelands – septic – forestry
- Farm assessments and implementation with OCNRCD





Lake Seymour 2008 sample sites

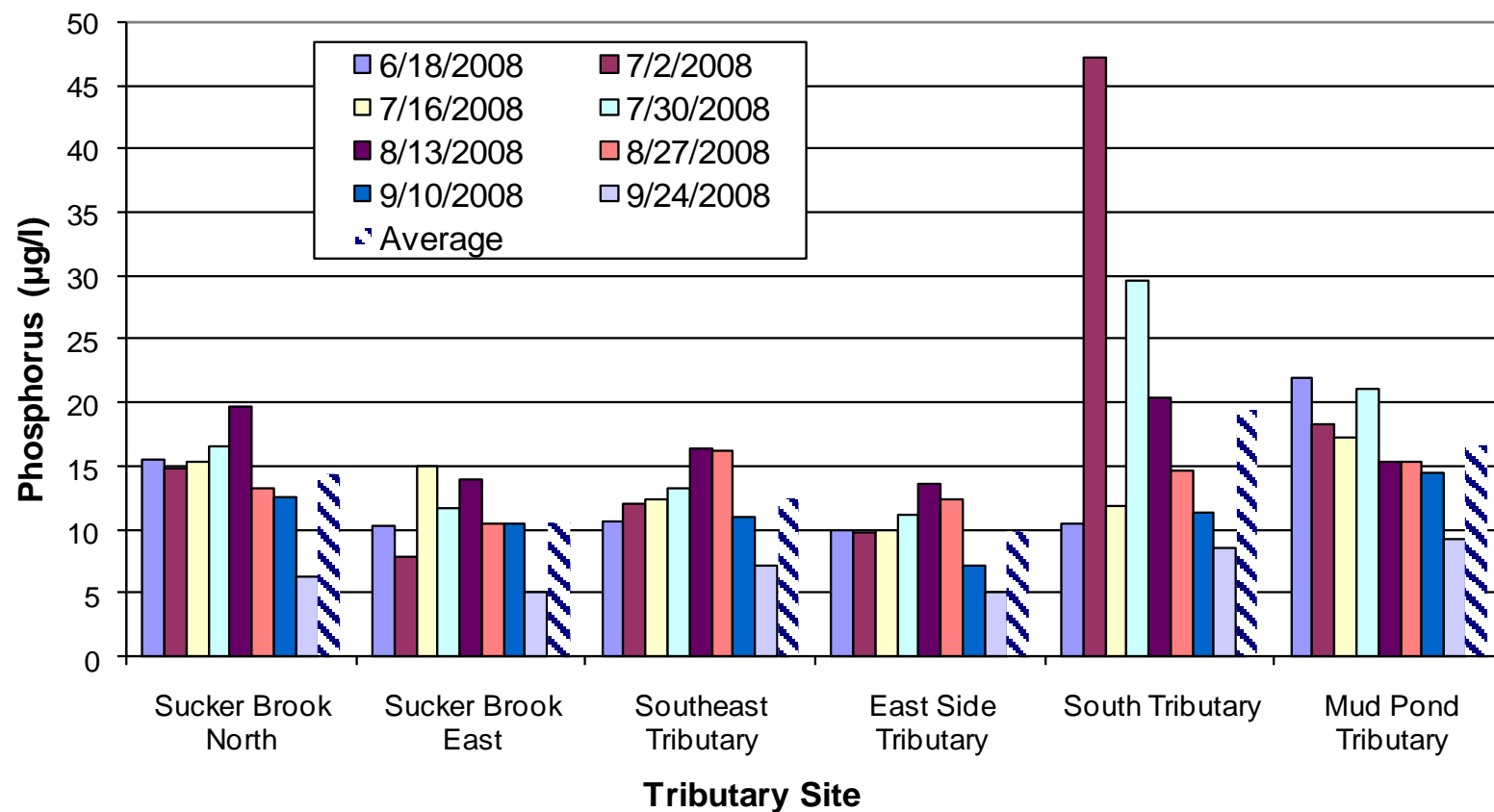


- Legend**
- 2008 sample sites
  - Seymour streams
  - Lake Seymour watershed
  - Contours (50 Ft)
  - VT Town Boundaries (No Fill)

0 0.375 0.75 1.5 2.25 3

# Tributary WQ monitoring 2007 2008

Phosphorus Levels in Tributaries to Lake Seymour in the Summer of 2008

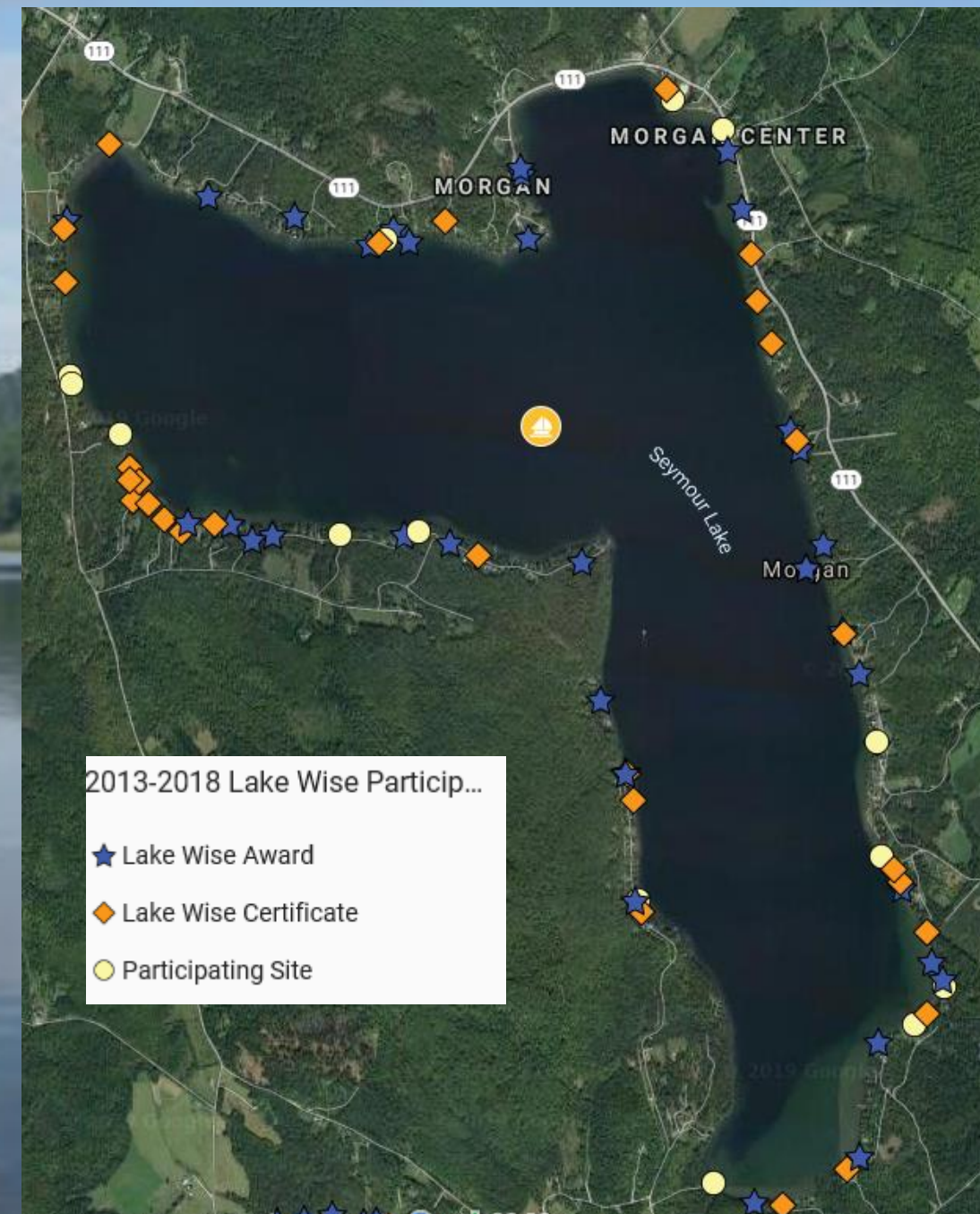




# Lake Wise Assessments

It takes local energy paired with partnerships with technical partners some funding tossed in to identify and address the broad array of issues :

- 44 Awards, 29 certificates, 16 with no award or certificate YET...
- This is more than 25% of the total awards in the state of Vermont!
- More than 22 BMP projects have been installed over the years

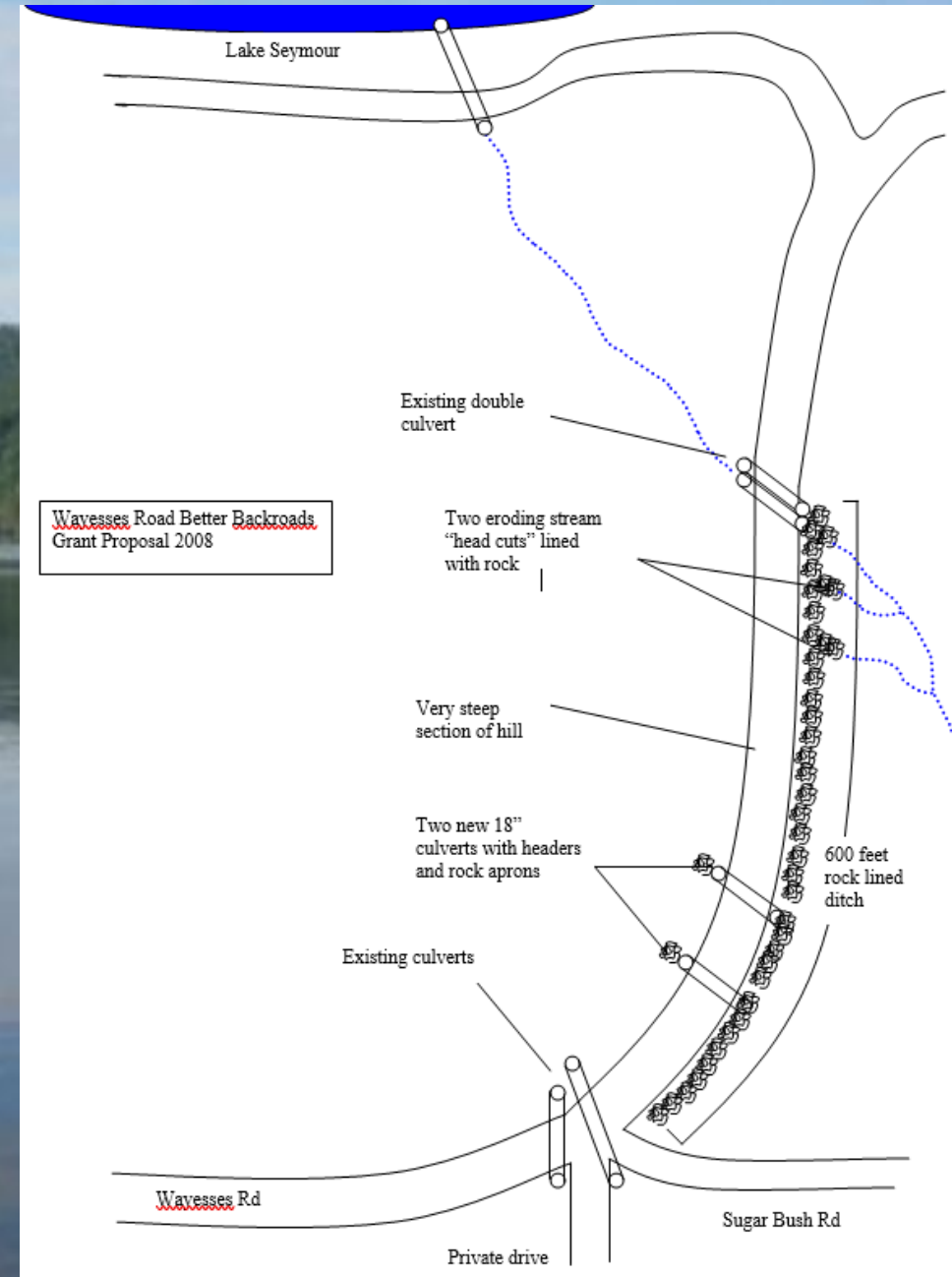


# Lake Wise Assessments





# Road projects – Large scale projects





# Community Outreach

- The Seymour Lake Association has held workshops each year for lake association members and local community. Many of these have been in partnership with other Lake Associations and organizations.
- Topics have included:
  - Forestry to protect water
  - Lake Wise practices
  - Septic Socials
  - Shoreland walks
- This is part of the effort to change the culture of shoreland management around the lake





# Working with farms...

- The Orleans County NRCD has been working with a farm in the watershed doing targeted water quality monitoring to help identify, implement and evaluate BMP's.
- Initial results in the watershed have been positive.
- This sector is one where technical assistance is often necessary.



# Evidence We Can Turn These Trends Around

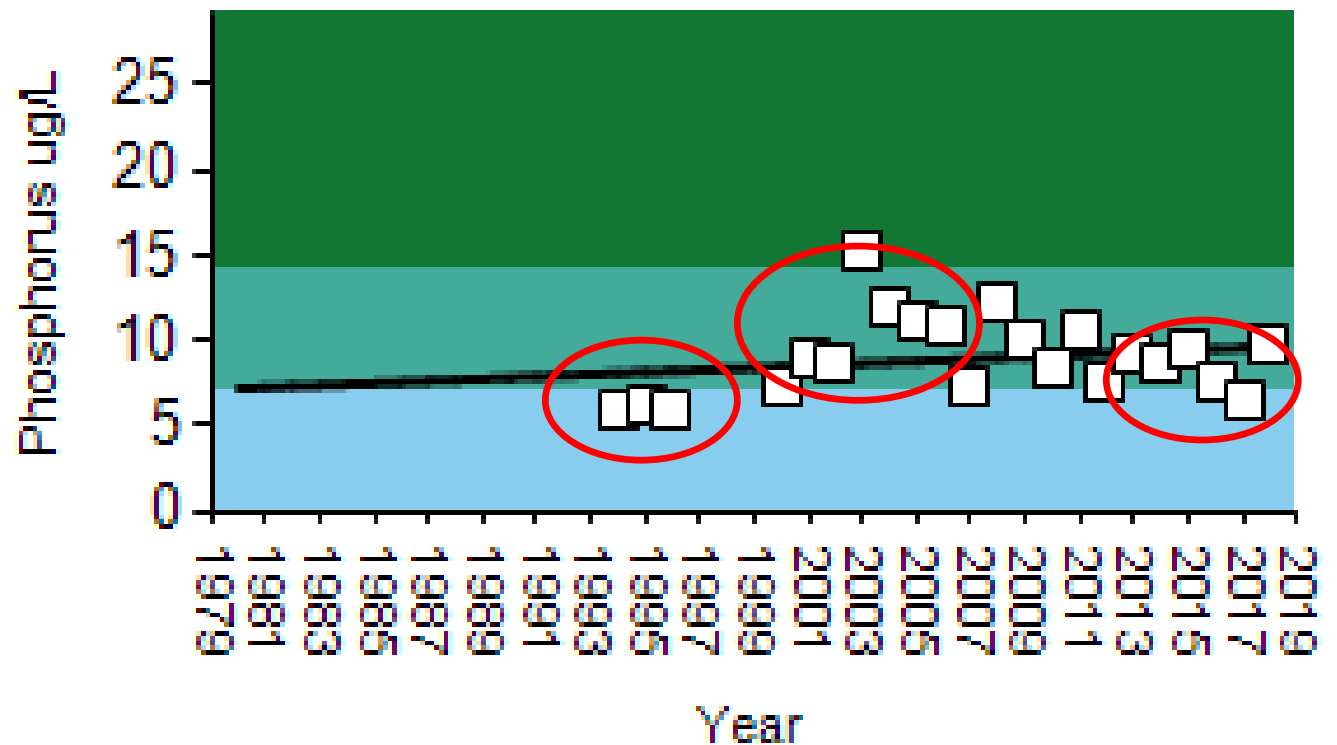
There is no longer a statistically significant increasing phosphorus trend

Phosphorus concentrations are consistently lower than levels in 2003-2006 (although they appear to be slightly above what they were in 1994-1996.)

Work continues – with efforts at a local farm – and buffer plantings at VFW access – maintaining some of the projects already in place

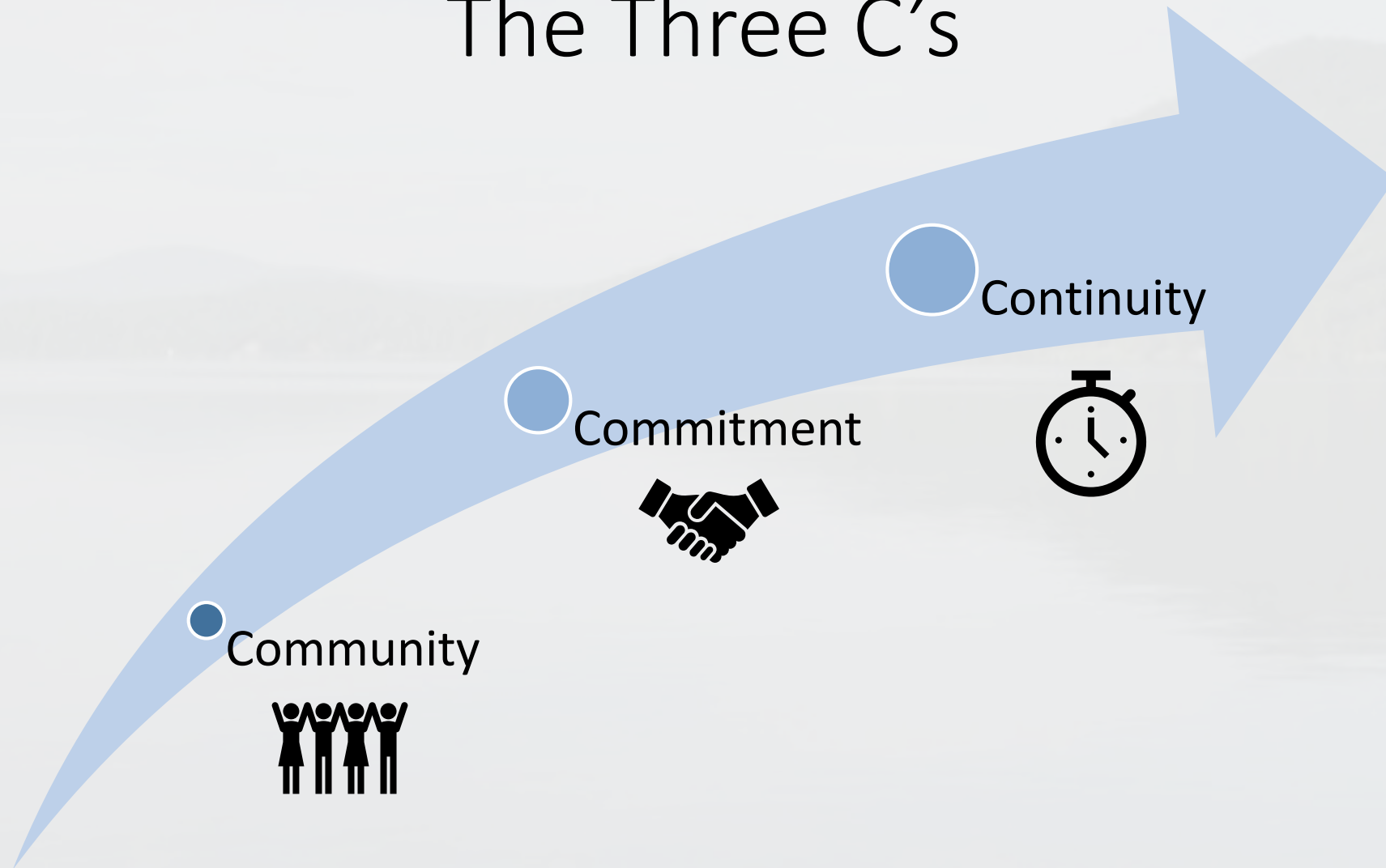
Summer TP Trend:  $p = 0.3183$  | CV = 22  
Stable

## Summer TP Annual Means





# The Three C's

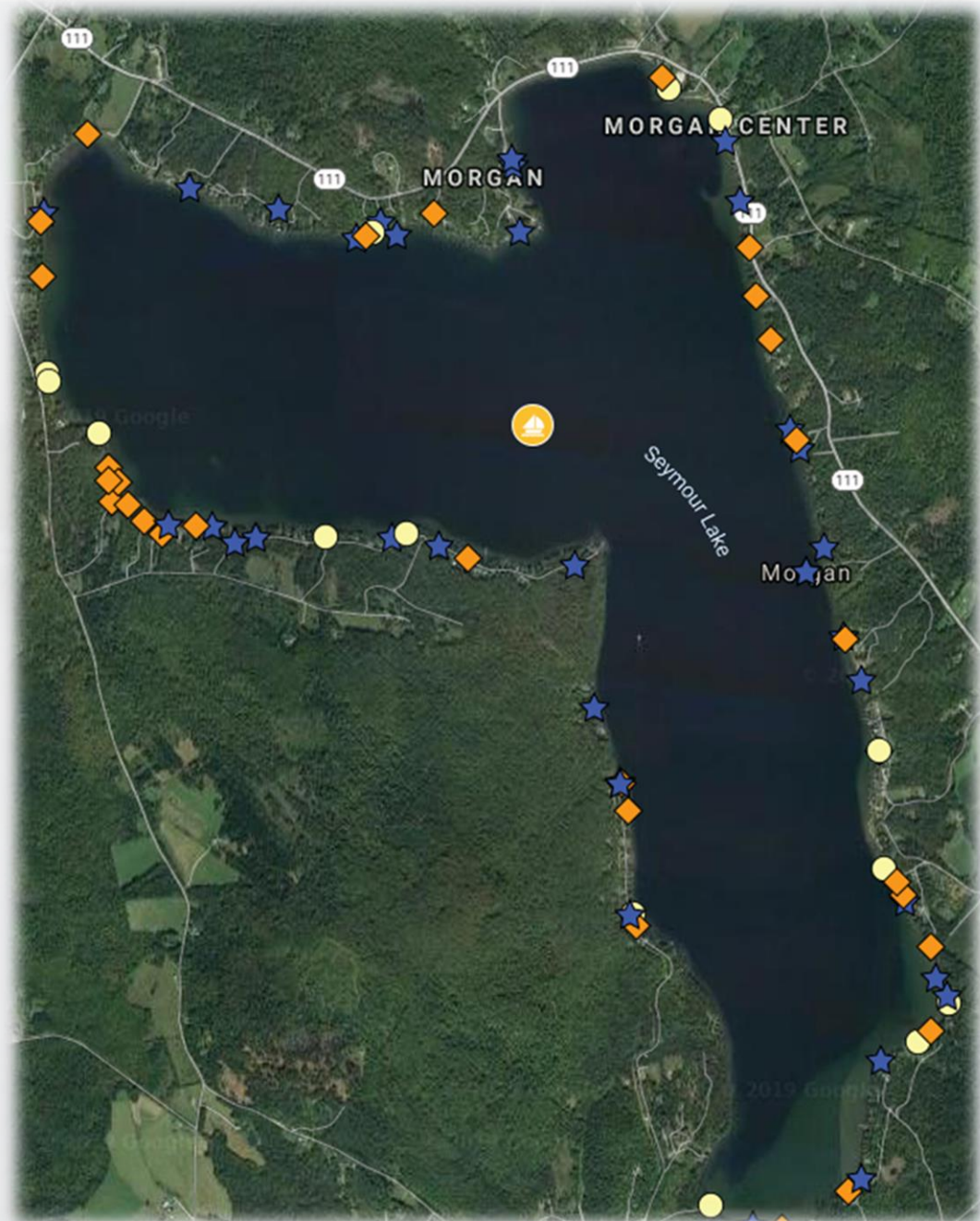


# Community



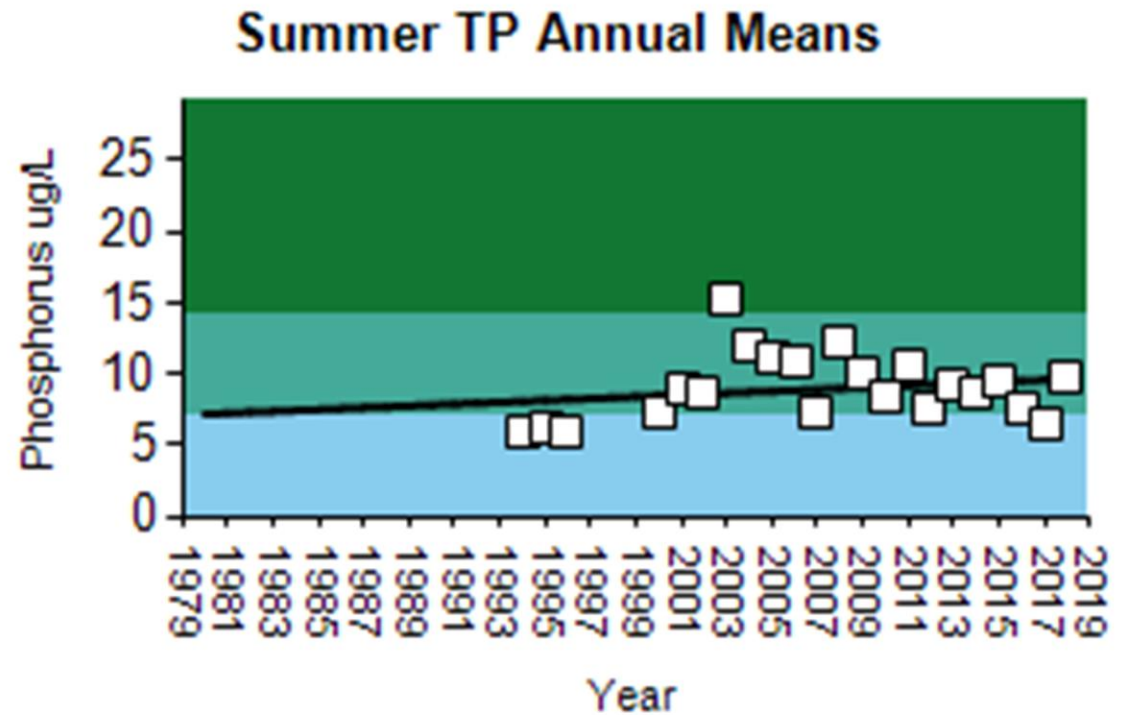


# Commitment



Continuity 

Summer TP Trend:  $p = 0.3183$  | CV = 22  
Stable



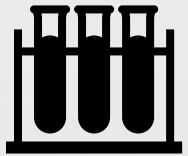


# Actions for a Healthy Lake



This Photo by Unknown Author is licensed under CC BY-SA

# Establish a Lay Monitor





# Establish a Cyanobacteria Monitor



**Generally Safe**

Recreation ok



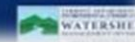
**Low Alert**

Recreation with caution  
Stay away from blooms

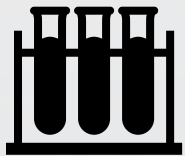


**High Alert**

No recreation



Rachel Penders Uploaded By Lake Champlain Committee



# Establish a Tributary Monitoring Program

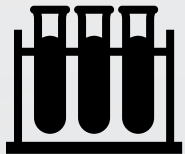
**Lake Tributary Monitoring Form**

Project Name		Caspian Lake Tributary Monitoring		Collected By	
Lake Name	Caspian Lake	Date *	06/03/2019	Time	(00:00)
Weather Conditions (circle all that apply)					Antecedent
Cloudy	Sunny	Partly Sunny	Hot	Warm	Cool
Rain	Showers	Drizzle	Dry	Windy	Breezy
Air Temp (F)					52°
					24 hrs (in)
					Water Height (inches)
					Flow Category (circle one)

Change to Customer Sample ID

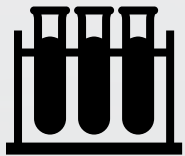
Sample ID	Inlet ID	Time *	Parameters Measured (circle all that apply)	Other	Photo? (Y/N)	Latitude (xx.xxxx)
1900422-001	Outlet	10:25	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5769
1900422-007	Trib ID	10:52	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5891
1900422-006	Trib 6	11:17	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5917
1900422-005	Highland Lodge Trail-Porter BK	11:45	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.59753
1900422-004	TATE BK	12:05	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5964 -72.3174
1900422-003	Cemetery	12:16	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5885811 -72.3289696
1900422-002	Trib 1	12:26	TP, DP, TN, NOx, Cl, SO <sub>4</sub> , Other	NA	Y	44.5882524 -72.3280189

Flip over for more sample rows

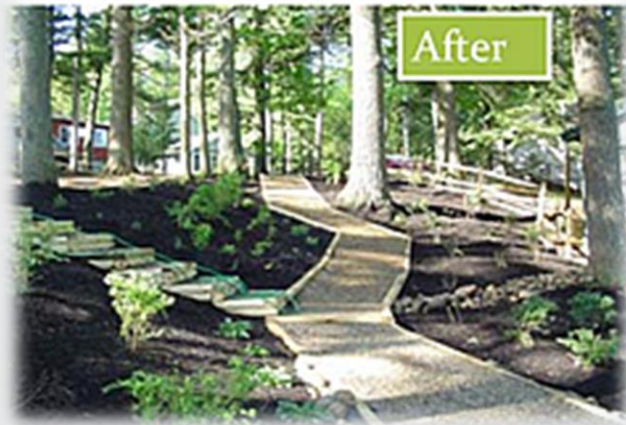




# Contact VDEC for Other Sampling Opportunities



# Initiate Lake Wise Assessments





# Initiate Private Road Assessments





# Hold a Septic Social





# Develop a Lake Watershed Action Plan

	<b>Milestone</b>	<b>Deliverable(s)</b>	<b>Due Date</b>
1	Project initiated; RFP issued and contractor selected (if applicable)	Copy of RFP and signed contract; statement of reasoning for contractor selection (if applicable)	September 1, 2018
2	Data acquisition and review completed	Locator map(s); documentation of data gaps; data library	November 1, 2018
3	Existing condition water quality improvement needs and objectives identified	Documentation of problem areas with locator maps and site photo(s)	June 1, 2019
4	Prioritization criteria developed; project prioritization completed	List of criteria used for prioritization; prioritized project list	July 1, 2019
5	Meeting(s) with stakeholders held	Summary of meeting(s)	August 1, 2019
6	Restoration plans developed for a subset of prioritized projects	Restoration plans of prioritized projects including preliminary (30%) engineering designs and cost estimates	October 1, 2019
7	Lake Watershed Action Plan Completed	Storm Water Master Plan (includes synthesis from prior completed project	November 15, 2019



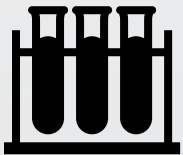
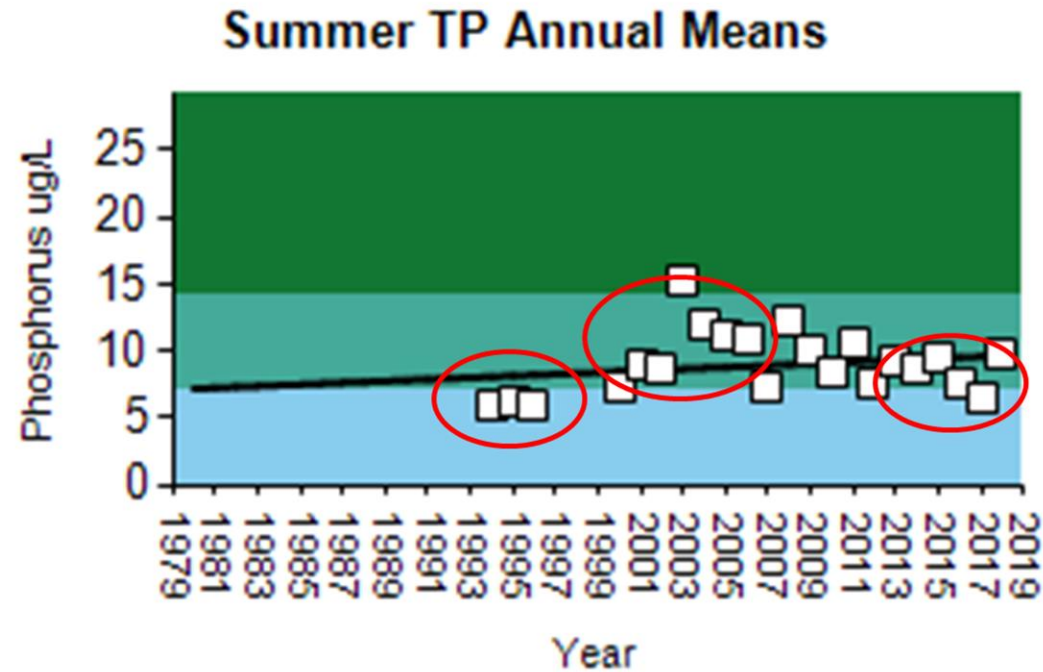
# Implement practices





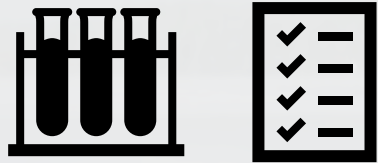
# Continue Monitoring to Track Response

Summer TP Trend:  $p = 0.3183$  | CV = 22  
Stable



# Lakes In Danielle's Basins

Lake Eden



Lake Elmore



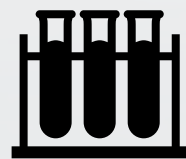
Ticklenaked Pond



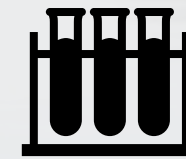
Lake Morey



Lake Caspian



Lake Fairlee





# The Three C's

