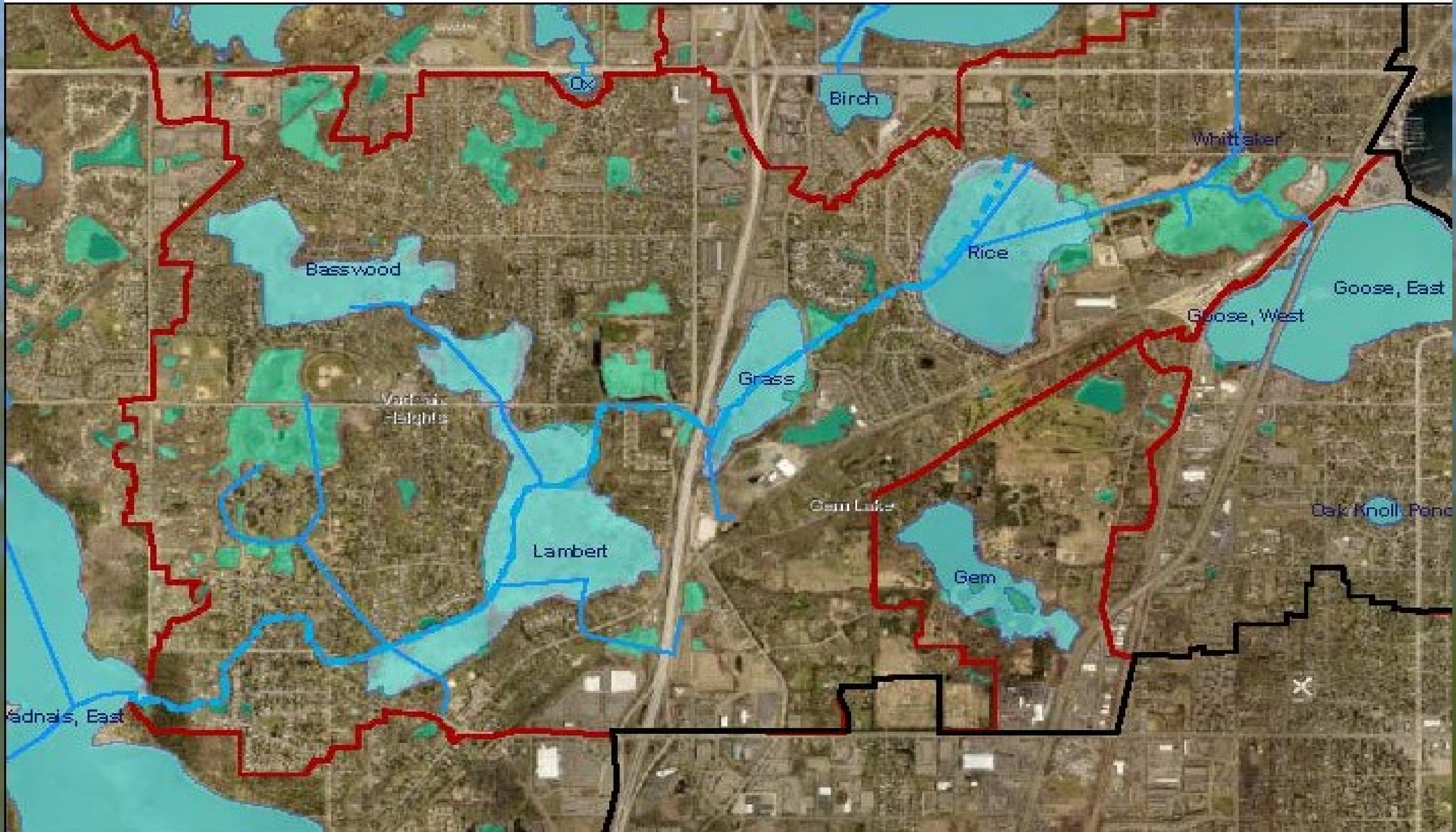
Goose Lake:
Challenges & Compromise

- Context
- What is an alum treatment?
- Goose Lake issues
- Costs and comparison
- Vision and compromise:

  What role will Goose Lake play in the future?

Connections to the water network

Goose Lake - Headwaters of Lambert Creek w/wt



What is an alum treatment?

- Aluminum sulfate
- Removes phosphates through precipitation, forms a "floc"
- Safe & effective lake management tool
- Settles to bottom, creates barrier that retards sediment phosphorus (P) release

-North American Lake Management Society

Alum treatment process

- Alum treatments have improved over the last 50 years
- Commonly used & effective in-lake technique to improve water quality in eutrophic lakes
- Better knowledge and understanding, especially dosing and factors that influence effectiveness
- The result: Clearer lakes for longer

- **Barr Engineering Recommendation:** If **fall treatment**, there would ideally be no water skiing the following year, to allow the alum floc to settle, become crystalline, and biofilm to form during the growing season
- Fall is possible due to the lack of vegetation; spring is normally the best time
- Two doses best separated by a year to maintain pH

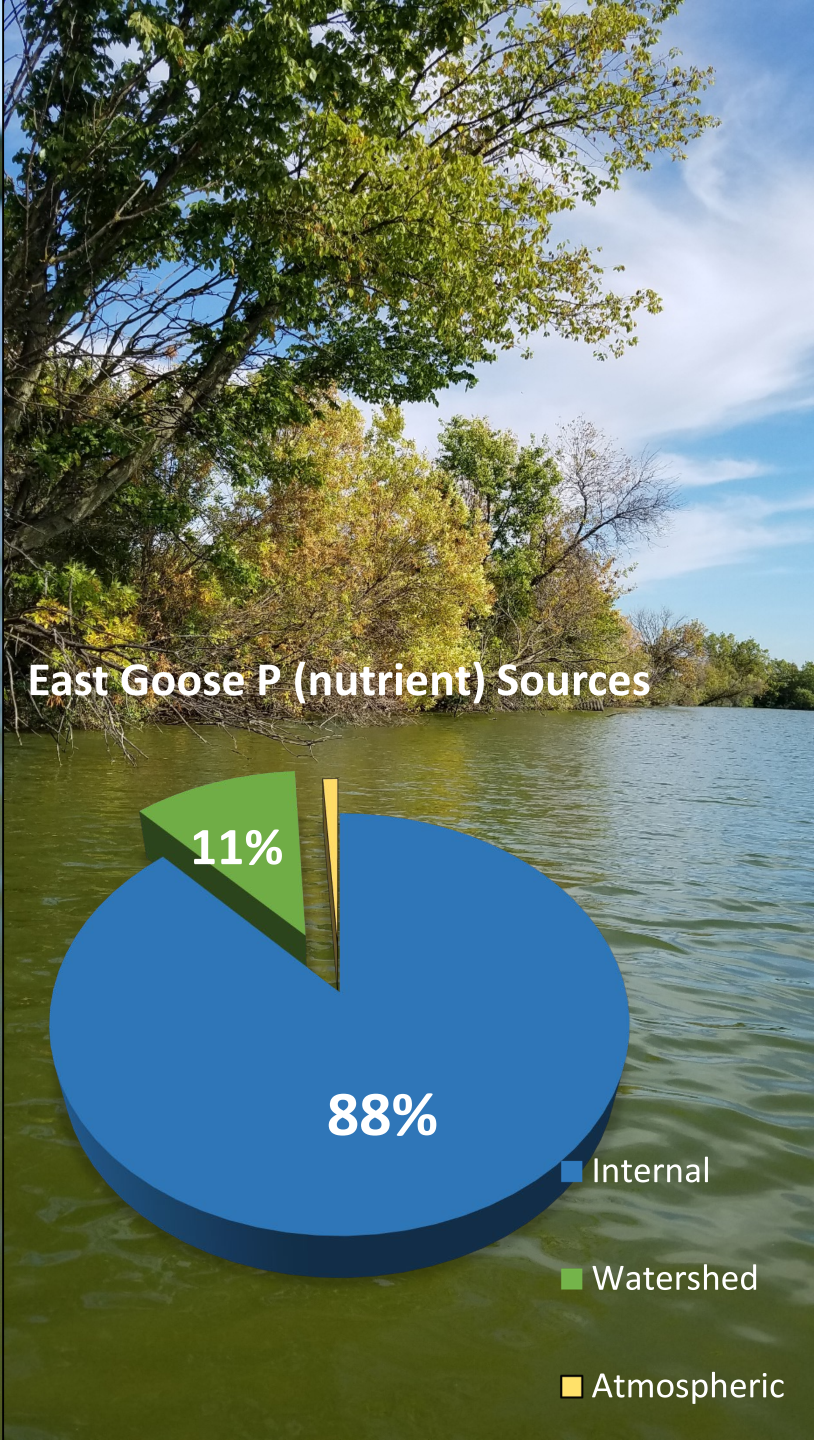
Costs

- $170,000
- Budget includes full treatment delivered in 2 separate years
- Literature cites that alum treatments are 50 times more effective on average than external-load BMPs in urban lakes
- The Barr study found an alum treatment 32 times more effective on East Goose than the next most cost-effective option

Why?

- Nutrient reduction from surrounding area cannot be fully effective if problem is internal load
- Goose Lake: 88% internal load and 11% external load
- Historical uses: Wetland alteration & receiving waterbody for WBL wastewater discharge from the 1930s-1960s

- TMDL requires 91% load reduction, primarily from internal sources with some watershed load reduction
- An important factor in meeting the TMDL for West Goose is the improvement of East Goose to meet the shallow lake standard (60 µg/L)
- TMDL goals are connected to MS4 WLAs



Bottom-feeding fish

- 2012 Fish Survey: 80 Black bullheads per net
- 2013-2014 Bullhead harvest of 16,000 lb
- 2017 Fish Survey: 22 Black bullhead per net
  few small fish

- 2019 Fish Survey: preliminary results show resurgence of 2-4” Black bullhead
- Harvest likely needed prior to treatment (waiting for final report)

Sediment and motor boats

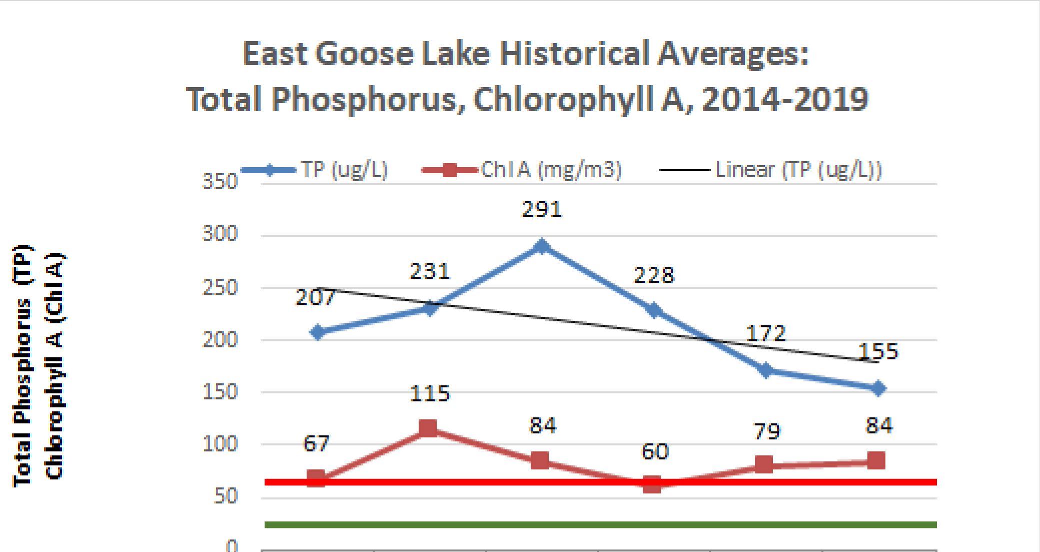
Horsepower	Mixing Depth (m) and (ft)	
10	1.8 m	5.9 ft
28	3.0 m	9.8 ft
50	4.6 m	15.1 ft

Nedohin & Elefsiniotis, 1997

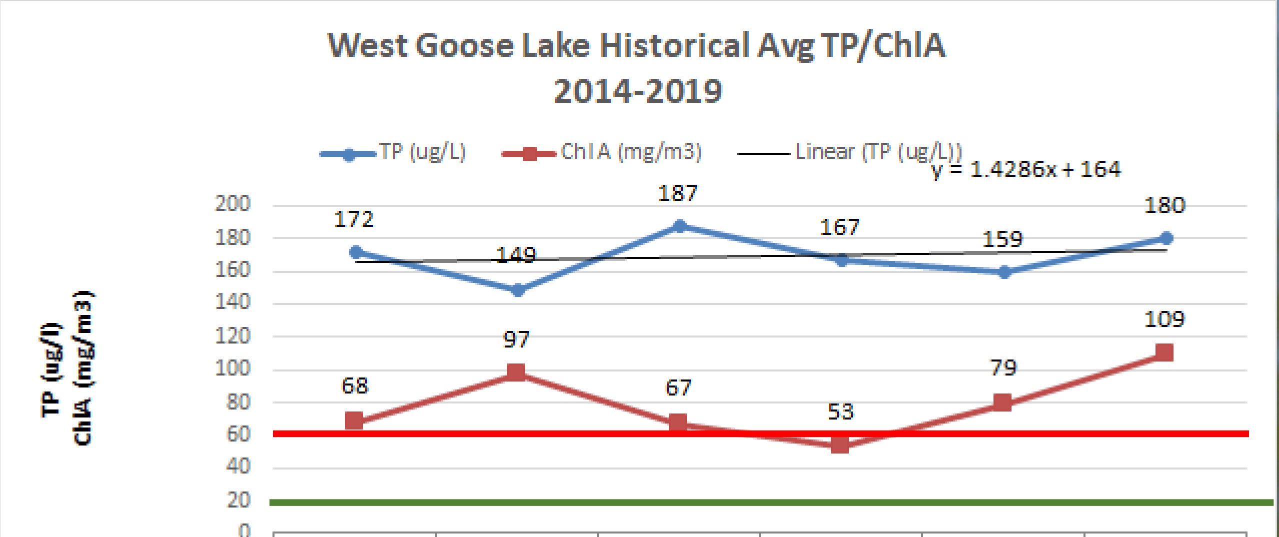
Why consider boating impacts?

- Shorelines eroded
- Damage to Plants: emergent, floating and submerged
- Reduce light penetration which is necessary for plants
- Potential to spread invasive plants (Curly-leaf pondweed)
- Damage banks and shorelines
- Fuels and emissions found to be toxic to fish and aquatic insects

Nutrient trends



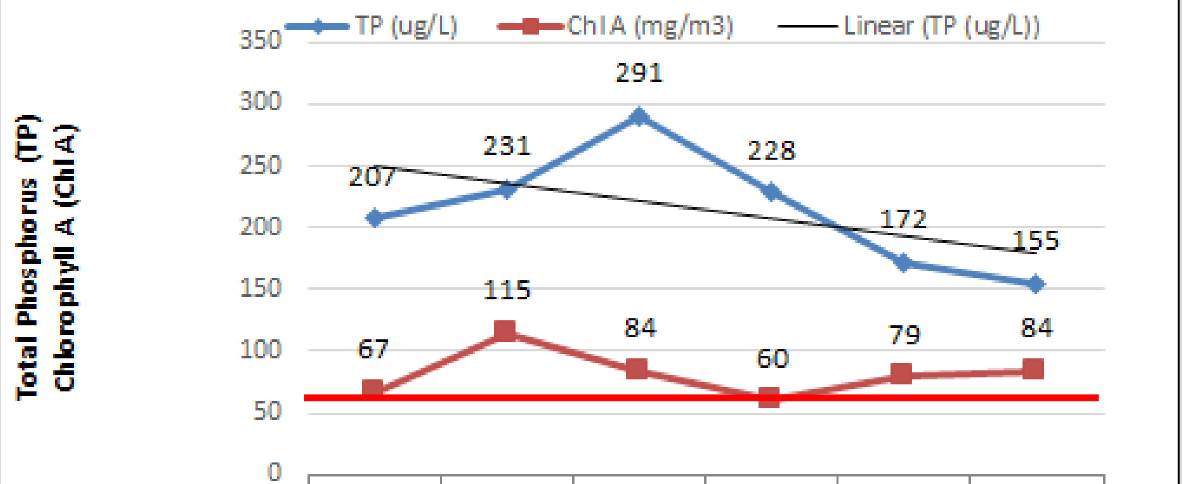
	2014	2015	2016	2017	2018	2019
TP (ug/L)	207	231	291	228	172	155
Chl A (mg/m3)	67	115	84	60	79	84



	2014	2015	2016	2017	2018	2019
TP (ug/L)	172	149	187	167	159	180
Chl A (mg/m3)	68	97	67	53	79	109

Comparison: Birch Lake

Quality water and a healthy plant community



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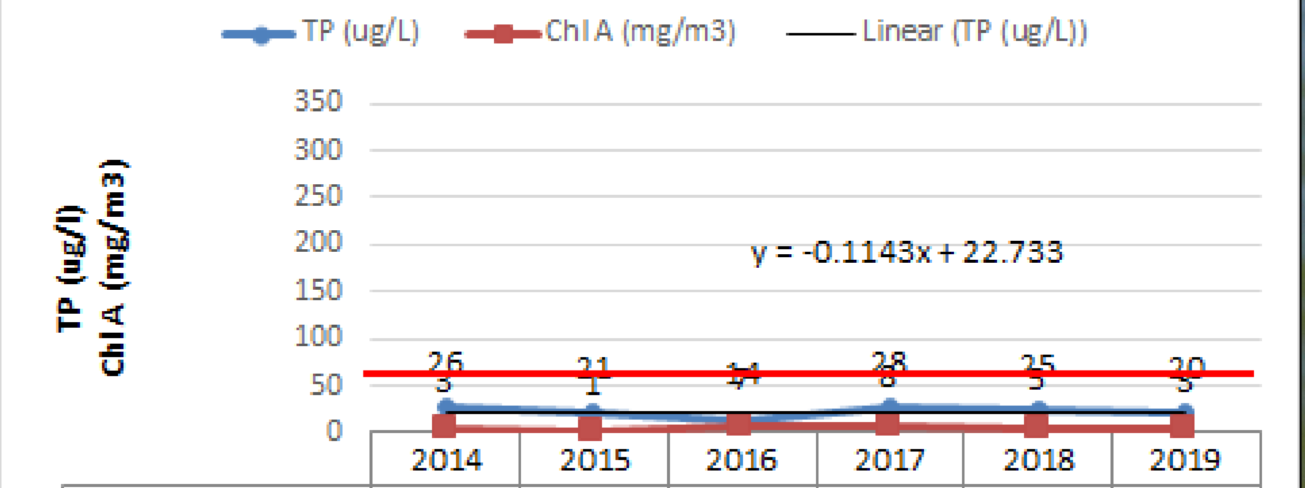
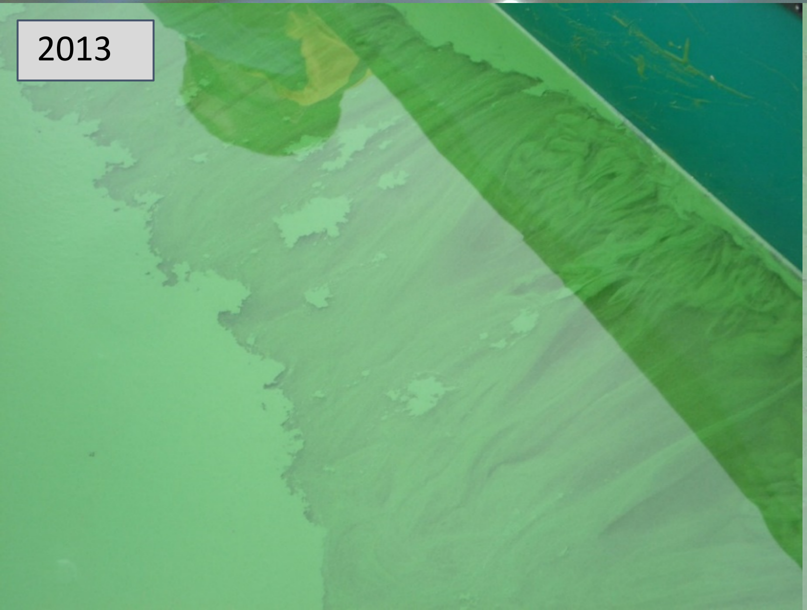


	2014	2015	2016	2017	2018	2019
TP (ug/L)	26	21	14	28	25	20
Chl A (mg/m3)	3	1	7	8	5	3

Birch Lake

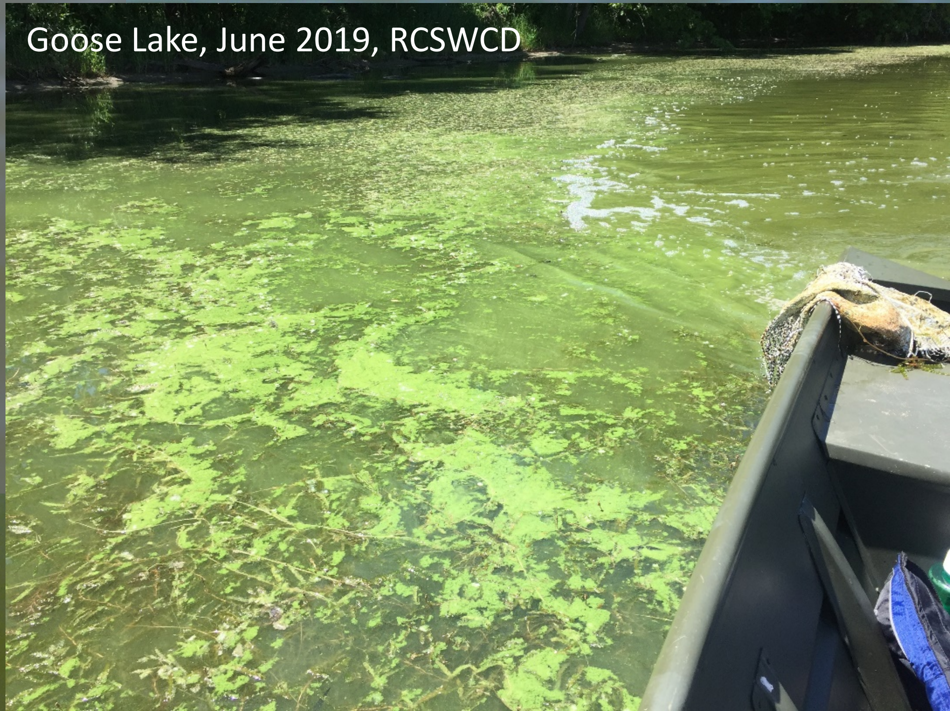
Goose Lake status

- East Goose 10-year average TP: 236 ug/L
- West Goose 10-year average TP: 160 ug/L
- Standard: < 60 ug/L



Why have nutrient levels dropped while the algae population has not?

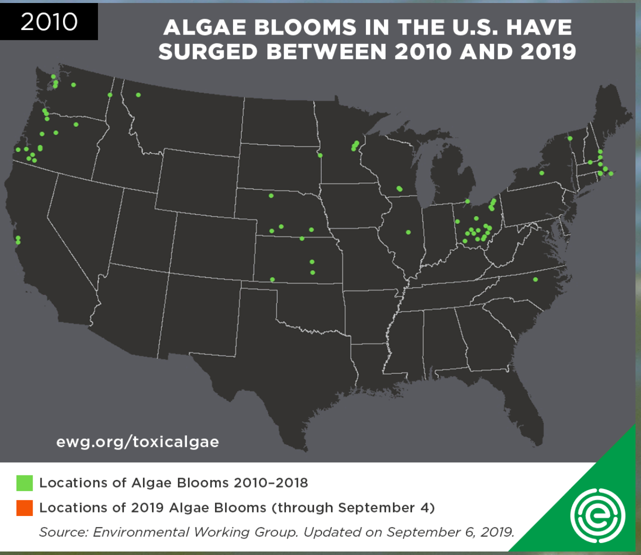
- Dilution effect from above average rainfall
- Changes in discharge in West Goose
- External load reductions in the subwatershed
- Rough fish removal in the lake; although rebounding
- Algae remains at extremely high levels
- Internal load is more than sufficient for algae growth

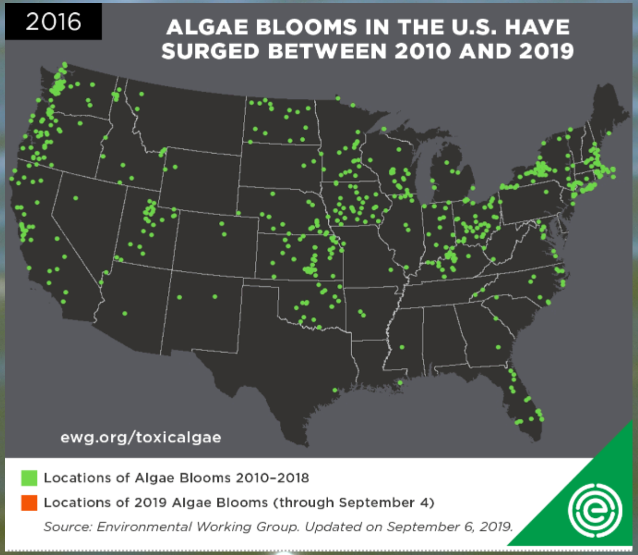


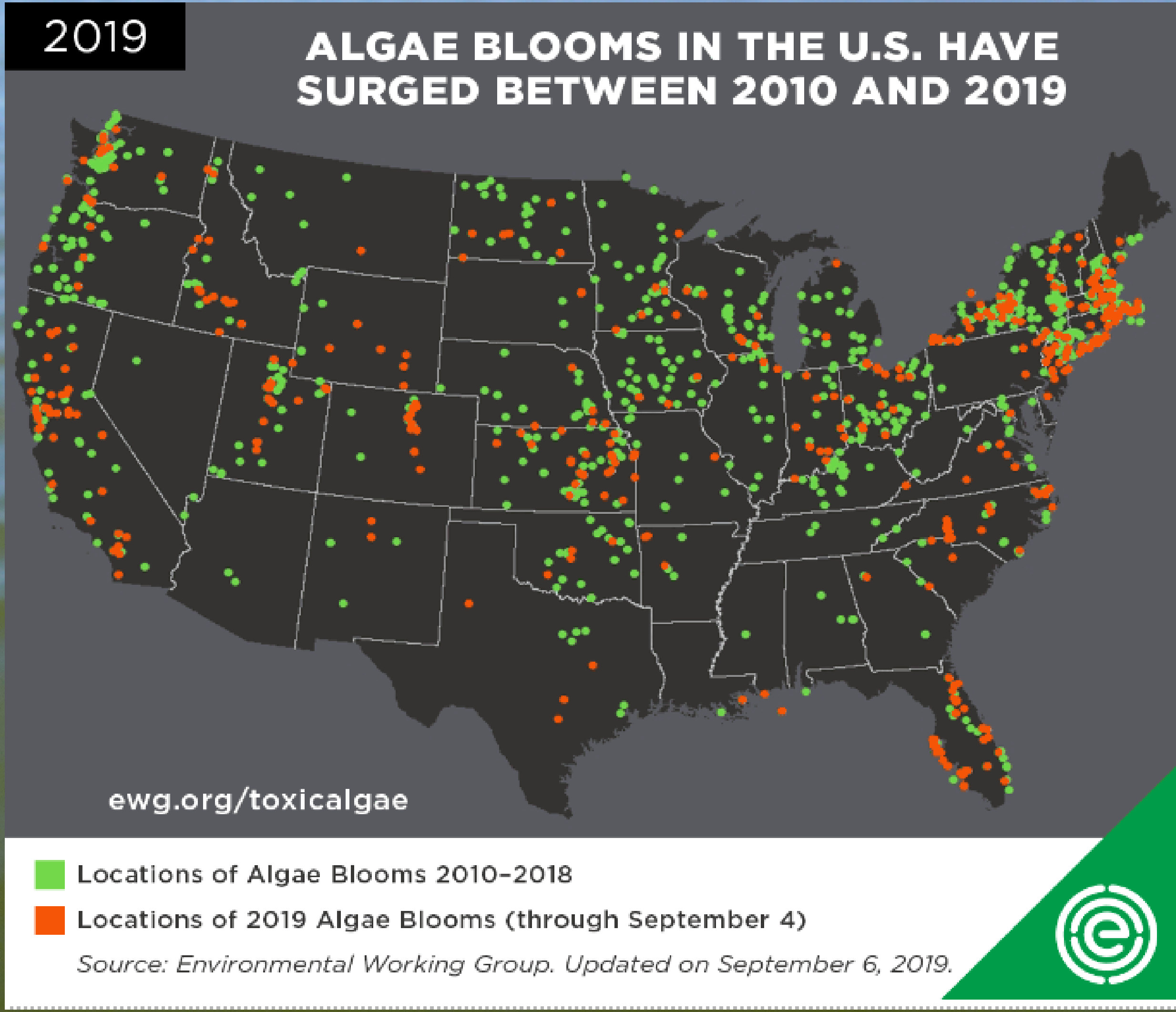
Goose Lake, June 2019, RCSWCD

Are toxic algal blooms a threat?

Toxic Algae Blooms in the U.S. 2010-2019







Source: www.ewg.org
Environmental Working Group

East Goose: Weighing options

- High visibility in WBL; no public water access
- Priority in VLAWMO's Comprehensive Water Plan
- 6 years of study & drainage-area work leading to: Alum treatment with continued monitoring, vegetation restoration, & adaptive mgmt
- Internal load study on East Goose Lake predicts an 800 lb reduction/yr
  - Corresponds to 400,000 lbs of algae removed
  - Cost per pound is $213
- Other non-alum BMPs are more expensive, less effective
- 800 pounds phosphorus vs. 25 pounds: 32 times more effective

Goose Lake, Sept 2019, VLAWMO

East Goose: Weighing options

	Cost	P Reduction	Cost per lb
Infiltration pipe on school property	$100,000	25 lb/yr	**$4,000**
Retrofit channel for stormwater treatment	$100,000	10 lb/yr	**$10,000**
Construct off-line filtration system for low flow	$300,000	25 lb/yr	**$12,000**
Alum treatment – West basin	$55,000	100 lb/yr	**$550**
Alum treatment – East basin	$170,000	800 lb/yr	**$213**

Property value

- Annual value losses in recreational use and waterfront real estate were $2.2 billion annually as a result of eutrophication in U.S. freshwaters in 2009
- Greatest losses attributed to lakefront property values ($0.3-$2.8 billion per year) and recreational use ($0.37-$1.16 billion)

(Zamparas & Zacharias, 2014)

Compromise: Where and how?

- Most effective choices proposed from feasibility study:
  1. East Goose Lake alum treatment: 800 lb/yr phosphorus removed, 32 times more effective
  2. West Goose Lake alum treatment: 100 In/yr, 4 times more effective
- High boat traffic and shoreline vegetation removal continues to cause erosion and has been a source of conflict
- Upstream improvements (East Goose) will promote a healthier West Goose Lake and Lambert Creek

VLAWMO decided not to pursue West Goose alum treatment to allow continued motorized boating and water skiing, recognizing the value of this recreational use to the ski team and community.

The cost of doing nothing

- Harmful algal blooms
- Serious public health risk
- Acute and chronic possible health risks
- Negative impacts to wildlife/food web
- Reduced oxygen in lake
- Plants cannot recover, and the lake cannot recover
- City waste load allocations not met
  or need to be met in an even more expensive way
- Downstream loads cannot be effectively reduced
  without dealing with headwaters
- What happens when someone or their pet
  gets sick or dies?

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