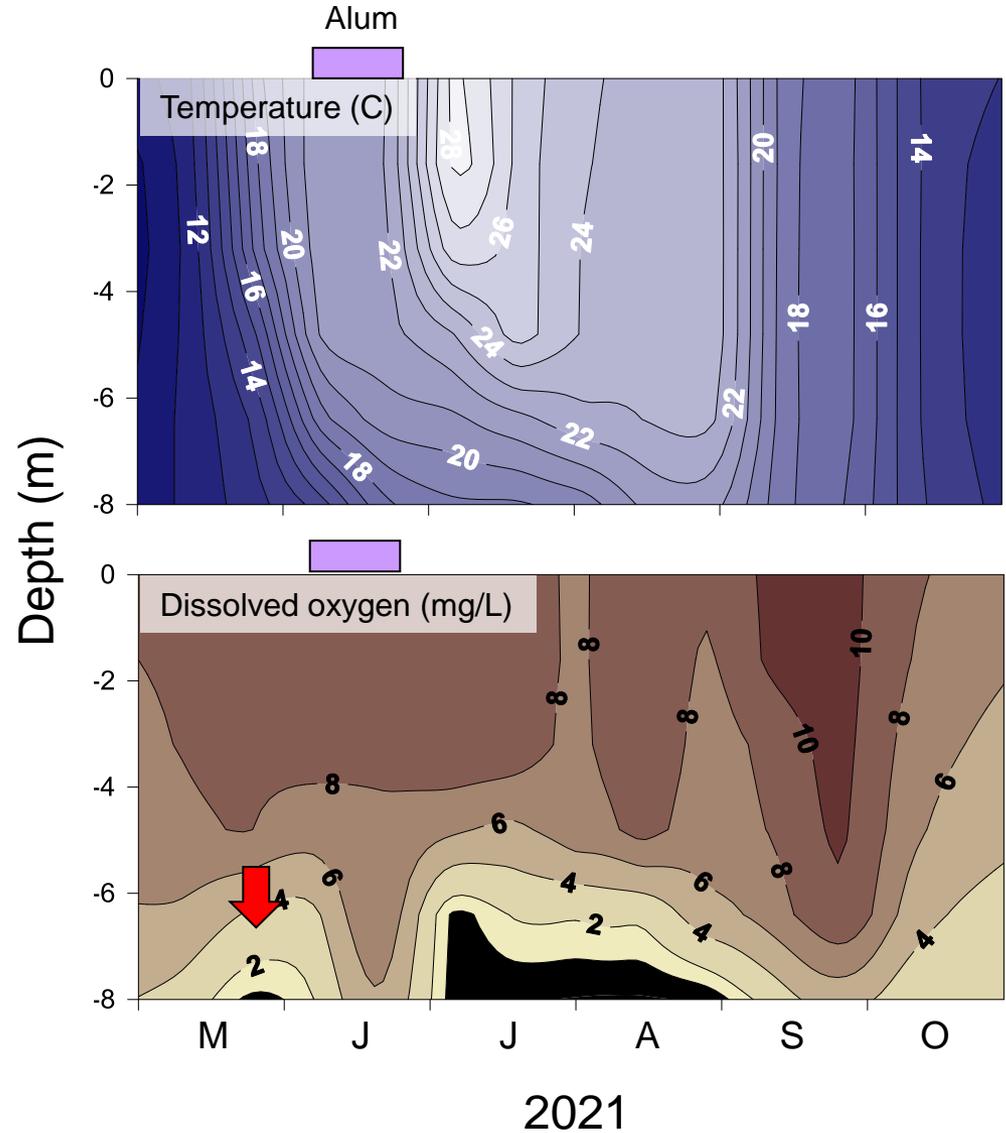
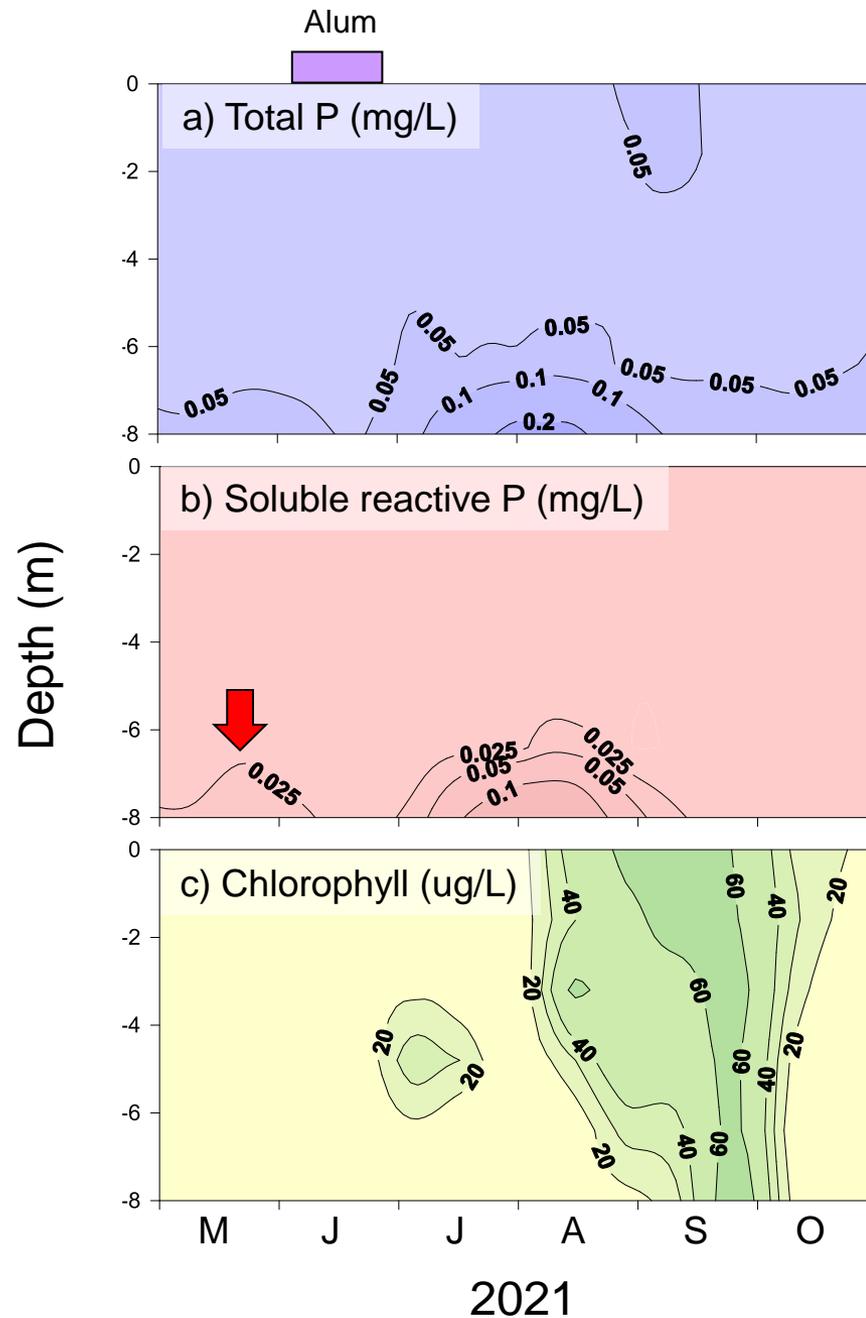


Insights into cyanobacteria bloom development in Cedar Lake, 2021

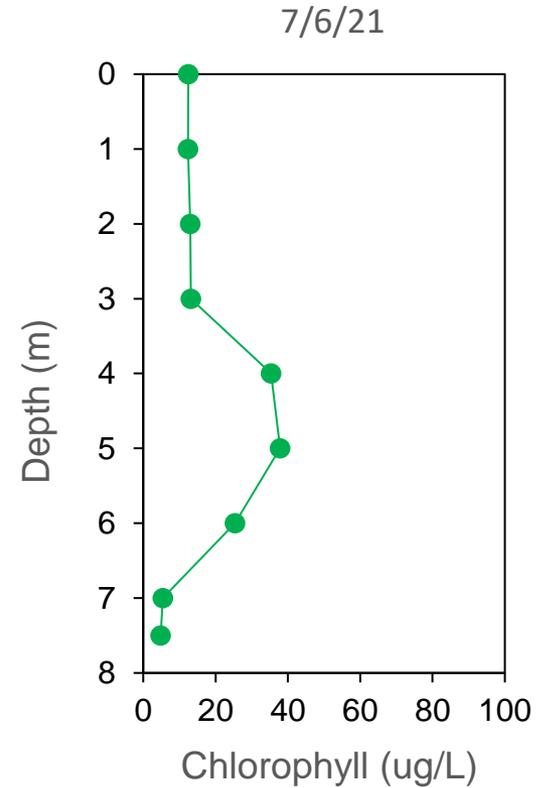
- Early Spring, early ice-out, and warming in May led to stratification and bottom anoxia (Red Arrow).
- Bottom anoxia occurred before the alum treatment.
- In 2020, internal P loading overwhelmed the alum floc resulting in bottom P accumulation.
- Thus, the alum floc was apparently P saturated allowing for potential internal P loading into the hypolimnion by May 2021.



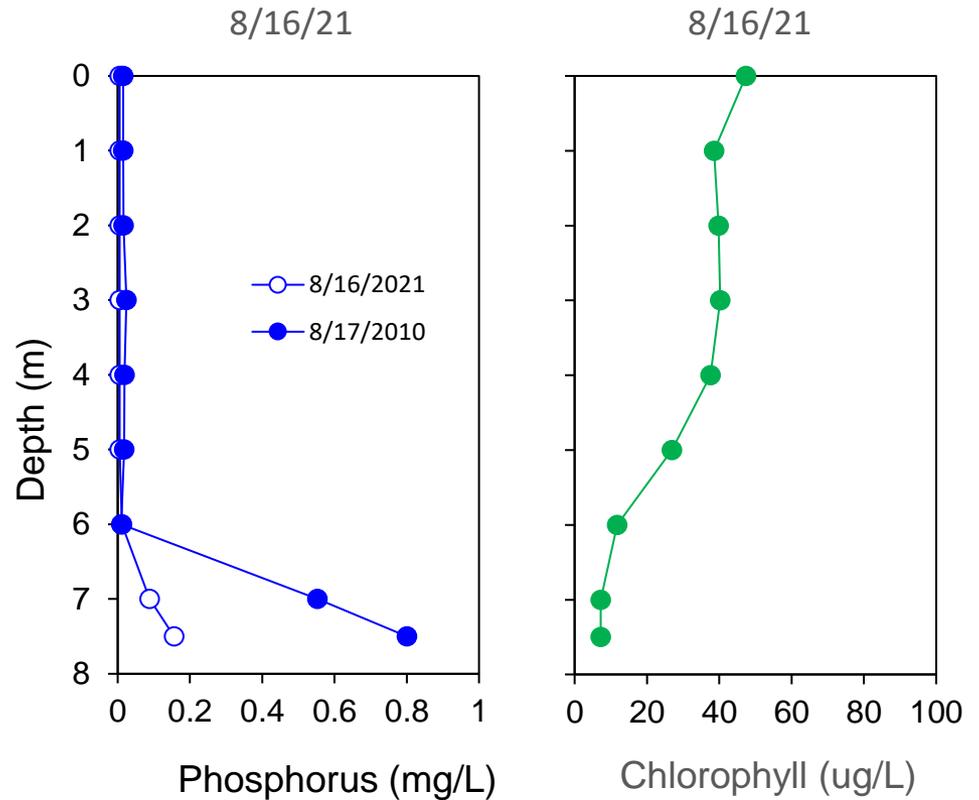
- Unfortunately, bottom soluble P increased in May in conjunction with stratification and anoxia (Red Arrow).
- The soluble P concentration increase was modest but enough for uptake by cyanobacteria before the alum treatment.
- In addition, soluble P concentrations increased in the bottom waters in later July through early August after the alum treatment.



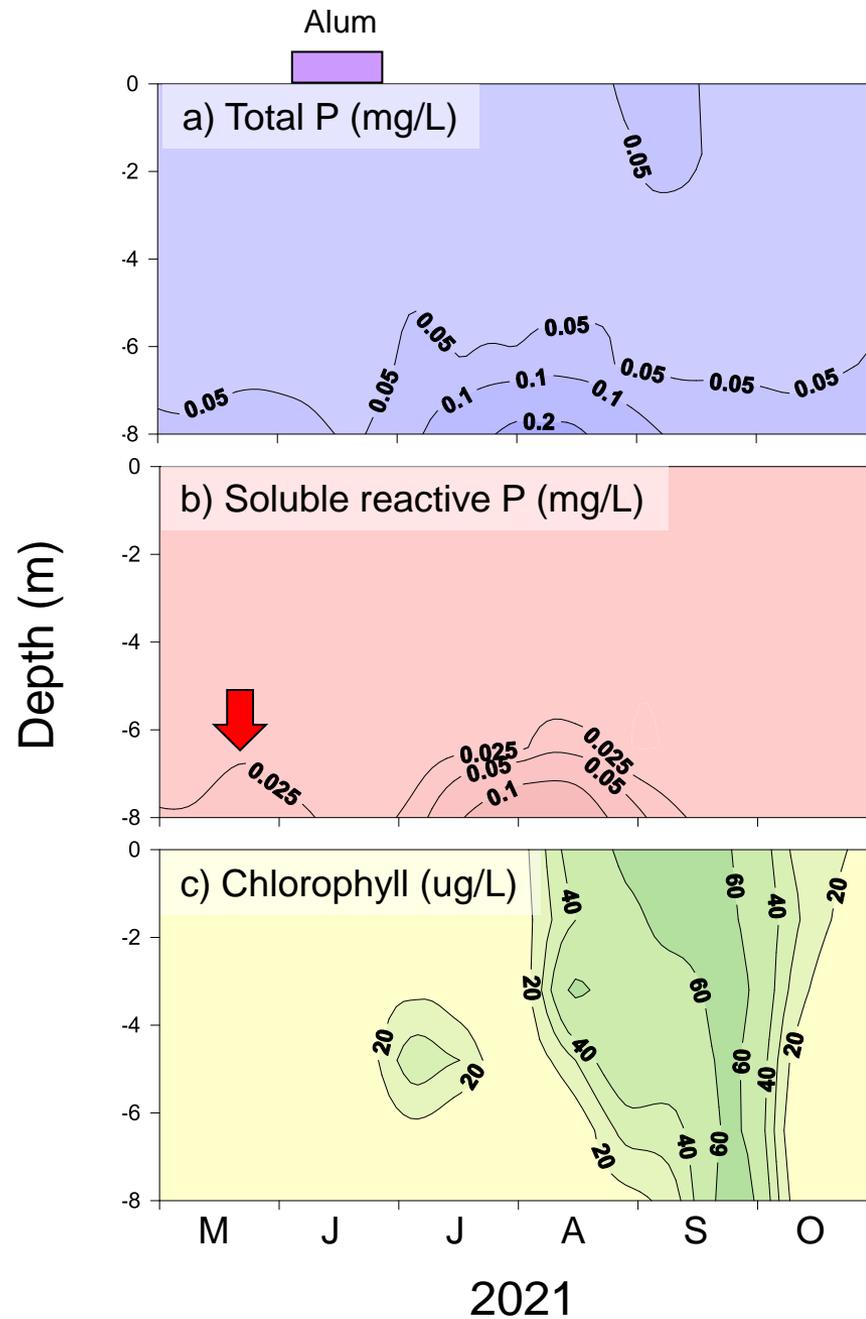
- *Aphanizomenon flos-aquae* (cyanobacteria or blue-green algae) survived the alum treatment. Not all cells were flocculated to the sediment.
- The population formed a bloom in the metalimnion in early July.
- Secchi transparency was deep and *A. flos-aquae* growth is sensitive to higher light intensities. So they grew at a depth where light intensity was optimal (4-6 m)



- Although the 2021 alum treatment was effective in reducing bottom P, concentrations still increased to ~ 0.20 mg/L in early to mid-August (Please note the comparison to pretreatment 2010 concentrations).
- The lake started mixing and turning over in August. Mixing disrupted the metalimnetic bloom and mixed it into the 5-m water column. Mixing also entrained hypolimnetic soluble P into the surface waters for uptake and growth.



- Entrainment of this modest internal P load fueled an algal bloom that peaked in biomass in September.



Conclusions

- Patterns in 2021 again emphasize the need for nearly complete control of internal P loading to significantly reduce cyanobacteria.
- As the frequency of early ice-out and early Spring increases, perhaps alum application needs to occur earlier in the summer or even late Spring to capture internal P loads that might develop as a result of Spring stratification and bottom anoxia.
- The final 2 future alum applications will be critical in fully controlling internal P loading in Cedar Lake.