



# MANAGEMENT & MITIGATION

# Cyanobacteria bloom management & mitigation using hydrogen peroxide

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# PROJECT SUMMARY

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## NSF

- **Interaction between hydrogen peroxide (HP) & cyanobacteria**
- Natural abundance of HP.
- Comparison of chemical & biological HP dynamics.

## FDEP

- **Early detection & treatment of harmful algal blooms using HP**
  - One-year high-resolution monitoring
  - Algal treatments using HP & amino acid L-lysine (Two mesocosms & two field applications).

## USACE

- **Biology, ecology, & genomics of cyanobacteria**
- Nova Southeastern Univ, USGS.
- Isolation & identification
- Toxicity tests
- Genomic study
- Culture deposit to the culture collection (UNC)

# MAJOR TAKEAWAYS

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## NSF findings

- Florida freshwater had the **highest HP** concentration in the world.

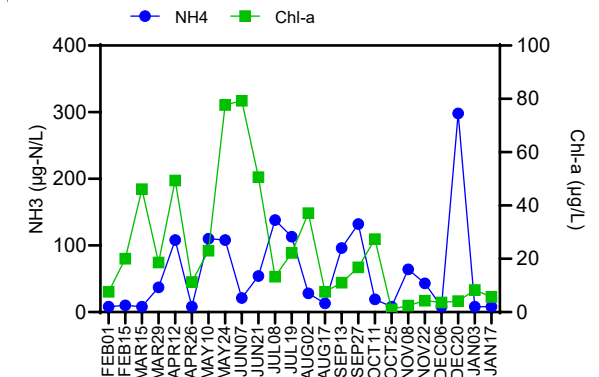
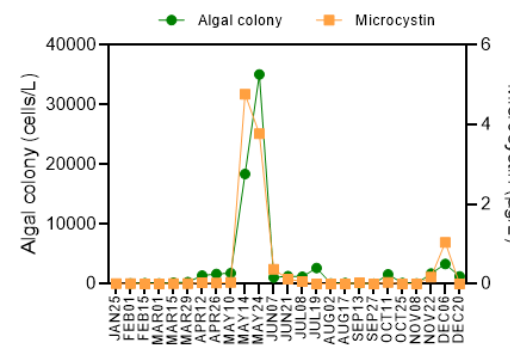
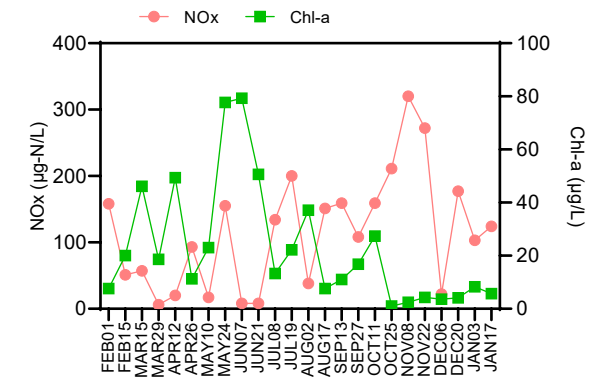
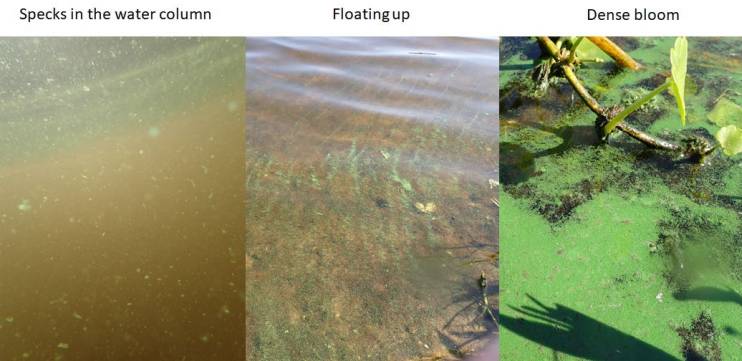
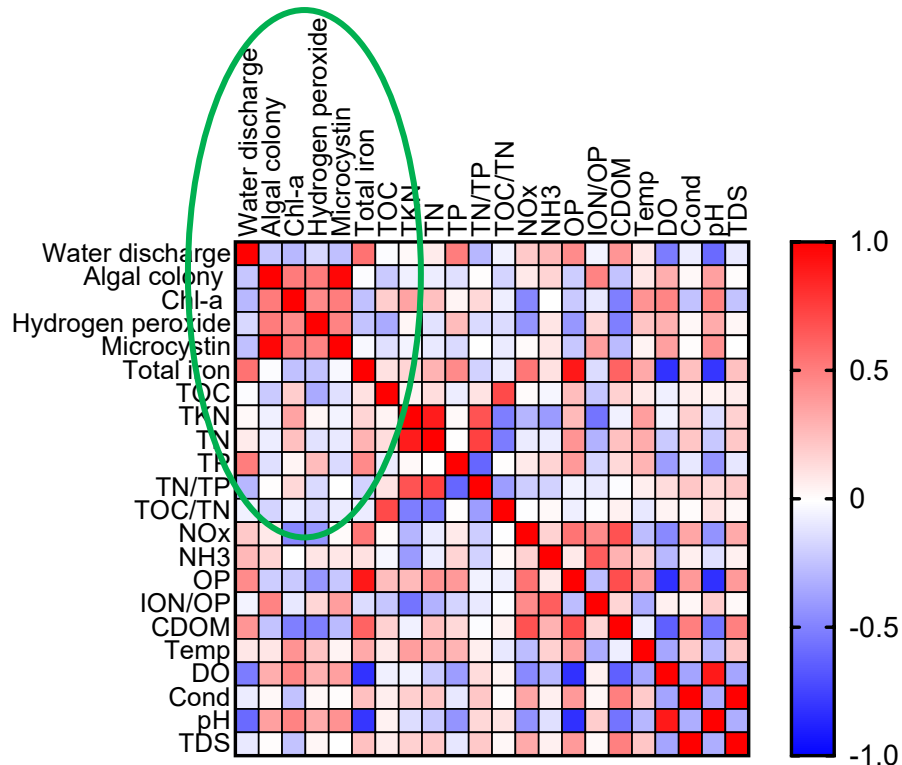
## FDEP

- **1<sup>st</sup> mesocosm: Complete elimination** of *Microcystis* in the first mesocosm experiment (HP conc. = 449 mg/L, 0.04%, 13 mM).
- **2<sup>nd</sup> mesocosm: L-lysine** has a great potential to selectively control *Microcystis* (the second mesocosm & **synergetic effect**).
- **Field applications** (16.7 mg/L & 200.4 mg/L) were **safe**.
- All HP induced the **succession** of phytoplankton communities.
- HP treatment **did not induce** the gene expression of microcystin.
- Gene expression patterns showed *Microcystis* was **stressed out** by HP.
- HP increased the **extracellular microcystin** but it did not last long.



# ADDITIONAL RELEVANT INFO FROM ONE-YEAR MONITORING

- **Correlation** between algal colony counts, HP, Chl-a, & microcystin.
- **Counting algal colonies** in the water column can be the easiest and cheapest prediction of *Microcystis* blooms.
- At the **Franklin Lock & Dam (S-79)**, N shaped the phytoplankton community and was provided by watershed. P was provided from sediment. It is mainly released through low oxygen & low pH conditions.



# RESEARCH PRIORITIES & OUR RESPONSES

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## The research priorities identified in 2019 & our responses

- Determine the relative importance (quantitative measures) of different nutrient inputs **(1)nitrate (2) ammonia (3) P from sediment**
- Determine if your management practice will actually achieve the goal of reducing blooms in Lake Okeechobee **I do not think it works in LO but works in waterways.**
- Develop blue-green algae control methods **Yes**
- Evaluate and weigh engineering approaches versus ecological approaches (**the ecological approach was better**)
- Evaluate what hydrological conditions can impact management and future management options (**should be extremely shallow**)
- Determine a strategy for effective messaging to the public regarding expectations, timelines, and costs (**HP treatment is not an instant approach**)

# NEW DATA GAPS

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## Combat against HAB

*For a better understanding of the strategy of the treatment methods*

- Timing
- Concentration
- The size of the water body
- Application methods (surface or mixing)
- The presence and the absence of flows
- Frequency of the use of HP
- **More field tests & scientific validation are strongly recommended.**

# ACKNOWLEDGEMENTS & PUBLICATIONS

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- **Funding agencies** (FDEP, USACE, NSF)
  - **Students** (FGCU, USF)
  - **Water managers** (USACE, Lee County)
  - **Collaborators** (FGCU, Nova Southeastern University, USGS, Sanibel-Captiva Conservation Foundation, UNC-Wilmington)
1. **Urakawa, H.**, Steele, J.H., Hancock, T.L., Dahedl, E.K., Schroeder, E.R., Sereda, J.V., Kratz, M.A., Garcia, P.E. & Armstrong, R.A. (2023). Interaction among spring phytoplankton succession, water discharge patterns, and hydrogen peroxide dynamics in the Caloosahatchee River in southwest Florida. **Harmful Algae**, 126, 102434. (IF: 5.9, 2022)
  2. **Urakawa, H.**, Ndungu, K. L., Hancock, L. T., Steele, J. H., & R. Bartleson (2021) Subtropical freshwater cyanobacterial blooms as hydrogen peroxide hotspots. **Environmental Science & Technology Letters** 8, 911-917. (IF: 11.6, 2023)
  3. Ndungu, L. K., J. H. Steele, T. L. Hancock, R. D. Bartleson, E. C. Milbrandt, M. L. Parsons, **H. Urakawa** (2019) Hydrogen peroxide measurements in subtropical aquatic systems and their implications for cyanobacterial blooms. **Ecological Engineering** 138: 444-453. (IF: 4.4, 2022)
  4. **Urakawa, H.**, Hancock, T.L., Steele, J.H., Dahedl, E.K., Urakawa, H.E., Ndungu, L.K., Krausfeldt, L.E., Rosen, B.H. & Lopez, J.V. (2020). Complete genome sequence of *Microcystis aeruginosa* FD4, isolated from a subtropical river in southwest Florida. **Microbiology Resource Announcements**, 9(38). 10.1128/MRA.00813-20 (IF: 0.3, 2020)
  5. Dahedl, E.K. and **H. Urakawa**. (2023) Differential effects of hydrogen peroxide and L-lysine treatments on the growth of freshwater Cyanophyta and Chlorophyta. **Ecologies** (in review)
- Lauren E Krausfeldt, Elizaveta Shmakova , Hyo Won Lee , Viviana Mazzei , Keith A Lofton , Robert Phillip Smith , Emily Karwacki , Eric P Fortman , Barry H Rosen, **Hidetoshi Urakawa**, Manoj Dadlani, and Jose V Lopez (2023) The microbial diversity, genomic potential, and co-occurring phage-host interactions that promote cyanobacterial blooms. (rejected by Nature Communications, to be resubmitted to **mSystems**)
  - Viviana Mazzei, Emily Karwacki, Keith A. Loftin, Jose V. Lopez, Lauren E. Krausfeldt, Barry H. Rosen, and Hidetoshi Urakawa. (2023) Phytoplankton responses to experimental nitrogen and phosphorus loading in a eutrophic and turbid subtropical river. (to be submitted to **Ecological Applications**)
  - Dahedl, E.K. and **H. Urakawa**. (2023) Transcriptome analysis of the effect of hydrogen peroxide and L-lysine on *Microcystis aeruginosa* (to be submitted to **STOTEN**)
  - Taylor L. Hancock, Elizabeth K. Dahedl, Michael A. Kratz, and Hidetoshi Urakawa. (2023) Microcystis bloom forecasting using hydrogen peroxide and transcriptome analysis (to be submitted to **STOTEN**).