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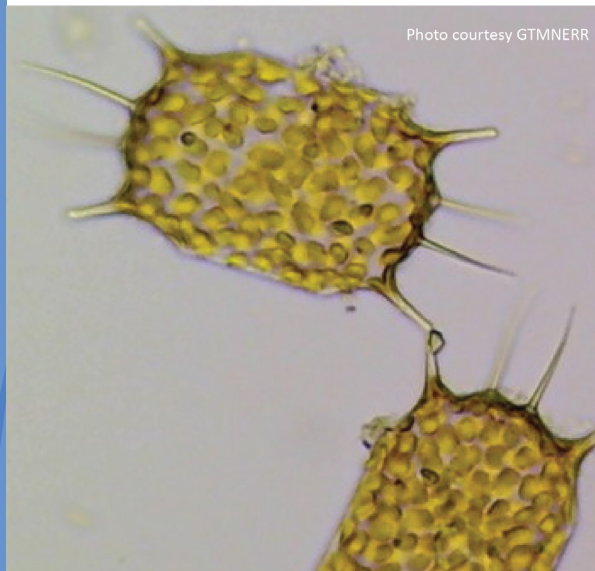
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Recommendations for Chlorophyll Monitoring in the NERRS



Why this project?

Chlorophyll *a* is often used as a proxy for phytoplankton in studies of eutrophication, the food web, and harmful algal blooms. Traditionally, this photosynthetic pigment is measured by extracting it from water samples in the lab—the current practice used by the NERRS System-wide Monitoring Program (SWMP). Monthly grab samples are valuable when assessing long-term trends, however, they are not sufficient to track short-term changes in phytoplankton.

Recent advances in optical sensor technology have made high frequency, *in situ* measurement of chlorophyll *a* possible. Yet, while there is a relationship between these and extracted measurements, there are inconsistencies that—prior to this project—had not been tested. As a result, high frequency, *in situ* chlorophyll *a* monitoring has not been incorporated into NERRS SWMP, even though its use would enhance SWMP's value by allowing Reserves to respond to local and national needs for algal bloom research, management, and education.

A multi-Reserve study explored the feasibility of including high frequency, *in situ* chlorophyll *a* monitoring in the National Estuarine Research Reserve System-wide Monitoring Program (NERR SWMP). The study confirmed a relationship between fluorescence detected by optical sensors and measurements of extracted chlorophyll from monthly grab samples. The strength of that relationship varied with Reserve and according to site conditions. The team determined that both approaches to chlorophyll monitoring have strengths that complement the NERRS mission. They synthesized their findings into recommendations to support the integration of *in situ* chlorophyll monitoring into NERRS SWMP monitoring.

RECOMMENDATIONS

1. The NERRS implements high-frequency, *in situ* chlorophyll monitoring where appropriate and capacity exists. See Table 1 on page 3 for an estimate of costs.
2. The *in situ* sensor is not a direct substitute for lab-based, extractive chlorophyll analysis.
3. To save time and provide the most accurate reflection of what the sensor detects, calibrate sensors to relative fluorescence units (RFUs) only and update the Centralized Data Management Office (CDMO) data submission requirements accordingly. This is consistent with the YSI EXO TAL manual.
4. Calibrate the YSI EXO TAL sensor using a revised CDMO SOP. We've also drafted a SOP for calibrating the EXO FDOM sensor according to the YSI manual.
5. The NERRS Data Management Committee develops standard metadata language and guidance on QAQC documentation for chlorophyll sensor deployment. Technician training could be improved with a "tips and tricks" document, supply list, and instructional videos.

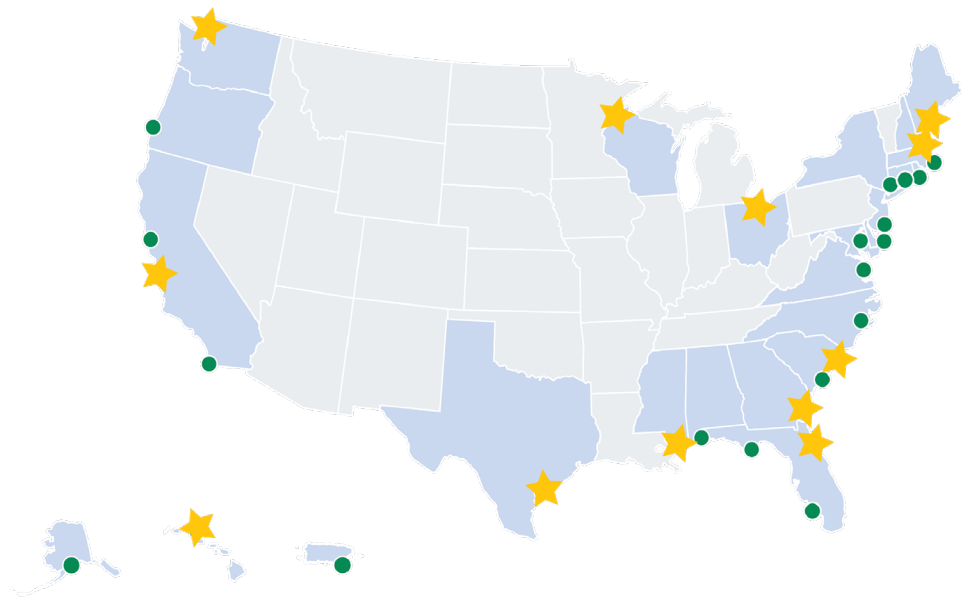
DATA POINTS PER YEAR

IN SITU APPROACH:

32,660

MONTHLY GRAB
SAMPLES:

12



★ *Research reserves that participated in the study.*

Our Approach

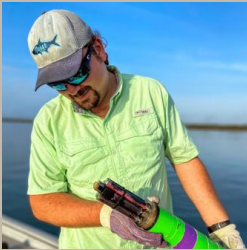
With funding from the NERRS Science Collaborative, scientists from 12 biogeographically diverse Reserves compared fluorescence measurements taken by the YSI EXO TAL sensor to extracted chlorophyll concentrations processed in the lab. They explored possible sources of error in fluorescence measurements, including temperature, turbidity, and fluorescent dissolved organic matter (FDOM). They also looked at how best to predict extracted chlorophyll *a* from the suite of YSI EXO sensors. Ultimately, they synthesized their work into recommendations on whether and how to include high-frequency, *in situ* chlorophyll *a* monitoring in SWMP. (More information on methods and findings [here](#).)

What We Learned

The study confirmed a relationship between fluorescence detected by YSI EXO TAL sensors and extracted chlorophyll measurements, but the strength of that relationship varied by Reserve. Temperature, turbidity, and fluorescent dissolved organic matter all influenced sensor readings, independently of phytoplankton biomass. Taken together, and with a proper understanding of respective strengths and limitations, both *in situ* and extracted metrics can be informative.

Each approach has strengths that complement the NERRS mission. Extracted measurements contribute to understanding long-term change because they can be compared with historical data. High-frequency, *in situ* measurements are useful to assess short-term variability, allowing us to explore, for example, how chlorophyll changes with tides, from day to night, seasonally, and after storms. The use of both approaches strengthens Reserves as reference sites and living laboratories for research on topics ranging from ecosystem metabolism and the drivers of primary production to harmful algal blooms and coastal acidification.

High-frequency, *in situ* chlorophyll data also can support management, education, and aquaculture, particularly when the monitoring stations are telemetered. Near real-time chlorophyll data could support early detection of, and rapid response to, algal blooms; aquaculturists could use this data to assess food availability for their filter feeder crops; and teachers could integrate it with efforts to educate students on data literacy, primary production, and food web dynamics.



Is *in situ* monitoring right for your site?

The decision to integrate *in situ* chlorophyll monitoring into your SWMP program depends on site conditions, the goals for your field stations, and your capacity. To help you decide, we've synthesized an estimate of costs in Table 1, and a path for decision making in Figure 1.

TABLE 1: ESTIMATED COSTS OF <i>IN SITU</i> CHLOROPHYLL <i>a</i> MONITORING	
ITEM	COST
YSI EXO TAL Sensor: 5 year lifespan, 2 year warranty	\$3,150
FDOM Sensor: 5 year lifespan, 2 year warranty	\$2,394
Calibration standards	\$350 per year
Disposal of standards	Varies by standard and Reserve
Staff time: 90 minutes to pre/post calibrate TAL and FDOM sensors on each sonde	Varies by Reserve
Lost opportunity of including an alternative sensor on a sonde. EXO2 has only enough ports to accommodate the TAL and FDOM sensors, excluding other non-required SWMP sensors, e.g., YSI's NITRALED sensor.	Varies by Reserve

Figure 1: Decision Pathway for Adoption of *in situ* Chlorophyll *a* (CHL-A) Monitoring

