

## Implementation of the Great Lakes Observing System, 2011-2015

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### PROJECT SUMMARY

The Great Lakes-St. Lawrence River region is home to over 44 million US and Canadian citizens within eight U.S. states and two Canadian provinces. With a coastline totaling nearly 11,000 miles, the region encompasses the largest surface freshwater system on Earth, comprising nine-tenths of the U.S. surface freshwater supply and one fifth of the global supply. The resource is extensively- and intensively- used by a diverse group of stakeholders whose environmental health, economic well-being and quality of life is fundamentally dependent upon the informed use, protection and management of the region's water and related natural resources. The Great Lakes Observing System (GLOS) sees the region's uniqueness as an opportunity to showcase and demonstrate the interoperability of the Integrated Ocean Observing System (IOOS) while contributing to national and regional priorities that include supporting ecosystem restoration and protection; reducing public health risks; improving safety and efficiency of maritime operations; increasing effective mitigation of natural hazards; and improving understanding of climate change and supporting the development of adaptation strategies.

In addition to addressing issues similar to other IOOS regions (e.g., spill response, search and rescue, beach quality, beach hazards such as rip and channel currents), GLOS is also positioned to address unique regional issues resulting from its freshwater composition and geography. These issues include source water protection; providing baseline data to managers of Great Lakes Areas of Concern (AOCs) and Lakewide Management Plans (LaMPs); identifying, collecting and integrating key fishery and associated environmental (physical, chemical and biological) observations to support state and provincial fishery managers; understanding the impacts of climate change upon net basin water supplies; assisting municipal/regional planners in adapting to climate change; and prioritizing maintenance funds for key port and harbor infrastructure.

### PROGRESS AND ACCOMPLISHMENTS (Report Period: 6/01/15 through 11/30/15)

#### I. PROGRAM PLANNING AND MANAGEMENT

GLOS underwent a staff transition, as acting Executive Director Kelli Paige transitioned to Executive Director and hired two new staff members, a Program Coordinator Andrea Maguire and Communications Manager Kristin Schrader (see bios at: <http://www.glos.us/about-glos/board-staff>)

GLOS ED has been working on several activities such as:

- Updating budget reports and other documentation for the Board of Directors.
- The ED worked to complete an updated scope and budget for Year 5 of the Cooperative Agreement

- Evaluating opportunities for improvement to existing business practices that will make financial and contract management easier and more clearly aligned with requirements, especially those related to the new OMB Super-Circular.

GLOS ED and staff continued participation in partner initiatives such as:

- IOOS and IOOS Association committees, Can-Am GEO Great Lakes Testbed activities, NOAA Great Lakes Regional Collaboration, and the Great Lakes Water Quality Agreement Annex 10 (Science Annex, including data management and sharing) Committee, among others.
- GLOS ED, board and staff met with Environment Canada and Ontario Ministry of the Environment and Climate Change to explore collaboration and strengthen connections with Canadian partners (6/10)

GLOS continued to work on implementing the GLOS strategic plan (the Blueprint), a foundational document for developing its 2016-2020 IOOS proposal (available online at:

[http://glos.us/sites/default/files/documents/GLOSBlueprint\\_2016-20\\_0.pdf](http://glos.us/sites/default/files/documents/GLOSBlueprint_2016-20_0.pdf)).

- ED and staff submitted proposal for the GLOS/IOOS 5 year Cooperative Agreement, which included projects from a pre-proposal competition conducting in Spring 2015. Pre-proposal reviews were conducted and selected pre-proposals submissions were notified about their status. Based on final funding amounts from IOOS, the collaborative proposal will become the basis for the GLOS/IOOS 5 year Cooperative Agreement.
- Staff initiated planning activities for year 5 of the current cooperative agreement, including:
  - Starting a needs assessment process, including a stakeholder survey
  - Coordinated updates to Google analytics tracking and began implementation of improved metric tracking and “GLOS by the Numbers”
  - Initiated next steps for revisiting the Enterprise Architecture Report/ Build-out plan
  - Initiated an update of the GLOS Quality Management Plan and related processes
- Submitted IOOS Certification Application, working on revisions based on the 1<sup>st</sup> review
- Staff hosted a successful Annual Meeting
- Staff started planning activities for our 10 year anniversary in 2016.
  - Submitted IAGLR Session proposal
  - Began drafting materials a Great Lakes Data Challenge competition
- Staff began work on a new development campaign called “Adopt-a-Buoy”
- Board meeting in Toronto, ON (6/8-6/9)

## **SUB AWARD: IOOS ASSOCIATION**

### **The National Network of Regional Coastal Ocean Observing Systems: Coordination and Communication Support for the Regional Component of the U.S. Integrated Ocean Observing System**

(PI Josie Quintrell)

#### **Project Summary**

The goals of this project are to support and develop the national network of regional coastal observing system through support of the IOOS Association. The IOOS Association works closely with the eleven regional systems and the NOAA IOOS Program office to successfully implement IOOS, facilitate communications and coordination between federal and regional partners, identify emerging needs, build awareness of the strength and contributions of IOOS, and to represent regional perspective on observing issues.

## **Progress and Accomplishments**

Task 1 - Serve as a point of contact for the IOOC Federal agencies for communication with the RA and will work with the Program Office on organizing the fall and spring IOOS Coordination meetings.

### *Accomplishments:*

IOOS Fall 2015 Meeting. The 2015 Fall IOOS Meeting was hosted by GCOOS and SECOORA on September 15-16 in St Petersburg, FL. The fall meeting launched the Closing the Gaps campaign, a five-year program to fill critical observing gaps. Over the next 6 -12 months, the IOOS Association will work with the RAs and the Program Office to develop a scalable approach to filling gaps. In addition, the meeting was an opportunity for the RAs to meet with Program Office staff to discuss goals for the coming year, certification, data management, IOOS branding and metrics. A tour of the local facilities highlighted the importance of observing to the region.

IOOS Spring 2016 Meeting Planning Committee. March 1-3 2016. The Planning Committee for the Spring 2016 meeting held its first call on November 30. The meeting will be held in Washington DC.

Task 2 - Work with the Program Office on the monthly planning and coordination calls with the Program Office staff and the RAs. These calls are essential for the coordination of a distributed program.

### *Accomplishments*

IOOS monthly calls were held on July 21, Aug 18, Sept 22 and Nov 17. (The June and December calls are IOOS Association Board Calls.) The monthly calls include updates and discussions on a range of topics including updates from the PO, funding, certification, data management, COMT, glider task team and regional roundtables. In September, Pat Burke provided a brief on the CO-OPS Modeling Strategy and possible interactions with the regions.

Task 3 - Support task team efforts such at the Modeling Steering Team and others that require regional input and review.

### *Accomplishments:*

The Association continues to advocate for regional representation on national efforts such as the Modeling Task Team, the IOOC Glider Task Team and most recently the NOAA Data Buoy Steering Committee. The Modeling Task Team has not met in over a year and the report is still being revised. Barb Kirkpatrick of GCOOS is co-lead of the IOOC Glider Task Team and Ru Morrison, Jan Newton and Carol Janzen will represent the regions on the NOAA Data Buoy Steering Committee. The Association provided input on the Biological Task Teams final list of biological variables.

Task 4 - Engage with the NOS Roundtable to foster collaborations with NOS extramural partners at the regional level.

*Accomplishments*

The IOOS Association Executive Director attends the monthly call with the NOS Roundtable that includes the leads for the NOS offices and the NOS extramural partners - Coastal States Organization, NERRA, Sea Grant Association, Sanctuaries and IOOS. The calls have focused on resiliency, developing a compelling wrapper on the importance of the NOS extramural network and preparing for the change in administrations. The Association also works closely with NCOOS on harmful algae bloom outreach and education. In July, the Association Director and Julie Thomas of SCOOS met with Admiral Glang and Rick Brennan of the Office of Coast Survey to discuss the collaborations on precision navigation.

Task 5 - Facilitate communications and coordination among the regions through activities such as the monthly IOOS calls, website updates, email updates and hosting the outreach committee.

*Accomplishments*

- Second RA Director Meeting – September 1, 2015. For the second year, the RA Directors met for a day to discuss common issues. A major focus of this year’s meeting was the recently completed five-year funding proposals. A memorandum outlining suggestions for the next funding round was sent to the Program Office. Other topics included possible development of a common product.
- Outreach Committee. The Association hosts the monthly outreach calls with regions and the Program Office. Topics that were discussed during this project period include: 1) implementation on the new IOOS logo 2) MTS booth 3) review of the six month reporting format 4) User engagement 5) Metrics and 6) monthly roundtable updates.
- Scoping a national data portal of ocean acidification (OA) - On November 4<sup>th</sup>, the Association hosted a call with interested RA directors about the possibility of expanding the west coast OA portal to all interested regions. Jan Newton of NANOOS provided an overview. Next steps include: 1) east coast regions assessing their interest in participating 2) exploring the technical issues for integrating new data sets into the existing portal and 3) funding considerations.
- Metrics - All RA have agreed to convert to Google Universal and to begin to monitor # page of view and # of page hits to add the development of “IOOS by the Numbers.”
- The IOOS Association website features up-to-date stories and links concerning the broad range of IOOS activities

Task 6 - Develop a common voice on IOOS-related issues, develop updates on RA progress for NOAA, the IOOC and the IOOS Federal Advisory Committee. Serve as a clearinghouse for information for the RAs, represent the IOOS Association at RA meetings and at national conferences.

- IOOS Federal Advisory Committee. The IOOS Association Executive Director briefed the Committee in November about the work of the regions, reauthorization, certification, filling the gaps and other work of the Association.

- MTS Fall Meeting - The Executive Director represented the organization at the October MTS meeting that feature several IOOS related activities including an Ignite session, a Town Hall meeting and the roll out of the new IOOS logo.
- The IOOS Association has held meetings with several NOAA offices to build relationships with the regions. Meetings were held with Manson Brown, Holly Bamford, Rich Edwing and Ellen Clark of CO-Ops to discuss the integration of HFR data into CO-OPS data, the need for water level standards; Mary Erickson of NCOOS about the role that the RAs can play in ecological forecasting and implementation of HABARCA, and Kola Garber of the Sea Grant Office, and Sherri Goodman, new Director of the Consortium of Ocean Leadership.

#### Publications:

Josie Quintrell co-authored a chapter on “The Importance of Federal/Regional Relationship in Ocean Observing” in the book “Coastal Ocean Observing Systems: Advances and Synthesis” Edited by Yonggang Lui, Heather Kerkering and Robert H Weisburg. 2015.

## II. DATA MANAGEMENT

### Project Summary

Project IOOS/DMAC-04 provides essential support for coordination, operation and maintenance, tool enhancement and dataset enrollment, and IOOS harmonization for the Great Lakes Observing System’s Data Management and Communications (DMAC) infrastructure.

Major accomplishments for the period include:

- Rapid design, development and deployment of a data portal focused on harmful algal bloom (HABs) issues in Lake Erie (<http://habs.glos.us/map/>).
- Enrollment of nine new fixed sensors related to monitoring source waters at potable water plants along Lake Erie.
- Added e-mail alert for non-reporting sensors to improve response.
- Added ERDDAP services
- Design and implementation of alpha version of myGLOS replacement for existing general-purpose data portal.
- Formed and leading IOOS DMAC QARTOD Working Group to coordinate RA-BOA interactions.
- Virtualizing products to support move to virtual host servers for improved redundancy and failover.
- Updated Google Analytics to Google Universal and configured to match IOOS requests
- Added coordinated daily lake levels to services and portal
- Continued archiving of non-Federal sensor data with NCEI
- Supported “mini-DMAC” activities funded by GLOS through education and consultation with new data providers.

See also the Data Management Supplement

### DATA MANAGEMENT MINI GRANTS

As a follow-up to the Sea Grant Needs Assessment and GLRI Enterprise Architecture DMAC support studies, GLOS ran an *Improving Data Availability: Data Management Mini Grant* competition to support

projects that help make data more widely available. All of the 5 projects that were invited to submit full proposals in 2014 were awarded funding in 2015.

### **A Harmful Algal Bloom and Water Quality Data Management Program for Western Lake Erie**

*(PI: Thomas Bridgeman, University of Toledo)*

#### **Project Summary**

Presently, and for the past 13 years, the University of Toledo Lake Erie Center (LEC) has routinely collected harmful algal bloom (HAB) and water quality data in western Lake Erie. Although these data have been used in several scientific publications and have been made available to colleagues, the LEC has lacked the capacity to “make the data available to a wider potential audience of data users and stakeholders.” The LEC proposes here to partner with LimnoTech, an experienced data management developer, to create a data management and communication (DMAC) system that would provide the “local road” between the LEC data sets and GLOS, allowing increased access to archived data and a convenient portal for the LEC to provide data updates. The proposed DMAC system would fill a need for access to Lake Erie water quality data, particularly the intense interest in and requests for HAB data from a variety of stakeholders and fellow researchers.

#### **Progress and Accomplishments**

- Continue to meet monthly with Tom Bridgeman and Brenda Snyder to discuss how the University of Toledo and Tom’s research program can best benefit by data management.
- Work closely with Tom and his graduate students to review lab and data processing steps to determine what tools would make it easy to assist with the timely processing of data to get it online.
- Review the 2014 complete dataset as a model for setting up the database structure. Populate online database with dataset.
- Begin investigating ways to easily import and view data from the database.
- Review the netCDF format to determine the best way to put data from the database into a netCDF file.

### **An Open Standards Data and Metadata Pipeline for the Natural Resources Research Institute Great Lakes Data** *(PI: Terry N. Brown, University of Minnesota, Duluth)*

#### **Project Summary**

Many large, high-value Great Lakes focused data sets are generated by or managed by the University of Minnesota Duluth’s Natural Resources Research Institute (NRRI), including the “GLEI” (Great Lakes Environmental Indicators) projects and multiple basin wide environmental stress products. Our project deploys modern geospatial data and metadata federation technologies (CKAN) to increase the availability of these datasets and lower the barrier to their integration into other analyses. We will provide a web front end for direct interaction with NRRI datasets, harvestable metadata and data for federated searching and external data hosting, and GIS layers as web services (WMS / WCS / WFS / GeoJSON / KML / etc.) for simple integration into analyses being performed elsewhere.

#### **Progress and Accomplishments**

- We have finalized deployment of the CKAN server and held internal training sessions on its use.

- We have started using the system to publish data, both within and beyond the project scope (<http://data.nrri.umn.edu/data/dataset/glei-data>, <http://data.nrri.umn.edu/data/dataset/ws5971agdev>, etc.)

**Aiding management and advancing Great Lakes ecology: Combining 50+ years of data with the 2013 Lake Ontario Cooperative Science and Monitoring Initiative** (PI: Lars Rudstam, Cornell University)

**Project Summary**

The primary objective of our project is to consolidate five decades of ship-based limnological data for Lake Ontario, including water column profiles (temperature, dissolved oxygen, fluorescence, etc.), zooplankton communities and biomass, water chemistry and nutrients, and chlorophyll-a concentrations. Monitoring programs administered by binational government agencies and educational institutions have resulted in separate, but complimentary time series of spatially-referenced data. We are compiling these data sets to assist researchers and managers in understanding Lake Ontario ecosystem dynamics on a lake-wide scale and in a historical context.

Data resulting from intensive sampling years on Lake Ontario (Lake Ontario Lower Trophic Assessment [LOLA] in 2003 and 2008; Coordinated Science and Monitoring Initiative [CSMI] in 2013) are being included. Final reports and manuscripts describing the CSMI 2013 are in progress and will benefit from data being centralized, historically referenced and in a consistent format.

Compiled data sets will be made available through GLOS and hosted either by Cornell or GLOS. Quality control and quality assurance documentation that meet the requirements for GLOS certification will be provided with the data. Metadata records will be added to the GEO Great Lakes Metadata Catalog and potentially other metadata discovery tools.

**Progress and Accomplishments**

Many data sets have been contributed to our project and discussions continue to take place with collaborators to identify additional relevant data sets. We are working with contacts to find missing information, understand sampling methods and to address quality concerns for data that is being processed. Data sets that have been identified or acquired are described in the following table.

We have participated in bimonthly conference calls with GLOS representatives and other mini-DMAC grant recipients with the purpose of discussing common concerns and giving progress updates. Topics of discussion have included quality control and assurance, metadata content and formatting, data formatting, hosting data and data sharing.

For most profile and zooplankton data, scripts have been written in R to extract raw data from the original source files, translate them into a consistent format and output compiled data in flat text files. The resulting data tables have been imported in Access databases and organized into relational database structures. These databases are continually being updated to maintain flexibility in accepting data from different sources and to address requirements necessary for analysis.

To address quality control requirements we will provide GLOS with documentation of methods and checks incorporated into the data processing workflow and incorporate flags into the final databases. Checkpoints added to the R code will verify that processing occurs without making changes to the actual data. Queries within the Access files will flag data points if they exceed a range of accepted values.

Some checkpoints and flagging queries have been created, and these will be added to and updated as more data is processed and final database structures are realized.

The format and content of metadata records is still being determined. Metadata files in Ecological Metadata Language (EML) formatting from previous projects were supplied to determine if EML is compatible with the GeoNetwork format used by GLOS. It was determined that EML is not easily translated to the GeoNetwork format. The next step is to decide how metadata will be reported, whether by data type, source, project, etc. and work with GLOS to determine how to proceed.

On 10/7-8 Jim Watkins and Matt Paufve attended the GLOS Annual Meeting in Ann Arbor, Michigan. Jim presented about advanced technology in Lake Ontario research and contributing data to online repositories and visualization engines as part of the "Leveraging Technology: Working with Data" panel. We discussed preparing metadata and quality control measures for our data sets with Tad Slawecki and talked with colleagues about working with different types of profile data and applications for zooplankton data.

We also attended a meeting with CSMI 2013 sampling year participants on 11/9-10 at the Canadian Centre for Inland Waters in Burlington, Ontario. The meeting provided a chance to talk with data providers and promote our project to potential end users of the data. We discussed the zooplankton database structure and questions about sample information and collection methods with a data contributor. Applications for the compiled 2013 zooplankton data include an investigation of the role of *Dreissena veligers* in the pelagic zooplankton community and trophic connections with prey fish, determination of focal sampling stations in preparation for the CSMI 2018 sampling year, updating a mass balance Ecopath food web model, the role of zooplankton in deep chlorophyll layer dynamics and assessing the influence of time of day and stratified sampling on zooplankton biomass and density estimates. There is also interest in the profile database for creating a historical timeline of thermocline depth and comparing fluoroprobe profiles with chlorophyll for determining phytoplankton community composition.

**Building a Great Lakes Adaptation Data Suite (GLADS) for Informed Decision Making in the Great Lakes Region** (PI: David Schwab and Catherine Riseng, University of Michigan)

**Project Summary**

The overall goal of this project is to create a usable, standardized climate adaptation data resource for practitioners and researchers in the Great Lakes region. To accomplish this, we are acquiring, evaluating, and standardizing climate variables from atmosphere-focused and lake-focused observational data sets.

We have organized a team of committed research scientists with experience in both atmospheric and lake dynamics. Our final product will include climate adaptation related variables standardized to consistent temporal (hourly, daily, monthly) resolutions and spatial resolutions, consistent with the spatial approach modeled by the Great Lake Aquatic Habitat Framework (GLAHF). Many climatological datasets have been standardized and are ready for inclusion in the data suite.

**Progress and Accomplishments**

Our contract with the Great Lakes Observing System (GLOS) went into effect in late March 2015. Since that time we have taken the following steps to fulfill the contract:

- Prioritized critical data sets to include the suite



- Convened regular meetings of research stakeholders to advise the project course • Hired key temporary staff to lead data standardization efforts
- Presented the GLADS approach at two international events:
  - 2015 AGU-GAC-MAC-CGU Joint Assembly, Montreal, QC, CA
  - 2015 International Association of Great Lakes Research, Burlington, VT, USA
- Several climatological datasets have been standardized into a consistent output format:
  - NOAA NCEI Global Historical Climate Network-Daily (GHCN-Daily) station observations
  - NOAA NCEI Climate Division (nClimDiv) observations
  - NOAA NCEP Climate Forecast System Reanalysis (CFSR), aggregated to 0.5° x 0.5° latitude-longitude grid
  - University of Delaware (UDel) regrided, aggregated to 0.5° x 0.5° latitude-longitude grid
  - NOAA GLERL Great Lakes Monthly Maximum Ice Coverage
  - NOAA GLERL Great Lakes Monthly Average Lake Levels
- GLAHF Coordination
  - Work with GISP programmer to use NetCDF's in ArcGIS
  - The gridded products (CFSR and UDel) are used to create the raster files in ArcGIS
  - GLAHF gridded resolution: 9 km, 1.8 km, and 30 m, primarily using the 1.8 km grid for integration
  - Have meetings with programmer to check-in on progress

Through our engagements and effort to date the following lessons have emerged:

- There is a much higher interest in this effort from fundamental research scientists than we anticipated, including a high interest in this work among regional hydrologists and ecologists.
  - Much of this interest has been in the area of inter-comparison of gridded observations and modeled reanalysis products for performance over the Great Lakes region.
- Open source programming and software is incredibly important for this work. We are moving forward with our programming using Python, an OSI-approved open source license, making it freely usable and distributable, even for commercial use. R is another important open source programming software package being rapidly adopted across many fields.
- While many datasets are becoming more readily available through distribution channels which make the data easier to find, challenges of varied data quality and accessibility still remain, making it difficult to readily analyze data across multiple data-sets, particularly if the data originate in fields that require a wide range of expertise.
  - The ever increasing range of data availability and formats of original sources reinforces the need to adhere to community-accepted standards for metadata documentation.

**Bay of Green Bay Lower Fox River Data Management System** *(PI: Jessica Schultz, Fox-Wolf Watershed Alliance)*

### **Project Summary**

Expand the GLOS network through the development of a Regional Water Quality Data Management System to support of the restoration of Green Bay and implementation of the Lower Fox River Total Maximum Daily Load. This will include collection of historical and current data; building a dynamic, query-able data hub; creating a map user interface and a REST Access (in order to provide distributed interactions between systems), utilizing GIS tools for a wide variety of end users.

## **Progress and Accomplishments**

A template has been developed to standardize collection reporting for continuous data and grab sample data. This template (Excel spreadsheet format) is now a base for the design of a geodatabase, schema for which is in construction. Data testing, research and development for the ArcGIS prototype, and user interfaces (UI) implementing methods that take input data and return display data have been advanced. Bi-weekly and/or monthly discussions were held to ensure compatibility between systems, and provide updates and needed information. Some historical images of the Bay have been scanned for access in a digital format.

Supplementary actions:

- Attended monthly conference calls with mini DMAC project data managers and Data Curator for GLOS.
- Engaged end users in the beginning of development to ensure the information they need is being made available in a format they understand

## **III. OBSERVATIONS**

Note: Funds for Observation work are “bopped” to the Cooperative Institute Program and thence to the Cooperative Institute for Limnology and Ecosystem Research (CILER). CILER serves as the Institutional Partner that manages and executes the sub-awards for each of the academic institutional participants on the project. They execute the sub-awards through an existing Cooperative Agreement with host lab NOAA-GLERL. The following is intended as a summary update on their activity.

### **Project Summary: Observing Network**

The Great Lakes Observing System Regional Association (GLOS-RA) is implementing key observing system and modeling improvements over the 2011-2016 period that focus on critical needs of the Great Lakes region as identified through an extensive needs assessment process. The focus of this work is to develop new products for four priority issue areas that affect the health, well-being and economic viability of the region, these being: climate change impacts; ecosystem and food web dynamics; protection of public health; and navigation safety and efficiency. Critical information needs for these priority areas will be addressed by implementation of an array of integrated observations including new moorings and additional sensors to measure temperature and current profiles. AUV/gliders technologies have been initiated to collect critical transect information. Cross-lake ferries and other vessels of opportunity are being instrumented to collect repetitive observations of surface chemistry. Satellite remote sensing products are being derived to provide daily monitoring of lake surface loadings of nutrients and sediments.

### **Sub-Award: Cooperative Institute for Limnology and Ecosystems Research – University of Michigan**

*(PI: Tom Johengen)*

### **Project Summary**

CILER serves as the Institutional Partner that manages and executes the sub-awards for each of the academic institutional participants on the project. We will execute the sub-awards through our existing Cooperative Agreement with our host lab NOAA-GLERL. Partner institutions include: University of Wisconsin-Milwaukee, University of Minnesota Duluth Large Lakes Laboratory, Great Lake Regional

Consortium located at the SUNY College of Environmental Sciences and Forestry, Michigan Technological University, and Michigan Technological Research Institute.

An existing AUV and Glider system, previously purchased in PY2010, will be used in a shared context throughout the Great Lakes basin. These systems will be housed and maintained by CILER and we will work with each of the Partners to plan missions in each lake to serve local needs within their environments and that are coordinated with priorities of the Coordinated Science and Monitoring Initiative (annual bi-national lake-by-lake effort). CILER will support a Technician that will complete all of the initial set-up and calibration of the instruments and their sensors and travel with the instrument to support missions in each of the Partners field sites. In addition, CILER will collaborate with Dr. Guy Meadows of Michigan Tech to deploy, operate, maintain and retrieve two real-time coastal environmental monitoring buoys in Lake Michigan.

### **Progress and Accomplishments**

- The Ludington buoy was deployed 5-18-15 and recovered 11-14-15, it was operational and transmitted data to NDBC, GLOS and the UGLOS websites for the season except for a period of 10 days during which communication was lost. CILER's local partners, The Ludington Charter Fishermen Association assisted in servicing the buoy to get it back on line.
- The glider operated in conjunction with the EPA glider Nokomis for CSMI in partnership with EPA and USGS. The glider did three crossings (deployed over 60 days) from Muskegon to Milwaukee to continue a four year time series in conjunction with UMW tracing the ferry route as well as the buoys. The glider was transitioned to lithium batteries which give over 120 days of operation. The EPA glider was recovered twice, data was downloaded and it was re-deployed.
- The AUVs were used in support of a rapid spill response drill in the Straights of Mackinac in conjunction with the Coast Guard and GLERL.
- The Little Traverse Bay buoy was transitioned to CILER from MTU. It will be maintained and operated by CILER from now on in partnership with Irish Marina and the local communities.

### **Scope of Work**

This project is on schedule from a technical perspective and no changes to the scope of work have occurred.

#### **Planned Activities:**

- While the Ludington buoy is out of the water, its sensors will be calibrated and annual maintenance will be performed. The thermistor will be repaired or replaced and the buoy deployment for next season is planned for April.
- While the Little Travers Bay buoy is out of the water, its sensors will be calibrated and annual maintenance will be performed. The batteries will also be replaced with a new design to extend deployment time.
- There are a number of AUV missions planned for 2016 deployment season. Two of these deployments will be in partnership with UWM to study hypoxia events in Green Bay. Two other missions will be run in Lake Erie in partnership with GLERL to support the HABs modeling project.
- There will be two glider missions planned for Lake Michigan during the 2016 deployment season. One mission would be in partnership with Great Lakes Environmental Laboratory (GLERL). The glider will fly from Muskegon to Milwaukee and back, this data would be used to compliment the tow data collected by GLERL. One more Lake Michigan crossing is planned in

partnership with University of Wisconsin Milwaukee. This data would be to compliment pCO<sub>2</sub> data collected by the Lake Express.

**Sub-Award: University of Wisconsin-Milwaukee**

*(PIs: Val Klump and Harvey Bootsma)*

**Project Summary**

The overall objective of this GLOS effort is to increase observing capacity to improve wave forecasting, over-lake weather forecasting, circulation modeling, and monitoring of lake heat and water balances through the collection of continuous data from a variety of observing assets in Lake Michigan, and continued implementation of the GLOS Regional Coastal Ocean Observing System (Nearshore Network) conceptual design, based on a national blueprint. Additional objectives include the validation and improvement of air quality (ozone) forecast models, monitoring of long-term changes in nearshore water quality, and provision of water quality data and decision support tools for managers at municipal, state and federal levels.

**Progress and Accomplishments**

- **GLOS Monitoring Buoys:** Between April and November 2015, the UW-Milwaukee School of Freshwater Sciences (SFS) at the Great Lakes WATER Institute operated several observing systems as part of GLOS, including two nearshore buoys at depths of 10 m (Endurance) and 20 m (NOAA 45013) north of Milwaukee, a buoy in Green Bay (13 m, NOAA 45014) and a monitoring system on the high speed Lake Express ferry that operates between Milwaukee WI and Muskegon MI. The Lake Michigan GLOS buoys contribute to a larger Lake Michigan nearshore monitoring effort that is coordinated among UWM-SFS, the Wisconsin Department of Natural Resources which operates a monitoring station near Kewaunee, WI, and the National Park Service which contracts SFS to operate a monitoring station near Sleeping Bear Dunes National Lakeshore. These systems were fully operational during the reporting period.
- One of the shortcomings of the monitoring systems has been the inability to collect data during the winter months. To address this challenge, SFS has installed a monitoring system at a water intake site in Whitefish Bay (immediately north of Milwaukee), which is operated by the North Shore Water Commission (NSWC). Lake water temperature, CO<sub>2</sub> concentration, and chlorophyll *a* concentration are currently being monitored at this site.
- Previously replaced temperature strings on NOAA 45013 and 45014 operated throughout the 2015 season. Wave gauges were not deployed on either buoy for 2015 (issues with the system were described in previous reports). Inertial based wave gauges for NOAA 45013 and 45014 are to be purchased and installed over winter, with the expectation that they will be operational for 2016. We are also investigating the possibility of installing real-time camera systems on both buoys. These systems will provide images of current weather conditions and sea states around the buoys, and we expect they will be popular with public stakeholders, as they are in other parts of the lake.
- For the 2015 season, the observing systems were operable during the following times:
  - Milwaukee 45013 (20 m): Met station 4/23/15 to 11/10/15 (100%); Sondes 4/23/15 to 11/10/15 13 (93.5%); Aquadopp current meter 4/23/15 to 11/10/15 (100%); Temperature string 4/23/15 to 11/10/15 (100%). This buoy was also used as a platform to deploy dissolved oxygen monitoring probes provided by the EPA Great Lakes National Program Office.
  - Milwaukee Endurance Buoy (10 m): Met station 4/28/15 to 11/10/15 (approx. 75%); Sondes 4/29/15 to 11/10/15 (80%); CO<sub>2</sub> monitor 4/29/15 to 11/10/15 (73%) Failing sensors

- resulted in met station down time. Data gaps can be augmented with the nearby Milwaukee 45013 buoy met data. In addition to the above measurements, this buoy is augmented by several bottom sensors, including a light logger, a bottom sonde, and a time lapse camera that were deployed 4/29/2015 and recovered 11/10/2015. The data from these sensors are being used to calibrate and validate a nearshore ecosystem model that has been requested by the Milwaukee Metropolitan Sewerage District and the Wisconsin DNR to predict the severity of nuisance algal blooms and to develop nutrient management criteria for the Lake Michigan nearshore zone.
- Green Bay 45014: Met station 6/10/15 to 10/27/15 (100%); Sondes 6/10/15 to 10/27/15 (98%); Aquadopp current meter 6/10/15 to 10/27/15 (100%); Temperature string 6/10/15 to 10/27/15 (100%). Surface water oxygen sensor data combined with meteorological data from this buoy are producing the first continuous estimates of oxygen exchange across the air-water interface, water column gross primary production (GPP), and net ecosystem production (NEP) in Green Bay. These data are contributing to a larger effort to understand the drivers of hypoxic and anoxic conditions in the bay.
  - Lake Express High-Speed Ferry: The high-speed ferry monitoring system was installed on May 27<sup>th</sup> and recovered October 29<sup>th</sup>. The system had occasional service requirements which resulted in minimal data gaps for the 2015 ferry operating season (May-Oct). Some of these data have been used to calibrate and validate a Lake Michigan hydrodynamic / biogeochemical model (currently in press in Journal of Geophysical Research: Oceans).
  - Northshore Water Monitoring: The over-winter nearshore monitoring system was deployed October 20<sup>th</sup>.

### **Scope of Work**

In addition to the routine monitoring program, several additional activities are being conducted, including the installation of the new over-winter monitoring system, installation of inertial wave gauges, and consideration of real-time camera systems. In addition, a public website is being developed for dissemination of archived data and in the future will serve as a portal to real-time buoy images. Data processing protocols are being further developed to improve quality assurance of collected data before it is disseminated.

### **Sub-Award: University of Minnesota-Duluth**

*(PI: Jay Austin)*

*June-November 2015*

### **Project Summary**

The goal of this project is to improve meteorological and limnological observations in the western portion of Lake Superior. This is being achieved through the use of two well-instrumented meteorological buoys, autonomous gliders, and harbor instrumentation

### **Progress and accomplishments**

- Meteorological buoys 45027 (LLO1) and 45028 (LLO2)
  - Deployed 13 May 2015 at the same locations as in previous years. Recovered 11 November 2015.
  - LLO2 had a battery failure on 6 November, less than a week before its scheduled recovery.

When disassembled, a small amount of water was found inside the buoy housing. We hypothesize that this led to a slow short somewhere.

- Standard instrumentation (WS/WD, AT, RH, BP, LW (LLO1), SW, PAR (LLO1), WTx10, waves (LLO2)), plus the addition of a multi-sensor package on LLO1 (Lufft WS-600), which also measured precipitation type and amount. This is one of very few over-water precipitation sensors on the Great Lakes.
- The multi-sensor provided redundant measurements of WS/WD, AT, and RH. These data compared favorably to the primary sensors.
- Data ported to GLOS and NDBC. Data archived at UMD.
- Post recovery activities:
  - Replacement of LLO2 batteries
  - Replacement of coin batteries in both dataloggers
  - Preparation of data report.
  - Replacement of LLO2 main sealing gasket.
  - Cleaning of buoy hulls, which are showing their age.
  - Update logger firmware, shoreside software.
  - Work with Ed Verhamme to improve local outreach visibility.
- Autonomous gliders Gichigami and Nokomis
  - Gichigami: three Keweenaw to Isle Royale crossings (out and back) ably assisted by MTU boat crews for deployment and recovery. Late start to the season due to the glider being at TWR for repair (last year's leak).
  - Nokomis: two long deployments in Lake Michigan in support of CSMI, plus a short check-out deployment in the western arm of Lake Superior early in the season.
- Harbor instrumentation
  - Superior entry equipment deployed and recovered. We are forming a more formal partnership with the Lake Superior National Estuarine Research Reserve to operate this equipment, as they already have such a large presence in the harbor. We are sharing data freely with them.

#### **Publications and presentations, with GLOS acknowledgements:**

Florentino, L. and **J. Austin**, Spatial and temporal structure of the benthic nepheloid layer in Lake Superior. International Association of Great Lakes Research annual meeting, Burlington, VT. May 2015.

Bernstein, D.N, Austin, J.A, Xue, P, Spence, C., and Blanken, P.D., Estimation of the Spatial Distribution of Evaporative Flux on Lake Superior. IAGLR 2015.

#### **Outreach**

- We continue our collaboration with the Great Lakes Aquarium, with a display showing data from the meteorological buoys.
- We are going to work in the coming season to improve our web presence, social media presence, and public regional visibility.
- Received a public engagement grant to work on an educational installation for the Great Lakes Aquarium.

#### **Synergistic activities (activities not funded by GLOS but addressing the goals of GLOS)**

Several currently funded projects have strong synergy with GLOS goals

- Series of deployments of Autonomous moored Profilers at LLO2 site. Measuring a wide variety of biogeochemically relevant parameters at high vertical resolution and medium time resolution

(12 or 36h repeat). Profiler currently deployed and should operate until next Spring.

- A single open lake mooring continues to be maintained at the western mooring (45006) site.
- EPA funding to further develop models of circulation and thermodynamics in the St. Louis Estuary/Duluth Harbor/Lake Superior system.
- LCCMR funding to work on characterization of the western arm of Superior, and to develop models of open lake circulation

#### **Sub-award: Michigan Technological University**

*(PIs: Guy Meadows, and W. Charles Kerfoot)*

#### **A. Buoy and Other Physical Observations**

##### **Project Summary**

Michigan Tech supports GLOS by calibrating, deploying and operating two buoys in Lake Superior near the north and south entrances to the Keweenaw Waterway, one buoy in Little Traverse Bay of Northern Lake Michigan, one buoy in the Straits of Mackinac (leveraged using non- IOOS funding), and deploying a temperature profiling array on both entrances to the Keweenaw Waterway. Little Traverse Bay buoy will be maintained in 2016 by CILER.

Additionally, during the period just ended, Michigan Tech supported joint operations support of three glider missions (7/22, 9/2, and 11/4) between North Entry and Isle Royale. Launched, recovered and transported the LLO Slocum glider in cooperation with Dr. Jay Austin of UMD LLO.

To support the reporting of the real-time buoy observations, an interactive web portal site ([greatlakesbuoys.org](http://greatlakesbuoys.org)) has continued to be developed and maintained by Michigan Tech. This website not only supports the Michigan Tech real-time assets but also those of other GLOS participants, twenty-two assets total. This website nominally provides rapid response, ten-minute data from all buoys and sensor systems to more fully capture the dynamics of the coastal zone and to augment the hourly observations provided by NDBC. The data collected by Michigan Tech is shared with GLOS and the NDBC.

##### **Progress and Accomplishments**

- Integrated and deployed an additional TIDAS buoy in the Straits of Mackinac mid-season (August). This platform includes the only near real-time ADCP data in the Straits. The buoy was leveraged from non-IOOS funding.
- Optimized GLOS-wide ADCP code for improved accuracy. Shared this optimization with all GLOS partners using ADCP's.
- Upgraded battery capacity on two Lake Superior buoys. This resulted in fewer power issues during the fall season.
- Continued work on buoy energy management systems and exploration of potential power generation via wave motion.
- Completed QA/QC for all buoy sites.
- Recovered and refurbished each buoy (3) and will redeploy in late May 2016. Little Traverse Bay buoy was recovered, and will be maintained in the future, by CILER.
- Monitored and maintained new mooring design for all four buoys.
- Continued analysis of ADCP and sonde measurements made from the North buoy.
- Continued to maintain and operate GLRC roof top/waterfront met station.
- Continued co-located live video to support the met station at the GLRC (supported by funding from Michigan Tech).

- Launched, recovered and delivered the LLO Slocum glider three times in cooperation with Dr. Jay Austin of LLO (using supplemental GLOS funding).

**Sub-award: Michigan Technological University- Remote Sensing Component**

*(PIs: Robert Shuchman and Mike Sayers)*

**B. Remote Sensing Observations**

**Project Summary**

The overall goal of the GLOS remote sensing activity is to further advance the use of ocean color satellites to map water quality in the Great Lakes. The water quality parameters that are retrieved from the satellite data include chl, doc, sm, HABs, optical properties (Kd 490 (clarity), KdPAR, and photic depth) sediment plumes, primary productivity (PP), and Lake Bottom mapping.

To support the further development of remote sensing algorithms and derived products an extensive database of *in situ* optical water properties and coincident chemistry has been constructed to provide this data to the broader user community. This Great Lakes Optical Properties Geospatial Database can be found at [www.glopgd.org](http://www.glopgd.org). Additional in situ water optical properties are being measured this summer in Lakes Michigan, Huron (Saginaw Bay) and Erie in collaboration with NOAA/GLERL. The following Five tasks are being performed under this GLOS remote sensing initiative:

1. Clean-up, document, and distribute through a web based distribution system the Great Lakes Optical Properties Geospatial Database (GLOPGD).
2. Generate satellite derived time series products of the Great Lakes to support the GLOS mission.
3. Transition the CPA-A algorithm to NOAA for use operationally within the Great Lakes Coast Watch System.
4. Document in reports, journal articles, and conference presentations the algorithms description (CPA-A, HABs, lake bottom mapping), their initial performance and recommendations for additional work. Provide the algorithms and share our findings with NOAA and other Great Lakes scientists.
5. Collaborate with Dr Jay Austin on evaluating the utility of fusing glider data with derived remote sensing products to improve the understanding of water properties changes at the surface as well as depth.

**Progress and Accomplishments since the Last Reporting Period**

- Continue to update the GLOPGD website ([www.glopgd.org](http://www.glopgd.org)) with additional data sets collected in collaboration with NOAA/GLERL. The new IOP measurements include time series in Lakes Erie, Michigan and Saginaw Bay.
- Finalized the monthly retrievals (2002 –present) of chl, doc, and sm, cdom, KPAR, and photic zone for all three upper Great Lakes.
- Generated additional satellite remote sensing derived products of Lake Superior that will be combined with the 2014 and 2015 University of Minnesota- Duluth Glider deployments.
- Generated additional example remote sensing data products for GLOS DMAC.
- Continue transitioning the CPA-A chl, doc, and sm retrieval algorithm to NOAA for operational use in the NOAA Great Lakes Coast Watch system.
- Presentations/Posters

**Presentations**



Grimm, Brooks, R.A. Shuchman, M. Sayers, L. Bourgeau-Chavez, 2015 Remote Sensing for Great Lakes Mapping and Monitoring, 9th Biennial State of Lake Michigan/15th Annual Great Lakes Beach Association Joint Conference (Presentation), Acme, MI. 23-30 October, 2015

Grimm, A., C. Brooks, M. Sayers, R. Shuchman, M. Auer. 2015. Mapping Submerged Aquatic Vegetation in the Great Lakes Using Satellite Imagery, 9th Biennial State of Lake Michigan/15th Annual Great Lakes Beach Association Joint Conference (Presentation), Acme, MI. 23-30 October, 2015

### **Posters**

R. A. Shuchman, G. L. Fahnenstiel, M. Sayers, G. Leshkevich. 2015. Development of New Regional Carbon Monitoring Products for the Great Lakes Using Satellite Remote Sensing Data (Poster). International Ocean Colour Science (IOCS) Meeting, San Francisco, CA. 15-18 June, 2015.

### **Sub-award: Great Lakes Research Consortium, SUNY-ESF**

*(PI: Greg Boyer)*

### **Project Summary**

The overall goals of the work was to improve our understanding of the nearshore environment along the New York Coasts of Lake Ontario and Lake Erie, with a particular emphasis on how these environments will respond to a changing climate and to understand the nutrient and water column dynamics related to harmful and nuisance algal blooms.

### **Progress and Accomplishments**

- All buoys have been retrieved and serviced for winter storage.
- Due to issues with the offshore anchor system, the TIDAS buoy to be deployed off of Oswego NY remained in the Oswego Harbor for the summer. Four attempts were made to locate and attach the buoy to the existing anchor system – all failed. The system continued to broadcast information from within the harbor, giving us an unplanned look at water changes within the harbor. Analysis of that data string is currently in progress. Over the winter, we will be doing a full review of that water quality information for Quality Control and Quality Assurance. We have also obtained new anchors for the Oswego buoy and will deploy them in early spring pending ship availability.
- The E. Lake Erie TIDAS Buoy operated by the Buffalo State College was deployed approximately 5 miles N of Dunkirk, NY in 33 meters of water on June 4, 2015- (Because of another unusually cold winter ice remained on the lake well into May, pushing back availability of a vessel to deploy the mooring system) The buoy was recovered on October 26, 2015. With the exception of one t-node sensor all the systems, (weather station, t-nodes, YSI, wave height) functioned normally throughout the entire season. During the winter of 2014-2015 the t-string cable was replaced with an armored cable and new t-nodes, this replacement system seems to have functioned much better than the original cable and t-node system. Upon retrieval of the buoy in October significant wear was observed in the cable clamps. Failure of these clamps resulted in significant wear on the YSI data cable and the tether cable. Although no data were lost because of this damage both cables will need to be replaced and we will also need to come up with a different cable clamping system.
- The failure of the TIDAS buoy interface with the YSI sonde remains a major issue as this is our primary sensor for chlorophyll and algal pigments. The systems were fully evaluated by engineers from NexSens to determine the cause of instrument failure. We have tested several

different connector systems without success and will evaluate several different new connectors over the winter storage season.

- In summer of 2015, we deployed three MB300 Bay buoys in Sodus Bay Lake Ontario specifically to monitor for harmful algal blooms. This effort was jointly funded by the Great Lakes Restoration Initiative. Over the winter, changes were made to all 3 MB300 to allow better flow around the submerged C6 sensor. This consisted of drilling a series of holes in the ballast tube above and below the area in which sits the C6. In addition, stand-alone temperature loggers were purchased with the intent of being deployed in the hypolimnetic waters of Sodus Bay. All three buoys worked well with the meteorological data from the center buoy and the thermistor string approaching 100% successful data transfer. Interface with the C6 sounds approached 80% with the bulk of the missing 20% correlated with when we needed to remove the sondes from the water for calibration and cleaning. This information was transferred to the GLOS website.
- Winter efforts are focusing on fine tuning the C6 and sonde calibration protocols for all 5 buoys. This includes additional tank testing to look at calibration protocols and secondary standards. All the sondes will be taken apart, cleaned, reassembled and recalibrated as needed. Sensors on both the C6 units and YSI 6600 series sondes that fail our QAQC checks will be replaced as needed. New pH probes were installed on all 6600 series sondes in 2015.
- We moved and fixed our shore based weather station located in Sodus Bay at LeRoy Island. This was to repair the wind sensor and corresponding data logger to eliminate aesthetic complaints from the homeowner that was hosting the installation. That system will continue to function over the winter through the ice season and provide important year round information.
- In summer 2015, we hosted a GLOS intern (Morgan Zyzik) who deployed a dock mounted sensor system for cyanobacteria at the Sodus Bay Yacht club. The sensor system received considerable interest from the public and provided high quality data on the occurrence of algal blooms in the marina. We are currently evaluating next steps for that aspect of the project.

### **Scope of Work**

- This project on schedule from a technical perspective with four of five buoys successfully deployed in Lake Ontario and Lake Erie plus a supplemental weather station on the shores of LeRoy Island. All four sites were available through the NDBC website and the LeRoy island site continues to be available over through GLRC and the GLOS data portals. Several of our buoys were equipped with sensors for algal and cyanobacterial abundance. Unfortunately we have been unable to successfully transfer that information to the GLOS data portal. This remains an area of focus in the upcoming winter.
- Currently plans are to deploy the Oswego buoy in late May of 2016. We will need to redesign the mooring system based on the fact that our buoy broke free in fall of 2014 and we could not deploy a suitable anchor system in 2015. This prevented its deployment offshore of Oswego Harbor in 2015. The MB300 bay buoys will also be deployed in Sodus Bay starting in late May to catch the start of the phytoplankton season.
- The Lake Erie buoy is in generally good condition and we expect deployment again in May of 2016 following winter maintenance and repairs. There are components that need to be replaced during the winter of 2015-2016 as well as routine calibrations. Components of the anchor system may need to be replaced as well, but that won't be determined until we have retrieved the anchor, chains, and nylon tether line (November 2015). The biggest challenge with the Dunkirk buoy that we are aware of at this time is finding a better system for clamping the four cables (data and tether) that run to a depth of 25 m.

## **LEVERAGED OBSERVATIONS: Coastal Storms Program**

GLOS was provided another opportunity by NOAA's Coastal Storms Program to administer 2014 funding for observing assets in the Great Lakes region. Contracting was completed for 2 projects in December, and projects are underway.

**A Coastal Hazard Observing System for Southeastern Lake Superior** (PI: Norma J. Froelich, Northern Michigan University)

### **Project Summary**

The long stretch of beaches and coastal rock formations along the southeastern shore of Lake Superior make it a popular destination for swimming, kayaking, surfing, recreational boating, and fishing. This shoreline, which stretches from west of the Huron Islands to east of Whitefish Point, encompasses the coastal communities of Marquette, Munising, and Grand Marais, as well as popular tourist destinations such as Pictured Rocks National Lakeshore and Whitefish Point. Despite the popularity of this region, as well as its use by the commercial shipping industry, no nearshore measurements of wave height are available along the entire, 300-km stretch of shoreline. The proposed project will establish a coastal hazard observing system for southeastern Lake Superior that includes: 1) an environmental data buoy within five nautical miles of Pictured Rocks National Lakeshore (near Munising), and 2) a standalone wave buoy that will be deployed at a variety of locations. The new data buoy will provide observations of weather, wave height / period / direction, and water temperature, while the standalone wave buoy will be deployed at Granite Island (near Marquette) in year 1 and other strategic locations in subsequent years (e.g., Grand Marais, Whitefish Point) to characterize variations in the nearshore wave climate. Granite Island, a leveraged NMU research site, is presently the only over-lake meteorological site in the nearshore region. All data from the observing system will be provided in real-time to GLOS, the National Weather Service, a project website and smartphone app, and emergency management officials. We will engage with local communities and the National Park Service to provide education and outreach materials, to ensure effective dissemination and use of the data, and to provide long-term support and maintenance for the observing system.

### **Progress and Accomplishments**

Progress and accomplishments for the current reporting period included the following:

- Final assembly of a TIDAS-900 environmental data buoy was completed at Seaview Systems. The data buoy includes weather and wave sensors, a thermistor string, datalogger and communications, power supply, and a donated webcam (and modem).
- The TIDAS-900 buoy was transported to Marquette and temporarily deployed at Granite Island (~100m south of the island) on June 16, 2015. This temporary deployment occurred while awaiting anchor deployment in Munising (by the Coast Guard), which allowed for an intercomparison of the two buoy designs used in this project (the TIDAS-900 and NexSens). A photo of the TIDAS-900 buoy at Granite Island is included below.
- The 1700-lb mooring anchor was transported to Duluth, where it was loaded onto the Coast Guard Cutter Alder. The Alder deployed the anchor offshore from Munising on July 20, 2015.
- On July 31, the TIDAS-900 buoy was towed from its temporary location at Granite Island and deployed ~5 nautical miles offshore from Pictured Rocks, near Munising. A photo of the buoy is included below, and the exact deployment location is as follows: 46°34'22" N, 86°34'19.8." W (46°34.3667' N, 86°34.3333' W)

- A mobile app was developed to provide simple, readily accessible real-time data (free-of-charge) to users with Apple or Android devices. The app “Superior Buoys” was tested and launched (~October 15, 2015). A screenshot of the app is included below.
- The Munising buoy was retrieved on November 8, 2015, and put in storage in Munising.
- The Granite Island buoy was retrieved on November 10, 2015, and put in storage in Marquette.
- The top of the Munising buoy was transported to Sault Ste. Marie, Michigan. It has been set up on the south shore of the St. Marys River, a few miles upstream of the Soo Locks. The meteorological sensors will be used to monitor winter weather conditions, while photos and videos from the webcam will show ice development and ship traffic on the river (<http://www.limnotechdata.com/stations/Munising/>). It is anticipated that this winter utilization of the webcam will attract new users from the far eastern end of Lake Superior, potentially in advance of buoy deployment near Whitefish Point in 2016.
- Arrangements are currently being made with the Coast Guard and several private boat owners to coordinate retrieval of the Grand Marais data buoy in early December 2015. The buoy is still operating and providing high-quality data and, as of November 25, is the only remaining buoy on Lake Superior. Anecdotal input from the NWS (Marquette office) indicates that continued late operation of this buoy into the current warm, El Niño winter will be very valuable.
- Development of interpretive displays is in progress (see attached mock-up). These signs will be installed in spring 2016 at public boat launches in Marquette, Munising, Grand Marais, and Pictured Rocks.
- The domain name superiorbuoys.org was purchased, and development of content for the main project website is in progress.

### **Changes to Scope of work**

Two changes to the scope of work – as a result of private donations – have resulted in enhancements to the proposed project. This includes:

- Donation of funds (from Pictured Rocks Cruises, Inc. and the Munising Visitors Bureau) to purchase a webcam for the Munising buoy. This has provided real-time still images and videos to monitor waves, fog, and other weather conditions.
- The landowner of Granite Island donated funds to purchase a second, complete wave sensor for deployment at Granite Island. The purchase of a second, stand-alone wave buoy allowed the other (GLOS-funded) wave sensor to be deployed at Grand Marais in year 1, instead of year 2 (as was originally proposed). The privately-funded buoy will remain seasonally deployed at Granite Island, while the Grand Marais buoy may be placed near Whitefish Point in year 2 of the project.

Three problems were encountered related to sensor problems and deployment / retrieval, but this has led to relatively little change in scope for the project.

- Deployment of the Munising anchor was delayed due to the inability of various agencies to assist with the large anchor (U.S. Coast Guard, Michigan DNR, and USGS were all contacted). The National Weather Service prevailed on the Coast Guard to assist with the deployment, and the anchor was finally deployed on July 15, 2015. Due to this delay, the TIDAS-900 buoy intended for Munising was instead deployed temporarily at Granite Island from June 16 – July 31, 2015. Despite the delay, however, this did provide a unique opportunity to compare wave measurements from the two buoy designs (TIDAS-900 and NexSens). Preliminary comparison of the two datasets shows very good correspondence in similar wind conditions.
- The temperature string on the TIDAS-900 buoy (at Munising) began to fail in mid-August due to problems with internal strain relief. It was retrieved from the lake on September 5 and returned

to the original manufacturer (RBR) for a warranty repair, as the company had seen similar problems with other devices. RBR is developing a new design for their temperature strings and will incorporate this into their repair of the unit. The new temperature string will be ready for deployment in spring 2016.

- During a strong storm (the night of November 5-6), the Munising buoy broke free of its mooring and drifted toward Pictured Rocks National Lakeshore. Despite up to 10-foot waves, it managed to safely beach itself ~150 m offshore from Miners Beach (approximately 8.1 km southeast of its original location). The buoy was retrieved (without damage) on November 8. The mooring line and anchor, however, may be lost, as the line was severed about halfway down, due to chaffing (of unknown source) at the bottom of the lake. Local businesses have offered to use underwater cameras to search and grapple for the mooring line in the spring. The 2016 location for this buoy may depend on whether the mooring line is successfully recovered. If not, we may move the “Munising buoy” to the existing anchor / mooring location at Grand Marais, and then also shift the “Grand Marais buoy” to Whitefish Point. Our intent would be to return the “Munising buoy” to its original location in 2017, once the anchor / mooring issue has been resolved.

**Real-time data gathering buoy in the Illinois waters of Lake Michigan** (PI: Tomas Höök and Ed Verhamme, LimnoTech, Purdue University)

### **Project Summary**

The Illinois coast of Lake Michigan is home to three million people, and is one of the most densely populated regions of any Great Lakes coast. Despite the high population density, potential for strong wave action, and economic importance of this region, there are currently no nearshore real-time monitoring data, e.g., wave height, water temperature, water quality, being collected from non-swimming areas or in > 5 feet of water. We propose to place a real-time monitoring buoy in the nearshore waters of Lake Michigan just north of Chicago, approximately 3 miles offshore. We will leverage on-going education and outreach activities within our organizations and will connect with local stakeholders, e.g., NWS scientists, recreational boaters, to inform them of this and other real-time monitoring equipment in the Great Lakes region, with a goal to increase personal safety.

Progress and Accomplishments

### **Progress and Accomplishments**

Our project was divided into seven categories of work (see Table 1). We have made progress in the following areas:

1. **Acquire buoy hardware and software.** The buoy was purchased through Purdue University. LimnoTech facilitated proper function of all sensors, and staff from both institutions worked to ensure proper communication with interested stakeholders via various channels (i.e. multiple websites, text-a-buoy, dial-a-buoy). **This task is complete.**
2. **Acquire permits.** Purdue University/Illinois-Indiana Sea Grant (IISG) staff will reapply for permits for the 2016 season. **For 2015, this task is complete.**
3. **Deploy, repair, revise data as necessary.** The buoy was first deployed on August 4, 2015 by staff from LimnoTech and Purdue University/IISG. Repairs were completed on August 27, 2015 by LimnoTech. The buoy was retrieved on November 1, 2015 by staff from LimnoTech and Purdue University. Data were continuously transmitted to the National Data Buoy Center ([http://www.ndbc.noaa.gov/station\\_page.php?station=45174](http://www.ndbc.noaa.gov/station_page.php?station=45174)), [greatlakesbuoys.org](http://greatlakesbuoys.org) ([http://greatlakesbuoys.org/station\\_page.php?station=45174](http://greatlakesbuoys.org/station_page.php?station=45174)), GLOS, and the IISG site

(<http://iiseagrant.org/wilmettebuoy/index.php>). Data issues were addressed and comments from end users were relayed between project partners and appropriate NOAA staff members.

4. **Winter repairs if necessary.** The buoy is currently being evaluated. At this time, repairs are not anticipated.
5. **QC data and post to historic databases.** Data have been archived at the NDBC site and by IISG. Quality control is currently being performed by LimnoTech.
6. **Plan workshop.** Purdue University/IISG staff have initiated conversations with local stakeholders and currently plan to conduct two workshops with local stakeholders: one directed at anglers and recreational fishers, the other directed at sailors and paddlers.

#### **News stories related to the Wilmette buoy: (metrics included for those we can track)**

- <http://lakesideviews.blogspot.com/2015/11/bye-bye-buoy.html>  
Twitter: 1,263 impressions, 29 engagements  
Facebook: 402 people reached  
Blogger (Lakeside Views): 224 pageviews
- <http://lakesideviews.blogspot.com/2015/11/friday-foto-michigan-city-buoy-picks-up.html>  
Twitter: 722 impressions, 12 engagements  
Facebook: 599 people reached  
Blogger (Lakeside Views): 201 pageviews
- <http://lakesideviews.blogspot.com/2015/08/new-buoy-offers-real-time-lake-michigan.html>  
Twitter: 3,747 impressions, 67 engagements  
Facebook: 328 people reached  
Blogger (Lakeside Views): 1,122 pageviews
- [https://www.facebook.com/permalink.php?story\\_fbid=796975783755051&id=738860142899949](https://www.facebook.com/permalink.php?story_fbid=796975783755051&id=738860142899949)
- <http://www.fondriest.com/news/new-lake-michigan-buoy-to-provide-nearshore-info-to-beachgoers-scientists.htm>
- <http://www.journalgazette.net/news/local/indiana/Buoy-reads-conditions-on-lake-to-alert-public-8668676>
- <http://havekayakswilltravel.com/its-a-buoy-chicago-gets-a-new-data-station/>
- <http://chicago.suntimes.com/outdoors/7/71/860169/anchoring-weather-buoy-water-memories>
- <http://www.illinoispadding.info/2015/09/illinois-first-lake-michigan-weather-buoy/>
- <http://www.chicagotribune.com/news/local/breaking/ct-windsurfers-lake-michigan-met-20150929-story.html>

#### **Data requests for station 45174:**

79,000 data requests from greatlakesbuoys.org

50,000 data requests from ndbc.noaa.gov

22,000 pageviews of the webcam website <http://www.limnotechdata.com/stations/Wilmette/>

1,700 pageviews of the IISG website (note this does not include data for individual graph pageviews)

<http://iiseagrant.org/wilmettebuoy/index.php>

#### **Changes to Scope of Work**

Deployment of the buoy was delayed from May to August 2015. This was due to unanticipated delays in production of the buoy and anchor. Given distance to travel and method of deployment, placing the anchor (diver and boat time donated by partners at Henry's Sports and Bait Shop in Chicago, IL) required

near-perfect conditions, which resulted in further delays to deployment. We do not anticipate similar delays in the 2016 season.

Given the length of time the buoy was in the water and the expected revisions to how data were being transmitted and displayed, we have decided to conduct the outreach workshop(s) as a lead-in to the 2016 season. We believe this will provide a better platform for discussing the buoy and gathering meaningful feedback.

### **West Michigan Buoy Project** (PI: Ed Verhamme, LimnoTech)

#### **Project Summary**

For this project, GLOS has secured funding through the NOAA Coastal Storms Program to fund the deployment and maintenance of one buoy in West Michigan in the nearshore waters of Lake Michigan from 2013 to 2015. Deploy a monitoring buoy system capable of transmitting a basic set of physical parameters (wave height and direction, air and water temperature, wind speed and direction, and air pressure) in real-time to several data portals. This includes securing all permits, the buoy hull, instruments/electronics, mooring, and the entire data management systems to deliver data from the buoy to data portals. Deploy the buoy by May 15 and retrieve after November 1 from 2013 to 2015 offshore of Grand Haven, MI. Visit buoy if needed throughout deployment period to address instruments issues and equipment failures. Develop a data management plan and maintenance schedule that ensures all transmitted data is high quality. Address any problems immediately. Work with local community organizations to develop a plan to deploy buoy beyond the end of the project.

#### **Progress and Accomplishments**

- Buoy was deployed continuously from Late April 2015 to October 2015.
- Greatlakesbuoys.org and ndbc.noaa.gov logged nearly 800,000 web requests for buoy observations in the 2015 boating season.
- Webcam partnership with WOODTV allowed video clips to be broadcast on air many times during the 2015 season to a monthly audience of nearly 800,000 in the greater Grand Rapids area.
- Webcam website received nearly 100,000 page views just for the Port Sheldon buoy cam images
- Began a campaign with GLOS to help secure O&M funds for 2016 deployment. A public meeting is being held in the Holland area on Dec 7 with a public fundraising campaign to follow.
- Worked with local newspaper to publish story about buoy's need for additional funding [http://www.mlive.com/news/grand-rapids/index.ssf/2015/11/port\\_sheldon\\_holland\\_buoy.html](http://www.mlive.com/news/grand-rapids/index.ssf/2015/11/port_sheldon_holland_buoy.html)
- Holland Community Television produced a great video segment during the deployment of the buoy in spring 2015. <https://www.youtube.com/watch?v=OHE8FhHOTmE>

### **A Buoy for the Pennsylvania Waters of Lake Erie** (PI: Jeanette Schnars, Regional Science Consortium)

#### **Project Summary**

Prior to the Regional Science Consortium's (RSC) Nearshore Buoy project, there were no weather buoys reporting real-time data for the nearshore forecast on Lake Erie except for the one at Sandusky, Ohio. The Nearshore Buoy deployed off of Erie, Pennsylvania by the RSC reports realtime weather, wave, and water conditions providing the missing data to the NOAA-National Weather Service, the Great Lakes Observing System (GLOS), and the RSC. The objectives for this project were to design a nearshore buoy

which included a weather station, water quality sonde, and wave meter. In addition the buoy system was also outfitted with a video camera to provide a visual of lake conditions. The project also created and distributed information to recreational water users in a variety of venues on accessing the data collected from the Nearshore Buoy System, which resulted in community support for the nearshore buoy system.

The buoy measures 17 different parameters using a weather station, accelerometer (wave meter), and water quality sonde. In addition the buoy was outfitted with a video camera which captures 10 second video clips of the Lake Erie weather and wave conditions and posts the videos on the website approximately each hour. All data and video clips are publically accessible at [www.PaLakeErieBuoy.com](http://www.PaLakeErieBuoy.com). The website received a maximum of 48,822 (July 2014) visits per month, averaging 1,575 visits per day, with 13,457 unique users. This far exceeded the expected website visits.

### **Progress and Accomplishments**

- This project was completed in August 31, 2015. In conclusion, the Nearshore Buoy project has been a great success and received a great deal of community support. All goals and objectives for this project were attained and often exceeded. The funds received through the Great Lakes Observing System were a critical part of creating the community awareness needed to promote the use of the buoy for safe boating practices on Lake Erie. In addition, the funding from this grant has created a great deal of community support that will financially sustain the Nearshore Buoy project into the future.
- The Lake Erie Buoy System was deployed and operational for a second season May 6, 2015 – October 21, 2015.
- All real-time data and video clips are publically accessible at [www.PaLakeErieBouy.com](http://www.PaLakeErieBouy.com).
- In August 2015 the analytics reported 13,457 unique users.
- A Text Alert App was released to the public June 2015 and an outreach campaign with informational card (Figure 4) and guest lectures accompanied the full launch of the text alert system.
- As a result of two successful years of data provided to the public and many guest lectures, the RSC has received over \$10,000 in community donations to support future
- deployment/retrieval, maintenance, and operations of the buoy. These funds will cover the 2016 costs. We continue to raise funds for future support of the buoy.
- Presented on Buoy at Summer Slam Fishing Tournament Weigh-In (June 20, 2015) - >100 attendees, and the Charter Boat Captain Association (July 11, 2015) – 18 attendees

### **LEVERAGED OBSERVATIONS: SOAR**

#### **Lake Erie Information System SOAR Buoy – Cleveland DO monitoring (PI: Ed Verhamme, LimnoTech)** **Project Summary**

The bottom waters of central Lake Erie regularly go anoxic during the summer and fall months. This presents a problem for water intake managers that rely on a consistent source of freshwater to supply drinking water to plants located along the Ohio shoreline. The hypoxic zone hugs the bottom of the lake and as the summer progresses the thickness of the bottom hypoxic layer increases. The water intake cribs draw water from about 10 to 15 feet off the bottom. In past years the hypoxic layer expands enough vertically that the low DO water was drawn into the intakes. Passing storms and internal seiches can also temporarily drive the hypoxic layer up in the water column and into the



intakes. A monitoring system is needed to track the thickness of the hypoxic zone called the hypolimnion.

The project proposed here would support the acquisition of an environmental monitoring buoy in 2014 and cover the deployment, retrieval, and maintenance costs for two seasons (2015 and 2016) to continually monitor dissolved oxygen levels and other environmental variables offshore of the water intake cribs. The observations provided by the buoy would be used by water intake managers and scientists to inform management decisions and advance our understanding of the dynamic nature of the hypoxic zone in Lake Erie. The buoy will be located 14 miles from shore at a depth of approximately 22 meters. The performance period of this project is June 1, 2014 to May 31, 2016.

### **Progress and Accomplishments**

- Obtain proper permits from US Coast Guard
- Deploy offshore DO buoy (45164) at original NOAA site (15 miles offshore) on June 25, 2015 to measure bottom DO and water temperature at 10 depths. Buoy also contains an all-in-one weather sensor to measure air temperature, wind speed/direction, and pressure.
- Deploy nearshore buoy (45169) at wind farm demonstration site (7 miles off shore) on June 23, 2015 to measure wind speed/direction, air temperature, pressure, wave height and period.
- Attended a Great Lakes week event at the Cleveland Science Museum on June 26. Interacted with hundreds of local youth and community members. Held a follow-up meeting with local stakeholders. Over 20 in attendance from area organizations.
- Worked out a partnership with Lake Erie Energy Development Corporation (LEEDCo) to add a webcam to the nearshore buoy. LEEDCo contributed \$5,000 to support the web camera addition.
- Retrieved nearshore and offshore buoy in October 2015. Performed fall maintenance.

### **Scope of Work**

The buoy deployments were delayed until June 24 due to some equipment delivery delays. This was anticipated due to the specialized nature of this equipment and the care taken to ensure that all equipment is suitable for long term deployment. The mooring for the nearshore buoy (45169) failed in early October 2015 after a large storm. The buoy drifted 15 miles down the shoreline and was safely recovered on October 2015. Upon further inspection of the mooring line still attached to the buoy we believe that a shackle failed during the storm. In 2016 a new mooring and stronger shackles will be used to ensure the buoy stays moored in place. When the offshore buoy (45164) was retrieved in October it was discovered that the YSI sonde had been lost during a previous storm. The sonde was likely torn from the mooring line during a storm and is lying on the bottom of the lake in heavy silt. For 2016 a new YSI sonde will be purchased and a stainless steel cage will be used to secure the sonde in place and to protect it from damage. Neither the mooring issue nor the loss of the YSI will cause the project to go over budget. There were significant savings in the budget from earlier decisions to simplify the labor to deploy and retrieve the buoy by combining it with other trips to the region to install/maintain YSI sensors for water treatment plants.

## **IV. MODELS AND TOOLS**

GLOS staff and DMAC contractors continue ongoing support for existing model output access and decision-support tool operations.

- The GLOS DMAC Team has been developing and improving decision support tools, including a new data portal, a new harmful algal bloom data portal. See the Data Management section and supplement for details.
- Participation in the Lake Michigan Modeling group was deferred during GLOS staff transition. The Executive Director and staff continue to work to determine the appropriate future direction for GLOS to support ongoing coordination of modeling activities. As part of this assessment, GLOS ED and staff met with Eric Anderson at NOAA-GLERL and Alison Allen at NOAA to discuss opportunities for support of the NOAA Ecological Forecasting Roadmap.

**Tributary Loading Tool to Support Harmful Algal Bloom Forecasting in Lake Erie** (PI: Tad Slaweki, *LimnoTech*)

**Project Summary**

Harmful algal blooms and hypoxia in Lake Erie are highly influenced by tributary nutrient loadings. This project supports (1) the ongoing automated sampling of nutrients in the Maumee (OH) River and the optimization of workflows to shift delivery of analytical results to a weekly schedule; (2) publication of the analytical results and associated loading estimates through GLOS THREDDS services and (3) development of a GLOS product page that presents the loading estimates in a stakeholder-friendly format.

**Progress and Accomplishments**

During the reporting period, Heidelberg University refined its workflow to increase the frequency of data delivery, briefly achieving weekly frequency during critical late spring periods and then relaxing the frequency later in the summer as higher latency became acceptable. A placeholder product page has been developed for the product (<http://data.glos.us/maumee/>), and an alpha prototype deployed for testing and comments ([http://www.limno.com/testing/Maumee Trib Tool.html](http://www.limno.com/testing/Maumee_Trib_Tool.html)). NetCDF packaging for the data has been developed and is in the process of being tested.

**V. OUTREACH AND EDUCATION**

**Website/Newsletter**

GLOS staff has updated the content of the website including but not limited to:

- Project, news and events pages (e.g. Annual Meeting, CSP buoy updates).
- Updated Staff and Board of Directors page.
- GLOS newsletters sent monthly, and can be found at <http://glos.us/news-events/glos-newsletter>.
- As of 12/16/2015 website is exactly a month out from a significant update. The current site is losing functionality and is hard to repair without significant work as it was designed in Drupal. After evaluating website usage it was determined that WordPress would be a satisfactory platform, and would be easier to keep current, in terms of version updates and content.
- GLOS unveiled a new logo and is currently undergoing rebranding along with the website update.

**Outreach**

Participated in the following meetings/workshops/projects:

- Great Lakes Regional Collaboration Team, monthly team calls
- GLOS annual meeting (10/7 – 10/8)
- Contributing to High School Visualizing Your Water Challenge, partnering with ESRI, EPA, USGS
- Wrote and submitted abstract for the DEQ State of Lake Michigan/Beach Association conference (6/18/2015) Great Lakes Regional Collaboration Team, monthly team calls

- Great Lakes St Lawrence Cities Initiative Conference, June 18, 19
- Multiple Combined Federal Campaign events
- Ecological Society of America Meeting (8/10 – 8/14)
- Presented at State of Lake Michigan/ Great Lakes Beach Association Conference (10/28 –10/30)
- Lake Michigan Monitoring Coordination Council meeting (10/28)
- MEOPAR Data Management Forum (11/17 – 11/19)
- Great Lakes Science Museum event June 26,27
- Contacted elected officials to educate them on how GLOS delivers a safer, healthier Great Lakes. There were two major pushes, one in April/May and one in September related to action on IOOS reauthorization.
- Began collaboration with NSF DataNet project Sustainable Environment/Actionable Data (SEAD)

## **Education**

### **GLOS Teaching with Great Lakes Science (PI: Jim Diana, University of Michigan)**

#### **Project Summary**

The Michigan Sea Grant communications and education program is working with its partners (e.g., National Geographic, Michigan Science Teachers Association (MSTA), Great Lakes Stewardship Initiative) with the goal of improving and promoting the use of Teaching Great Lakes Science curriculum and resources and the Great Lakes FieldScope tool. Specifically, we aim to increase the number of Great Lakes educators who utilize these tools as well as increase the number of registered users on Great Lakes FieldScope. To achieve this goal, Sea Grant staff provided direct mailings, development of publications, increased the amount of data in Great Lakes FieldScope, improved to the Teaching Great Lakes Science curriculum and resources. We also increased participation and partnership by promoting FieldScope at events and conferences.

#### **Progress and Accomplishments**

A large portion of the work and activities in the second half of the reporting period continued to focus on promoting and enhancing both Great Lakes FieldScope and the Teaching Great Lakes Science lesson. We produced new publications and drafted other important documents in addition to the work done in the first half of the funding period. The next steps are to finalize a technical guide on the FieldScope-based Teaching Great Lakes Science.

Since mid 2015 we have accomplished the following tasks related to the project:

- Developed a survey for assessing the alignment of the Teaching Great Lakes Science Lessons & activities with the Next Generation Science Standards (NGSS).
  - Survey results show educators feel the information is presented in a useful manner and are more inclined to use the material in their classrooms.
- Advertised recent alignment with NGSS and the survey in Michigan Sea Grant's October issue of Upwellings.
- Updated Great Lakes FieldScope with more data and new protocol sheet.
- Enlisted over 15 new users on Great Lakes FieldScope since June 2015.
- Teaching Great Lakes Science Guide:
  - Contacted teachers to help lead the outline of the Teaching Great Lakes Science Guide.
  - Finalized draft and will be made available on Teaching Great Lakes Science website by the end of the year 2015.

- Developed new Teaching Great Lakes Science Lesson *Exploring Great Lakes Environmental Data: Dissolved Oxygen and Lake Stratification Lesson Plan*, which integrates Great Lakes FieldScope into the Teaching Great Lakes Science materials.
- Submitted a feature article in the MSTA Fall 2015 Journal on the new lesson that was developed on *Exploring Great Lakes Environmental Data: Dissolved Oxygen and Lake Stratification Lesson Plan*.
- Presented our new lesson, *Exploring Great Lakes Environmental Data: Dissolved Oxygen and Lake Stratification*, at the Great Lakes Place Based Education Conference in Grand Rapids, MI on November 7<sup>th</sup>, 2015. 8 teachers attended the session.
- Developed a 5 E fact sheet as a teacher tool for the Teaching Great Lakes Science website. Will be finalized by Michigan Sea Grant Communications staff and made available online by December 30<sup>th</sup>, 2015.
- Attended the GLOS annual meeting as a panel member for "Information Creation: Using Data to Support Decision-Making."
  - Presented Michigan Sea Grant's work on developing the Great Lakes FieldScope Project as a multi-stakeholder data and mapping tool, which contains utility for groups ranging from educators to non-profit organizations.
- Additionally, we have maintained a solid presence on social media by tweeting on Twitter and posting to the Facebook and Michigan Sea Grant website.

We have publicized all events and conferences we plan to attend as well as notified followers of new publications and documents made available.

#### **SCOPE OF WORK (Report Period: 6/01/15 through 11/30/15)**

There are no anticipated changes to the scope of work as re-scoped and approved for FY2015 or in the organization's ability to achieve the milestones and deliverables for this or future reporting periods under that scope of work.

#### **PERSONNEL AND ORGANIZATIONAL STRUCTURE (Report Period: 6/01/15 through 11/30/15)**

Mark Burrows ended his term on the GLOS Board of Directors at the Fall 2015 Board Meeting. Two new members, Jennifer Boehme and Randolph Helland, joined the board in the Fall of 2015.

#### **ANNUAL SUPPLEMENTALS (Report Period: 6/01/15 through 11/30/15)**

The GLOS DMAC infrastructure provides on-demand access to all of its data services. These services depend on accessing data directly (e.g. satellite and model gridded data for WMS) or a local cache (e.g. PI buoy data).

- Products and Services - number and brief description of contributions to new or improved
  - regional products or services
    - GLOS deployed the HABS Data Portal (<http://habs.glos.us>) based on OceansMap platform
    - Developed alpha version of next-generation data portal ("myGLOS") also based on OceansMap
  - national products or services
    - Contributed mission data to Glider DAC
- Data Management

- Progress towards a standards-based foundation for DMAC capabilities
  - *Next-generation myGLOS portal will be fully service-oriented and catalog-driven*
- Demonstrated progress towards:
  - open data sharing
    - *Set up ERDDAP instance accessing selected key data sources.*
  - provision of data to WMO GTS
    - *Maintained PI data flow to NDBC for various buoys and sensors.*
  - implementation of a service-oriented architecture
    - *Maintained key services, including 52N SOS, sciWMS, and THREDDS*
    - *Added ncSOS in support of HABS portal*
    - *Developing next-generation portal to leverage GLOS services*
  - use of common vocabularies and identifiers
    - *Harmonized variable names across multiple HABS-related platforms*
  - improved use of metadata conventions
    - *GeoNetwork catalog expanded and improved to host metadata for sensors in addition to static resources, and used to drive new portal.*
  - data storage and archiving
    - *Continued submittal of non-Federal partner sensor data to NCEI*
    - *Beginning enrollment of datasets from “mini-DMAC” partners for storage, publication, and (2016 goal) NCEI archiving.*
- On-going program-level participation in:
  - data management planning and coordination
    - *Leading IOOS DMAC QARTOD Working Group focused on coordination and communication between RAs and QARTOD BOA on QARTOD implementation*
- Observing Assets
  - No “platforms of opportunity” are being used to support monitoring of ocean acidification
  -

Program	Location	Description of Instruments	Data Type Collected	Changes
CILER	Multiple Lakes, AUV  Lake Michigan (Ludington, Grand and Little Traverse Bays)	Full-time AUV Tech Up to 4 AUV missions  2 buoys Instrumentation used: ACT recommended commercial 6 DOF directional wave sensor	Green Bay- nearshore substrate classification and mapping, and profiling between EPA grid points. Data provided for CSMI Lake Michigan- bathymetry survey  Focused AUV support on Lake Michigan in 2015 to support coordination with CSMI activities.  Parameters: Full Met / Solar / IOOS Directional Waves / Ocean Currents and vertical Temperature distribution	
U Minnesota-Duluth	Lake Superior (Duluth)	2 buoys Up to 4 glider missions	Standard suite of measurements (AT, WTx10, SW, RH, WS, WD, BP, waves (45028 only) LW (45027 only)  Glider Deployed six times, from May-November Total of 40 days	One buoy and glider are leveraged from non-IOOS funding

			Total of >900km surveying CTD, chl-a, CDOM, DO, backscatter	
Michigan Technological University	Lake Superior (2 Keweenaw Peninsula)	2 buoys  Ranger3 Glider	Keweenaw: Weather conditions (full met suite) Wave dynamics (6° freedom sensor) Water quality ( 7 parameter sonde) Currents (ADCP) Water temperature profiles (thermistor chain to 22m)	
U Wisconsin-Minnesota	Lake Michigan (Milwaukee)	2 buoys  Lake Express Ferry system	Milwaukee buoys: surface temp, temp profile, algal fluorescence, conductivity, DO, Turbidity, CO2, MET, currents, water depth, wave height/frequency Lake Express: surface temp, algal fluorescence, DO, Turbidity, CO2, Ozone	One buoy leveraged from non-IOOS funds Additional support will be prioritized to extending the buoy deployment to the full ice-free season Partner collaboration will continue to the extent that it is not dependent on extended deployments
Great Lakes Research Consortium (SUNY ESF)	Lake Ontario (Oswego, Sodus Bay) Lake Erie (Buffalo, Dunkirk)	2 TIDAS buoys  3 MB300 Bay buoys  2 stationary land-based weather stations	TIDAS Buoy (Oswego, Buffalo, Dunkirk): Air temperature, wind speed, wind direction, humidity, barometric pressure, Wave height, speed, direction and period, water temperature (T-string), YSI selections from Chl, PC, ODO, pH, Turbidity, SpecCond., T)  MB300 Bay: full meteorological station, thermister string and YSI sondes, surface temperature, conductivity and an experimental Turner designs C6 sonde to measure algal productivity.	
NOAA-GLERL	Lake Erie (Cleveland) Lake Michigan (Muskegon) Lake Erie (Monroe) Lake Huron (Saginaw Bay)	4 RECON buoys	Cleveland: Hypoxia, Internal Waves; DO, T, Currents Muskegon: Met, Rip Currents, Pri Prod; DO, T, Waves, Currents	NOAA GLERL is leveraging GLRI funds by sharing costs on the Cleveland and Muskegon buoys which meet both GLOS and GLRI objectives.
Wisconsin Department of Natural Resources	Lake Superior	8 buoys		
Michigan Department of Environmental Quality		1 buoy		
University of Michigan Hydrodynamics Laboratory (MHL)	Lake Michigan (2) and one in Douglas Lake (UMBIO)	3 buoys	U-GLOS 004: significant wave height, wind direction, water temperature, dew point, air temperature, air pressure, significant wave period, wind gust, wind speed  45024: same as above plus water temp @ 19 to 72 ft  UMBIO: same as above plus water temp @ 23 to 77 ft	3 buoys decommissioned (U-GLOS 003 45021, GTBOSS1 45020, and GTBOSS2 GTBKM4)
LimnoTech	Lake Michigan (Holland, St. Joseph) Lake Erie (Monroe, Toledo Water Intake buoy, Cleveland Wind buoy, Cleveland DO buoy)	6 buoys	45026: wind direction, wind speed, wind gust, air temperature, relative humidity, dew point, wave period & direction, thermistor temperature at depths from 3.3 to 55.8 ft. 45029: same as above plus thermistor temperature from 3.3 to 68.9 ft. 45168: same with thermistor temperature from 3.3 to 55.8 ft	

			<p>45165 (Toledo): wind direction, wind speed, wind gust, air temperature, relative humidity, air pressure, dew point, significant wave height, maximum wave height, water temperature @ 2 ft, pH, ORP, turbidity, chlorophyll, blue green algae</p> <p>45169 (Cleveland): wind speed, wind gust, wind direction, air temperature, relative humidity, dew point, air pressure, significant wave height, wave direction and period, water temperature at surface</p> <p>45164 (Cleveland Wind): barometric pressure, air temperature, wind speed, thermistor temperature from 6.6 to 65.6 ft, specific conductivity, dissolved oxygen saturation, dissolved oxygen</p>	
Grand Valley State University	Muskegon Lake Buoy	1 buoy	GVSU1: wind direction, air temperature, air pressure, relative humidity, wind gust, wind speed, water temp @ 7, 13, 20, 26, 33, & 39 ft	
Illinois-Indiana Sea Grant and Purdue Civil Engineering	Lake Michigan (offshore Michigan City, IN and Wilmette, IL)	2 buoys	<p>45170: wind speed, wind gust, wind direction, air temp, relative humidity, dew point, water temp at surface, significant wave height and thermistor temp from 3.3 to 42.7 ft.</p> <p>45174: wind speed, wind gust, air temperature, relative humidity, dw point, air pressure, significant wave height, wave direction</p>	
NDBC Chicago Park District	Lake Michigan	5 buoys		
National Data Buoy Center	Lake Michigan, Lake Huron, Lake Superior, Lake Erie, Lake Ontario	9 buoys 10 land based stations		
GLERL		7 land based stations		
USCG Marine Reporting stations		2 land based stations		
Center for Operational Oceanographic Products and Services		53 stations		
National Estuarine Research Reserve System		4 stations		
USGS		225 stations		
<b>SATELLITE OBSERVATIONS</b>				
National Weather Service		213 stations		
NEXRAD (Next Generation Radar)		Base reflectivity measures	Measures precipitation and wind	
Michigan Technological Research Institute (MTRI)		Satellite	Measures: Chlorophyll; Colored dissolved organic matter; dissolved organic carbon; natural color; suspended materials; water surface temperature	
<b>MODEL FORECASTS and DATASETS</b>				
GLERL		Models	Currents; Ice thickness; Water level; Waves	
NOS		Model	Currents	
NAM		Model	Winds	
GLCFS		Great Lakes Coastal Forecasting System (POM)		

SLRFVM		Upper St. Lawrence River (FVCOM)		
HECWFS		Huron-Erie Connecting Waterways Forecasting System (FVCOM)		
OTHER				
US Army Corps of Engineers (USACE) Water Levels	Lake Erie, Lake Huron, Lake Michigan, Lake Ontario, Lake St. Clair, Lake Superior	6 water level measurements	Lakes Erie, Huron, Michigan, St. Clair and Lake Superior: Daily Mean water level  Lake Ontario: Adjusted Daily Mean water level	
NOAA GLERL		Hydrologic datasets	NBS, atmospheric, precipitation, air temperature	
Great Lakes Commission		Historical 2006-2011	Water use	

**PROGRESS AND ACCOMPLISHMENTS (Report Period: 12/01/14 through 05/31/15)**

**I. PROGRAM PLANNING AND MANAGEMENT**

GLOS underwent a staff transition, as acting Executive Director Kelli Paige transitioned to Executive Director and hired two new staff members, a Program Coordinator Andrea Maguire and Communications Manager Kristin Schrader (see bios at: <http://www.glos.us/about-glos/board-staff>)

GLOS ED has been working on several activities necessary to complete staff transition including providing orientation to the new staff and updating budget reports and other documentation for the Board of Directors. The ED worked to complete an updated scope and budget for Year 5 of the Cooperative Agreement and had been evaluating opportunities for improvement to existing business practices that will make financial and contract management easier and more clearly aligned with requirements, especially those related to the new OMB Super-Circular.

GLOS ED and staff continued participation in partner initiatives such as IOOS and IOOS Association committees, Can-Am GEO Great Lakes Testbed activities, NOAA Great Lakes Regional Collaboration, and the Great Lakes Water Quality Agreement Annex 10 (Science Annex, including data management and sharing) Committee, among others.

GLOS continued to work on implementing the GLOS strategic plan (the Blueprint), a foundational document for developing its 2016-2020 IOOS proposal (available online at: [http://glos.us/sites/default/files/documents/GLOSBlueprint\\_2016-20\\_0.pdf](http://glos.us/sites/default/files/documents/GLOSBlueprint_2016-20_0.pdf)). ED, Board and staff held a pre-proposal competition in preparation for the next IOOS 5-year Cooperative Agreement funding cycle. A Request for Pre-Proposals was announced in January 2015, and subsequent webinar and Q&As were made available. The request can be viewed online at: <http://www.glos.us/news-events/news/2015-01/call-pre-proposals>. Reviews are currently being conducted, and selected pre-proposal will be invited to submit full proposals for consideration for inclusion in the full proposal to IOOS. Based on final funding amounts from IOOS, the collaborative proposal will become the basis for the GLOS/IOOS 5 year Cooperative Agreement.

**SUB AWARD: IOOS ASSOCIATION**



**The National Network of Regional Coastal Ocean Observing Systems: Coordination and Communication Support for the Regional Component of the U.S. Integrated Ocean Observing System**  
(PI Josie Quintrell)

**Project Summary**

The Association will continue to work with the Program Office on coordinating the activities of the RAs, fostering communication and collaboration between the Program Office and the RAs and in facilitating communication among the RAs. The Association provides NOAA and the IOOC Federal agencies with “one-stop-shopping” for its communications with the regions and for building a partnership that will make the IOOS a seamless network of federal and regional assets. The IOOS Association will continue to build strategic partnerships with groups interested and supportive of IOOS. The Association will continue to work with existing partners such as The Alliance for Earth Observations, Coastal States Organization, Consortium of Ocean Leadership, Ocean Conservancy, MTS and will also reach out to the maritime industry groups and emergency managers.

**Deliverables**

1. Regular updates to the IOOS Association website so that it continues to serve as a central communication portal for the RAs.
2. Summaries of the monthly coordination and education calls.
3. An updated version of the “Providing Coastal Information in a Changing Climate”
4. Summary report from the RA Director’s retreat.
5. Annual reports that document the accomplishments of the above tasks during the period of performance.

**ACCOMPLISHMENTS**

- 1) Sustaining the functions and organization of the IOOS Association.
  - a) strategic planning session at its Fall Annual Meeting in Washington DC
  - b) Spring Board meeting was held in Washington DC in conjunction with the IOOS Spring meeting.
  - c) The Executive Committee continues to hold monthly conference calls to plan and organize for meetings, IOOS reauthorization, and to discuss the creation of an Advisory Board and membership.
- 2) Facilitating information sharing among regions. several mechanisms to encourage discussions among the regions on specific topics or to develop common goals and objectives, and respond to requests for regional input on specific topics and works with the IOOS Program Office to continually review and enhance these efforts:
  - a) *Education and Outreach Committee.* The Association continues to support the monthly calls with the outreach coordinators from the RAs and the IOOS office.
  - b) *Monthly IOOS RA Calls.* The Association works with the Program Office to host monthly calls with the RAs and the IOOS Program office. These calls are one of the few forums that regularly bring together RA Directors with the Program Office staff. Calls were held on Dec16, Jan 13, Feb 17, Mar 17, Apr 12 and June 16. Each call consists on update from the Program Office (budgets, staffing, IOOS branding, certification, data management) and also have special topic (NOAA’s Sea Surface Temperature Program).
  - c) *Presentations to RAs.* During this time period, the IOOS Association Executive Director briefed NERACOOS, CeNCOOS, PaCIOOS, MARACOOS and SECOORA on the activities of the Association, IOOC, the IOOS Federal Advisory Committee and on emerging issues.

3) Implementation of IOOS.

- a) IOOS Coordination Meetings. The IOOS Association worked with a steering committee that included representatives from the RAs and the IOOS Program Office on the agenda for the Spring IOOS All Hands Meeting on March 2-3 in Silver Spring.
- b) IOOS Association Flyer. A new 4-page flyer that provides an overview of IOOS, the system and how it is making a difference. <http://waterviewconsulting.com/files/IOOS-Association-webversion.pdf>
- c) NOAA's Ecological Forecasting Roadmap Webinars.
- d) IOOS Federal Advisory Committee.
- e) NOS Roundtable Monthly Calls.
- f) NOAA Meeting.

2. Representing regional interests to national programs. The Association routinely meets with the IOOS Federal partners. This includes briefings with the Consortium on Ocean Leadership Public Policy Forum and Capitol Hill Oceans Week.

Attachments:

- 1) IOOS Annual Meeting Minutes and notes from Strategic Session
- 2) IOOS 2015 Spring All Hands Meeting Agenda
- 3) IOOS FAC Presentation

3. Ecological Forecasting Presentation (includes summary of regional webinars)

4. Building strategic alliances with IOOS partners. The Association engages with other organizations on the national and regional level on ocean and Great Lakes observing. The RAs focus on regional partnerships while The Association complements those partnerships with national organizations such as the Consortium for Ocean Leadership and the Alliance for Earth Observations, the Friends of NOAA, the Coastal States Organization, the Sea Grant Association, The Nature Conservancy, Ocean Conservancy and maritime trade associations.

## II. DATA MANAGEMENT

### Planning and Coordination

- Held coordination meetings with DMAC Team and participated in IOOS DMAC calls.
- Provided support to GEO-Great Lakes planning activities and updated GeoNetwork metadata catalog to version 2.10, IAGLR presentation
- Provided DMAC perspective through attendance and presentation at IAGLR (Burlington), and Great Lakes Data Integration Roundtable (Ann Arbor) meetings and at NOAA-GLERL (Ann Arbor).
- Held coordination meetings to review Heidelberg University data processing, schedule data deliverables and discuss handling of updates and QA/QC.

### Ongoing Operations

- Reconfigured GLOS DMAC virtual hosts to use VMWare and improve backup with VEEAM
- Added RAM to second virtual host to improve performance
- Improved metadata harvesting process by addressing bugs, reducing space requirements to store XML records

### DMAC Enhancements

- Developed and deployed customized data portal to support HABs monitoring in Western Lake Erie Basin as a prototype for user-configurable "myGLOS" portal

- Addressed bugs and enhancement requests for Great Lakes Acoustic Telemetry Observation System.
- Updated display (in beta) of Coordinated Great Lakes Levels from the US Army Corps of Engineers
- Added harvesting and display of data from local Canadian provider (Lake Simcoe Resource Conservation Authority) as part of a pilot project under GEO-GL to incentivize other Conservation Authorities to
- Provided technical guidance to grantees in GLOS “mini-DMAC” program
- Began integration into GLOS web presence of asset landing pages and other local DAC functionality previously provided by the “Upper Great Lakes Observing System” through Michigan Technological University.
- Submitted 2014 data to Glider DAC.
- LimnoTech and Heidelberg University implemented a simple Excel-based prototype of data display for internal testing and developed an internal specification for the data display web page. An alpha version of the data display web page was then implemented ([http://www.limno.com/testing/Maumee\\_River\\_Nutrient\\_Tracker.html](http://www.limno.com/testing/Maumee_River_Nutrient_Tracker.html))

### **Compliance with IOOS Standards**

- Continued to support 52N SOS deployment
- Led discussion and coordination of QARTOD-related webinars
- Began drafting materials supporting RICE certification

### **DATA MANAGEMENT MINI GRANTS**

As a follow-up to the Sea Grant Needs Assessment and GLRI Enterprise Architecture DMAC support studies, GLOS ran an *Improving Data Availability: Data Management Mini Grant* competition to support projects that help make data more widely available. Of the 5 projects that were invited to submit full proposals in 2014, 4 were awarded funding in 2015, and contracting for a 5<sup>th</sup> is currently underway.

### **A Harmful Algal Bloom and Water Quality Data Management Program for Western Lake Erie**

*(PI: Thomas Bridgeman, University of Toledo)*

#### **Project Summary**

Presently, and for the past 13 years, the University of Toledo Lake Erie Center (LEC) has routinely collected harmful algal bloom (HAB) and water quality data in western Lake Erie. Although these data have been used in several scientific publications and have been made available to colleagues, the LEC has lacked the capacity to “make the data available to a wider potential audience of data users and stakeholders.” The LEC proposes here to partner with LimnoTech, an experienced data management developer, to create a data management and communication (DMAC) system that would provide the “local road” between the LEC data sets and GLOS, allowing increased access to archived data and a convenient portal for the LEC to provide data updates. The proposed DMAC system would fill a need for access to Lake Erie water quality data, particularly the intense interest in and requests for HAB data from a variety of stakeholders and fellow researchers.

#### **Progress and Accomplishments**

- Meet with GLOS and UT to discuss project goals and timeline
- Obtain 13 years of historical monitoring data from Tom Bridgeman
- Begin to deconstruct historical data to identify sampling stations and parameters
- Work through issues related to station identification with UT. Separate master stations from stations created specifically for a given project in a given year
- Review 2014 dataset and format in Excel to identify samples and results.

- Develop a draft database structure
- Populate an Access database with 2014 data
- Research netCDF format and communicate with GLOS regarding output format.

**An Open Standards Data and Metadata Pipeline for the Natural Resources Research Institute Great Lakes Data** *(PI: Terry N. Brown, University of Minnesota, Duluth)*

**Project Summary**

Many large, high-value Great Lakes focused data sets are generated by or managed by the University of Minnesota Duluth's Natural Resources Research Institute (NRRI), including the "GLEI" (Great Lakes Environmental Indicators) projects and multiple basin wide environmental stress products. Our project deploys modern geospatial data and metadata federation technologies (CKAN) to increase the availability of these datasets and lower the barrier to their integration into other analyses. We will provide a web front end for direct interaction with NRRI datasets, harvestable metadata and data for federated searching and external data hosting, and GIS layers as web services (WMS / WCS / WFS / GeoJSON / KML / etc.) for simple integration into analyses being performed elsewhere.

**Progress and Accomplishments**

- We have purchased and deployed the hardware (server) funded by the project. The server shows high levels of performance and we expect it to serve the project well.
- We have largely completed a documented, automated, repeatable procedure for deploying CKAN on a virtual machine on the server. We hope that this procedure in itself will be valuable to others. It also forms part of our migration strategy for ensuring the long term maintenance of the system.
- Separate from the CKAN deployment process, we have gained significant familiarity with the GeoServer component of the CKAN system which we hope to leverage for providing internal and external OGC web services.
- We hope to use the preparation of one of the three datasets we're delivering to GLOS for this project, the "Minnesota North Shore stream data", as a demonstration project in collaboration with other entities working in the Saint Louis River Estuary showcasing state of the art geospatial data sharing practices. Briefly, the goal would be to have resources from NRRI and others perhaps including Wisconsin SeaGrant and Minnesota Pollution Control Agency be discoverable through federated searches via CSW and similar pathways, and available through OGC standard web services. An "example analysis" would then be demonstrated to interested parties (certainly Saint Louis River Estuary researchers, and possibly others) to promote the wider adoption of these technologies.

**Aiding management and advancing Great Lakes ecology: Combining 50+ years of data with the 2013 Lake Ontario Cooperative Science and Monitoring Initiative** *(PI: Lars Rudstam, Cornell University)*

**Project Summary**

Ecosystem-based resource management, in the face of changing Great Lakes ecosystems, requires an understanding of lake dynamics at a whole-lake scale and a perspective that values historical observations for their insight into the future. Our project will coalesce existing historic physical and lower trophic level data sets that span 5 decades with data sets from the 2013 Lake Ontario Cooperative Science and Monitoring Initiative that included bi-national federal, provincial, state agencies. This project will deliver spatially-explicit data sets that will be hosted by a suite of web and agency-based data catalogs and portals. Funding covers a year of support for a database manager. Initial efforts will

coalesce all available depth discrete profile data (temperature, depth, and others), mineral nutrient, chlorophyll a, and zooplankton data.

#### Deliverables

1. Coalesced data bases in formats that match data hosting needs (ie. relational databases or flat files) that include all pertinent metadata and spatial references
2. Poster and slide based presentations that introduce the data sets and locations to be distributed to potential user groups
3. Synthesis report detailing the process, including suggestions for improvements

#### **Progress and Accomplishments**

- Conducted candidate search for data manager position
- Hired Matthew Paufve (started 6/1/2015)
- PI meeting at CBFS 6/2/2015 – outlined first steps and organized roles
- Contacted Department of Fisheries and Oceans Canada (Kelly Bowen) and received zooplankton data for CSMI 2013 Lake Ontario.
- Meeting with Kelli Paige (GLOS) at IAGLR meeting in Burlington, Vermont.
- Meeting with EPA-GLNPO on profiles at IAGLR

#### **Building a Great Lakes Adaptation Data Suite (GLADS) for Informed Decision Making in the Great Lakes Region** (PI: David Schwab and Catherine Riseng, University of Michigan)

#### **Project Summary**

The overall goal of this project is to create a usable, standardized climate adaptation data resource for practitioner and research communities in the Great Lakes region. To accomplish this goal we are acquiring, evaluating, and standardizing climate variables from over-land and over-lake observational data sets.

To accomplish this goal we organized a team of committed research scientists with experience in both atmospheric and lake dynamics. Our final product will include climate adaptation related variables standardized to consistent temporal (hourly, daily, monthly) resolutions and spatial resolutions, consistent with the spatial approach modeled by the Great Lake Aquatic Habitat Framework.

#### **Progress and Accomplishments**

Our contract with the Great Lakes Observing System (GLOS) went into effect in late March 2015. Since that time we have taken the following steps to fulfill the contract:

- Identified and prioritized critical existing data sets to evaluate and climate adaptation related variables for inclusion in the full suite
- Convened regional stakeholders from the scientific research community to discuss this project on two occasions
- Hired key temporary staff to lead the data acquisition and standardization effort in fulfillment of the project
- Presented the GLADS approach at two international events: The Joint Assembly of American Geophysical Union and Canadian Geophysical Union and the International Association of Great Lakes Researchers

Through our engagements and effort to date the following lessons have emerged:

- There is a much higher interest in this effort among members of the fundamental research community than we had initially anticipated, including a high interest in this work among region hydrologist and water resource researchers
- The emergence of open source programming language is incredibly important for this work. Based on this lesson we are moving forward with our programming using Python, an OSI-approved open source license, making it freely usable and distributable, even for commercial use. R is another important open source programming software package being rapidly adopted across many fields.
- While many datasets are becoming more readily available through distribution channels which make the data easier to find, challenges of varied data quality and language still remain, making it difficult to readily analyze data across multiple data-sets, particularly if the data originate in fields that require a wide range of expertise

### III. OBSERVATIONS

Note: Funds for Observation work are “bopped” to the Cooperative Institute Program and thence to the Cooperative Institute for Limnology and Ecosystem Research (CILER). CILER serves as the Institutional Partner that manages and executes the sub-awards for each of the academic institutional participants on the project. They execute the sub-awards through an existing Cooperative Agreement with host lab NOAA-GLERL. The following is intended as a summary update on their activity.

#### **Project Summary: Observing Network**

The Great Lakes Observing System Regional Association (GLOS-RA) is implementing key observing system and modeling improvements over the 2011-2016 period that focus on critical needs of the Great Lakes region as identified through an extensive needs assessment process. The focus of this work is to develop new products for four priority issue areas that affect the health, well-being and economic viability of the region, these being: climate change impacts; ecosystem and food web dynamics; protection of public health; and navigation safety and efficiency. Critical information needs for these priority areas will be addressed by implementation of an array of integrated observations including new moorings and additional sensors to measure temperature and current profiles. AUV/glider technologies have been initiated to collect critical transect information. Cross-lake ferries and other vessels of opportunity are being instrumented to collect repetitive observations of surface chemistry. Satellite remote sensing products are being derived to provide daily monitoring of lake surface loadings of nutrients and sediments.

#### **Sub-Award: Cooperative Institute for Limnology and Ecosystems Research – University of Michigan**

*(PI: Tom Johengen)*

#### **Project Summary**

CILER serves as the Institutional Partner that manages and executes the sub-awards for each of the academic institutional participants on the project. We will execute the sub-awards through our existing Cooperative Agreement with our host lab NOAA-GLERL. Partner institutions include: University of Wisconsin-Milwaukee, University of Minnesota Duluth Large Lakes Laboratory, Great Lake Regional Consortium located at the SUNY College of Environmental Sciences and Forestry, Michigan Technological University, and Michigan Technological Research Institute.

An existing AUV and Glider system, previously purchased in PY2010, will be used in a shared context throughout the Great Lakes basin. These systems will be housed and maintained by CILER and we will work with each of the Partners to plan missions in each lake to serve local needs within their

environments and that are coordinated with priorities of the Coordinated Science and Monitoring Initiative (annual bi-national lake-by-lake effort). CILER will support a Technician that will complete all of the initial set-up and calibration of the instruments and their sensors and travel with the instrument to support missions in each of the Partners field sites. In addition, CILER will collaborate with Dr. Guy Meadows of Michigan Tech to deploy, operate, maintain and retrieve two real-time coastal environmental monitoring buoys in Lake Michigan.

### **Progress and Accomplishments**

- The Ludington buoy, recovered for the winter season, was maintained and calibrated prior to its redeployment off the coast of Ludington on May 18, 2015. As part of the buoy maintenance, the thermistor was replaced as well as the navigational beacon. The buoy is currently operational and transmitting data to NDBC, GLOS and the UGLOS websites.
- The buoy located in Douglas Lake off shore of the University of Michigan Biological Station was maintained and calibrated over the winter season. Maintenance included the replacement of the battery pack due to a leak in one of the gel batteries. The buoy was deployed on April 30, 2015 and is currently transmitting data to GLOS and UGLOS websites.
- The glider was returned to Slocum for CTD calibration, and was outfitted with a new hull extension to support the addition of a Bio-Spherical PAR sensor. The PAR will be used for verification of remote sensing in Lake Michigan. A new lithium battery pack was also purchased, allowing the glider to be deployed for a total of 180 days per pack in comparison to the 30 days if it were run on the alkaline battery pack.
- The AUV's were maintained and calibrated over the winter season. A new technician has been training on the deployment and use of the AUV's to help support the existing technician in deployments this summer.
- In partnership with GLERL, four restoration sites located in Muskegon Lake were mapped using side scan sonar during the first week of May.

### **Scope of Work**

This project is on schedule from a technical perspective and no changes to the scope of work have occurred. Planned Activities:

- The Ludington buoy will be maintained throughout the 2015 navigational season to ensure that it continues to transmit valid data to GLOS, UGLOS and NDBC.
- There are a number of AUV missions planned for 2015 deployment season. These deployments will be in partnership with GLERL in support of the HABs modeling and forecasting in the Western Lake Erie basin. Missions will also be run with UWM to survey parts of Green Bay to map spots of hypoxia.
- There will be a number of missions totaling 150 days of deployment planned for the glider in Lake Michigan during the 2015 deployment season. The missions will be in partnership with USGS, EPA and GLERL, all in support of the Lake Michigan Cooperative Science Monitoring Initiative.

### **Sub-Award: University of Wisconsin-Milwaukee**

*(PIs: Val Klump and Harvey Bootsma)*

### **Project Summary**

The overall objective of this GLOS effort is to increase observing capacity to improve wave forecasting, over-lake weather forecasting, circulation modeling, and monitoring of lake heat and water balances through the collection of continuous data from a variety of observing assets in Lake Michigan, and continued implementation of the GLOS Regional Coastal Ocean Observing System (Nearshore Network)

conceptual design, based on a national blueprint. Additional objectives include the validation and improvement of air quality (ozone) forecast models, monitoring of long-term changes in nearshore water quality, and provision of water quality data and decision support tools for managers at municipal, state and federal levels.

### **Progress and Accomplishments**

- GLOS Monitoring Buoys: Between May and November 2015, the UW-Milwaukee School of Freshwater Sciences at the Great Lakes WATER Institute will operate several observing systems as part of GLOS, including two nearshore buoys at depths of 10 m and 20 m (NOAA 45013) north of Milwaukee, a buoy in Green Bay (13 m, NOAA 45014) and a monitoring system on the high speed Lake Express ferry that operates between Milwaukee WI and Muskegon MI. In addition, SFS will be helping to coordinate the collection and dissemination of data from two other nearshore locations on Lake Michigan and Lake Superior –one at Sleeping Bear Dunes National Lakeshore in north eastern Lake Michigan and the other at the Apostle Islands National Lake Shore in Lake Superior, both operated by the National Park Service. The Sleeping Bear Dunes station will be deployed mid-June and the new Apostle Islands station in early July.
- Previously replaced temperature strings on NOAA 45013 and 45014 are operating nominally and the buoys continue to report accurate and robust data. Wave gauges were not deployed on either buoy for 2015 (issues with the system were previously reported) however we are considering new hardware to deploy this season. For the 2015 season, systems became operable during the following times:
- Milwaukee 45013: Buoy deployed 4/24/2015 and all systems successfully began transmission to the National Data Buoy Center (NDBC) 5/13/15.
- In addition to the above measurements, this buoy is augmented by several bottom sensors, including a light logger, a bottom sonde, and a time lapse camera. The data from these sensors have been used, to calibrate and validate a nearshore ecosystem model that will be used by managers to predict the severity of nuisance algal blooms and to develop nutrient management criteria for the Lake Michigan nearshore zone. These systems were deployed 4/29/15.
- Green Bay 45014: Buoy deployed 6/2/2015 and all systems successfully began transmission to the National Data Buoy Center (NDBC) 6/10/15.
- Surface water oxygen sensor data combined with meteorological data from this buoy are producing the first continuous estimates of oxygen exchange across the air-water interface, water column gross primary production (GPP), and net ecosystem production (NEP). These data are contributing to a larger effort to understand the drivers of hypoxic and anoxic conditions in Green Bay.
- Lake Express High-Speed Ferry: The high-speed ferry monitoring system was reinstalled on May 27<sup>th</sup> and monitoring began immediately. The system has had sporadic issues which have been resolved quickly resulting in minimal data gaps thus far for the 2015 ferry operating season (May-Oct). All data collected since 2007 have been analyzed. Some of these data are currently being used in the calibration and validation of a Lake Michigan carbon model, which was initiated in the fall of 2011. In addition, these data are being used to test and improve models of ozone distribution, which is influenced to a large degree by chemical reactions in the above-lake atmosphere.

### **Scope of Work**

No significant changes in the scope of work are anticipated. All buoys and monitoring systems will be serviced as necessary over the summer sampling period. It is to be determined if wave gauges will be added to the system this season. In addition, data processing protocols will be further developed to improve quality assurance of collected data before it is disseminated.



## **Sub-Award: University of Minnesota-Duluth**

*(PI: Jay Austin)*

### **Project Summary**

The goal of this project is to improve meteorological and limnological observations in the western portion of Lake Superior. This is being achieved through the use of two well-instrumented meteorological buoys and an autonomous glider.

### **Progress and accomplishments**

- Meteorological buoys 45027 and 45028: UMD's two meteorological buoys (NDBC 45027 and 45028) were deployed on 15 May 2015 from the R/V Blue Heron. These buoys are reporting the same parameters as in previous years; in addition, 45027 now has a precipitation sensor on it, which uses radar to measure the amount and type of precipitation. To our knowledge this is the only open water precipitation measurement anywhere on the Great Lakes. Both buoys are operating normally, and are feeding data directly to NDBC and GLOS on a 10-minute schedule. We are currently contracting with a local web design firm to develop a smart-phone friendly website, focusing on providing information immediately useful to commercial and recreational boaters in the western arm of Superior.
- Glider: The UMD glider has recently been returned from TWR, having undergone repairs for a suspected leak, and we are currently working on pre-deployment exercises such as ballasting, compass calibration, and mission planning. We are currently in the planning stages for a series of monthly Keweenaw-to-Isle Royale glider deployments, again in conjunction and collaboration with MTU.
- Harbor Instrumentation: Our instrumentation at the Superior Entry has been deployed. Periodic calibration/ground-truthing visits are being conducted regularly.

### **Publications, with GLOS acknowledgements**

A presentation on GLOS-sponsored glider data was made at IAGLR 2015 last May by a postdoc in our lab, Laura Fiorentino. She is also in the final stages of preparing a manuscript using the same data.

## **Sub-award: Michigan Technological University**

*(PIs: Robert Shuchman, Guy Meadows, and W. Charles Kerfoot)*

### **Project Summary**

Michigan Tech will support GLOS in 2015 by deploying and operating, two buoys in Lake Superior near the north (NDBC 45023) and south (NDBC 45025) entrances to the Keweenaw Waterway, one buoy in Little Traverse Bay in Lake Michigan (NDBC 45022), and continuing to deploy separate temperature profiling arrays at both entrances (north and south) to the Keweenaw Waterway.

### **Progress and Accomplishments**

- Continued work on buoy energy management systems and began new exploration of potential power generation via wave motion.
- Completed QA/QC for all buoy sites.
- Refurbished each buoy (3) and will redeploy in late May 2015.
- Monitored and maintained new mooring design for all three buoys.
- Analyzed all standard GLOS buoy observations, as well as YSI and ADCP measurements made from the North buoy.

- Designed, implemented and successfully operated waterfront met station (using supplemental GLOS funding) through the winter of 2014-15.
- Continued co-located live video to support the met station at the GLRC (supported by funding from Michigan Tech).
- Upgraded capability and reliability of underwater/ice cabled observatory with real-time data to UGLOS. This activity will be continued in the upcoming year.

### **Remote Sensing- Project Summary**

The overall goal of the GLOS remote sensing activity is to further advance the use of ocean color satellites to map water quality in the Great Lakes. The water quality parameters that are retrieved from the satellite data include chl, doc, sm, HABs, optical properties (Kd 490 (clarity), KdPAR, and photic depth) sediment plumes, primary productivity (PP), and Lake Bottom mapping.

To support the further development of remote sensing algorithms and derived products an extensive database of *in situ* optical water properties and coincident chemistry has been constructed to provide this data to the broader user community. This Great Lakes Optical Properties Geospatial Database can be found at [www.glopgd.org](http://www.glopgd.org). Additional *in situ* water optical properties are being measured this summer in Lakes Michigan, Huron and Erie in collaboration with NOAA/GLERL. The following four tasks are being performed under this GLOS remote sensing initiative:

1. Clean-up, document, and distribute through a web based distribution system the Great Lakes Optical Properties Geospatial Database (GLOPGD).
2. Generate satellite derived time series products of the Great Lakes to support the GLOS mission.
3. Transition the CPA-A algorithm to NOAA for use operationally within the Great Lakes Coast Watch System.
4. Document in reports, journal articles, and conference presentations the algorithms description (CPA-A, HABs, lake bottom mapping), their initial performance and recommendations for additional work. Provide the algorithms and share our findings with NOAA and other Great Lakes scientists.

### **Progress and Accomplishments**

- Continue to update the GLOPGD website ([www.glopgd.org](http://www.glopgd.org)) with additional data sets.
- Finalized the monthly retrievals (2002 –present) of chl, doc, and sm, cdom, KPAR, and photic zone for all three upper Great Lakes.
- Generated additional satellite remote sensing derived products of Lake Superior that will be combined with the 2014 University of Minnesota- Duluth Glider deployments.
- Generated additional example remote sensing data products for GLOS DMAC.
- Continue transitioning the CPA-A chl, doc, and sm retrieval algorithm to NOAA for operational use in the NOAA Great Lakes Coast Watch system.
- Presentations/Posters

### **Presentations**

Brooks, C.N., R.A. Shuchman, M. Sayers, A. Grimm, R. Sawtell, and M. Billmire. "Developing and Applying User-Friendly Web Portals for Sharing Great Lakes Remote Sensing Data." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

Meadows, G., A. Grimm, C.N. Brooks, and R.A. Shuchman. "Remote Sensing-Based Detection and Monitoring of Dangerous Nearshore Currents." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

Sawtell, R., M. Sayers, R.A. Shuchman, G. Leshkevich, C.N. Brooks, and C. Hatt. "Water Quality Observations in the Great Lakes Using an Optimized Satellite Bio-optical Algorithm." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

Sayers, M., A. Korosov, D. Pozdnyakov, R.A. Shuchman, and R. Sawtell. "Bio-Optical Retrieval Algorithm for Optically Shallow Water of the Great Lakes." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

Shuchman, R.A., G. Fahnenstiel, M. Sayers, S. Pothoven, R. Sawtell, and F. Yousef. "Long-term Trends in Lake-wide Phytoplankton Productivity in the Upper Great Lakes: 1998-2013." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

Shuchman, R.A., M. Sayers, A. Grimm, M Weber, M. Whitley, C.N. Brooks, and H. Stone. "Extending the Satellite-Based Time Series of Harmful Algal Bloom Extents in the Great Lakes." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

#### **Posters**

Brooks, C.N., A. Grimm, R.A. Shuchman, P. Chow-Fraser, and M. Sayers. "Satellite-based Assessment of Nutrient Status and Benthic Algae Distribution in Eastern Georgian Bay." *IAGLR 58th Annual Conference on Great Lakes Research* (2015).

#### **Scope of Work**

No changes to the scope or work, or the ability to achieve milestones and deliverables. There are not any noted changes/additions to the work elements of the proposed scope of work.

**Sub-award: Great Lakes Research Consortium, SUNY-ESFU (PI: Greg Boyer)**

#### **Project Summary**

The overall goals of the work was to improve our understanding of the nearshore environment along the New York Coasts of Lake Ontario and Lake Erie, with a particular emphasis on how these environments will respond to a changing climate and to understand the nutrient and water column dynamics related to harmful and nuisance algal blooms.

#### **Progress and Accomplishments**

- All buoys have been retrieved and serviced for winter storage.
- A 1.5m TIDAS buoy will be deployed in Lake Ontario off of the City of Oswego during the summer of 2014. This buoy is scheduled for Deployment in mid June 2015.
- In summer of 2014, we deployed three MB300 Bay buoys in Sodus Bay Lake Ontario specifically to monitor for harmful algal blooms. This effort was jointed funded by the Great Lakes Restoration Initiative. Over the winter, changes were made to all 3 MB300 to allow better flow around the submerged C6 sensor. These buoys are scheduled for deployment in early June, 2015

#### **Scope of Work**

- This project on schedule from a technical perspective with four buoys successfully deployed in Lake Ontario plus a supplemental weather station on the shores of LeRoy Island. All five sites were available through the NDBC website and the LeRoy island site continues to be available over through GLRC and the GLOS data portals.
- Currently plans are to deploy the Oswego buoy in June of 2015. We will need to redesign the mooring system based on the fact that our buoy broke free last year. The MB300 bay buoys will also be deployed in June to catch the start of the phytoplankton season.

**LEVERAGED OBSERVATIONS: Coastal Storms Program**

GLOS was provided another opportunity by NOAA's Coastal Storms Program to administer 2014 funding for observing assets in the Great Lakes region. Contracting was completed for 2 projects in December, and projects are underway.

### **A Coastal Hazard Observing System for Southeastern Lake Superior**

#### **Project Summary**

The long stretch of beaches and coastal rock formations along the southeastern shore of Lake Superior make it a popular destination for swimming, kayaking, surfing, recreational boating, and fishing. This shoreline, which stretches from west of the Huron Islands to east of Whitefish Point, encompasses the coastal communities of Marquette, Munising, and Grand Marais, as well as popular tourist destinations such as Pictured Rocks National Lakeshore and Whitefish Point. Despite the popularity of this region, as well as its use by the commercial shipping industry, no nearshore measurements of wave height are available along the entire, 300-km stretch of shoreline. The proposed project will establish a coastal hazard observing system for southeastern Lake Superior that includes: 1) an environmental data buoy within five nautical miles of Pictured Rocks National Lakeshore (near Munising), and 2) a standalone wave buoy that will be deployed at a variety of locations. The new data buoy will provide observations of weather, wave height / period / direction, and water temperature, while the standalone wave buoy will be deployed at Granite Island (near Marquette) in year 1 and other strategic locations in subsequent years (e.g., Grand Marais, Whitefish Point) to characterize variations in the nearshore wave climate. Granite Island, a leveraged NMU research site, is presently the only over-lake meteorological site in the nearshore region. All data from the observing system will be provided in real-time to GLOS, the National Weather Service, a project website and smartphone app, and emergency management officials. We will engage with local communities and the National Park Service to provide education and outreach materials, to ensure effective dissemination and use of the data, and to provide long-term support and maintenance for the observing system.

#### **Progress and Accomplishments**

Progress and accomplishments for the current reporting period included the following:

- Two public forums were held in the eastern Upper Peninsula to engage the public in planning for the proposed observing assets (see attached flyer). One forum was held in Marquette on November 30, 2014 and the other in Munising on December 30, 2014. Each forum included a presentation from the project team on the buoy project and a talk by the local National Weather Service office describing the local meteorology, storms, and the need for a nearshore observing system. Input was received from the community, including a number of local businesses regarding the placement of buoys (e.g., fishing groups, and boat rental / cruise ship operators).
- In response to the public forum in Munising, two local businesses donated funds to purchase a webcam for placement on the Munising buoy (to monitor waves, fog, and other weather conditions). In addition, the landowner of Granite Island donated funds to purchase a second, complete wave sensor for deployment at Granite Island (which has allowed the other wave sensor to be initially deployed at Grand Marais).
- Two NexSens wave buoys (with surface water temperature / weather sensors) were purchased from Fondriest Environmental, along with various mooring supplies. The buoys underwent final testing at LimnoTech in April, before being transported to Marquette on May 20, 2015.
- A TIDAS-900 environmental data buoy was purchased from DT Concepts and Seaview Systems, Inc. The data buoy includes weather and wave sensors, a thermistor string, datalogger and communications, power supply, and the (donated) webcam. The buoy is currently undergoing final assembly at Seaview Systems, Inc. and will be transported to Munising in early June, 2015.

- An aid-to-navigation permit application was submitted to the U.S. Coast Guard for deployment of the three Lake Superior buoys. The approved permit was received from the Coast Guard on February 10, 2015.
- A Joint Permit application was submitted to the Michigan DEQ and U.S. Army Corps for deployment of the three Lake Superior buoys. An approved DEQ General Permit (15-52-0019-P) was received on April 15, 2015, and the Corps authorization was received on April 30, 2015.
- Arrangements are currently being made with local businesses in Munising to coordinate deployment of the Munising anchor and data buoy.
- Development of interpretive displays and a smartphone app for the buoy data is in progress (see attached mock-up).
- A 1700-lb mooring anchor was purchased from Michigan Technological University and transported to Munising on May 22, 2015. Deployment options are currently being arranged.
- The two NexSens buoys were deployed in southeastern Lake Superior, along with anchors and mooring lines. One buoy was deployed ~0.2 miles north of Granite Island on May 21, 2015 and the other was deployed ~4.5 miles north of Grand Marais on May 22, 2015. Photos of the two buoys are included below, and the exact deployment locations are as follows:
  1. Granite Island buoy: 46°43'26" N, 87°24'41" W (46°43.435' N, 87°24.683' W)
  2. Grand Marais buoy: 46°44'28" N, 85°58'32" W (46°44.4673' N, 85°58.5313' W)

### **Changes to Scope of work**

Two changes to the scope of work – as a result of private donations – have resulted in enhancements to the proposed project. This includes:

- Donation of funds (from Pictured Rocks Cruises, Inc. and the Munising Visitors Bureau) to purchase a webcam that is being installed on the Munising buoy to monitor waves, fog, and other weather conditions. The webcam will provide near-real-time still images and video.
- The landowner of Granite Island donated funds to purchase a second, complete wave sensor for deployment at Granite Island. The purchase of a second, stand-alone wave buoy has allowed the other (GLOS-funded) wave sensor to be immediately deployed at Grand Marais in year 1, instead of year 2 (as was originally proposed). The Granite Island buoy will remain seasonally deployed in place at its current location, while the Grand Marais buoy will be available for placement near Whitefish Point in year 2 of the project.

Residual ice cover on Lake Superior during the month of May led to a 1-week delay in the deployment of the two wave buoys (originally scheduled for May 15, 2015). Deployment of the Munising anchor has also been delayed due to the inability of various agencies to assist with the large anchor (U.S. Coast Guard, Michigan DNR, and USGS were all contacted). A local fishing business in Munising has offered to assist, and we are currently planning for deployment on June 8, 2015.

**Real-time data gathering buoy in the Illinois waters of Lake Michigan** (PI: Tomas Hook, Purdue University)

### **Progress and Accomplishments**

This progress report summarizes progress and accomplishments from December 2014 to May 2015.

- Coordinate with Purdue/Illinois-Indiana Sea Grant about buoy location and mooring.
- Work with buoy manufacturer on building custom hull for this project.
- Coordinate logistical issues with buoy component construction and licensing between U of M, S2 Yachts, and Don Wire of DT Concepts.
- Address issues related to mooring attachment point on buoy and ballast weight.

- Coordinate with SeaView Systems for installation of buoy electronics (solar panels, batteries, wave sensor). Delay in finalizing solar panel installation and new hinged data logger box.

### **Scope of Work**

The buoy was scheduled to be deployed by Mid May, per the proposal, however delays in buoy construction and securing the mooring have delayed the anticipated deployment date. We are working to deploy the buoy by June 15. Will update GLOS as deployment nears.

### **West Michigan Buoy Project (LimnoTech)**

#### **Project Summary**

As a regional association of the Integrated Ocean Observing System, GLOS focuses on connecting users and consumers of environmental observations of the Great Lakes with providers of that data. For this project, GLOS has secured funding through the NOAA Coastal Storms Program to fund the deployment and maintenance of one buoy in West Michigan in the nearshore waters of Lake Michigan from 2013 to 2015.

The buoy will fill an observing system gap identified by the National Weather Service, who has a mission to understand present and future marine conditions in the nearshore waters. The buoy observations are an important component of the forecast, warning, and verification system utilized by the National Weather Service to inform swimmers, recreational and commercial boaters, and others of hazardous conditions. This project falls under the Maritime Operations and Public Health and Water Security Focus Areas as identified in the GLOS Blueprint for Great Lakes Decision Making.

In addition to improving nearshore marine forecasts and hazardous weather alerts, real-time data from the buoy will be used by a wide range of local recreational boaters, sailors, fishermen, weather watchers, surfers, search and rescue personnel, and others. Each of these user groups has specific data needs that are addressed by the buoy.

Listed below are the requirements of the project as summarized from the original request for proposals:

1. Deploy a monitoring buoy system capable of transmitting a basic set of physical parameters (wave height and direction, air and water temperature, wind speed and direction, and air pressure) in real-time to several data portals. This includes securing all permits, the buoy hull, instruments/electronics, mooring, and the entire data management systems to deliver data from the buoy to data portals.
2. Deploy the buoy by May 15 and retrieve after November 1 from 2013 to 2015 offshore of Grand Haven, MI. Visit buoy if needed throughout deployment period to address instruments issues and equipment failures.
3. Develop a data management plan and maintenance schedule that ensures all transmitted data is high quality. Address any problems immediately.
4. Work with local community organizations to develop a plan to deploy buoy beyond the end of the project.

#### **Progress and Accomplishments**

This progress report summarizes progress and accomplishments from December 2014 to May 2015.

- Over the winter the buoy was prepared for the 2015 deployment.
- All instruments were checked prior to deployment
- The buoy was ran at LimnoTech for 4 days prior to launch to test transmission and components.
- The monitoring buoy was deployed on April 28, 2015, which was ahead of the required May 15 deployment date.

- We worked with WOODTV8 who is now fully supporting paying for the data charges and a portion of the equipment fee for the webcam, which transmits high definition images and video clips hourly. Per this agreement with WOODTV8 we are listing them as a sponsor on the camera webpage and overlaying their logo on the publicly available images and video clips.
- WOODTV and Holland Community Television covered the buoy launch
  - <http://woodtv.com/2015/04/28/high-demand-buoys-back-on-lake-michigan/>
  - <https://www.youtube.com/watch?v=0HE8FhHOTmE>

### **Project Title: Evanston, IL Buoy w/IISG & Purdue**

#### **Project Summary**

As a regional association of the Integrated Ocean Observing System, GLOS focuses on connecting users and consumers of environmental observations of the Great Lakes with providers of that data. For this project, GLOS has secured funding through the NOAA Coastal Storms Program to fund the deployment and maintenance of one buoy offshore of Evanston, IL.

Listed below are the requirements of the project as summarized from the original request for proposals:

- Deploy a monitoring buoy system capable of transmitting a basic set of physical parameters (wave height and direction, air and water temperature, wind speed and direction, and air pressure) in real-time to several data portals. This includes securing all permits, the buoy hull, instruments/electronics, mooring, and the entire data management systems to deliver data from the buoy to data portals.
- Deploy the buoy by May 15 and retrieve after November 1 from 2013 to 2015 offshore of Grand Haven, MI. Visit buoy if needed throughout deployment period to address instruments issues and equipment failures.
- Develop a data management plan and maintenance schedule that ensures all transmitted data is high quality. Address any problems immediately.
- Work with local community organizations to develop a plan to deploy buoy beyond the end of the project.

#### **Progress and Accomplishments**

- Coordinate with Purdue/Illinois-Indiana Sea Grant about buoy location and mooring.
- Work with buoy manufacturer on building custom hull for this project.
- Coordinate logistical issues with buoy component construction and licensing between U of M, S2 Yachts, and Don Wire of DT Concepts.
- Address issues related to mooring attachment point on buoy and ballast weight.
- Coordinate with SeaView Systems for installation of buoy electronics (solar panels, batteries, wave sensor). Delay in finalizing solar panel installation and new hinged data logger box.

#### **Scope of Work**

The buoy was scheduled to be deployed by Mid May, per the proposal, however delays in buoy construction and securing the mooring have delayed the anticipated deployment date. We are working to deploy the buoy by June 15. Will update GLOS as deployment nears.

### **Lake Erie SOAR – Cleveland Bottom DO monitoring**

#### **Project Summary**

The bottom waters of central Lake Erie regularly go anoxic during the summer and fall months. This presents a problem for water intake managers that rely on a consistent source of freshwater to supply drinking water to plants located along the Ohio shoreline. The hypoxic zone hugs the bottom of the

lake and as the summer progresses the thickness of the bottom hypoxic layer increases. The water intake cribs draw water from about 10 to 15 feet off the bottom. In past years the hypoxic layer expands enough vertically that the low DO water was drawn into the intakes. Passing storms and internal seiches can also temporarily drive the hypoxic layer up in the water column and into the intakes. A monitoring system is needed to track the thickness of the hypoxic zone called the hypolimnion.

The project proposed here would support the acquisition of an environmental monitoring buoy in 2014 and cover the deployment, retrieval, and maintenance costs for two seasons (2015 and 2016) to continually monitor dissolved oxygen levels and other environmental variables offshore of the water intake cribs. The observations provided by the buoy would be used by water intake managers and scientists to inform management decisions and advance our understanding of the dynamic nature of the hypoxic zone in Lake Erie. The buoy will be located 14 miles from shore at a depth of approximately 22 meters. The performance period of this project is June 1, 2014 to May 31, 2016.

### **Progress and Accomplishments**

This progress report summarizes progress and accomplishments from December 2014 to May 2015.

- Meet with NOAA GLERL and GLOS to discuss project status in February 2015
- Investigate S2 buoy option instead of NexSens buoy for the nearshore buoy.
- Meet with NOAA GLERL and GLOS to review new equipment options
  - Offshore buoy (NexSens CB450) to measure water temperature and bottom dissolved oxygen concentrations
  - Nearshore buoy to measure waves, winds, and surface water temperature
- Consult with Work with S2 and SeaView Systems to cost out an S2 buoy to monitor wind speeds and wave heights
- Acquire the offshore buoy through NexSens and test at LimnoTech. Identified that the manufacturer designed the thermistor string incorrectly. They are preparing a new thermistor string ASAP for delivery.
- Delays in buoy construction and electronic integration are pushing the buoy launch back to the end of June.
- Made contact with many local organizations
  - Lake Erie Energy Development Corporation (LEEDCo)
  - Ohio Sea Grant
  - Cleveland Water Alliance
  - Cleveland Water
  - USGS
  - Cleveland Metro Parks
  - County Health Department
  - NOAA NWs office in Cleveland
- Plan for a project open house on June 26 and 27, 2015 at the Cleveland Science Center to display buoy and talk to local groups about the project
- LEEDCo has agreed to fund a webcam on the buoy.

### **Scope of Work**

As discussed with NOAA GLERL and GLOS, LimnoTech is choosing a different equipment manufacturer for the nearshore buoy. This has no impact on then budget or project output. The new buoy hull for the nearshore buoys, now manufactured by S2 yachts, will be more robust than the previously quoted NexSens buoy platform. The switch to the more robust buoy hull has caused a delay in deploying the



buoy by May 15. LimnoTech is working closely with the buoy manufacturer contact, Don Wire, and SeaView Systems, the electronic integrator, to ensure the buoy is ready to be deployed by June 15, 2015.

## **REGIONAL SCIENCE CONSORTIUM**

### **Project Summary**

The goal of this project is to increase observational data on the nearshore conditions in Lake Erie off the coast of Pennsylvania. A nearshore buoy was deployed May 6, 2014 off the Presque Isle State Park peninsula (42.185593, -080.136269) in approximately 15 meters of water. Real-time data readings are taken every 20 minutes on 17 parameters from weather, wave, and water quality meters. This data is provided to the Great Lakes Observing System, NOAA – National Data Buoy Center, and the Regional Science Consortium databases. The buoy also supports a video camera that updates the website several times daily with video clips of lake conditions. The buoy was retrieved from the lake on November 17, 2014 for winter storage.

The nearshore buoy was deployed for its second season on May 6, 2015 at approximately the same location (42.185406, -080.137070). Data and videos have been successfully uploading to the website [www.PaLakeErieBuoy.com](http://www.PaLakeErieBuoy.com). Data and video are collected at the same time periods and to the same institution websites as the 2014 season (described above). Buoy retrieval is scheduled for late October to avoid poor lake and weather conditions that occur often in this region during the month of November.

### **Progress and Accomplishments**

The Pennsylvania nearshore buoy had a very successful first season, and is currently in its second season. The nearshore buoy was deployed May 6, 2015. Data transfers continue to send real-time data to the Great Lakes Observing Systems, the National Data Buoy Center, and the Regional Science Consortium databases. A Total Algae probe, measuring Phycocyanin (blue-green algae) and Chlorophyll a (funded by Pennsylvania Department of Environmental Protection) has been installed on the nearshore buoy sonde for the 2015 season. This is to complement our current monitoring of swimming beaches for Microcystis that are responsible for harmful algal blooms.

As a means of quality assurance/quality control (QA/QC), RSC staff has made weekly trips to the buoy site to measure and assess all parameters measured by the buoy. An additional EXO sonde is used to take water quality measurements for comparison to those recorded by the buoy.

From May 6 through May 31, 2015, the website displaying the real-time data received 21,748 visits, which averages to 836.5 visits daily. Local anglers, boaters, sailors, charter boat captains, and recreational water users continue to have extensive positive feedback. We have been working with the U.S Geological Survey, PA Fish and Boat Commission, and Erie Public Water Works in utilizing the data for various research projects. Local meteorologists continue to report the nearshore buoy data daily on local weather reports.

### ***Text Alert System (implemented 2015 season)***

The text alert App has been created for Android and Apple devices. It is a free download from Google Play and the App store. The App is currently being tested and will be advertised to the public in the next couple weeks. The App can be customized to select features that the user is most interested in, such as:

- Small Craft Advisory
- Storm Warning

- Gale Warning
- Water Temp >80 degrees F
- Water Temp <32 degrees F
- Wind Speed over 20 mph
- Wave Height over 3 ft

This text alert App was made possible by a Boat U.S. Foundation grant to support an awareness campaign of the nearshore buoy project.

### ***Education and Outreach***

All four of our local television station affiliates (ABC, CBS, NBC, and FOX) continue to feature the buoy data daily on the local news casts. I have worked closely with the local meteorologists to inform them on how to use the website, access the data (historic), and video clips.

During the period of this grant cycle, we have participated in the following education and outreach events:

- Sail Erie group (February 12, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 15 attended
- Erie Yacht Club (February 25, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 85 attended
- Friends of TREC, Senior Series (March 18, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 12 attended
- Presque Isle Rotary (March 31, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 20 attended
- Presque Isle Rotary – Satellite Group (April 23, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 5 attended
- Presque Isle Antique Car Club (May 18, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 12 attended
- Pittsburgh Downriggers Fishing Club (May 26, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 22 attended
- Springhill Senior Living Community (May 28, 2015)
  - Provided information on how to access buoy data, summary of the 2014 season, and upcoming changes for the 2015 season – 20 attended

### ***Other Accomplishments***

- The Nearshore Buoy Project received the Governor's Award for Environmental Excellence on April 28, 2015 ([http://www.governor.pa.gov/Pages/Pressroom\\_details.aspx?newsid=1646#.VXIaxbfD9D8](http://www.governor.pa.gov/Pages/Pressroom_details.aspx?newsid=1646#.VXIaxbfD9D8)). The Pennsylvania Department of Environmental Protection selected 15 projects to receive awards ([http://www.portal.state.pa.us/portal/server.pt/community/governor's\\_award\\_for\\_environmental\\_excellence/21540](http://www.portal.state.pa.us/portal/server.pt/community/governor's_award_for_environmental_excellence/21540)) and Pennsylvania Environmental Council hosted the award dinner in Harrisburg,

Pennsylvania (<http://pecpa.org/press-releases/governors-awards-honor-15-pennsylvania-organizations/>).

- Outdoor signs promoting the buoy, website and its Quick Response (QR) code were installed at over 20 boat launches and marinas along the Pennsylvania Lake Erie coastline.

### **Future Plans**

The nearshore buoy has been a successful project and has received a great deal of support from the community. We are looking forward to continuing to meet with anglers, boaters, sailors, and other sportsman groups. The text alert App has been developed and is currently being tested since the buoy deployment on May 6, 2015. The release of the App to the public will occur in June 2015.

## **IV. MODELS AND TOOLS**

GLOS staff and DMAC contractors continue ongoing support for existing model output access and decision-support tool operations.

Participation in the Lake Michigan Modeling group was deferred during GLOS staff transition. The new Executive Director will be working with new staff to determine the appropriate future direction for GLOS to support ongoing coordination of modeling activities. As part of this assessment, GLOS ED and staff met with Eric Anderson at NOAA-GLERL to discuss opportunities for support of the NOAA Ecological Forecasting Roadmap and are working with him to prepare for an in person meeting at GLERL with Alison Allen in August.

## **V. OUTREACH AND EDUCATION**

### **Website/Newsletter**

GLOS staff has updated the content of the website including but not limited to:

- Project, news and events pages (e.g. Lake MI Working Group, CSP buoy updates).
- Updated Staff and Board of Directors page.
- GLOS newsletters were sent out 12/4/14, 1/20/15, 2/18/15, 3/19/15 and 5/13/15 (can be found at: <http://www.glos.us/news-events>).

### **Outreach**

Participated in the following meetings/workshops/projects:

- Great Lakes Waterways Conference Feb February 10, 2015 - February 11, 2015
- Great Lakes Commission Semiannual Meeting and Great Lakes Day in Washington, February 24-26, 2015
- Lake Erie Harmful Algal Bloom Public Forum, April 2015
- IOOS Association Spring Meeting, March 2-3, 2015
- Lake Erie Monitoring Methods Workshop May 15, 2015
- International Association of Great Lakes Research Conference May 25-29, 2015
- Great Lakes Acoustic Telemetry Observation System (GLATOS) coordination meeting in Ann Arbor on March 11 and 12, 2015
- Great Lakes Regional Collaboration Team, monthly team calls
- GLOS annual meeting planning is underway

### **Education**

#### **National Geographic Collaboration:**

- Sea Grant and GLOS staff continue to collaborate with National Geographic and USGS on the ongoing improvements to The Great Lakes FieldScope, a GIS tool targeting K-12 educators and citizen scientists.
- Sea Grant and GLOS will continue to facilitate the delivery of GIS layers and add additional data. Data entry forms have been updated for users to upload data. Various water quality related data has been entered, particularly Secchi disk information from the Michigan Clean Water Corps.
- Sea Grant is coordinating this effort in promoting and enhancing both Great Lakes FieldScope and Teaching Great Lakes Science.
  - Presented on Great Lakes FieldScope at the Northeast Michigan Great Lakes Stewardship Initiative networking meeting in Alpena, Michigan on February 17th, 2015. Approximately 50 people attended.
  - Presented on Great Lakes FieldScope and Teaching Great Lakes Science at the annual MSTA conference in Grand Rapids, MI on 2/26/2015 and 2/27/2015, 2015.
  - Tabled at National Oceanic Science Bowl in Ann Arbor, MI on 2/7/2015.
  - Presented at the Clinton River Water Festival in Rochester, MI on 5/15/2015.
  - Great Lakes FieldScope and Teaching Great Lakes Science fact sheet developed, and provided to regional educators at meetings including the Northeast Michigan Great Lake Stewardship Initiative meeting and the MSTA conference.
  - Attended the Detroit Zoo Green Festival in Rochester, MI
- Completed a news release on Teaching Great Lakes Science alignment with the Next Generation Science Standards, it will appear in the MSTA spring newsletter.
- Connections made with partner organizations have strengthened throughout the project, particularly with regional Extension educators and members of the Great Lakes Stewardship Initiative.
  - Enhanced our user base in Great Lakes FieldScope by enlisting 32 new users since January 2015

**SCOPE OF WORK**

There are no anticipated changes to the scope of work as re-scoped and approved for FY2015 or in the organization’s ability to achieve the milestones and deliverables for this or future reporting periods under that scope of work.

**PERSONNEL AND ORGANIZATIONAL STRUCTURE**

In addition to the staff transition reported earlier, several members of the GLOS Board of Directors ended their terms at the Fall 2014 Board Meeting including Bill Werick, Frank Kudrna, and Dale Phenicie. Terry Geddes also submitted his resignation at the end of 2014. Ron Baird and Kathryn Buckner were newly elected at the Fall meeting and two additional new board members have been recruited to start terms in the Fall of 2015.

**ANNUAL SUPPLEMENTALS- June Report (Report Period: 12/01/14 through 05/31/15)**

**Updates To RA Governance Board Membership** (utilizing the following table):

Region	Type of Gov	Distribution of Governance Board Membership			Total number of
		Government	Non-Government	Foreign	

		State	Local	Tribal	Fed	Research Institute	Industry	NGO	(all sectors)	Board members
GLOS	501(c)(3)		1*			2	2		2**	7

\* Great Lakes/St. Lawrence Cities Initiative

\*\* 1 from the "bi-national" International Joint Commission

### **Governance Activities and Accomplishments**

As of April 2014, the Board of Directors revised their by-laws, elected a new chair and established two new positions: Vice-Chair Relations and Vice-Chair Development. The Secretary and Treasurer positions have been consolidated into one position.

Chair: Dr. John Carey

Vice-Chair Relations: Dr. Nancy Frank

Vice-Chair Development: G. Tracy Mehan III

Secretary/Treasurer: Mark Burrows

### **New Board Members**

- Ron Baird
- Kathryn Buckner

### **Education and Outreach Activities**

*Please see V. OUTREACH AND EDUCATION section above.*

The information contained in the Education and Outreach Inventory tool is still missing a link for Great Lakes FieldScope: <http://greatlakes.fieldscope.org/>. An email was sent to noaa.ioos.webmaster@noaa.gov on 6/18/2015.