

MAKING THE LAKES GREAT

An IISG Partner Report

2017



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UNIVERSITY OF ILLINOIS
EXTENSION

Great Lakes
RESTORATION



PURDUE
EXTENSION

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INTRODUCTION

Throughout the Great Lakes basin, community leaders face the challenge of making long-term management decisions that lead to positive impacts on ecological integrity and community quality of life. For local decision makers with limited resources, understanding the implications of development and identifying optimal planning strategies to make their communities more resilient—economically, environmentally, and socially—requires research, outreach and monitoring at a larger, basin-wide scale, coupled with local pilot testing and adaptive management.

Regional Setting and Overarching Principles

In 2012, the U.S. and Canada updated the Great Lakes Water Quality Agreement, outlining binational cooperation to restore and maintain Great Lakes resources and commit the two countries to a series of goals and initiatives. These include: restoring near shore habitats, including drinking water sources; restoring or delisting Areas of Concern; identifying and mitigating emerging contaminants; updating nutrient targets; and working with communities to understand how

Identifying optimal planning strategies make communities more resilient—economically, environmentally and socially.



climate change will impact water quality. The U.S. Environmental Protection Agency Great Lake National Program Office (GLNPO) is in charge of coordinating U.S. efforts.

In 2010, GLNPO adopted the Great Lakes Restoration Initiative (GLRI) Action Plan to catalyze protection and restoration in the region. The plan seeks to engage non-federal partners in research that advances Great Lakes Water Quality Agreement goals. GLRI Action Plan II continues and refines the efforts set forth in Plan I through 2019.

The Illinois-Indiana Sea Grant Partnership

Sea Grant programs specialize in science-based, unbiased outreach and extension programming. Located at Land Grant universities in coastal and Great Lakes states and U.S. territories, Sea Grant programs couple research with outreach and education expertise to inform decision making at all levels—from K-12 students to policy makers.

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Illinois-Indiana Sea Grant (IISG) is administered at the University of Illinois and Purdue University and focuses on water issues in Lake Michigan locally, the Great Lakes regionally, and, as the two states are almost entirely hydrologically connected to the Mississippi River, the Gulf of Mexico nationally.

Starting in 2005, GLNPO established an interagency agreement with National Oceanic and Atmospheric Administration (NOAA) to fund IISG and other Great Lakes Sea Grant programs to help the agency bring EPA science to local and regional decision makers. This initial five-year agreement resulted in substantial progress and led to a second agreement. The results of this 2010-2015 award are detailed in this report.

PREVENTING POLLUTION

The good news is that in our modern world, we have more chemicals and products to help us stay safe and healthy, and well-groomed to boot—pharmaceuticals, flame retardants, and hair conditioners, for example. The bad news is that these same chemicals can fall under the category of emerging contaminants. Many of them have not been frequently monitored, but have the potential to have adverse effects when they ultimately end up in the environment.

Case in point, researchers have found traces of pharmaceuticals in waterways around the country. While the levels are not high enough to pose immediate human health concerns, negative impacts on aquatic species have been well documented. IISG has focused most its efforts in the area of emerging contaminants in helping prevent medicines from ending up in lakes and rivers.

A Prescription for Medicine Disposal

From time to time, we all have medicines that we no longer want or need—they expire, we get better, they don't work—the reasons are many. If you flush medicine or throw it in the trash, it's gone from your immediate world, but many of these chemicals can pass through water treatment systems or leach from landfills and turn up in local waterways, potentially affecting aquatic organisms and becoming extra ingredients in drinking water. With that in mind, what should one do with unwanted or expired medicines?

In 2006, in response to a U.S. Geological Survey (USGS) study that found pharmaceuticals in waterways around the country, IISG's Susan Boehme and Elizabeth Hinchey Malloy and Hollings Scholar Lara Polansky looked for possible solutions. They found that, indeed, flushing medicines was a common practice. They focused on providing support for organized collection events so that people could bring in unwanted medicines, which would then be incinerated. Boehme and Hinchey Malloy developed a tool kit for communities to create their own collection programs. They held workshops to share this resource with local officials in the region.

In 2010, Laura Kammin became IISG's pollution prevention specialist. Word of the toolkit and collection programs spread as IISG reached out to communities to educate them about medicine disposal. From 2010 to 2015, IISG presented at 68 conferences, workshops, and outreach events and had direct contact with and

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From 2010 to 2015, IISG helped communities in Illinois and Indiana host 33 single-day medicine take-back events that collected 20,675 pounds of medication for disposal.

provided information to 24,738 people. IISG also reached out to new partners to leverage resources, including collaborative efforts with the American Veterinary Medical Association, the Prescription Pill and Drug Disposal Program, and 17 Sea Grant programs in the Great Lakes region and around the country.

Collection Programs Catch On

As Kammin joined IISG, communities were just getting started organizing single-day collection programs. With no national or state-led programs available, local decision makers were taking the initiative to do it themselves. And they were eager to do so—from 2010 to 2015, IISG helped communities in Illinois and Indiana host 33 single-day medicine take-back events that collected 20,675 pounds of medication for disposal.

These events were great at engaging community members and local audiences. For example, Kammin reached out to University of Illinois students, raising their awareness about improper disposal of pharmaceuticals. The students were inspired to host their own medicine collection program on campus, with cooperation and support from IISG and the University of Illinois Police Department.

Keep Northern Illinois Beautiful, a non-profit environmental organization, organized and hosted a hugely successful medicine collection with IISG support. Thousands of pounds of

medications were collected, but what's more, this event provided an opportunity for IISG to produce a how-to video on hosting a medicine collection event.

In 2011, Kammin began working with faculty and students at Purdue University College of Pharmacy to host single-day collection events on campus and for the public in West Lafayette, Indiana. Surveys revealed that participants would prefer access to permanent medicine take-back locations, which they believed would be more convenient than the single-day events.

IISG joined the Indiana Attorney General's Prescription Drug Abuse Task Force in 2013. Kammin provided educational resources for the Bitter Pill campaign, participated as part of the speaker's bureau, and helped communities requesting assistance on setting up take-back programs. The years of work came together in 2015, when IISG, Purdue College of Pharmacy, the Indiana Attorney General's Office, and the Yellow Jug Old Drugs program joined forces to launch the first permanent collection program at the Purdue pharmacy.

It was clear that people needed more opportunities to drop off medications than single-day events. Since the Drug Enforcement Administration recognizes law enforcement offices as secure medicine take-back sites, Kammin worked to educate law enforcement officials and local decision makers about how to

set up collection programs that were available to the public 24 hours a day, 365 days a year. She helped local officials understand regulations and install collection boxes, and directed them on legal, environmentally-sound methods for disposal.

From 2010 to 2015, IISG helped communities start 52 permanent medicine take-back programs in Illinois, Indiana, Wisconsin, and Michigan. All but one are still active and the programs have collected 73,612 pounds of unwanted medication so far.

In one of many successful partnerships, IISG and the Indiana Hazardous Waste Task Force educated county solid waste managers about proper medicine disposal. After Kammin helped a take-back program in Monroe County get off the ground, the idea quickly caught on. In less than a year she helped launch 11 programs in seven more Indiana counties.

The take-back education program continues to grow by word of mouth—IISG regularly receives calls from law enforcement offices, inspired by success stories from neighboring communities, requesting information and support for setting up programs of their own. The demand for technical assistance is still strong. So much so that IISG has incorporated providing pharmaceutical and personal care product (PPCP) resources and assistance to communities into its 2018–2021 strategic plan.

Joining Forces with AVMA

IISG has reached out to other organizations to help spread the word about proper storage and disposal of medications. In 2011, the National Sea Grant Office (NSGO) and the American Veterinary Medical Association (AVMA) signed a three-year memorandum of understanding to develop a joint outreach campaign for veterinary clients. IISG served as the NSGO representative.

A kick-off event began during the holiday season that year and ran through the following March—a public service announcement aired on the CBS JumboTron Super Screen on 42nd Street in Times Square in New York City. The message “Don’t Flush your Medicine” was on display in a 15-second video for millions to see. An estimated 500,000 people go through Times Square every day, and one million people crowded the streets at midnight on New Year’s Eve.

AVMA and IISG developed a brochure with a set of five medication management steps for veterinarians to share with their clients. Additionally, IISG hosted exhibitor booths at the AVMA and Indiana Veterinary Medical Association conventions reaching over 470 veterinarians, veterinary technicians, and veterinary students from 33 states as well as Peru, South Korea, Japan, Canada, and Italy.



In LaSalle County, Illinois, drop boxes have been placed in police stations where ongoing medicine collections are taking place.

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Expanding Outreach

One of the best management practices of the medicine disposal work has been developing partnerships that bring together different skills, resources, and sometimes, geography.

The success of this program led University of Illinois Extension to award \$300,000 to IISG and the Illinois Sustainable Technology Center (ISTC) for a PPCP research, education, and outreach project in 2014. Multiple outreach events were conducted in Cook, DuPage, Champaign, Jackson, and Pope counties and reached hundreds of people. The research conducted by ISTC has been, and will continue to be, included in IISG's outreach on the PPCP disposal issue.

Kammin led the effort to help bring medicine disposal issues to national attention, hosting or co-hosting conferences to expand the community of researchers and educators working on PPCP issues. In 2013, with NSGO funding, IISG hosted a Sea Grant workshop in Florida, reaching specialists from programs around the country. This began the Sea Grant National PPCP Working Group, led by Kammin, which brings together 17 Sea Grant programs through regular conference calls. In 2015, Kammin joined with members of the working group to set up the SerPIE One Health Conference on Pharmaceuticals and Personal Care Products, which was hosted by Alabama A&M and IISG in Huntsville, Alabama.

Education for All Ages

IISG's education team—Robin Goettel and Terri Hallesy, along with Paul Ritter of the Prescription Pill and Drug Disposal Program (P2D2)—set in motion the development of a school curriculum and engagement with teachers and students. *The Medicine Chest*, published in 2010, is a collection of activities that introduces students to the issues of medicine disposal through a variety of disciplines. Furthermore, through its partnership with the P2D2 program, IISG was able to connect teachers with *The Medicine Chest* as well the *4-H Guide for Sensible Disposal*.

The groundwork was laid for more projects. In 2010, IISG began working with Sea Grant programs in Pennsylvania, New York, and Ohio on the GLRI-funded *Undo the Great Lakes Chemical Brew: Proper PPCP Disposal* project. This work covered a broad swath of partners, outreach opportunities, resources, and stewardship projects. As a result, more than one million Great Lakes states residents were educated and more than 10,000 pounds of medication were disposed of. Undo the Chemical Brew won the 2012 Great Lakes Outreach Programming Award from the Great Lakes Sea Grant Network.

The Illinois State Fair offers a great opportunity to talk directly to the people of the state and IISG creates games and displays to engage audiences of all ages. Between 2011 and 2015, IISG came to the fair with exhibits focused on pollution prevention—Getting Rid of Stuff Sensibly, for example—and those that encompass a broader range of Sea Grant topics, including PPCP issues. Over the course of those summers, IISG spoke directly with over 7,000 people, many of those children, about water quality concerns.

Between 2010 and 2015, the IISG education team brought the issue of medicine disposal to people in a variety of settings. Through eight workshops, 24 conferences, nine summits, seminars or symposiums, eight exhibits or fairs, two webinars, and two service learning courses, altogether 6,700 educators, students, and citizens learned not to flush their PPCPs.

Here are some stories from those numbers.

- ◆ Windy City Earth Force, a non-profit program through the Field Museum joined forces with IISG to focus on schools in Chicago's Calumet region, encouraging students to explore the effects of PPCPs on the watershed. Goettel and Hallesy introduced the topic to seventh and eighth graders from Niños Héroes Elementary School. The students turned their new knowledge into posters and fliers, they gave presentations to other students, and created a public service announcement.
- ◆ Students at George M. Pullman Elementary School also took steps to educate others about the disposal of medicines. The youth created an informational banner, made educational brochures, and spoke to the local school council as well as other students.
- ◆ As part of the B-WET project, environmental educator LaToya Gilbert in Gary, Indiana, who took part in the Field Experiences for Watershed Educators workshop, selected the topic of medicine disposal as a stewardship project. Her scout troop organized a Walk4Water community event highlighting this issue. The students invited participants to join them in walking three miles carrying water bottles symbolic of the watershed. Along their walk they provided watershed information and had stops where participants would receive information and answer trivia questions.
- ◆ Gilbert's homeschool co-op students dove in further by creating a research project complete with surveys, data input, and analysis. The students developed online surveys and they brought surveys to pharmacists and citizens at the local drug stores. They also spoke with pharmacist technicians regarding proper disposal methods.
- ◆ In 2013 and 2014, Goettel, Hallesy, and Kammin worked with 12 University of Illinois Learning in Community (LINC) students to help educate others about how to prevent medicines from contaminating local waterways. The LINC program provides service-learning opportunities for students to gain hands-on experience and create activities, in this case, focused on medicine disposal. The IISG team introduced *The Medicine Chest* and other resources that provided background on the issue and inspiration for students' outreach projects. These two classes raised awareness in U of I students, local organizations and businesses, and the Champaign-Urbana community at-large.

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Gilbert's students developed a trivia game, *Wheel of Water*, to showcase what they had learned. They were invited to present at a Shedd Aquarium Great Lakes Awareness Day and at local schools.

Emerging Contaminants Research

Emerging contaminants are new to the environment or have only recently been detected. In either case, it is important to understand their source, transport, where they end up, and, particularly, their potential impacts on the food web and human health. IISG has sought to support research on emerging contaminants and share new information.



Scientists' Stories

To make research in the arena of PPCPs and other emerging contaminants more accessible to the public, IISG launched the UpClose interview series in 2012. In 12 publications, IISG strove to connect the work of engineers, microbiologists, chemists, and other researchers to those who could use the information to make positive behavior changes regarding the way they purchase and use products. The focus areas were PPCPs, microplastics, and coal tar sealcoat.

Microplastics Go Big

The microplastics common in personal care products and clothing can enter lakes and rivers through wastewater treatment plants that are not designed to remove such small materials. IISG funded and helped conduct the first study of plastics in southern Lake Michigan. Early results indicate that these waters contain more than 19,000 microfibers/sq. km, making these the most prevalent microplastic and setting southern Lake Michigan apart from the other Great Lakes. These microfibers are most likely from clothing, particularly those made from polyester or polyurethane.

An Associated Press story on the research and its implications for Great Lakes ecosystems was published in more than 40 news outlets worldwide.

An Associated Press story on the research and its implications for Great Lakes ecosystems was published in more than 40 news outlets worldwide, including The New York Times, The Guardian, and the Chicago Tribune. The media effort also led to a Time Magazine story on research showing that Great Lakes fish are ingesting plastic fibers.

MONITORING THE GREAT LAKES

GLNPO has supported extensive research on the status and health of the Great Lakes. These data, gathered over more than 30 years, can enrich and inform work done by fellow scientists in the region, helping them tell a more accurate and thorough story or create new measuring techniques and models. This resource is also useful in support of lakewide management plans and in ongoing decisions faced by local resource managers and public officials. However, until recently, no mechanism existed to easily transfer and integrate this valuable information to end users.

To address this, IISG has been working with GLNPO since 2002 to develop products, tools, and strategies to provide access to Great Lakes research findings from offshore water quality sampling.



And, the program is engaged in initiatives that develop quantitative analyses for agencies to improve the effectiveness of monitoring programs, by developing ways to make Great Lakes data collection and analysis more efficient, dependable, and precise. Through new algorithms, huge datasets can be understood quickly, and sampling can happen with more consistent accuracy.

IISG is also leading efforts to coordinate agency and university scientists as they come together to study the Great Lakes in a systematic and comprehensive fashion.

In these and other efforts, IISG specialists work with community leaders, natural resource professionals, and Great Lakes residents to monitor, improve, and protect the quality of the Great Lakes overall and in critical locations.

Access to Data

GLNPO's years of monitoring data can be a valuable tool for scientists and resource managers to see trends and shifts over time. As scientists connect historical data with their own, they can tell a more accurate story of the health of the Great Lakes or create new measuring techniques and models.

IISG and the National Center for Supercomputing Applications (NCSA) at the University of Illinois have developed a web application—Great Lakes Monitoring—that is a one-stop shop for information. What used to take months to find and retrieve now takes minutes—environmental data from across the Great Lakes

region is just a click away. The web application makes it easy to view and analyze decades of nutrient, contaminant, and other water characteristic data.

Much of the information available now comes from GLNPO, but USGS, NOAA, Heidelberg University, and others have also contributed data from their environmental monitoring programs.

IISG's Paris Collingsworth, Great Lakes ecosystem specialist, and Kristin TePas, community outreach specialist, worked with NSCA to design data views with different users in mind. For example, a higher-level manager may find the basin-scale views of the Explore Trends useful, whereas a researcher may want more specific time-series information about a particular parameter at a specific location.

Great Lakes Monitoring also allows researchers to create and download their own data sets for the locations, sources, environmental characteristics, and dates that most interest them. And a variety of available file types make offline use easy.

Smarter Data Analysis

When GLNPO's rich data resource informs the development of new algorithms, new data can be analyzed much quicker and more consistently. The historical data can also be key to developing new technology to address old and new Great Lakes concerns.

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Collingsworth has been working with engineers at NCSA to develop ways to consistently pinpoint fluctuating lake elements that are critical to understanding the health of the lakes, such as the thermocline and the deep chlorophyll layer, and to highlight anomalies in sensor data.

New state-of-the-art algorithms can read thousands of lines of data in near real time

Detecting Anomalies

As the Lake Guardian moves through Great Lakes waters collecting vast amounts of data, it may be recording bits of information that reveal unexpected or revealing changes in conditions. New state-of-the-art algorithms developed by the NSCA team can read thousands of lines of data in near real time from Triaxus and Seabird sensors, filling in missing information and flagging unexpected results as they go—spikes in water temperature, drops in oxygen levels, or a pocket of zooplankton-rich water.

This process otherwise takes months and suffers from more user errors. In contrast, the modeling software running these algorithms get better at finding hidden insights with each use, without being explicitly programmed where to look.

Barbara Minsker, an environmental engineer at the University of Illinois, and PhD student Wenzhao Xu developed the program using 30 years of EPA Great Lakes data. Through this historical benchmark, the detection algorithms can indicate which bits in these large datasets are most in need of human review.



Collingsworth expects that these detection algorithms will enable the Lake Guardian to receive near-real-time assessment of data anomalies that may warrant further investigation, such as a developing algal bloom or high nutrient or sediment fluxes from the shore or rivers. It would also enable synchronous timing of sample collecting (for example, of phosphorus) during these events.

Locating the Thermocline

The thermocline is a thin layer that separates warmer water on top and significantly colder water below. Knowing where this layer is can help inform what depths to send monitoring equipment to get accurate measures of temperature and other characteristics down the water column. This data can convey the location of upwelling events, the structure of the deep chlorophyll layer, and other lake dynamics.

Another new algorithm developed by the NCSA team and informed by GLNPO's historical data provides the precise location of the thermocline. With this tool, guesswork is gone. Across studies and over the course of monitoring seasons, a consistent measure of the thermocline makes datasets directly comparable and measurements more reproducible.

This rich trove of data and the new machine-learning algorithm can help scientists discover new and old patterns and answer critical questions. For example, Collingsworth and other researchers are looking into the implications of climate

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change on water temperature and the thermocline layer. Other scientists may use it to monitor the depth of the hypoxic layer in an algal bloom.

Monitoring Dissolved Oxygen

Working with GLNPO and state and federal managers, Collingsworth helped obtain and deploy an array of dissolved oxygen sensors in Lake Erie, which in recent years, saw a reemergence of algal blooms and the growth of the hypoxic zone. This three-year investigation of dissolved oxygen levels suggests that dead zones can spring up across the lake and disappear just as quickly.



The large dataset from this intensive monitoring revealed that hypoxia doesn't systematically spread out from the central basin of the lake as scientists have long believed. Pockets of low oxygen also continuously spring up at the edge of the basin, where they're sloshed around by internal waves.

The finding moves EPA and Environment Canada substantially closer to fulfilling their commitment to pinpoint the location and size of the hypoxic zone, one of many priorities codified in the Great Lakes Water Quality Agreement.

It also has potentially sweeping repercussions on fishery management in Lake Erie—the lake has more fish than the other lakes combined. The Great Lakes Fishery Commission bases annual commercial catch limits on models that assume that the number of fish and the effectiveness—or catchability—of different fishing gear are the same anywhere in the lake and at any time in the season.

The high-resolution data collected in this study, brought to light the fine details of how hypoxic waters move and impact where fish are found. The number of fish and other aquatic wildlife spikes at the edge of hypoxic waters as some flee suffocation and others hunt those on the run. The result is an ever-changing patchwork of high and low-density habitats that could lead managers to think there are more or less fish in the lake than actually reside there.

Ohio Department of Natural Resources (DNR), USGS, and others are examining new survey designs that would offer a more accurate picture of species behavior and numbers. In the meantime, the Lake Erie Committee of the Great Lakes Fishery Commission in 2015 approved an interim rule that allows managers to keep outlying data out of the models.

The discovery that pockets of low dissolved oxygen spring up and disappear across Lake Erie in a matter of hours has led to a new effort to model and predict hypoxic conditions. Led by the USGS, EPA, and NOAA, the results would make it possible to alert utilities to conditions that may lower drinking water quality below federal safety standards.

Focused Great Lakes Research

The discoveries in Lake Erie are a shining example of how the Cooperative Science Monitoring Initiative (CSMI) can heighten research on issues plaguing the region. CSMI is a binational research program organized through GLNPO and Environment Canada.

Lake Michigan's food web may be more dynamic than previously thought

Every year, multiple federal, state, and university scientists gather on one of the Great Lakes to take part in coordinated research. Collingsworth, in collaboration with EPA scientists, has provided leadership in recent years, defining critical questions and coordinating research efforts of various agencies for large-scale studies. He is a member of the Great Lakes Water Quality Act Annex 10 CSMI task group and has participated in numerous research cruises.

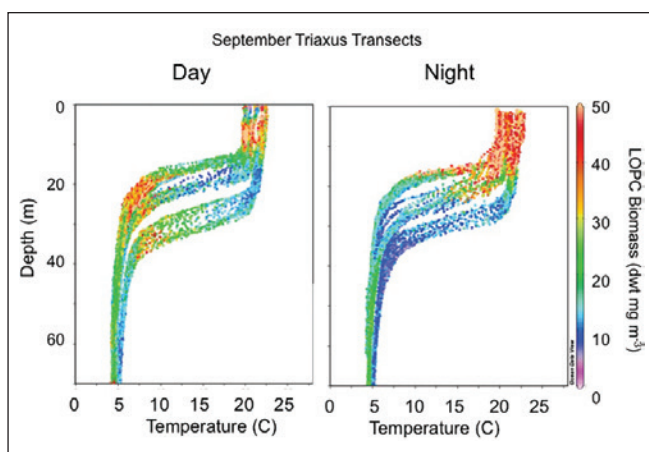
Since 2002, CSMI has been engaging agency scientists. Then, efforts like the Lake Erie Millennium Network and the Great Lakes Regional Research Information Network brought university researchers to the table, and provided a venue where agency and university scientists, as well as representatives from potential funding sources could share ideas and begin to study lakes in a focused fashion. With a new concerted effort to pull results together, CSMI is now an opportunity for scientists to find synergies and paint the big picture of the status of each lake.

Lake Ontario was the focus in 2013, which included monitoring variations in the deep chlorophyll layer. This rich source of energy for the lake's plankton may be key to the food web as a whole.

Collingsworth aided GLNPO's deployment of the dissolved oxygen loggers during the 2014 CSMI field year focused on Lake Erie, and with the project's success, it has continued in subsequent monitoring seasons. In addition, EPA, USGS, Ohio DNR, NOAA, and other state and federal agencies, along with researchers at University of Toledo, Ohio State University, Heidelberg University, and Case Western Reserve University, came together to focus their monitoring programs on closing some research gaps identified by lake managers.

During the 2015 Lake Michigan field year, some researchers set out to map the change in number of phytoplankton living near the surface as they surveyed nearshore to offshore. Initial analysis of the data collected with Triaxis sensors suggests that the role of surface productivity in Lake Michigan's food web may be more dynamic than previously thought.

Collingsworth is working with specialists at New York and Ohio Sea Grant to summarize and publish the CSMI field year projects in lakes Ontario and Erie and to design outreach programs. And, he is providing oversight for a newly-funded project to develop communication tools that will provide access to results of CSMI activities for each lake, beginning with Lake Erie.



Bringing It All Together

Although CSMI field year data is currently managed by individual agencies and researchers, GLNPO and NCSA hope in the coming years to integrate the results into the online portal and visualization tool Great Lakes Monitoring.

The planned expansion is made possible by the hybrid database NCSA built the tool on. It was designed to be as flexible as possible. Luigi Marini of NCSA and three other developers merged elements of the traditional relational database—imagine a series of spreadsheets—with something computer scientists call NoSQL that makes it easier to incorporate large quantities of different data types.

The team behind Great Lakes Monitoring also plans to take advantage of the hybrid database to incorporate data from the Lake Erie dissolved oxygen loggers as well as the results of EPA biological surveys.

The next challenge is to find ways to visualize these disparate types of data and sources—to bridge different types of data and make them accessible as a complete data set. A tool that can do that will be unique. With these visualizations worked out, the growth potential for Great Lakes Monitoring is huge.

GREAT LAKES CLEANUPS

The Great Lakes Legacy Act helps communities reconnect with once thriving waterways that over time have become degraded by toxic chemicals and other pollutants from long-gone industries. Signed into law in 2002, and reauthorized in 2008, the Legacy Act provides opportunities to clean up contaminated sediments in EPA Great Lakes Areas of Concern (AOC). It is helping to revitalize local waterfront economies through strong partnerships with states, municipalities, and businesses. So far, 21 sites have been cleaned up, and 4 million cubic yards of contaminated sediment removed or capped. More remediation is in progress.

Throughout the cleanup process, IISG works closely with residents, school children, and stakeholders to ensure that their questions are answered and concerns are heard or addressed, and to help the community make the most of this chance to turn the waterfront environment and economy around.

In 2006, IISG's Susan Boehme was connecting with residents and stakeholders in communities undergoing remediation to keep them informed about the cleanup projects. Caitie Nigrelli brought her social science expertise to the role in early 2011.

Here are some on-the-ground stories from AOCs around the Great Lakes.

The Milwaukee Estuary Area of Concern

In Milwaukee, Lincoln Park is intersected by Lincoln Creek and the Milwaukee River, which provides opportunities for fishing, kayaking, and other activities. The park also has a golf course, picnic areas, a water park, and trails for walking, biking and cross country skiing. When the Legacy Act project was announced, residents had many questions about what would happen with their park.

The Legacy Act, which provided federal matching funds from EPA, shared the project cost with Wisconsin Department of Natural Resources (DNR) and Milwaukee County Parks. Over a four-year period, 171,000 cubic yards of sediment laced with an alphabet soup of contaminants, including PCBs, PAHs, and NAPLs, were removed from targeted zones in the river and 12.5 acres of shoreline were restored.

Connecting the Community

IISG, working with all the project partners, developed a plan to ensure that the community was part of the process and that residents had ample opportunity to

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learn about what was taking place and why. At town meetings, EPA, Wisconsin DNR, and Milwaukee County Parks representatives explained the project and provided information on specific concerns. Questions were addressed in a follow-up meeting and a publication.

READING THE SIGNS ♦ To ensure that anyone visiting the park would be able to learn about the cleanup, IISG, as part of the project outreach team, developed two kiosks that were placed on highly-traveled trails. These kiosks provided general information about the project and were frequently updated about the cleanup progress.

COMMUNITY INPUT ♦ Large-scale needs assessments are a wise investment for big outreach projects. They provide detailed information about the audience concerning a specific topic—in this case, sediment remediation. Needs assessments help outreach providers understand what stakeholders are actually interested in or concerned about. This helps them design better messaging and better outreach events.

During the ongoing remediation and restoration work in Lincoln Park, the University of Wisconsin Extension and IISG conducted two focus groups to evaluate the efficacy of outreach efforts, to understand stakeholder perceptions of the cleanup project, and to generate ideas for long-term park stewardship. Participants identified lack of community engagement in the Lincoln Park area as potential barriers to mobilizing stewardship efforts. They expressed significant interest in participating in a stewardship group themselves.

The discussions revealed several implications for continuing outreach efforts, including which outreach tools are most effective, which audiences should be targeted, and which messages should be prioritized. These results helped improve future outreach efforts and decision-making processes in Lincoln Park, the Milwaukee River Estuary, and other AOCs in the Great Lakes.

THE FRIENDS OF LINCOLN PARK ♦ With support from focus groups, residents were inspired to create a way to voice their thoughts and concerns on the future of the park. In 2014, Nigrelli facilitated the development of the Friends of Lincoln Park, a neighborhood organization that helps residents play a role in the restoration of this popular Milwaukee park. The Friends, in association with Milwaukee County Parks, the Park People, Wisconsin DNR, and Wisconsin Sea Grant, are now working to revitalize Lincoln Park in a way that brings together the surrounding community.



Since the group's inception, members have organized eight workdays to clean up the park and pull invasive species. Altogether, 104 people participated in six weeding events. And for two annual river cleanup days, 100 people volunteered each year. Along with plans to clear out areas overgrown with invasive plants, members have provided 13 park outings to learn how to fish or canoe and to get to know the park's natural surroundings.

THE RIBBON CUTTING ♦ Milwaukee residents who have spent most of their lives near the sprawling Lincoln Park have stories to tell about how degraded the park had become.

The Milwaukee River was hidden behind buckthorn and other brush and the fish that lived in the tainted water were too contaminated to eat. In the spring of 2016, they shared some of these memories as part of a celebration of the park and river cleanup. State Representative Mandela Barnes described the park now as “good for people’s health.” At this event, which was attended by project partners, stakeholders, and Friends members as well, a ceremonial ribbon was cut and the park was officially reborn.

The Grand Calumet River Area of Concern

The Grand Calumet River in northwest Indiana has long been recognized as one of the most contaminated rivers in the nation. With a history rich in steelmaking, meatpacking, and oil refining, a cocktail of heavy metals, PCBs, PAHs, NAPL, and oil and grease was discharged into the river before modern environmental controls were established. Water quality is still challenged by pollution from combined sewer overflows, non-point sources, and industrial discharges, but the sources responsible for contamination are mostly a thing of the past.

For this project, Legacy Act funding is matched through support from EPA, Indiana Department of Natural Resources (DNR), Indiana Department of Environmental Management (IDEM), NIPSCO, U.S. Fish and Wildlife Service, The Nature Conservancy, Save the Dunes, and Shirley Heinze Land Trust, Gary Sanitary District, and East Chicago Waterway Management District.

Since 2009, more than 2 million cubic yards of contaminated sediment have been dredged or capped in the river. Eighty-four acres of wetland and shoreline have been restored with native trees, grasses, and other plants, providing food and shelter to local fish and wildlife. Three river sections are finished, one is currently in the cleanup stage, and two sections are in the design or feasibility study stage.

Connecting the Community

At various stages of remediation including before and after, Nigrelli has been helping inform residents, as well as local decision makers and stakeholders to help make the process and results better. Nigrelli also took the opportunity to connect local school children to the remediation process.



STUDENT SCIENCE AND STEWARDSHIP ♦ Nigrelli’s involvement with local schools began with visits to Hammond Academy of Science and Technology and the East Chicago Lighthouse Charter School, talking with 120 fourth and eighth grade students. With help from Anne Remek at IDEM, the science students visited the Grand Cal, collecting water samples for study. The results of the students’ analyses were shared with Legacy Act project partners. EPA provided native plants for the fourth graders to grow and ultimately plant at Roxana Marsh, the first section of the Grand Calumet cleanup.

Nigrelli and her partners helped facilitate student stewardship at the East Chicago Lighthouse Charter School for two years. She created a photobook that documents this project, and copies were distributed to key staffers of local U.S. congressmen Joe Donnelly and Pete Visclosky.

HELPING HANDS ♦ Through this work with teachers, students, project partners, and IISG education specialists, Nigrelli developed a curriculum. *Helping Hands: Restoration for Healthy Habitats* offers lessons and hands-on activities to connect students in the Great Lakes with recent or ongoing cleanup and restoration projects happening in their communities.

Thirty-five teachers attended two Helping Hands workshops in the Grand Calumet River. IISG and New York Sea Grant held a workshop for teachers in the Buffalo River area of New York also using Helping Hands. This edition was specific to the Buffalo River AOC, and offered a direct link to environmental projects taking place in the community. Eighteen fourth through eleventh grade teachers attended the workshop to learn more about the restoration project and the curriculum.

ROXANA MARSH EDUCATION DAYS ♦ The idea of Roxana Marsh Education Days was born at a gathering and press event to celebrate the cleanup of Roxana Marsh. The 2012 event brought stakeholders, partners, community activists, and residents to the restored site. Forty local fourth-graders capped off their semester-long learning experience on the restoration project by planting native seedlings along the marsh's shores—these plants are thriving today.



Since then, each spring, Nigrelli has organized three Roxana Marsh Education Days for approximately 150 local middle school children to spend several hours in the field, engaging in learning and stewardship. The first surprise for the students is just how close the natural area is to their school and their world. In addition to planting natives, the students have learned the basics of birding, explored the small community of life in sediment, and manned trash bags. There have been water beetles, egrets, killdeer, toads, dragonfly nymphs, and more.

Throughout these afternoon tours, students have been guided by experts from Audubon Chicago Region, EPA, The Nature Conservancy, Shirley Heinz Land Trust, Indiana DNR, IDEM, Northwest Indiana Regional Planning Commission, Dunes Learning Center, and IISG.

A SENSE OF PLACE ♦ Nigrelli was able to show that the 29 sixth grade students who took part in the 2015 Roxana Marsh Education Day developed a “sense of place” for the natural area. She used an evaluation from the social science literature that measures a sense of place to assess the potential for increased environmental stewardship as a result of the educational program. The day’s activities were effective in changing students’ perceptions from apathetic to feeling a connection with Roxana Marsh. This provides additional assurance that a \$48 million government investment in restoration will be maintained for a generation by new stewards.

Other AOC Outreach Highlights

Through focus groups and interviews, Nigrelli sought to understand what residents and other stakeholders are really concerned about related to their local waterways and the cleanup projects. Knowing this is critical to effective communication efforts. In each of these AOCs, Nigrelli and her interns interviewed local stakeholders—residents, river users, and decision makers.

Sheboygan River

In 2012-2013, almost 300,000 cubic yards of sediment contaminated with PCBs and PAHs were removed from the Sheboygan River in Wisconsin. River-goers now have a deeper river with better navigation and access, and fish and wildlife can thrive in a cleaner habitat.

The Sheboygan River study provided an in-depth picture of how a cleanup was viewed by those most affected by it. The river was viewed as an asset, but still, it had a negative stigma. Also, the river's depth was the primary concern, and the interviewees were mixed in their regard to fish advisories and as to how the remediation will impact fish populations. This study offered insight into how to communicate about the sediment remediation project and provided recommendations for gaining public support for a cleanup.

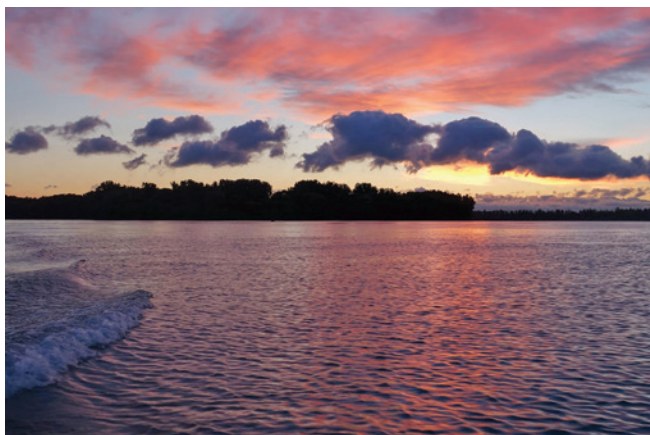
Detroit River

The Detroit River is a 32-mile international channel linking Lake St. Clair and the upper Great Lakes to Lake Erie. The Black Lagoon in the Trenton Channel was the first completed Legacy Act project, finished in 2005. Now it is time for the Upper Trenton Channel to undergo restoration.

Interviews revealed that a majority of the community surrounding the remediation project regard the cleanup efforts with optimism and enthusiasm. Yet these feelings are by no means unanimous. About a third of the stakeholders interviewed said that cleaning up pollution would provide no significant community benefits.

Nigrelli's team also learned that the safety of the channel and river during dredging is of prime importance. This is a fast flowing channel, and outreach efforts need to explain—in terms that everyone can understand—the science and engineering of how stirred-up sediment will not flow downstream.

From competitive rowing to world-class fishing tournaments, the Trenton Channel is a haven for recreation, which was confirmed in the needs assessment. With this in mind, in 2014, the presentation of the draft of a cleanup plan took place at the Wyandotte Boat Club. The meeting offered the 100 people in attendance a chance to provide input on improvements and voice their concerns.



Muskegon Lake

This property is contaminated from decades of oil spills that began at the turn of the 20th century

The Muskegon Lake AOC is situated along Lake Michigan's eastern shoreline. EPA has completed two Legacy Act sediment cleanups there—Ruddiman Creek and Division Street Outfall. The next site slated for cleanup is the former Zephyr Oil Refinery—this property on the Muskegon River is contaminated from decades of oil spills that began at the turn of the 20th century.

Nigrelli's team found that regardless of its dirty and neglected past, many in the community are interested in seeing its remediation and recovery. The participants also spoke of the importance of clear, consistent communication with property owners adjacent to the site.

The needs assessment also revealed a concern about odor and air quality impacts from dredged and stockpiled sediment. As a result, the plan has been updated to require the contractor to perform air monitoring and odor control. The study also led the project team to schedule remediation for the fall and winter to lessen neighborhood impacts.

St. Louis River

The St. Louis River AOC is located at the northern Minnesota-Wisconsin border and encompasses many contaminated areas along 39 miles of the river. Spirit Lake is a large open area in the St. Louis River estuary near the former U.S. Steel Duluth Works site. In the lake is Spirit Island, a sacred place for the Fond du Lac Band. Spirit Lake is also important to the Morgan Park neighborhood, which began as a town for U.S. Steel plant workers.

Nigrelli's study is helping tailor efforts of the Spirit Lake Outreach Team toward local stakeholder needs and interests. Her team stress the importance of collaboration with local organizations and the recognition of Spirit Lake as part of the identity and culture of the Fond du Lac Band and other local people.



GREAT LAKES LEARNING

The Great Lakes face many threats—invasive species, pollutants, and climate change, among others. However, decision makers, managing a large ecosystem, may come to the task unprepared. They, along with the general public, may not have a good grasp of the characteristics, functions, and value of these waterbodies.

These lakes are also woefully underrepresented in school textbooks and other educational resources. A more Great Lakes-literate public could better contribute to the environmental, economic, and social sustainability of the Great Lakes.

Sea Grant Takes the Lead

Sea Grant's strength is in translating and delivering cutting-edge, science-based information to address complex issues so it is well suited for filling this literacy gap. The Great Lakes Sea Grant Network education specialists collectively bring over 120 years of experience to the table. Increasing literacy across the basin can be accomplished in many ways, though one of the most effective and efficient ways is through working with educators. These efforts could also help grow future scientists that conduct aquatic research, and resource managers that guide the responsible use and conservation of the Great Lakes ecosystem.

In 2005-2010, through funding from the National Science Foundation, the Center for Ocean Sciences Education Excellence (COSEE) Great Lakes brought aquatic science to the classroom and beyond under the leadership of Sea Grant education specialists. Over its five-year run, COSEE Great Lakes connected 2,000 educators in the region

AN ILLINOIS-INDIANA SEA GRANT STORY

When people no longer need their medicine, they often flush or throw them away. But doing so can contaminate waterways, harming fish and other aquatic wildlife. In response to growing concerns about this and prescription drug abuse, CGLL offers curricula and service-learning projects that teach youth how they can be part of the solution.

The Medicine Chest, originally developed by Robin Goettel and Terri Hallesy, IISG's education team, is a stewardship-based middle and high school curriculum. It includes multidisciplinary, standards-based classroom lessons, sample activities, and background information describing how the improper disposal of unwanted medicines can be harmful to people, pets, and the environment. This service-learning collection features samples of student projects, including billboards, eco-poems, songs, artwork, and student presentations—all meant to inspire action.

The Medicine Chest was updated with new lessons by IISG's Kirsten Hope Walker. The new version is getting positive reviews. From an Ohio high school teacher, "I just completed the medicine chest curriculum and it is fabulous! The kids loved doing the serial dilutions in Lesson 3 or 4 with the lettuce seeds. We had some fun with that."

A MINNESOTA SEA GRANT STORY

Over the 2014-2015 academic year, Minnesota Sea Grant's Cynthia Hagley led a program called *Seeing below the Surface: Lake Superior Shipboard Science* for 20 educators. For starters, Minnesota and Wisconsin educators spent a day helping Michelle Gutsch, a University of Minnesota Ph.D. student, trawl for data aboard the Large Lakes Observatory's *R/V Blue Heron*. Gutsch and Joel Hoffman, an EPA and University of Minnesota Duluth biologist, are studying how invasive ruffe might be affecting Lake Superior native fish. A follow-up *Dig in Day* brought the educators together with Great Lakes Aquarium educators and Hoffman and Gutsch to process and analyze their samples. The teachers were also introduced to Great Lakes Literacy Principles and student lessons and activities.

During the school year, many scientist-educator interactions were taking place. Gutsch worked closely with nearly half of the teachers, visiting classrooms and joining in field trips. Other scientists and education specialists interacted with the teachers as well. The personal connections between educators and scientists were invaluable.

A year of learning, synthesis, scientist mentoring, and classroom implementation culminated in a Great Lakes Awareness Day. Everyone gathered together for a show and tell. Many teachers brought students to present their work, examples of what they had created, or stories of how they implemented Great Lakes literacy in their classrooms.

with 400 scientists. With so much groundwork laid, and productive relationships developed and enhanced, the work needed to continue.

GLNPO stepped in to collaborate, and with funding from GLRI, education specialists in the Great Lakes Sea Grant Network created the Center for Great Lakes Literacy (CGLL—pronounced sea gull).

The CGLL team started with successful established education programs and through promoting more hands-on experiences, educational resources, and networking opportunities CGLL has grown throughout the region. Educators, scientists, citizen scientists, and environmental organization professionals comprise a community of practice, where together they have an effect beyond their individual reach.

IISG has provided leadership for CGLL since its inception. IISG's Kristin TePas, located in GLNPO, helped ensure that CGLL got off the ground—she brought together Sea Grant education specialists to create and give flight to the program's vision and mission. She continued to keep the network on course as a unified center by moving the group's ideas and plans forward.

In all the Great Lakes states, Sea Grant specialists created and ran educational programs, providing hands-on experiences, educational resources, and networking opportunities that promote Great Lakes literacy among an engaged community of educators, scientists, and citizens.

At the heart of CGLL educator resources is a rich supply of curricula on the Great Lakes, as well as hot topics in the region, such as aquatic invasive species and medicine disposal.

Workshops, Resources, and More

CGLL connects educators with scientists, both onboard research vessels, and in their local watersheds. Also, at the heart of CGLL educator resources is a rich supply of curricula on the Great Lakes, as well as hot topics in the region, such as aquatic invasive species and medicine disposal. These resources are showcased in workshops and are available online. And what can't be downloaded, can be borrowed. For example, educators can borrow the Aquatic Invader

Attack Pack, filled with materials about aquatic invasive species, the problems they cause, and what can be done about them. Educators who are introduced to CGLL workshops and curricula have opened a door to many more resources, ideas, and support.

All Aboard Science Workshops

Each summer, on one of the Great Lakes, Sea Grant and GLNPO facilitate a week-long workshop aboard the *R/V Lake Guardian*, providing educators in the region the opportunity to actually “do” science alongside aquatic researchers, and learn strategies to successfully integrate Great Lakes science into their curriculum.

As the Shipboard Science Workshop rotates around the lakes, the relevant Sea Grant state program education specialists step up to plan the cruise with support from TePas. From 2011–2015, 75 educators participated in these Great Lakes science immersions (with the ability to reach nearly 12,000 students annually), and cruises set sail on all five lakes.

The hands-on, immersive nature of the experience fosters a broader and deeper understanding of science by integrating knowledge and research skills to enhance scientific investigation. Educators expand their “treasure box” of lessons, teaching strategies, and network of like-minded colleagues. Participants of the workshops described them as once-in-a-lifetime professional development opportunities.

Cooperating scientists were equally impressed with the experience. One noted that “more importantly than collecting data for my research, the goal of the cruise was to bridge the gap between scientists and educators so scientific research can be conveyed to the youth in our community. We have started to achieve this goal.”

The most notable outcomes reported by the teachers from all five workshops were invigorating their passions for science, providing confidence to comfortably teach science, and arming them with tools, skills, knowledge, and resources to equip students to be better environmental stewards. Almost every participant affirmed: an increase in knowledge of Great Lakes ecosystems, threats, and protection efforts; more confidence to teach about the Great Lakes; and, consequently, an increase in Great Lakes content incorporated into their instructional units.

The teachers implemented more than 35 school initiatives following their time aboard the *R/V Lake Guardian*. Ohio teacher David Murduck engaged in many of these activities in his fifth grade science classroom—collecting real world data, connecting with scientists, and engaging in stewardship, in this case, removing invasive plants in a national park. Ohio Sea Grant helped lead the 2014 workshop on Lake Erie.

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A MICHIGAN SEA GRANT STORY

Alongside Great Lakes scientists, 20 teachers hiked schoolyard wetland habitats in the rain, investigated invasive species, explored water quality in the Thunder Bay River Watershed, sampled aquatic food webs, and explored marine archaeology and maritime history. These teachers participated in the Lake Huron Place-Based Education Summer Teacher Institute at the NOAA Great Lakes Maritime Heritage Center in northeast Michigan.

The four-day annual summer workshop offers educators a chance to get their feet wet with Great Lakes science while learning about place-based education strategies. In addition to advancing Great Lakes literacy, the goal is to help foster student involvement in stewardship. Michigan Sea Grant's Brandon Schroeder and other specialists and Extension educators team up with scientists and youth education partners in offering this teacher workshop.

In past workshops, educators joined NOAA marine debris scientists and the Alliance for the Great Lakes Adopt-a-Beach™ program. Every year they take students to the Lake Huron shores, adopting and cleaning up local beaches. In the 2014 workshop, educator John Caplis connected with Lake Huron fisheries scientists and NOAA Thunder Bay National Marine Sanctuary historians. He brought these new relationships to his Alpena High School "Shipwreck Alley" class. His students gathered stories from the community to help interpret the history of local Lake Huron fisheries, which helped inform a Great Lakes Fisheries Heritage exhibit at the Besser Museum for Northeast Michigan.



Local Watershed Workshops

Over the past three years, Sea Grant education specialists organized 15 land-based workshops for 280 educators. Altogether, these teachers bring new knowledge, skills, and resources to more than 27,000 learners.

Shoreline workshops, which range from one day to a week, employ the same best professional development practices as the shipboard workshops, including experiential education and opportunities to interact with scientists. What makes the shoreline workshops distinctive is that they are typically place-based—classroom and stewardship activities are brought home as local educators learn about issues in their watershed. Curriculum is often the focus as it relates to hot topics in the region.

Teachable Moments are short workshops that focus on a specific Great Lakes emerging issue (e.g., microplastics, invasive species, medicine disposal, ecosystem dynamics). They may include talks by scientists, related curricula, or participation in a local stewardship project. These events also help cultivate rich partnerships between Great Lakes Sea Grant programs and informal education centers, university research faculty, and local or federal state agencies. There were 42 Teachable Moment workshops over three years, with 277 teachers participating.

Students Doing Real Science

The Limno Loan program, which is coordinated by IISG in partnership with GLNPO, is an opportunity for educators to borrow actual monitoring equipment used by scientists in the field.

With the Hydrolab data sonde, students can collect water quality data from their local waterways and analyze characteristics such as pH, conductivity, and



dissolved oxygen. Teachers have found that bringing the Hydrolab into the mix engages students to investigate real-world problems and provides an opportunity to discover answers.

It also draws students into the experience, both because they can operate high tech equipment, and they can read the data immediately. Educators have commented that their students say using the Hydrolab makes them feel like “real scientists.”

Over the course of the grant, eight workshops were conducted to introduce educators to the Limno Loan program. Of those trained (some shipboard, some shoreline), 42 educators have borrowed the Hydrolab (with many now borrowing it annually)—reaching over 4,400 students.

Two central Wisconsin teachers, Lynn Kurth and Cindy Byers, became more than fans of the equipment. They collaborated with TePas to develop a teacher manual for the Hydrolab with step-by-step instructions and lesson plans. They also volunteered to help train educators to use the Hydrolab at a CGLL water quality workshop in Milwaukee. Kurth helped secure a grant to buy her own Hydrolab and to fund ship time for another Great Lakes water quality workshop together with Byers, Wisconsin Sea Grant’s Kathy Kline, and TePas.

Scientists Visit Virtually

Some middle and high school classes in the Great Lakes region have taken a break from their regular activities to talk directly with scientists that take part in monitoring cruises. TePas connects EPA *R/V Lake Guardian* researchers with students through long-distance videocasting.

In some cases, students caught the crew while they were onboard collecting and analyzing samples. Others talked with GLNPO scientists from their offices. But for many students, it was a once-in-a-lifetime chance to discuss everything from water quality to food webs to what it’s like to live and work on a ship. Many of



these students have experience with the Hydrolab and can therefore discuss water quality issues with the scientists. They asked scientists about the health of the Great Lakes, how research is conducted offshore, and careers in the environmental field, and got a tour of the ship.

Since 2013 when this project began, 14 scientists have engaged in 44 videocasts with 15 educators throughout the Great Lakes basin, reaching around 1,400 students. Typically, teachers have their introduction to videocasting through

this project. As a result, many have incorporated videocasting with other organizations and speakers as part of their activities.

Here are some comments from students that have taken part in these virtual classroom visits:

“Personally I would like to get into a career like this myself!”

“I am curious as to if the invasive species will ever be completely removed from the Great Lakes.”

“I used to think that the Great Lakes couldn’t greatly have an effect on people, but now I know that we need to take as much care of them as we can because it will only help us in the long run.”

“I used to think science sucks but now I know it doesn’t.”

“I used to think that scientist didn’t have any jobs dealing with the Great Lakes but now I know there are tons of jobs out there dealing with water and the health of the water.”

“It was cool that we actually got to talk to real scientists face to face.”

Community of Practice

Curricula and workshops get the ball rolling, but CGLL is also there for teachers to take their involvement in Great Lakes literacy efforts further. From 2011–2015, CGLL supported more than 50 educators to attend and present at 32 state, regional or national professional education conferences. And, the CGLL team facilitated more than 120 place-based stewardship events involving over 15,300 students and adults throughout the watershed; many experiences were related to coastal, stream or watershed clean ups, but also storm drain stenciling and removing invasive species.

Paying it Forward

CGLL envisions a community of Great Lakes literate educators, students, scientists, environmental professionals, and citizen volunteers dedicated to improved Great Lakes stewardship. This requires a strong, vibrant, and self-sustaining community of practice to reduce the barriers that make it difficult to integrate Great Lakes literacy into classrooms. The CGLL team has demonstrated over a decade of impact on professional development throughout the Great Lakes.

CGLL's workshop participants represent some of the most enthusiastic, creative, and motivated educators from across the basin. These teachers often crave and actively seek out ways to share their new knowledge and cultivate a stewardship ethic with both their students and colleagues.

The CGLL team hopes to expand and strengthen the core network of experienced educators and scientists by offering more training on local Great Lakes issues to highly motivated and engaged educators interested in serving as mentors. The team will use a train-the-trainer approach to prepare these master teachers to assist CGLL education specialists with planning workshops or stewardship opportunities, and to serve as mentors for the cadre of new educators participating in these events.

A PENNSYLVANIA SEA GRANT STORY

Pennsylvania Sea Grant's yearlong support of teacher-student collaborations allows educators to build capacity in their districts and students to become Great Lakes literate stewards. Marti Martz, senior coastal outreach specialist, provides intensive support for ten educators and their students.

The relationship starts with a teacher workshop that includes the latest science, curricula, and other classroom resources on emerging Great Lakes issues. Going forward, Marti's team has monthly calls with the educators to ensure they have access to experts and materials to develop and implement a high-quality stewardship project. CGLL supports field trips and classroom speakers to build students' understanding of emerging Great Lakes issues. With teacher help, students develop a stewardship project that allows them to share what they've learned with their peers, families, and communities. Students then share their project with CGLL educators, students, and the public at a Great Lakes Awareness Day.

Though labor intensive, this approach provides the support teachers need to incorporate Great Lakes material into their lessons, and opportunities for students to fully engage with their community on Great Lakes issues. This builds confidence that they can make a difference. In the 2014-15 school year, this project led to a national teacher award, a Great Lakes Sea Grant Network Award, and the Pennsylvania Governor's Award for Environmental Excellence.

A NEW YORK SEA GRANT STORY

One of the most valuable aspects of CGLL workshops is building a network of educators who can share their new-found knowledge and enthusiasm with students and teachers. Although participants enjoy learning from scientists and Sea Grant educators during workshops, learning and sharing with colleagues is especially rewarding. CGLL mentor teachers can share valuable teaching tools and classroom tips and encourage others to use Great Lakes lessons and activities with their students.

Sandy Smith, from the Nichols School in Buffalo has proven to be one of New York Sea Grant's valuable mentors, regularly using what she learned on shipboard and at shoreline workshops with her students and other teachers. Smith's students have raised trout in her classroom and she has Skyped with *Lake Guardian* scientists so students can learn about the Great Lakes firsthand. She uses the EPA Hydrolab with her middle school students in local waterways. She also taught other teachers how to use this water quality testing equipment during a Lake Erie workshop. These teachers got to try out the equipment and help monitor the lake waters. They reported that they would be sharing this new knowledge with their students and many stated they plan to use the Limno Loan program during the school year. Sandy Smith certainly succeeded in "paying it forward" for New York teachers!





